GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
DIRECTORATE GENERAL OF TRAINING

COMPETENCY BASED CURRICULUM

INSTRUMENT MECHANIC

(Duration: Two Years)

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL- 5

SECTOR –ELECTRONICS AND HARDWARE

Directorate General of Training

INSTRUMENT MECHANIC

(Engineering Trade)

(Revised in 2019)

Version: 1.2

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL- 5

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

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1. COURSE INFORMATION

During the two-year duration of Instrument Mechanic trade, a candidate is trained on professional skill, professional knowledge, Engineering Drawing, Workshop Calculation & Science and Employability skill related to job role. In addition to this a candidate is entrusted to undertake project work and extracurricular activities to build up confidence.The broad components covered during the course are as below: -

FIRST YEAR: In this year the trainee learns about safety and environment, use of fire extinguishers, artificial respiratory resuscitation to begin with. He gets the idea of trade tools & its standardization, Familiarize with basics of electricity, construction of PMMC & MI instruments. Overhauling and testing & calibration of ammeters, voltmeters, wattmeter and ampere-hour meter of various types, meter sensitivity, accuracy, maximum power, capability etc. Test the cable and measure the electrical parameter, experiments on transformer, measuring current and voltage in primary and secondary windings filing practice, marking & measuring with the help of Vernier Caliper, Vernier Height Gauge. Skilling practice on different types & combination of cells for operation and maintenance of batteries being done. Identify and test passive and active electronic components. Construct and test unregulated and regulated power supplies. Practice soldering and de-soldering of various types of electrical and electronic components on through hole PCBs and different type of switches, application like buzzers, solenoid valves. The candidate will be able to construct and test different types of diode, V-I characteristics, rectifiers, amplifier, op-amps, oscillator and wave shaping circuits. Testing of power electronic components. Construct and test power control circuits. Identify and test opto electronic devices. Able to achieve the skill on SMD Soldering and De-soldering of discrete SMD components. Verifying the truth tables of various digital ICs by referring Data book. Verification of truth tables of various logic gates, RS and JK flip flops, Counters, BCD to decimal decoder, 7 segment display circuits, D/A and A/D circuit, RS485 to RS232 converter. Practice circuit simulation software to simulate and test various circuits. Assemble a computer system, install OS, Practice with MS office. Use the internet, browse, create mail IDs, download desired data from internet using search engines. Familiarization with microprocessor trainer kit, basic program on microprocessor. Measurement voltage, frequency using CRO, operating storage oscilloscope.

SECOND YEAR: In this year the trainee will be able to study various types of instruments constructions and identify various parts and section. Measuring speed and velocity using various tachometers. Operating stroboscope. Practice on various pressure sensors and pressure gauge. Testing and calibration of various type of pressure measuring instruments, dead weight tester and comparator. Testing and installation of pressure switches. Perform practical on pressure simulator or experimental setup. Operating and calibrating pressure transmitters. Checking various types of flow restrictors and use, D.P. cell/transmitter. Fitting of tapered glass tube checking and testing V- notches fitting, repairing various types of positive displacement flow meters, installation maintenance of flow instruments. Calibrating and installing turbine flow meter, vertex flow meter. Measurement of level performing on level measurement i.e. experimental setup for level measurement process simulator, calibration of level transmitters, level instrument maintenance, repairing and control. Temperature measurement with different sensors and temperature-controlled oil bath/furnace for low and high temperature, temperature instrument maintenance and calibration. Primary calibration standards, primary standard instruments, secondary standard instruments, instrument inspection, calibration and test method. The trainee will work with experimental setup/temperature simulator for temperature measurement controls. Thermocouple and RTD experiment on optical pyrometer and radiation pyrometer. Measurement of humidity. Recorders and servicing of pneumatic, electrical/ electronic recorders, study of paperless LCD/LED recorder. Study of control valves/final control elements and its various components. Piping tubing and fitting. Study the cut section of various type of control valves, operation on cascade, ratio, feed forward control trainer. Experiment on PID controller trainer on various process parameters, programmable logic controller trainer, programmes on timers and counters. Installing & operating HART transmitters/devises (I/O). Calibration of HART devices. Work on various network lines, uses of DCS & SCADA complete with communication system on process trainer. Working on Hydraulics and Pneumatics trainer, air filter regulator. Practice on PH meter, conductivity meter, online measurement of PH, conductivity and dissolved Oxygen.

2. TRAINING SYSTEM

2.1 GENERAL

The Directorate General of Training (DGT) under Ministry of Skill Development & Entrepreneurship offers a range of vocational training courses catering to the need of different sectors of Labour market. The vocational training programmes are running under aegis of Directorate General of Training (DGT). Craftsman Training Scheme (CTS) with variants and Apprenticeship Training Scheme (ATS) are two pioneer programmes under DGT for strengthening vocational training.

The Instrument Mechanic trade under CTS is one of the popular coursesdelivered nationwide through a network of ITIs. The course is of two years duration. It mainly consists of Domain area and Core area. The Domain area (Trade Theory & Practical) imparts professional skills and knowledge, while Core area (Workshop Calculation science, Engineering Drawing and Employability Skills) imparts requisite core skill & knowledge and life skills. After passing out of the training programme, the trainee is awarded National Trade Certificate (NTC) by DGT which is recognized worldwide.

Traineebroadly needs to demonstratethat they are able to:

- Read & interpret technical parameters/documentation, plan and organize work processes, identify necessary materials and tools;
- Perform tasks with due consideration to safety rules, accident prevention regulations and environmental protection stipulations;
- Apply professional knowledge, core skills & employability skills while performing the job, and repair & maintenance work.
- Check the job with circuit diagrams/components as per drawing for functioning, diagnose and rectify faults in the electronic components/module.
- Document the technical parameters in tabulation sheet related to the task undertaken.

2.2 PROGRESSION PATHWAYS:

- Can join industry as Technician and will progress further as Senior Technician, Supervisor and can rise to the level of Manager.
- Can become Entrepreneur in the related field.
- Can appear in 10+2 examination through National Institute of Open Schooling (NIOS) for acquiring higher secondary certificate and can go further for General/ Technical education.

- Can take admission in the diploma course in notified branches of Engineering by lateral entry.
- Can join Apprenticeship programs in different types of industries leading to a National Apprenticeship certificate (NAC).
- Can join Crafts Instructor Training Scheme (CITS) in the trade for becoming an instructor in ITIs.
- Can join Advanced Diploma (Vocational) courses under DGT as applicable.

2.3 COURSE STRUCTURE:

Table below depicts the distribution of training hours across various course elements during a period of two years: -

S No.	Course Element	Notional Training Hours	
		1st Year	2nd Year
1	Professional Skill (Trade Practical)	1000	1000
2	Professional Knowledge (Trade Theory)	280	360
3	Workshop Calculation & Science	80	80
4	Engineering Drawing	80	80
5	Employability Skills	160	80
	Total	**1600**	**1600**

2.4 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of course through formative assessment and at the end of the training programme through summative assessment as notified by the DGTfrom time to time.

a) The **Continuous Assessment** (Internal)during the period of training will be done by **Formative Assessment Method** by testing for assessment criteria listed against learning outcomes. The training institute has to maintain individual *trainee portfolio* as detailed in assessment guideline. The marks of internal assessment will be as per the formative assessment template provided on www.bharatskills.gov.in

b) The final assessment will be in the form of summative assessment. The All India Trade Test for awarding NTC will be conducted by Controller of examinations, DGT as per the guidelines.

The pattern and marking structure are being notified by DGTfrom time to time. **The learning outcome and assessment criteria will be basis for setting question papers for final assessment. The examiner during final examination will also check** individual trainee's profile as detailed in assessment guideline before giving marks for practical examination.

2.4.1 PASS REGULATION

For the purposes of determining the overall result, weightage of 100% is applied for six months and one-year duration courses and 50% weightage is applied to each examination for two years courses. The minimum pass percent for Trade Practical and Formative assessment is 60% & for all other subjects is 33%. There will be no Grace marks.

2.4.2 ASSESSMENT GUIDELINE

Appropriate arrangements should be made to ensure that there will be no artificial barriers to assessment. The nature of special needs should be taken into account while undertaking assessment. Due consideration should be given while assessing for teamwork, avoidance/reduction of scrap/wastage and disposal of scrap/wastage as per procedure, behavioral attitude, sensitivity to environment and regularity in training. The sensitivity towards OSHE (Occupational Safety & Health Environment) and self-learning attitude are to be considered while assessing competencies.
Assessment will be evidence based, comprising the following:

- Job carried out in labs/workshop
- Record book/ daily diary
- Answer sheet of assessment
- Viva-voce
- Progress chart
- Attendance and punctuality
- Assignment
- Project work

Evidences and records of internal (Formative) assessments are to be preserved until forthcoming examination for audit and verification by examination body. The following marking pattern to be adopted while assessing:

Performance Level	Evidence
(a) Weightage in the range of 60%-75% to be allotted during assessment	
For performance in this grade, the candidate	• Demonstration of good skill in the use of

should produce work which demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and practices	hand tools, machine tools and workshop equipment. • 60-70% accuracy achieved while undertaking different work with those demanded by the component/job. • A fairly good level of neatness and consistency in the finish. • Occasional support in completing the project/job.
(b) Weightage in the range of 75%-90% to be allotted during assessment	
For this grade, a candidate should produce work which demonstrates attainment of a reasonable standard of craftsmanship, with little guidance, and regard for safety procedures and practices	• Good skill levels in the use of hand tools, machine tools and workshop equipment. • 70-80% accuracy achieved while undertaking different work with those demanded by the component/job. • A good level of neatness and consistency in the finish. • Little support in completing the project/job.
(c) Weightage in the range of more than 90% to be allotted during assessment	
For performance in this grade, the candidate, with minimal or no support in organization and execution and with due regard for safety procedures and practices, has produced work which demonstrates attainment of a high standard of craftsmanship.	• High skill levels in the use of hand tools, machine tools and workshop equipment. • Above 80% accuracyachieved while undertaking different work with those demanded by the component/job. • A high level of neatness and consistency in the finish. • Minimal or no support in completing the project.

3. JOB ROLE

Mechanic Precision Instrument,General; tests, repairs, overhauls and assembles various precision instruments and their parts for efficient performance. Examinesinstrument fordefects. Dismantles components and cleans them in appropriate fluid such as petrol, kerosene etc. to find out extent of damage or wear and tear to parts. Removes minor defects of parts by grinding, filing, drilling, etc. and replaces worn out and damaged parts. Adjusts position of various parts using screwdriver, spanner etc. and assembles instrument to form complete unit. Makes simple electrical connections, solders contact points and performs other tasks as necessary. Tests performance either by visual observation or by conducting simple electrical and mechanical tests and ensures that repaired or assembled instrument conforms to prescribed efficiency. May make new components and assemble new instruments. May specialize in any particular type of instrument like mechanical, hydraulic, pneumatic, electrical, optical, orthopedic etc.

Technician Instrumentation; dismantles removes and replaces a range of instruments and faulty peripheral components down to unit and component level, setting up test equipment, troubleshooting components of instruments, calibrating them and also preparing service reports and accurately documenting parts replacement and repair.

Mechanic Precision Instrument, Mechanical; makes, alters and adjusts mechanical instruments or mechanical parts of electrical and optical instruments by accurate milling, filing, grinding, lapping and other processes. Studies drawings or samples and examines precision instrument like balance, meters, pressure gauges etc. for defects. Dismantles instrument, cleans metal components in petrol, kerosene oil or otherwise and checks them to find out extent of damage and further serviceability. Makes new parts on lathe milling or other machines, if necessary.Sizes and fits metal parts by filing, scraping, grinding lapping etc. as necessary and ensures their desired accuracy by checking with precision measuring instruments shadow graph and other highly perfect devices. Assembles parts to form complete unit. Gets electrical components repaired by Electrician. Fits electrical and optical parts to instrument and adjusts them as required. Texts repaired or assembled instrument for clarity or vision sensitivity, correct meter and scale readings etc. as required and ensures stipulated performance within prescribed limits. Makes necessary adjustments and seals meters to avoid manipulations. May specialize in particular type of instruments like balance, pressure gauges, meters, theodolites etc. May make new instruments from blueprints.

Functional Tester; is responsible forchecking functions of manufacturedindustrial equipment such as UPS,inverter, energy meter, PLC, oscilloscope,control panel. The individual at work testsspecified functions of every product being assembled on the production line.

Reference NCO-2015:

a) 7311.0100 – Mechanic Precision Instrument,General
b) 7311.0101 – Technician Instrumentation;
c) 7311.0400 – Mechanic Precision Instrument, Mechanical
d) 7543.0801 – Functional Tester

4. GENERAL INFORMATION

Name of the Trade	**INSTRUMENT MECHANIC**
Trade Code	DGT/1024
NCO - 2015	7311.0100, 7311.0101, 7311.0400, 7543.0801
NSQF Level	Level-5
Duration of Craftsmen Training	Two Years (3200 Hours)
Entry Qualification	Passed 10th class examination with Science and Mathematics or its equivalent.
Minimum Age	14 years as on first day of academic session.
Eligibility for PwD	LD, LC, DW, AA, LV, DEAF, AUTISM
Unit Strength (No. Of Students)	24 (There is no separate provision of supernumerary seats)
Space Norms	80 Sq. mtrs.
Power Norms	8.07 KW
Instructors Qualification for:	
(i) Instrument Mechanic Trade	B.Voc/Degree in Instrumentation/ Instrumentation and Control Engineering from AICTE/UGC recognized Engg. College/ university with one-year experience in the relevant field. **OR** 03 years Diploma in Instrumentation/Instrumentation and Control Engineering from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field **OR** NTC/NAC passed in the Trade of "Instrument Mechanic" With 3 years' experience in the relevant field. **Essential Qualification:** Relevant National Craft Instructor Certificate (NCIC) in any of the variants under DGT. ***Note: - Out of two Instructors required for the unit of 2(1+1),***

	one must have Degree/Diploma and other must have NTC/NAC qualifications. However, both of them must possess NCIC in any of its variants
(ii) Workshop Calculation & Science	B.Voc/Degree in Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. **OR** 03 years Diploma in Engineering from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. **OR** NTC/ NAC in any one of the engineering trades with three years' experience. **Essential Qualification:** National Craft Instructor Certificate (NCIC) in relevant trade **OR** NCIC in RoDA or any of its variants under DGT
(iii) Engineering Drawing	B.Voc/Degree in Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. **OR** 03 years Diploma in Engineering from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. **OR** NTC/ NAC in any one of the Electrical groups (Gr-II) trades categorized under Engg. Drawing'/ D'man Mechanical / D'man Civil' with three years' experience. **Essential Qualification:** National Craft Instructor Certificate (NCIC) in relevant trade OR NCIC in RoDA / D'man (Mech /civil) or any of its variants under DGT.

(iv) Employability Skill	MBA/ BBA / Any Graduate/ Diploma in any discipline with Two years' experience with short term ToT Course in Employability Skills from DGT institutes. (Must have studied English/ Communication Skills and Basic Computer at 12th / Diploma level and above) **OR** Existing Social Studies Instructors in ITIs with short term ToT Course in Employability Skills from DGT institutes.
(v) Minimum Age for Instructor	21 Years
List of Tools and Equipment	As per Annexure – I

Distribution of training on hourly basis: (Indicative only)

Year	Total Hrs. /week	Trade Practical	Trade Theory	Workshop Cal. & Sc.	Engg. Drawing	Employability Skills
1st	40 Hours	25 Hours	7 Hours	2 Hours	2 Hours	4 Hours
2nd	40 Hours	25 Hours	9 Hours	2 Hours	2 Hours	2 Hours

5. LEARNING OUTCOME

Learning outcomes are a reflection of total competencies of a trainee and assessment will be carried out as per the assessment criteria.

5.1 LEARNING OUTCOMES (TRADE SPECIFIC)

FIRST YEAR:

1. Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check dimensional accuracy using precision instruments following safety precaution. *[Basic fitting operation – marking, Hacksawing, Chiselling, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.5mm]*
2. Apply a range of skills to execute tube joints, dismantle and assembles tubes and fittings of PI arc & ferrule and test for leakage. [range of skills- cutting, threading, flaring, bending and joining]
3. Identify, test the cable and measure the electrical parameters.
4. Test various electrical passive and active components using proper measuring instruments and compare the data using standard parameter.
5. Identify, test and use of various types of switches, E.M. relays, Circuit breaker and construct electrical circuits.
6. Estimate, Assemble, install and test wiring system.
7. Verify characteristics of resonance circuits.
8. Plan, execute commissioning, testing and evaluate performance of AC & DC motors and generators.
9. Execute testing, evaluate performance and maintenance of transformer.
10. Plan, select, and carry out measurement, extension of range,overhauling, testing and calibration of D'Arsonval meter, PMMC meter.
11. Select, perform electrical/electronic measurement, earthing installation service and calibrate MI instruments, electro dynamometer instruments, Induction type and Special instruments- voltage tester, continuity tester, rotation tester, phase sequence indicator, synchronising, synchroscope, frequency meter, thermocouple type ammeter.
12. Identify, Test various analog and power electronics components, Construct, test and analyze the circuit functioning.
13. Detect the faults and troubleshoot SMPS, UPS, inverter, converter and Thyristor family.
14. Identify, place, solder and de-solder and test different SMD, discrete components with due care and following safety norms using proper tools/setup.

15. Construct and test different circuits using operational amplifiers circuits and execute the result.
16. Identify, test and verify all digital ICs. Assemble, test and troubleshoot various digital circuits and digital instruments.
17. Measure the various parameters by CRO and execute the result with standard one.
18. Install and setup operating system and related software in a computer & Practice with MS office and application software related to instruments.
19. Identify various functional blocks of a microprocessor system, identify various I/O Ports, write and executive simple program and Interface a model application with the microprocessor kit and run the application.

SECOND YEAR:

20. Identify the parameters of measurement systems. Identify, select, test, wire & execute the operation of different process sensors by selecting appropriate signal conditioning for stress, strain, load displacement and Thickness.
21. Select, Installs, services, and calibrate instruments for motion, speed, acceleration and vibration.
22. Identify different unit of pressure, terms and operation of basic instruments. Perform maintenance, Servicing calibration and installation of field pressure gauges, switches, electronic pressure indicators and transmitters for absolute, atmospheric, gauge, vacuum and differential pressure measurement.
23. Recognise the fundamental of fluid flow, terms, different unit of flow, read specification of flow meters. And fluid pump. Perform the maintenance, Servicing and calibration and installation of variable DP flow meters / head flow meters, variable area flow meters, positive displacement meters, Electronic type flow meters and mass flow meters for fluids flow measurement.
24. Identify, operate, maintain, troubleshoot and calibrate the devices for solid flow measuring system & verify the result within standard.
25. Identify, select, wire & execute the operation of different types of level instruments use for liquid level and solid level. Carry out maintenance, Servicing, calibration and Installation.
26. List out different unit of temperature, terms and read specification of temperature instruments. Perform measurement, maintenance, Servicing and calibration of Bimetallic and filled system thermometers & thermo switches.
27. Identify,select, Evaluateperformance, install, service and calibrate temperatureIndicators, Transmitters(RTD'S, Thermistors and Thermocouples types); various type of pyrometers.
28. Identify, select, Operate, maintain, Service and calibrate different types of recorders.

29. Identify different types of Final control elements and role. Identify different valve body, constructional feature, Dismantle, inspect parts, replace parts,recondition, check, and resetting of control valves with actuators, convertors & positioners. Install and test the performance.
30. Identify fundamental of automatic control system and various functional elements in control loop. Identify, select, Install, wire, configure, test the performance, maintain, and service various types of ON-OFF and PID controllers (electronic and pneumatic).
31. Tune controller mode and evaluate performance of control loops as per specification and system application.
32. Identify modules of PLC, its function, Wire and connect the digital I/OS field devices to the I/O Module of PLC, install Software, Hardware and configure plc for operation. Write and execute simple logic and real application programs.
33. Operate, maintain, service, configure, install, wire and test HART transmitters / devices (I/O). And Net-working system for instrumentation.
34. Identify the different modules of DCS, function, Wire and connect I/OS field devices to the I/O Modules, install Software, Hardware and configure DCS for operation with HMI. Write and execute DCS AND SCADA programs FOR real application.
35. Identify, check constructional Feature and function of hydraulic pump and hydraulic power system, accumulator,hydraulic hoses and fitting, Hydraulic components. Build and test hydraulic control circuit.
36. Lay out construction feature, operate, maintain of air compressor, air Distribution system, pneumatic associate components, piping, tubing and fitting. Build and test pneumatic control circuit.
37. Identify constructional feature, operate, maintain, service and calibrate of analytical instruments.

6. ASSESSMENT CRITERIA

LEARNING OUTCOME	ASSESSMENT CRITERIA
FIRST YEAR	
1. Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check dimensional accuracy using precision instruments following safety precaution. *[Basic fitting operation – marking, Hacksawing, Chiselling, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.5mm]*	Plan & Identify tools, instruments and equipments for marking and make this available for use in a timely manner.
	Select raw material and visually inspect for defects.
	Mark as per specification applying desired mathematical calculation and observing standard procedure.
	Measure all dimensions in accordance with standard specifications and tolerances.
	Identify Hand Tools for different fitting operations and make these available for use in a timely manner.
	Prepare the job for Hacksawing, chiselling, filing, drilling, tapping, grinding.
	Perform basic fitting operations viz., Hacksawing, filing, drilling, tapping and grinding to close tolerance as per specification to make the job.
	Observe safety procedure during above operation as per standard norms and company guidelines.
	Use and care non precision instruments such as different types of callipers, gauges, and making tools.
	Mark the job as per blueprint.
	Perform operation, maintenance, and use Precision Measuring Instruments.
	Quality check for dimensional accuracy as per standard procedure.
	Avoid waste, ascertain unused materials and components for disposal, store these in an environmentally appropriate manner and prepare for disposal.
2. Apply a range of skills to execute tube joints, dismantle and assembles tubes and *fittings* of PI arc &ferrule and test for	Ascertain and select tools and materials for the job and make this available for use in a timely manner.
	Plan to dismantle and assemble tube and ferrule fittings.
	Dismantle PI arc, ferrule and fittings in tube applying range of skills and check for defect as per standard procedure.

leakage. [range of skills- cutting, threading, flaring, bending and joining]	Demonstrate possible solution in case of defect and agree task within the team for repair or replacement.
	PI arc, ferrule and various tubes fitting using range of skills and observing standard procedure.
	Test for leakage and appropriate functioning of PI arc, ferrule.
	Avoid waste, ascertain unused materials and components for disposal, store these in an environmentally appropriate manner and prepare for disposal.
3. Identify, test the cable and measure *the* electrical parameters.	Plan work in compliance with standard safety norms.
	Identify the Phase, Neutral and Earth on power socket, use a tester to monitor AC power
	Construct a test lamp and use it to check mains healthiness.
	Identify the different types of single range electrical meter for measuring AC & DC parameters
	Measure the voltage between phase and ground and rectify Earthing.
	Identify and test different AC mains cables.
	Prepare terminations, skin the electrical wires /cables using wire stripper and cutter,
	Identify types of wires and verify their specification.
	Measure the gauge of the wire using SWG and outside micrometre. Refer table and find current carrying capacity of wires.
	Identify the type of single range meters andelectronic instruments for electrical measurement.
	Measure the value of resistance, voltage and current using Analog/ digital multimeter
4. Test various electrical passiveand active*components* using proper measuring instruments and compare the data using standard parameter.	Ascertain and select tools and materials for the job and make this available for use in a timely manner.
	Plan work in compliance with standard safety norms.
	Identify the different types of resistors.
	Measure the resistor values using colour code and verify the reading by measuring in multi meter.
	Identify the power rating using size.
	Measure the resistance, Voltage, Current through series and parallel connected networks using multi meter.

	Identify different inductors and measure the values using LCR meter.
	Identify the different capacitors and measure capacitance of various capacitors using LCR meter.
	Ascertain and select tools and materials for the job and make this available for use in.
5. Identify, test and use of various types of switches, E.M. relays, Circuit breakerand construct electrical circuits.	Plan work in compliance with standard safety norms.
	Identify different types of switches and test.
	Identify the types of switches their rating and applications.
	Identify the types of E.M. relays & Circuit breaker their rating and applications.
	Dismantle, identifyparts, service and test the different parts of a relay& Circuit breaker
	Build electrical control circuit and test its working.
	Wind a solenoid and determine the magnetic effect of electric current
	Solder the given components.
	Avoid waste, ascertain unused material and components for disposal, store these in an environmentally appropriate manner and prepare for disposal.
6. Estimate, Assemble, install and test wiring system.	Comply with safety & IE rules when performing the wiring.
	Prepare and mount the energy meter board.
	Draw and wire up the consumers main board with ICDP switch and distribution fuse box.
	Draw and wire up a bank/hostel/jail in PVC conduit.
	Identify the types of fuses their ratings and applications.
	Identify the parts of a relay, MCB & ELCB and check its operation.
	Estimate the cost of material for wiring in PVC channel for an office room having 2 lamps, 1 Fan, one 6A socket outlet and wire up.
	Estimate the requirement for conduit wiring (3 phase) and wire up.
	Estimate the materials and wire up the lighting circuit for a godown.
	Estimate the materials and wire up a lighting circuit for a

	corridor in conduit.
	Test, locate the fault and repair a domestic wiring installation.
7. Verify characteristics of resonance circuits.	Verify the characteristics of series, parallel and its combination circuit.
	Analyze the effect of the short and open in series and parallel circuits.
	Verify the relation of voltage components of RLC series circuit in AC.
	Determine the power factor by direct and indirect methods in an AC single phase RLC parallel circuit.
	Identify the phase sequence of a 3 ø supply using a phase-sequence meter.
	Prepare / connect a lamp load in star and delta and determine relationship between line and phase values with precaution.
	Connect balanced and unbalanced loads in 3 phase star system and measure the power of 3 phase loads.
	Make the solenoid and determine its polarity for the given direction of current.
	Group the given capacitors to get the required capacity and voltage rating.
8. Plan, execute commissioning, testing and evaluate performance of AC & DC motors and generators.	Plan work in compliance with standard safety norms related with AC motors.
	Draw circuit diagram and connect forward & reverse a 3-phase squirrel cage induction motor.
	Start, run and reverse an AC 3 phase squirrel cage induction motor by different type of starters.
	Measure the slip of 3 phase squirrel cage induction motor by tachometer for different output. Draw slip / load characteristics of the motor.
	Determine the efficiency of 3 phase squirrel cage induction motor by no load test/ blocked rotor test and brake test.
	Plot the speed torque (Slip/Torque) characteristics of slip ring induction motor.
	Speed control of 3 phase induction motor.
	Connect, start and run a 3-phase synchronous motor.

	Connect start, run, control speed and reverse the DOR of different type of single-phase motors.
	Install a single-phase AC motor.
	Plan work in compliance with standard safety norms related with DC machines.
	Determine the load performance of a different type of DC generator on load.
	Connect, start, run and reverse direction of rotation of different types of DC motors.
	Conduct the load performance tests on different type of DC motor.
	Control the speed of a DC motor by different method.
9. Execute testing, evaluate performance and maintenance of transformer.	Plan work in compliance with standard safety norms related with transformer.
	Identify the types of transformers and their specifications.
	Identify the terminals; verify the transformation ratio of a single-phase transformer.
	Connect and test a single-phase auto- transformer.
	Determine the losses (iron loss and copper loss) and the regulation of a single-phase transformer at different loads.
	Measure the current and voltage using CT and PT.
	Carry out winding for small transformer of 1KVA rating.
	Connect the given two single phase transformers a) parallel b) series (secondary only) and measure voltage.
10. Plan, select, and carry out measurement, extension of range,overhauling, testing and calibration of 'D'Arsonval meter, PMMC meter.	Identify the types of electrical instruments, types of scale dials, symbols of the instruments with respect to functions.
	Dissemble electrical meters, Identify different parts and Familiarwith theinternal Construction and operation of'D[1] Arsonval meter, PMMC meter for current and voltage measurement.
	Identify types of deflecting torque, controllingtorque, & damping torque arrangement in meter and adjustment for correct functioning
	Extend the range of voltmeter, ammeter. And ohm meters.
	Determine the types of measurement errors and correction procedure.

	Overhaul, check, fault find, repair, calibrate of Electrical PMMCinstruments for current, voltage and resistance.
11. Select, perform electrical/electronic measurement, earthing installation service and calibrate MI instruments, electro dynamometer instruments, Induction type and Special instruments- voltage tester, continuity tester, rotation tester, phase sequence indicator, synchronising, synchronouscope, frequency meter, thermocouple type ammeter.	Plan work in compliance with standard safety norms related with electrical instruments& earthing installation.
	Familiar with construction and operation of Megger,insulation tester and earth-tester
	Test open circuit / short circuit / continuity of cable using megger/ insulation tester.
	Measure the insulation resistance between conductors of anarmoured cable and insulation resistance between earth and conductors of an armoured cable.
	Prepare,Install the plate earthing/ pipe earthing and measure earth resistance by earth tester / megger.
	Service, calibrate and test Megger/insulation tester andearth-tester.
	Identify and select MI type, electro dynamometer type, Induction type and Special instruments for ac / dc voltage, current, frequency, power, power factors and energy etc. Measurement.
	Study with the construction and operationof MI type, electro dynamometer type, Induction type and Special instruments for the measurement of electrical variables
	Connect MI type, electro dynamometer type, Induction type and Special instruments to electrical circuit. Record the results, Draw the response curve, identify deviation and error.
	Dissemble,identify different parts, Overhaul, check and fault find, test and calibrate MItype meters, electro- dynamometer type instruments, Induction type meter,
	Measure the power and energy in a single & three phase circuit using wattmeter and energy meter.
	Measure the power factor in poly-phase circuit and verify the same with voltmeter, ammeter, watt-meter readings.
	Measure the frequency by frequency meter.
	Test single phase energy meter for its errors
	Measure the power factor in poly-phase circuit and verify the same with voltmeter, ammeter, watt-meter readings.
	Identify Special instruments and practice electrical

	measurements.
12. Identify, Test various analog and power electronics components, Construct, test and analyze the circuit functioning.	Practice on soldering components on lug board with safety.
	Identify the passive /active components by visual appearance, Code number and test for their condition.
	Identify the control and functional switches in CRO and measure the D.C. & A.C. voltage, frequency and time period.
	Construct and test a half, full wave and bridge rectifiers with and without filter circuits.
	Construct and test a Zener based voltage regulator circuit.
	Ascertain and select tools andinstrumentsforcarryingoutthe jobs.
	Construct and test the transistor-based switching circuit
	Construct and test CB, CE& CC amplifier circuit
	Ascertain the performance of different oscillator circuits.
	Construct and test Clipper, Clamper and Schmitt trigger circuit.
	Construct and test of Transistor and JFET amplifiers, oscillators and multi vibrators.
	Construct and test a UJT as relaxation oscillator.
	Construct and test lamp dimmer using TRIAC/DIAC with safety.
	Construct and test MOSFET, IGBT test circuit and apply for suitable operation with proper safety.
	Construct and test the universal motor speed controller using SCR with safety.
	Construct and test switching circuits using optical devices.
13. Detect the faults and troubleshoot SMPS, UPS, inverter, converter andThyristor family.	Identify the tools and equipments to perform the job with due care and safety.
	Dismantle the given stabilizer and find major sections/ ICs components.
	Identify various input and output sockets/ connectors of the given SMPS.
	Identify major sections/ ICs/components of SMPS.
	Identify and replace the faulty components and construct and test IC Based DC-DC converter for different voltages.
	Identify front panel control & indicators of UPS.
	Identify various circuit boards in UPS and monitor voltages at various test points.

	Test UPS under Fault condition & rectify fault.
14. Identify, place, solder and desolder and test different SMD, discrete components with due care and following safety norms using proper tools/setup.	Identify the various crimping tools for various IC packages.
	Identify different types of soldering guns and choose the suitable tip for the application.
	Practice the soldering and de-soldering the different active and passive components, IC base on GPCBs using solder, flux, pump and wick.
	Make the necessary setting on SMD soldering station to solder and de-solder various IC's of different packages by following the safety norms.
	Identify SMD components, de-solder and solder the SMD components on the PCB.
	Check the cold continuity, identify loose/dry solder and broken track on printed wired assemblies and rectify the defects.
	Avoid waste, ascertain unused materials and components for safe disposal.
15. Construct and test different circuits using operational amplifiers circuits and execute the result.	Demonstrate analog trainer kit with safety precautions.
	Identify various ICs, differentiate by code No. and test for their condition.
	Construct and test various OPAMP circuits.
	Construct and test R-2R ladder type digital to analog converter circuit.
16. Identify, test and verify all digital ICs. Assemble, test and troubleshoot various digital circuits and digitalinstruments.	Illustrate to practicethedigital trainerkit with safety.
	Identify various digitalICs, testIC usingdigitalIC tester and verify the truth table
	Construct and verify the truth table ofallgatesusingNORand NANDgates
	Construct an addercum subtractor circuits andverifythe truth table
	Construct and verifythe truth tableofvarious flipflops, counters and shift register circuits
	Construct a decoder andencoder, multiplexer andde-multiplexer circuits and verify the truth table
	Identify LCD/LED Display module and its decoder/driver ICs and display a word on a two-line LCD/LED.
	Construct and test D/A and A/D circuits

	Measure the current flowing through a resistor and display it. Measure/current flowing through a sensor and display it on a LCD/LED module (DPM).
	Service and test digital instruments
	Avoid waste and dispose the waste as per the procedures.
17. Measure the various parameters by CRO and execute the result with standard one.	Identify and demonstrate various control elements on front panel of a CRO.
	Measure different parameters of electronic signals using CRO.
	Store the waveform of a signal in CRO.
	Connect CRO with a printer and take printout of signal waveforms.
18. Install and setup operating system and related software in a computer&Practicewith MSoffice and application software related to instruments.	Assemble computer and configuring the CMOS setup.
	Install and configure windows OS and application software.
	Install the printer and other peripheral devices.
	Burn CD/DVD
	Troubleshoot the PC
19. Identifyvariousfunctional blocks of a microprocessorsystem, identifyvarious I/O Ports, write and executive simple program and Interfaceamodel application with the microprocessor kit and run the application.	Understand and interpret the procedure as per manual of Microprocessor.
	Identity various ICs & their functions on the given Microprocessor Kit.
	Identify the address range of RAM & ROM.
	Write data into RAM & observe its volatility.
	Identify the port pins of the controller & configure the ports for Input & Output operation.
	Demonstrate entering of simple programs, execute & monitor the results.
SECOND YEAR	
20. Identify the parameters of measurementsystems. Identify, select, test, wire & Execute the operation of different process sensors by selecting appropriate signal conditioning for stress, strain,	Identify various types of instrument constructions, various parts and section
	Identify units for Fundamental and Derived physical variable,in different system of measurements, multiplying factor.
	Measure the voltage and current usinganalog/ digital standard voltmeter and ammeter.
	Check the repeatability, reproducibility, drift, dead band, back

load displacement and Thickness.	clash, hysteresis speed of response and lag etc. of analog and digital instruments.
	Identify instrument specification and types of error.
	Identify types of sensors and transducers used in process industries for stress, strain, load, displacement and Thickness based on resistive, capacitive, inductive and photoelectric etc. such as strain gauge, load cells, LVDT and proximity transducers.
	Verify the characteristics of different types of resistive, capacitive, inductive, strain gauge, load cells, LVDT, RVDT,photoelectric, proximity Transducers.
	Detect different objectives using capacitive, inductive and photoelectric proximitysensors
	Identify and study the instrument specification and the circuit operation ofanalog/ digital instruments for stress, strain, load, displacement and Thickness referring to instrument manual.
	Measure stress, strain, load, displacement and Thickness variable. Record the readings and verify the performances for various factors by observing std condition referring to data chart.
	Carry out maintenance, Servicing and calibration 0f instruments for stress, strain, load, displacement and Thickness measurements.
21. Select, Installs, services, and calibrate instruments for motion, speed, acceleration and vibration.	Identify sensors used for motion, speed, and acceleration and vibration measurement andverify the characteristics.
	Identify different parts, its function, construction and operation of vibrometers and accelerometer.
	Measure the acceleration and vibration and verify the performances for various factors by observing std. condition referring to data chart.
	Identify different parts, its function and operation of mechanical tachometer and study construction.
	Measure the speed of motor using tachometers.
	Identify different parts its function and operation of eddy current type, AC and DC tachometer.
	Carry out maintenance, Servicing and calibration 0f vibrometers, accelerometer and speedometers

	Identify different parts/section, its function, operation and useof stroboscope and find motion of object.
22. Identify different unit of pressure, terms and operation of basic instruments. Perform maintenance, Servicing calibration and installation of field pressure gauges, switches, electronic pressure indicators and transmitters for absolute, atmospheric, gauge, vacuum and differential pressure measurement.	Select, operate and measure the atmospheric pressure using different types of barometers
	Select, operate and measure the gauge, vacuum, & differential pressure using manometers.
	Maintenance, servicing and calibration of analog& digital barometers and manometers.
	Measure the line and vessel pressure and vacuum using different types of pressure gauges. Record results and find deviation.
	Dismantle, Identify different parts, its function, construction and operation of bourdon tube, diaphragms capsules and bellows types pressure gauges and switches.
	Service, Assemble and calibrate bourdon tube types, diaphragms types,capsules types, and bellows types.Pressure gauges and switches.
	Study theconstruction, circuit operation of Different types electronic pressure indicators and transmitters: (potentiometricpr.transducers,Capacitivepr. transducers,strain gaugepressuretransducers, piezoelectricpressure transducer types).
	Wire and Measure the pressure using different indicating transmitters and verify the performances for various factors by observing std condition referring to data chart.
	Familiar with construction, Operation of Standard pressure Calibrator, Dead weight Tester and vacuum tester.
	Study the construction, circuit operation adjustments for correct functioning and test of indicators and transmitters for line and vessel pressure.
	Study construction, operation of different types of McLeod gauge.
	Study construction, operation and use of thermal conductivity gauges pirani gauges, thermocouple gauges, slack diaphragm, ionization gauge, and measure the vacuum.
	Test and calibrate of pressure gauges, indicators, transmitters with standard calibrator/dead weight tester.

	Service and calibrate electronic vacuum gauges/ indicators and transmitters
	Identify pressure installation component, impulse line, safety guideline and accessories and installation procedure of pressure instruments as per guidelines.
	Practice installation of gauges, transmitters and pressure switches on the fluid line and vessel.
	Identify and carry out preventive and breakdownmaintenance of pressure and vacuum gauges, transmitters, impulse line etc. As per guidelines.
23. Recognise the fundamental of fluid flow, terms, different unit of flow, read specification of flow meters. And fluid pump. Perform the maintenance, Servicing and calibration and installation of variable DP flow meters / head flow meters, variable area flow meters, positivedisplacementmeters, Electronic type flow meters and mass flow meters for fluids flow measurement.	Identify nature of fluid flow and factor affecting flow rate.
	Study operation of different types fluid pump.
	Identify different types of flow metres with their function& Read specifications of flow meters.
	Select and check constructional feature and use ofvarioustypes offlowrestrictors(orifice,venturi, flow nozzle, pitot tube) and tapings
	Installation and test of DP flow transmitter, primary flow elements, pressure taps, piping and fitting valve, electrical hook-up.
	Measure the flow rates using manometer and DP transmitters
	Identify constructionalfeature ofweirs,notches andflumes theirshapeandconnections and measurethe Openchannelflowrates using manometer and DP Transmitters
	Dismantling,checkingoverhaulingand calibrationofD.P.cell/ transmitter. (pneumatic & electronic)
	Study of construction of Rotameter and measure fluid flow rate by Rota meters.
	Dismantling, checking,overhaulingand calibrationof Rota meters
	Read the specification of various types of positive displacement meters and identify deferent parts, its function, and operation of various type of positive displacement meters.
	Practice the flow measurement using positivedisplacementmeters.
	Dismantle, Repair, assemble and calibration of oscillating piston type rotating vane meter, nutating disc meter. Lobed impeller and oval flow meter.

	Install and test of positive displacement flow meters for fluid flow.
	Identify the construction feature of flow meter body, study circuit operation of turbine flow meter, vortex flow meters, ultrasonic flow meters, electromagnetic flow meters, mass flow meter, carioles mass flow meters and read the specification.
	Measure fluid flow using electrical type flow meter and Mass flow meters.
	Service and calibrate electrical type and mass flow meters
	Identify and carry out preventive maintenance of all types flow meters.
	Perform the installation of flow meters as per guidelines and verify the performance
24. Identify, operate, maintain, troubleshoot and calibrate the devices for solid flow measuring system & verify the result within standard.	Study Construction and operation volumetric solids flow meter and mass flow meter for solids, belt type solid meters, belt speed sensing and signal conditioner and constant weight feeders.
	Measure the solid flow rates.
	Identify and carry out maintenance and preventive maintenance of solid flow measuring system.
	Service and calibrate solid flow meter.
25. Identify, select, wire & Execute the operation of different types of level instruments use for liquid level and solid level. Carry outmaintenance, Servicing, calibration and Installation.	Construction and operation of various type sight glasses.
	Install, test and measure the performance of sight glasses for liquid level.
	Identify different parts, its function and operation of various types of floats and displacers liquid level indicators, transmitters and different types of level switches for liquid vessel.
	Construction and operation of various types of liquid level traps, air purge, liquid purge, flash diaphragm, liquid level gauges and differential pressure indicating and transmitters.
	Install, wire, test and measure the liquid level by different types of floats displacers and hydrostatics level indicators and transmitters
	. Study the constructional feature, identify different parts, its function, and circuit operation of various types of electrical level

	indicators and transmitters i,e.capacitance probes, ultrasonic, microwave and nuclear types for liquid and solid level measurements.
	Install, wire, test and measure the liquid level/ solid level by different types ofelectrical level indicators and transmitters
	Service and calibrate electrical type's level indicators and transmitters.
	Identify and carry out maintenanceof level indicators and transmitters and switches for liquid and solid level.
26. List out different unit of temperature, terms and read specification of temperature instruments. Perform measurement, maintenance, Servicing and calibration ofBimetallic and filled system thermometers & thermo switches.	Identify different types of heating sources, transfer of heat and change of physical state.
	Identify different types of primary and secondary standards for calibration of temperature scales.
	Construction, operation and use of temperature-controlled oil bath/furnace for low and high temperature.
	Identify different types of thermometers and thermo switches for temperature with their function, Read its specifications and use.
	Dismantle, identify different parts, its function, adjustment, assemble and operation of bimetallic and liquid field system thermometers and thermo switches.
	Service and calibrate various types of thermometers and switches.
	Identify and carry out maintenance and preventive maintenance of thermometers and switches.
	Install and test various types of thermometers and switches as per guidelines.
27. Identify,select, evaluateperformance, install, service and calibrate temperatureIndicators, Transmitters (RTD'S, Thermistors and Thermocouples types); various type of pyrometers.	Identify and check different types of RTD's, Thermistors,Thermocouples, Ex-tension wires. and protecting wellsfor temperature measurement.
	Verify the characteristic of different types ofRTD's, Thermistors and Thermocouples sensors.
	Study circuit operation of analog/ digital indicators and transmitters design for RTD's, and Thermistors and Thermocouples sensors.
	Install, WIRE and test various types RTDS, Thermistor&

	Thermocouples with Indicators/ Transmitters as per guidelines.
	Measure the temperature using RTD'S, Thermistors &Thermocouples base instruments and verify the performance as per field requirements.
	Maintain,service,trouble shoot and calibrate various types of electronic indicatorsand transmitters(analog and digital version)
	Identify parts/ section and its function, circuit operation of analog/ digital type Optical and Radiationpyrometer.
	Install, WIRE and test Optical and Radiationpyrometer as per guidelines.
	Measure high temperature using optical andRadiation pyrometer.
	Identify and check different types of humidity sensors.
	Measure the relative humidity using humidity sensors.
	Install, wire, test, service,trouble shoots and calibratesvarious types' humidity sensors with Indicators/ Transmitters as per guidelines.
28. Identify, select, Operate, maintain, Service and calibrate different types of recorders.	Identify different types of recorders.
	Practice recording of variable signal.
	Construction, operation and use of circular chart recorder for temperature and pressure.
	Construction, operation and use strip chart pneumatic and electronics recorders.
	Study of paperless LCD/LED recorder.
	Carry out maintenance and preventive maintenance, fault find, repair, test and calibrate of various types of pneumatic, electronics recorders.
	Install and the check the performances of recorders as per guides lines.
29. Identify different types ofFinal control elements and role.Identify different valve body, constructional feature, Dismantle, inspect parts, replace	Identify final control element in process control loop and types of electric and fluidic control signals for operation of final control elements.
	Identify parts, its function, operation, service, and calibrate various types of converters.
	Construction, operation and use of various types of pneumatic

parts,recondition, check, andresettingof control valves with actuators, convertors & positioners. Install and test the performance.	and electrical actuators.
	Study, operation and use of various types of control valve positioners.
	Dismantle, fault finding, repair and install actuators and positioners on valve body.
	Examine, Operation and applications of various types of basic control elements viz. Valves body globe, gate, weir, rotary plug, split body, butterfly, louver etc.
	Identify characteristics of control valve.
	Dismantling, reconditioning, checking, replace parts and resetting of control valve.
	Examine operation and application of various types of electrical final control elements.
	Install, wire, test and verify the performance of various electrical type final control elements respect to control signal
	Maintain and service electrical type final control elements
	Remove and install control valves with service line.
	Carry out maintenance of final control elements.
	Construction and operation of capacitive, inductive type valve, proximity switch, IR switch, micro switch, limit switch.
	Identify final control elements in system and manually control feed water rate at desire value.
	Construction and operation of sequential control and block valves.
	Operation of electromechanical and solid-state relay.
	Design and test sequential logic operation using relay and turbine control system operation.
30. Identify fundamentalof automatic control system and various functional elements in control loop. Identify, select, Install, wire, configure, test the performance, maintain, and service various types of ON-OFF and PID controllers (electronic and pneumatic).	Basic Process control system and identify various functional elements.
	Study construction and operation of thermostatic, pressure and humidity switches.
	Install, wire up and test the control operationusing auto /smart switches.
	Study construction and operation of ON-OFF electronic and pneumatic controllers.
	Study construction and operation of PID electronic/ digital controller.

	Install, wire up, configure, test the control operation using ON-OFF &PID electronic/digital controller
	Verify the steady state and transient responses of PID electronic/digital controllers in P, PI, PD, PID.
	Study construction& operation of PID pneumatic Controllers.
	Install, connect pneumatic signal, align and test the control operation using PID pneumatic controller.
31. Tune controller mode and evaluate performance of control loops as per specification and system application	Familiar withfeedforward, and feedback process control system, checkloop and identify various functional elements.
	Familiar with cascade and ratio process control system.
	Check loop and identify various functional elements.
	Perform the control operation in manual and automatic mode.
	Set optimum setting for unit process in PID controller. (Electronic and pneumatic).
32. Identify modules of PLC, its function, Wire and connect the digital I/OS field devices to the I/O Module of PLC, install Software, Hardware and configure plc for operation. Write and execute simple logic and real application programs.	Identify each module in a rack and mount in the specified slot.
	Wire and connect the digital I/OS field devices to the I/O modules of PLC.
	Install PLC Programming software and establish communication with PC and PLC.
	Hardware configuration and prepare the input output addresses for each slot.
	Prepare and download ladder programmes for various switching gates.
	Write and execute programme logic control operation, sequence control using timers and counters.
	Develop programme using arithmetic/data copy operation, shift bit operation and execute.
	Interface analog I/P module of PLC with sensor, O/P module of PLC with actuator, relay.
	Prepare programmes based on ON-delay and OFF-delay timers making ON and OFF of a single LED taking one input and one output.
	Sequencer task using three LEDs as output and two input push buttons one as input (No) for start and other for stop (No).
	Development of the ladder logic for the running a traffic control with the different display indicator.

	Write and execute real application programs.
33. Operate,maintain,service, configure, install, WIRE and test HART transmitters /devices (I/O). And Net-working system for instrumentation.	Familiar with facilities, functions, operation and use HART communicators.
	Installing and operating HART transmitters and devises I/O.
	Configure and calibration of HART devices.
	Identify the cable and network component.
	Study various network lines.
	Preparation of network cables and connectors. Testing network cable.
	Preparation of network cable serial (RS 232/485 standard or equivalent) and Ethernet.
	Connect network connectivity hardware and check for its functioning.
	Construct and design pulse code modulation and demodulation.
	Identify and adjust the frequency of the sampling pulse generator and level of modulating signal to obtain the PWM waveform on CRO.
34. Identify the different modules of DCS, function, Wire and connect I/OS field devices to the I/O Modules, install Software, Hardware and configure DCS for operation with HMI. Write and execute DCS AND SCADA programs FOR real application.	Familiar with different facilities and function of DCS system.
	Identify the different modules of DCS and different process instruments in process plant.
	Install DCS programming software and establish communication with PC and DCS.
	DCS programming for sequence and safety operation.
	Programming of DCS to measure and control the flow&level loop with PID.
	Set the communication between DCS and SCADA system.
	Create the alpha numeric display.
	Setup and configure HMI with PLC.
	Animate objects on an HMI screen to monitor motor starters.
	Use security features to do tag logging and command execution.
35. Identify, check constructional Feature and function of hydraulic pump,	Familiar with hydraulic trainer and safety measure to handle hydraulic system.
	Practice symbolic representation of hydraulic components.

and hydraulic power system, accumulator, hydraulic hoses and fitting, Hydraulic components. Build and test hydraulic control circuit	Familiar with hydraulic hoses and fitting.
	Study Constructional FeatureFunction of hydraulic pump and hydraulic power system.
	StudyFeatures and function of hydraulic accumulator.
	Identify hydraulic component and check its function.
	Service and test different types valves.
	Build a hydraulic circuit for single acting, double acting cylinder actuation, and hydraulic rotary actuation usingpilot operated check valve, pressure reducing valve, pressure relive and pressure regulating valve, pressure sequencing circuit, pressure compensated flow control etc.
36. Lay out construction feature, operate, maintain of air compressor, air Distribution system, pneumatic associate components, piping, tubing and fitting. Build and test pneumatic control circuit.	Study construction operation and use of air compressor.
	Identify different device in air distribution system, air filters, regulators and lubricators.
	Practice and use of pneumatic piping, tubing and fitting. (Metallic and non-metallic.)
	Setup a system to provide pneumatic (Air) supply of 20 psi output from the available compressor.
	Draw Symbolic representation of different Pneumatic components, various supply elements such as Compressors, pressure regulating valve, serviceunit directional control valves etc.
	Build a pneumatic simple/sequential logic circuit to control actuation of a single acting cylinder & double acting cylinder Using various types of directional control valves
	Maintain and service pneumatic system and associate components.
37. Identify constructional feature, operate, maintain, service and calibrate of Analyticalinstruments.	Study the circuit operation of PH meter conductivity meter and dissolved oxygen meter.
	Wire up PH meter electrode to PH meter.
	Calibrate PH meter using buffer solution.
	Determination of PH value of solution.
	Wire up conductivity meter to electrode and find the electrolytic conductivity of solution.
	Maintain,Service and calibrate the conductivity meter & dissolved oxygen meter.

SYLLABUS FOR INSTRUMENT MECHANIC TRADE			
FIRST YEAR			
Duration	**ReferenceLearning Outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
Professional Skill 100Hrs. Professional Knowledge 28 Hrs.	Plan and organize the work to make job as per specification applying different types of basic fitting operation and Check dimensional accuracy using precision instruments following safety precaution. *[Basic fitting operation – marking, Hacksawing, Chiseling, Filing, Drilling, Taping and Grinding etc. Accuracy: ± 0.5mm]*	1. Importance of trade training, List of tools & Machinery used in the trade. (01 hr.) 2. Safety attitude development of the trainee by educating them to use Personal Protective Equipment (PPE). (05 hrs.) 3. First Aid Method and basic training. (02 hrs.) 4. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. (02 hrs.) 5. Hazard identification and avoidance. (02 hrs.) 6. Safety signs for Danger, Warning, caution & personal safety message. (01 hr.) 7. Preventive measures for electrical accidents & steps to be taken in such accidents. (02 hrs.) 8. Use of Fire extinguishers. (07 hrs.) 9. Practice and understand precautions to be followed while working in fitting jobs. (02 hrs.) 10. Safe use of tools and	Organization of the Institute, Departments various trades & functions. Types of work, responsibility to be undertaken, incentives and future planning of profession. Safely precautions to be observed in the trade both during 'theoretical Periods' and 'Practical hours/workshop hours' Elementary First Aid. Safety and hazards. Sign boards and types. Hazardous and non-hazardous. Environmental pollution related to the trade-caused, consequences, mitigation and control. (07 hrs.)

		equipments used in the trade. (01 hr.)	
		11. Demonstrationandusesofhandtools- screwdrivers,pliers, spanners,tweezers, tester, wire stripper, electrician knife,steel rule, scriber, punches, hammer. (02 hrs.) 12. Identification of tools &equipments as per desired specifications for marking & sawing. (02 hrs.) 13. Selection of material as per application. (02 hrs.) 14. Visual inspection of raw material for rusting, scaling, corrosion etc. (03 hrs.) 15. Filing- flat & square (Rough finish). (03 hrs.) 16. Filing practice, surface filing, side and checking 90^0 by try square. (03 hrs.) 17. Marking out lines, filling and saving use of vice to given dimensions. (03 hrs.) 18. Filing- Flat, square and Parallel to an accuracy of 0.5mm. (03 hrs.) 19. Use and care non precision instruments such as different types of callipers, gauges, and making tools. (04 hrs.) 20. Practice of marking and measurement with combination set. (04 hrs.) 21. File radios along a marked line (convex and concave) and match. (04 hrs.) 22. Check the internal and	Basic hand tools, types, classification use & metal cutting fundamentals. Filing- Flat, square and Parallel to an accuracy of 0.5mm. Measurement & measuring instruments, Marking tools, Fasteners & Fastening devices. (14 hrs.)

		external radius of curved surface by radius gauge. (03 hrs.) 23. Identify and use of various types of Fasteners & Fastening devices. (03 hrs.) 24. Measurement of Length, Height & Diameter by Vernier callipers and Micrometers. (06 hrs.) 25. Determine positional errors of surfaces and measurements of deformation using dial test indicator. (05 hrs.)	
		26. Carry out maintenances, servicing and calibration Precision Measuring Instruments. (5 hrs.) 27. Familiar with drilling machine operation, care and use. (05hrs.) 28. Select drill bits, reamers and tapes. (03hrs.) 29. Drill through holes and blind holes. (04hrs.) 30. Form internal thread with taps to standard size (Through holes & blind holes). (03hrs.) 31. Form external thread with dies to standard size. (05hrs.)	Precision Measuring Instruments, gauge blocks, sine bar, dial indicators,vernier calipers, micrometers, bevel protractor, thickness gauges. Element & types of screw threads used in instruments, Calculation of drill size for tapping. (07 hrs.)
Professional Skill 25 Hrs. Professional Knowledge 07 Hrs.	Apply a range of skills to execute tube joints, dismantle and assembles tubes and fittings of PI arc &ferrule and test for	32. Flaring of tube and tube joints. (03 hrs.) 33. Cutting and threading of tube length. (04 hrs.) 34. Fitting of tube and per sketch observing conditions used for tube work. (06 hrs.)	Types of tubes used for instrumentation. Tube cutter, Flaring tools, swedging tools, equipment's & fixture required for pipe bending, straightening, thread cutting, method of installation. (07 hrs.)

	leakage. [range of skills- cutting, threading, flaring, bending and joining]	35. Bending of tube cold and hot. (02 hrs.) 36. Fit and assemble tubes, PI arc and ferrule fittings. (05 hrs.) 37. Test leakage and functionality of PI arc and ferrule. (05 hrs.)	
Professional Skill 25 Hrs. Professional Knowledge 07 Hrs.	Identify, test the cable and measure the electrical parameters.	38. Identify the Phase, Neutral and Earth on power socket, use a tester to monitor AC power. (02 hrs.) 39. Construct a test lamp and use it to check mains healthiness. (02 hrs.) 40. Measure the voltage between phase and ground and rectify earthing. (02 hrs.) 41. Identify and test different AC mains cables. (03 hrs.) 42. Prepare terminations, skin the electrical wires /cables using wire stripper and cutter. (03 hrs.) 43. Measure the gauge of the wire using SWG and outside micrometre. (02 hrs.) 44. Refer table and find current carrying capacity of wires. (02 hrs.) 45. Measure AC and DC voltages using multi meter. (03 hrs.) 46. Use the multi meter to measure the various functions (AC V, DC V, DC I, AC I, R) (03 hrs.) 47. Identify the different types of meter for measuring AC & DC parameters (03 hrs.)	Electrical components- conductor, semiconductor & insulators. Standard wire gauge (SWG). Introduction of electricity- static electricity. Current, voltage, P.D, E.M.F, resistance. Electrical circuit - D.C & A.C circuit differences. Importance of grounding. (07 hrs.)

Professional Skill 25 Hrs. Professional Knowledge 07 Hrs.	Test various electrical passiveand active components using proper measuring instruments and compare the data using standard parameter.	48. Identify the different types of passive electronic components. (02 hrs.) 49. Measure the resistor value by colour code and verify the same by measuring with multi-meter. (02 hrs.) 50. Identify resistors by their appearance and check physical defects. (01 hrs.) 51. Practice soldering on IC bases and PCBs. (02 hrs.) 52. Practice de-soldering using pump and wick. (02 hrs.) 53. Join the broken PCB track and test. (02 hrs.) 54. Practice on measurement of parameters in combinational electrical circuit by applying Ohm's Law for different resistor values and voltage sources. (03 hrs.) 55. Measurement of current and voltage in electrical circuits to verify Kirchhoff's Law. (02 hrs.) 56. Verify laws of series and parallel circuits with voltage source in different combinations. (02 hrs.) 57. Measure the resistance, Voltage, Current through series and parallel connected networks using multi meter. (02 hrs.) 58. Identifythe primaryand secondarycells. (01 hr.) 59. Measure and test the voltages of the given	Uses of multimeter. Resistor, Resistivity and colour code, Types of resistors used in instrumentation. Definition and purpose of soldering and desoldering. Soft soldering. Types of soldering irons. Solder & flux. Care & precaution of soldering. De-soldering tools and method of use. Ohm's law & Kirchhoff s laws. Series & parallel circuits. Primary & secondary cells and batteries. {Liquid & dry). Maintenance free batteries construction-charging, efficiency-use, advantage. (07 hrs.)

		cells/battery using analog/digital multi-meter. (1 hr.) 60. Charging anddischarging the battery and Maintain the secondarybattery. &Use a hydro meter to measure the specificgravityof thesecondarybattery. (03 hrs.)	
Professional Skill 25 Hrs. Professional Knowledge 07 Hrs.	Identify, test and use of various types of switches, E.M. relays, Circuit breaker and construct electrical circuits.	61. Dismantle and identify the different parts of a relay. (05 hrs.) 62. Connect a timer relay in a circuit and test for its working. (02 hrs.) 63. Connect a contactor in a circuit and test for its working (02 hrs.) 64. Construct and test series and parallel resonance circuit (03 hrs.) 65. Identify and use SPST, SPDT, DPST, DPDT, tumbler, push button, toggle, piano switches used in electronic industries (04 hrs.) 66. Make a panel board using different types of switches for a given application (05 hrs.) 67. Wind a solenoid and determine the magnetic effect of electric current. (04 Hrs.)	Switches and types. Magnet and magnetism, magnetic properties. Magnetic campus and its uses. Explanation ofElectro-magnetism, Advantages, disadvantages-application-types E.M. relays. Types- uses of Solenoids. Circuit breakers and their working. (07 hrs.)
Professional Skill 25 Hrs. Professional Knowledge	Estimate, Assemble, install and test wiring system.	68. Identify various conduits and different electrical accessories. (03 hrs.) 69. Practice cutting, threading of different sizes & laying	Principles of alternating current, A.C & DC electricity, types of wave forms, time period and frequency, peak to peak values, RMS values,

07 Hrs.		Installations. (08 hrs.) 70. Draw layouts and practice in PVC Casing-capping, Conduit wiring with minimum to a greater number of points of minimum 15 mtrs. length. (08 hrs.) 71. Wire up PVC conduit wiring to control one lamp from two different places. (04 hrs.) 72. Draw layouts and practice Wiring for instrument panel. (02 hrs.)	Average values. (07 hrs.)
Professional Skill 25Hrs. Professional Knowledge 07Hrs.	Test various electrical passiveand active components using proper measuring instruments and compare the data using standard parameter.	73. Identify the different types of inductors. (03hrs.) 74. Measure the inductor value by written/colour code and verify the same by measuring with LCR meter. (04hrs.) 75. Identify inductor by their appearance and check physical defects. (02hrs.) 76. Measure quality factor of inductors in series and parallel circuits with voltage source in different combination. (03hrs.) 77. Identify the different types of capacitor and check by multi-meter whether open or short. (03hrs.) 78. Identify capacitor by their appearance and check physical defects. (02hrs.) 79. Measure charge, energy store of capacitor in series and parallel circuits with voltage source in different combination. (03hrs.)	Inductor and Inductance, types of inductors, Factors affecting the value of inductance, self-inductance (L), Mutual inductance (M), Inductors in series and parallel, Q factor of the coil. Capacitance, types of capacitor, unit of capacitance, factors affecting the value of capacitors, charge, energy stored in capacitors. Capacitors in series and parallel. Capacitors in DC circuit, RC time constant. (07 hrs.)

		80. Construct and test RC time constant circuit. (02hrs.) 81. Identify the different capacitors and measure capacitance of various capacitors using LCR meter. (03hrs.)	
Professional Skill 25 Hrs. Professional Knowledge 07 Hrs.	Verify characteristics of resonance circuits.	82. Measure capacitive and inductive reactance with increase/decrease the input frequency of the circuit. (03 hrs.) 83. Measure current & voltage and determine the characteristics of RL, RC and RLC in AC series circuits. (03 hrs.) 84. Measure the resonance frequency in AC series circuit and determine its effect on the circuit. (05 hrs.) 85. Measure current & voltage and determine the characteristics of RL, RC and RLC in AC parallel circuits. (04 hrs.) 86. Measure the resonance frequency in AC parallel circuit and determine its effects on the circuit. (05 hrs.) 87. Measure Current, voltage, power, energy and power factor in three phase circuits. (05 hrs.)	A.C.-impedance, Inductive reactance, capacitive reactance. AC current through - R, L, C circuits. Resonance in RLC circuit. Importance - of series and parallel resonance, properties. Impedance, Admittance, Q- factor. (07 hrs.)
Professional Skill 50Hrs. Professional Knowledge	Plan, execute commissioning, testing and evaluate performance of AC & DC motors and	88. Identify parts and terminals of different types of single-phase AC motors. (03 hrs.) 89. Install, connect and determine performance of	Introduction of AC and DC generators working principles, construction. Operation, field magnets, armature windings,

14Hrs.	generators.	single-phase AC motors. (05 hrs.) 90. Start, run and reverse the direction of rotation of single-phase AC motors. (03 hrs.) 91. Practice on speed control of single-phase AC motors. (06 hrs.) 92. Identify parts and terminals of different types of single-phase DC motors. (05 hrs.) 93. Install, connect and determine performance of single-phase DC motors. (06 hrs.) 94. Start, run and reverse the direction of rotation of single-phase DC motors. (04 hrs.) 95. Install an alternator, identify parts and terminals of alternator. (04 hrs.) 96. Connect, start and run an alternator and build up the voltage. (04 hrs.) 97. Perform speed control of DC motors - field and armature control method. (04 hrs.) 98. Connect, start and run three phase induction motors by using DOL, star-delta and auto-transformer starters. (03 hrs.) 99. Identify parts and terminals of different type of stepper motors. (03 hrs.)	commutator and brushes, EMF equation. Faraday's Law, Lenz's Law, Fleming's left Hand and right-hand rules. DC motors working principles, construction,operation, types. Different speed controlling techniques of DC motors. AC motors, induction motors, three phase motors, stepper motors. (14hrs.)
Professional Skill 25 Hrs. Professional	Execute testing, evaluate performance and maintenance of	100. Verify terminals, identify components and calculate transformation ratio of single-phase transformers.	Transformer, types, transformation ratio. Open circuit test and short circuit test, regulation Auto

Knowledge 07 Hrs.	transformer.	(03 hrs.) 101. Identifytheprimaryandsecondarytransformerwindings,test the polarity andMeasure the primary and secondary voltage of different transformers. (02 hrs.) 102. Perform OC and SC test to determine and efficiency of single-phase transformer. (05 hrs.) 103. Determine voltage regulation of single-phase transformer at different loads and power factors. (04 hrs.) 104. Verify and measure voltage regulation of auto transformer at different loads. (06 hrs.) 105. Perform series and parallel operation of two single phase transformers. (03 hrs.) 106. Identify the terminals and measure voltage & current of PT and CT transformer. (02 hrs.)	transformer. Current measurement. Instrument transformer. Potential transformer and current transformer. (07 hrs.)
Professional Skill 50 Hrs. Professional Knowledge 14 Hrs.	*Plan, select, and carry out measurement, extension of range, overhauling, testing and calibration of 'D' Arsonval meter, PMMC meter.*	107. Familiar with absolute and different types of secondary instruments. (02 hrs.) 108. Identify the instrument specification and internal construction. (02 hrs.) 109. Overhaul, check, fault find, repair, test of voltmeter and ammeter. (03 hrs.) 110. Identify different types of	**Basics of electrical measuring instruments-** Types - absolute and secondary instruments. Types of secondary instruments, Essential of electrical measuring instruments- deflecting torque, controlling torque, damping torque etc, Types of controlling torques-

		torques. (02 hrs.) 111. Install, wire up and test the spring control and gravity control operation. (02 hrs.) 112. Familiar with damping and identify various functional element like- air friction damping, fluid friction damping and eddy current damping. (04 hrs.) 113. Study the construction circuit operation and adjustment for correct functioning of zero errors on voltmeter and ammeter. (04 hrs.) 114. Identify different parts, its function and operation of PMMC instruments. (04 hrs.) 115. Find the minimum and maximum measurable range of the meter. (04 hrs.) 116. Check the accuracy, sensitivity and maximum power capability of ammeter & voltmeter. (5hrs.) 117. Test the shunt and series resistance of various range of ammeter. (04 hrs.) 118. Practice multipliers for different range extension of voltmeter and ammeter. (5hrs.) 119. Determine errors in meter movement and find the resistance. (9 hrs.),	spring control, gravity control. Types of damping - air friction damping, fluid friction damping, eddy current damping **DC** instruments - 'D[1] Arsonval meter, PMMC meter- working principle, method of working, moving coil operation. Construction-damping, magnetic shielding, bearings. Terminology -parallax error, (FSD) full scale deflection reading, measurement value, meter sensitivity, accuracy. Meter resistance, maximum power, capability etc. Ideal and practical characteristics of ammeter, voltmeter. **Meter range extension -** Converting galvanometer into ammeter, voltmeter. Range extension of voltmeter, ammeter. Shunt resistance and series resistance value calculation. Meter resistance, meter FSD identification techniques. (14 hrs.)

Professional Skill 75 Hrs. Professional Knowledge 21 Hrs.	Select, perform electrical/electronic measurement, earthing installation service and calibrate MI instruments, electro dynamometer instruments, Induction type and Special instruments- voltage tester, continuity tester, rotation tester, phase sequence indicator, synchronising, synchronouscope, frequency meter, thermocouple type ammeter.	120. Identify the different types of Ohm meter. (01 hr.) 121. Test and calibrate of various type of Ohm meter. (02 hrs.) 122. Prepare pipe earthing and measure earth resistance by earth tester / megger. (6 hrs.) 123. Prepare plate earthing and measure earth resistance by earth tester / megger. (6 hrs.) 124. Test earth leakage by ELCB and relay. (02 hrs.) 125. Identify different parts, its function and operation of Dynamometer type instrument and MI. (03 hrs.) 126. Overhaul, check and fault find of Dynamometer type instrument. (03 hrs.) 127. Test and calibrate Dynamometer type instrument. (04 hrs.) 128. Measure the power using wattmeter. (03 hrs.) 129. Test and calibrate wattmeter. (03 hrs.) 130. Familiar with the construction of energy meter and ampere hour meter. (03 hrs.) 131. Overhaul, check and fault find of ampere hour meter. (03 hrs.) 132. Test and calibrate ampere hour meter. (03 hrs.) 133. Measure power in single	**Ohm meters-** measuring electrical resistance. Basic construction of Ohm meter, working method of ohmmeter. Types of Ohm meter - series and shunt type of ohm meters. Megger/insulation tester, earth tester - construction working advantages and disadvantages of various types of ohm meter. AC **instruments** - types of AC measuring instruments -MI, electro dynamometer type, Working principle, construction, advantages and disadvantages of MI instruments and electro dynamometer instruments. Various applications. Electro dynamometer applications - as voltmeter, ammeter, power measuring instrument, energy measuring instrument, power factor meter etc. AC voltage and current measurement using PMMC meter (rectifier type). Induction type meters - working principle construction and operation of induction type instruments. Construction and Applications - single phase and three phase energy meter, watt meter. Walt hour meter, Ampere Hour meter, power factor meter etc. Special instruments: voltage

		and three phase circuit using voltmeter &ammeter. (05 hrs.) 134. Overhaul and maintenance of KWH meter and energy meter. (02 hrs.) 135. Test and calibrate KWH meter and energy meter. (03hrs.) 136. Measure power factor in three phase circuit by using power factor meter and verify the same with voltmeter, ammeter and wattmeter readings. (02 hrs.) 137. Practice of usevoltage tester to Test electrical power in circuit, to test for proper grounding, to determine whether adequate voltage is present in a wire. (02 hrs.) 138. Test continuity of wires, circuit and switches using continuitytester. (02 hrs.) 139. Practice to used rotation tester to: - determine 3 phase indication; Indication of phase rotation and Indication of motor rotation direction of runningmotor. (02 hrs.) 140. Determines the phase sequence of the three-phase supply system using Phase sequence indicator. (02 hrs.) 141. Identify different parts of	tester, continuity tester, rotation test, phase sequence indicator, synchronizing, the synchroscope, _ frequency meter. Thermocouple type ammeters. (21 hrs.)

		frequency meter and Measure the frequency of a periodic electrical signal. (02 hrs.) 142. Identify different parts of frequency meter AND Measure the frequency of a periodic electrical signal. (02 hrs.) 143. Identify different parts /section; check its function and operation of phase sequence meter and synchronoscope. (02 hrs.) 144. Practice to useSynchroscope for synchronizing the electrical machines. (02 hrs.)	
Professional Skill 100 Hrs. Professional Knowledge 28 Hrs.	Identify, Test various analog and power electronics components, Construct, test and analyze the circuit functioning.	145. Identify different types of diodes, diode modules and their specifications. (03hrs.) 146. Test the power diode, Zener diode, tunnel diode, photo diode using multi meter and determine forward to reverse resistance ratio. (04hrs.) 147. Determine V-I characteristics of semiconductor diode. (04hrs.) 148. Measure the voltage and current through a diode in a circuit and verify its forward characteristic. (04hrs.) 149. Measure the voltage and current through a Zener diode in a circuit and verify its forward and reverse	Semiconductor, Covalent bond, Doping, Intrinsic and extrinsic semiconductor. PN junction diode, Forward and Reverse characteristics. Specification of diodes (data sheets). Applications of diode. Special semiconductor diode-Zener diode, tunnel diode, Photo diode. **Transistors.** Defining transistors, NPN& PNP transistor, Symbol, operation, Biasing of Transistor & mode of Application. Transistor CB, CC, CE Amplification, current gain, voltage gain, and power gain. Introduction to FET, MOSFET. **Rectifiers:** half wave rectifier, full wave (bridge & center

		characteristic. (02hrs.) 150. Identify and check different type of transistors their package and specification. (02 hrs.) 151. Construct and test fixed-bias, emitter-bias and voltage divider-bias transistor amplifier. (03 hrs.) 152. Construct and Test a common emitter amplifier with and without bypass capacitors (03 hrs.) 153. Construct and Test common base amplifier. (03 hrs.) 154. Construct a single stage amplifier and measure current gain, voltage gain & power gain. (02 hrs.) 155. Identify different power electronic components, their specification and terminals. (03 hrs.) 156. Construct and test a FET Amplifier. (03 hrs.) 157. Identify variousPower MOSFET by its number and test by using multimeter. (02 hrs.) 158. Identify different heat sinks used with power MOSFET test circuit with a small load. (01 hr.) 159. Identify different types of transformers and test. (03 hrs.) 160. Identify the primary and secondary transformer windings and test the	tapped) rectifier. Voltage multipliers. Filters: Introduction, purpose and use of ripple filter. Types of filters. Capacitance filter, inductance filters, RC filters, LC filters, voltage dividers and bypass filters. **Voltage regulators.** Introduction & purpose Zener regulators, shunt regulators, series regulators, IC regulators, variable regulators. (28 hrs.)

		polarity (02 hrs.) 161. Construct and test a half wave, full wave and Bridge rectifier circuit. (05hrs.) 162. Construct and test different filter circuit used in rectifier and measure output voltage with load. (04hrs.) 163. Measure ripple voltage, ripple frequency and ripple factor of rectifiers for different load and filter capacitors. (04hrs.) 164. Construct and test voltage doubler and Tripler. (03 hrs.) 165. Construct and test Zener based voltage regulator circuit. (8hrs.) 166. Construct and test Zener based shunt regulator. (9hrs.) 167. Construct and test Zener and transistor-based series regulator. (09hrs.) 168. Construct and test a +12V fixed voltage regulator. (04hrs.) 169. Construct and test a fixed +15ve and –15ve voltage regulator using ICs. (04hrs.) 170. Construct and test a 1.2V – 30V variable output regulated power supply using IC LM317T and its characteristics. (05 hrs.)	
Professional Skill 25 Hrs. Professional	Detect the faults and troubleshoot SMPS, UPS, inverter, converterand	179. Identify the components/devices and draw their corresponding symbols. (02 hrs.)	**Power Supply units.** Introduction, purpose & use. UPS and SMPS, inverters and converters and their

Knowledge 07 Hrs.	Thyristor family.	180. List the defect and symptom in the faulty SMPS. (02 hrs.) 181. Measure / Monitor major test points of computer SMPS. (03 hrs.) 182. Troubleshoot the fault in the given SMPS unit. Rectify the defect and verify the output with load. Record your procedure followed for trouble shooting the defects. (04 hrs.) 183. Identify front panel control & indicators of UPS. (02 hrs.) 184. Open top cover of a UPS; identify its isolator transformers, the UPS transformer and various circuit boards in UPS. (03 hrs.) 185. Perform load test to measure backup time. (02 hrs.) 186. Install and test an inverter. (03 hrs.) 187. Troubleshoot the fault in the given inverter unit. Rectify the defects and verify the output with load. (02 hrs.) 188. Construct and test thyristor-based devices and check SCR, DIAC, TRIAC and other discrete components. (02 hrs.)	applications. **Thyristor devices:** basic description and applications of SCR, TRIAC, DIAC. (07 hrs.)
Professional Skill 25 Hrs.	Identify, place, solder and desolder	189. Measure and plot input and output characteristics of a	General characteristics of an amplifier, Concept of

Professional Knowledge 07 Hrs.	and test different SMD, discrete components with due care and following safety norms using proper tools/setup.	CE amplifier. (05 hrs.) 190. Check for cold continuity of PCB. (03 hrs.) 191. Solder the SMD components from the given PCB. (04 hrs.) 192. De-solder the SMD components in the same PCB. (04 hrs.) 193. Identify loose /dry solder, broken tracks on printed wired assemblies. (04 hrs.) 194. Repair solder mask and damage pad. (03 hrs.) 195. Construct and test a CE amplifier and measure the AC & DC load line. (02 hrs.)	amplification. Types of Amplifiers. Effect of temperature. DC load line and AC load line. PCB basic construction, applications. Lay outing circuit on PCB. (07 hrs.)
Professional Skill 25 Hrs. Professional Knowledge 07 Hrs.	Identify, Test various analog and power electronics components, Construct, test and analyze the circuit functioning.	**Oscillators** 196. Demonstrate Colpitts oscillator, Hartley oscillator circuits and compare the output frequency of the oscillator by CRO. (07 hrs.) 197. Construct and test a RC phase shift oscillator circuits. (05 hrs.) 198. Construct and test a crystal-controlled oscillator circuit. (05 hrs.) 199. Construct and test a clapp oscillator circuits. (04 hrs.) 200. Construct and test different type of ICs based Oscillator circuit. (04 hrs.)	**Oscillator's** oscillations, oscillation frequency, basic working principle and working of Talk circuit, Crystal controlled oscillators, Phase shift oscillators, RC phase shift oscillators, Colpitt, Clapp, Hartley, and IC oscillators. (07 hrs.)
Professional Skill 50Hrs.; Professional Knowledge	Construct and test different circuits using operational amplifiers circuits and execute the	201. Use analog IC tester to test the various analog ICs. (03 hrs.) 202. Construct and test various Op-Amp circuits Inverting,	**Operational Amplifier.** Differential amplifier, ideal op-amp. Op-amp with feedback, advantages of feedback.

14Hrs.	result.	Non-inverting and Summing Amplifiers. (08 hrs.) 203. Construct and test Differentiator and Integrator circuits. (05 hrs.) 204. Construct and test a voltage to current and current to voltage converter circuit using Op-amp. (04 hrs.) 205. Construct and test Instrumentation amplifier (05 hrs.) 206. Identify the pin configuration and check the output voltage of the pins. (03 hrs.) 207. Construct and test Astable timer circuit using IC 555. (03 hrs.) 208. Construct and test mono stable timer circuit using IC 555. (06 hrs.) 209. Construct and test VCO (V to F Converter) using IC 555. (05 hrs.) 210. Construct and test 555 timers as pulse width modulator (05 hrs.) 211. Construct and test automatic delay on circuit using 555 IC and other discrete components. (03 hrs.)	Inverting and Non inverting and inverting amplifier, Op-amp as summer, differential amplifier. V to I converter and I to V converter, Instrumentation amplifier Basics of op- amp applications - integrator, differentiator, Introduction of timers (555) and its applications. (14hrs.)
Professional Skill 150 Hrs. Professional Knowledge 42Hrs.	Identify, test and Verify all digital ICs. Assemble, test and troubleshoot various digital circuits and	212. Identify different Logic Gates (AND, OR, NAND, NOR, EX-OR, EX-NOR, NOT ICs) by the number printed on them. (05hrs.) 213. Verify the truth tables of all	**Number systems;** binary, octal, decimal and hexadecimal number system. Conversion of number systems. Boolean algebra, binary addition, subtraction, multiplication and

	digital instruments.	Logic Gate ICs by connecting switches and LEDs. (06hrs.) 214. Construct and verify the truth table of all the gates using NAND and NOR gates. (06hrs.) 215. Use digital IC tester to test the various digital ICs (TTL and CMOS). (07hrs.) 216. Construct and verify the truth table of all the gates using DTL circuit. (05hrs.) 217. Construct Half Adder circuit using ICs and verify the truth table. (03 hrs.) 218. Construct Full adder with two Half adder circuit using ICs and verify the truth table. (04hrs.) 219. Construct Half subtractor and full subtractor circuit using ICs and verify the truth table. (02 hrs.) 220. Construct the adder cum subtractor circuit and verify the result. (02hrs.) 221. Identify different Flip-Flop (ICs) by the number printed on them. (03 hrs.) 222. Construct and test R-S flip-flop using IC7400 with clock and without clock pulse. (03 hrs.) 223. Verify the truth tables of JK Flip-Flop using ICs by connecting switches and LEDs. (06 hrs.) 224. Construct and test 7493 as	division. 1's and 2's compliment, BCD code, ASCII code, gray code. **Logic Circuits.** Basic gates-AND, OR and NOT gates. De-Morgan \s Theorem. Universal gates - NAND and NOR gates. Special gates - Ex-OR, Ex -NOR gates and Buffer and its applications. Basic digital ICs, function, digital application, logic symbols. Adders - Half adder, full adder Subtractor - Half subtractor, full subtractor. Flip flops - RS flip flop, clocked RS flip flop, JK flip flop, Basics of Counters and registers. Multiplexer and de--multiplexer. Encoder and decoder. BCD display, BCD to decimal decoder. BCD to 7 segment display circuits. Digital meters: displays: LED, 7 segment display, LCD, CRT, electro- luminescent displays, electro-phoretic image display, liquid vapor display, dot matrix display. (28 hrs.)

		a modulus-12 counter. (04 hrs.) 225. Construct and test a four-bit Synchronous binary counter using 74163. (05 hrs.) 226. Construct and test synchronous Decade counter. (04 hrs.) 227. Construct and test an up/down synchronous decade counter using 74190 and monitor the output on LEDs. (04 hrs.) 228. Construct and test a multiplexer and de-multiplexer circuit using ICs. (04 hrs.) 229. Identify and test common anode and common cathode seven segment LED display using multi meter. (03 hrs.) 230. Construct and test octal to binary encoder & decoder circuit using IC 74148 and IC 74132. (03 hrs.) 231. Construct and test decimal to BCD encoder using IC 74147 and seven segment LED display. (04 hrs.) 232. Construct and test seven segment LED display decoder with IC 7447. (05 hrs.) 233. Measure current flowing through a resistor and display it on LED Module. (07 hrs.)	

		234. Identify different parts, its function and operation of LCD, CRT, Electro-luminescent displays, electro-phoretic image display, liquid vapour display and dot metrix display. (05hrs.)	
		235. Identify different parts, its function, operation &specification of D/A and A/D circuits. (04 hrs.) 236. Construct and test Digital to Analog (D/A) Binary Weighted resistor converter by using op-amps. (04 hrs.) 237. Construct and test Digital to Analog (D/A) converter using R-2R ladder network circuit. (04 hrs.) 238. Construct and test Digital Ramp Analog to Digital Converter (ADC) circuit. (04 hrs.) 239. Perform the interfacing of IEEE 488.2 standard with a single controller can control up to 15 different instrument connected star topology. (03 hrs.) 240. Identify different pins, signal and source of RS232. (02hrs.) 241. Perform the interfacing of RS232 to the PC. (02 hrs.) 242. Convert RS-485 signals to RS-232 signals using RS-485 to RS-232 converter. (02	**A/D and D/A converters,** Introduction, weighted register D / A converter, binary(R-2R) ladder D / A converter, specification for D / A converter, Ramp or counter type A/D converter, GPIB (general purpose interface bus) IEEE - 488, RS 232. (07hrs.)

		hrs.)	
		243. Identify different parts, its function and operation of frequency meter, phase measuring meter, time measuring instrument and digital capacitance meter. (04 hrs.) 244. Identify LED Display module and its decoder/driver ICs. (03 hrs.) 245. Display a word on a two-line LED. (03 hrs.) 246. Measure/current flowing through a sensor and display it on a LED module (DPM). (03 hrs.) 247. Practice on measuring instruments in single and three phase circuits e.g. Phase sequence meter and Frequency meter etc. (03 hrs.) 248. Identify the different capacitors and measure capacitance of various capacitors using digital capacitance meter. (04 hrs.) 249. Practice on time measuring instrument to measure the time in different electrical control circuit. (05 hrs.)	Digital meters: frequency meter, phase measuring meter, and time measuring instruments. Digital capacitance meter. (07hrs.)
Professional Skill 25 Hrs. Professional	Measure the various parameters by CRO and execute the result with standard	250. Identify the different front panel control of a CRO. (06 hrs.) 251. Measure the Amplitude,	CRO:introduction and applications of CRO, functional block diagram of CRO, CRT power supply.

Knowledge 07 Hrs.	one.	Frequency and time period of typical electronic signals using CRO. (07 hrs.) 252. Take a print of a signal from DSO by connecting it to a printer and tally with applied signal. (07 hrs.) 253. Identify different types of CRO probes used to measure the signals. (05 hrs.)	Various types of probes. Applications of various types of CROs like dual beamCRO, Dual trace CRO, storage oscilloscope. (07 hrs.)
Professional Skill 75 Hrs. Professional Knowledge 21 Hrs.	Install and setup operating system and related software in a computer &Practicewith MSoffice and application software related to instruments.	254. Identify PC components and devices. (02 hrs.) 255. Practice on windows interface and navigating windows. (04 hrs.) 256. Customize the desktop settings and manage user accounts. (05 hrs.) 257. View system properties and control panel details. (04 hrs.) 258. Install necessary application software for windows i.e. office package and media player. (03 hrs.) 259. Familiar with Multi Media System consisting of CD ROMS, DVD ROMS, Sound Cards. (03 hrs.) 260. Burn data, video and audio files on CD/DVD using application software. (04 hrs.)	Introduction to Computer, Block diagram of PC, software familiarization of Multimedia System consisting of CD ROMS, DVD ROMS, Sound Cards. (07hrs.)
		261. Identify different parts, its function and operation of CPU. (05 hrs.) 262. Familiar with different CPU operations. (08 hrs.)	Computer Hardware, Computer systems, computer hardware, CPU, CPU operations, ROMs and RAMs, I/P and O/P and peripheral

		263. Identify various computer peripherals and connect it to the system. (07 hrs.) 264. Dismantle and assemble the desktop computer system. (05 hrs.) 265. Replace RAM and ROM from CPU. (04 hrs.) 266. Install driver for printer and print document using different commands. (06 hrs.) 267. Identify different parts, its function and operation of modem. (05 hrs.) 268. Install a modem to the computer to send and receive data over a telephone line or a cable or satellite connection. (04 hrs.) 269. Construct and test DAC and ADC using computer network circuit. (06 hrs.)	equipments, terminals, printers, MODEMS, Data interface, ADC and DAC. (14 hrs.)
Professional Skill 50Hrs. Professional Knowledge 14Hrs.	Identifyvariousfunctional blocks of a microprocessorsystem, identifyvarious I/O Ports, write and executive simple program and Interfaceamodel application with the microprocessor kit and run the application.	270. Identify various ICs & their functions on the given Microprocessor Kit. (5hrs.) 271. Identify the address range of RAM & ROM. (2hrs.) 272. Measure the crystal frequency, connect it to the processor. (04hrs.) 273. Identify the port pins of the processor & configure the ports for Input & Output operation. (04hrs.) 274. Use 8085 microprocessor, connect 8 LED to the port, blink the LED with a switch.	Introduction to microprocessor microcomputers, Memories Intel 8085. Architecture Instruction set of 8085, Microprocessor. 1. Data transfer group. 2. Arithmetic group. 3. Logic group. (07hrs.)

		(05hrs.) 275. Familiar with instruction set of 8085 microprocessor Data transfer group, Arithmetic group and Logic group. (05hrs.)	
		276. Perform addition and subtraction of two 8-bit numbers using 8085 microprocessors. (05 hrs.) 277. Demonstrate entering of simple programs, execute &monitor the results. (08 hrs.) 278. Write a programme in assemble language load accumulator with 8-bit data and transfer the data accumulator to B register. (03 hrs.) 279. Write a programme in a assemble language data to load two 8-bit data into two memory location add them result be store in another memory location. (04 hrs.) 280. Identify different parts, pins diagram, function and operation of 8255. (05 hrs.)	Basic Programming of 8085 such as adding, subtraction of two 8-bit numbers, etc. Block diagram and pin' diagram 8255 and its operation. Microprocessor applications. (07 hrs.)

Project Work/Industrial Visit (optional)

Broad Areas:

a) Regulated & Unregulated Power Supply
b) BatteryMonitor& Charger
c) EmergencyLight
d) Electronic Fan Regulator
e) SCR, Using UJT Trigger Circuit.
f) Dimmer circuit using Triac and Diac.
g) DancingLEDs
h) DigitalClock
i) EventCounter
j) A to D Convertor.

SYLLABUS FOR INSTRUMENT MECHANIC TRADE			
SECOND YEAR			
Duration	**ReferenceLearning Outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
Professional Skill 75 Hrs. Professional Knowledge 27 Hrs.	Identify the parameters of measurement systems. Identify, select, test, wire & Execute the operation of different process sensors by selecting appropriate signal conditioning for stress, strain, load displacement and Thickness.	281. Identification of various instruments by their specifications. (04hrs.) 282. Finding the range, span and accuracy of instrument (example- ammeter, voltmeter etc.). (04hrs.) 283. Identifying the measuring units of instrument and Calculating resolution, multiplication factor of meter (multirange meter or analog multimeter). (04 hrs.) 284. Test the voltmeter/ammeter using std. voltage/ current source for total range. Check the dead zone, repeatability, reproducibility,drift,Dead band,backlash, hysteresis. (09 hrs.) 285. Check the speed of response and lag of measuring instruments. (04 hrs.) 286. Identify the strain gauge type, cantilever or load cell specification. (04 hrs.) 287. Check the strain gauge using ohm meter / multimeter. (04 hrs.)	Scopeandnecessityof instrumentation. Fundamentalsofmeasurement systems-functional block diagram of measurement system. Calibration and calibration standards– basic standards, secondary standards, working standards. Fundamental units - The metric system, Base& supplementary units, Derived Units, Multiplying factors and standards of length, mass, time & frequency. Temperature&electricalunits. Instrument characteristics Staticcharacteristics– accuracy, precision, sensitivity,resolution dead zone, repeatability, reproducibility,drift,Dead band,backlash, hysteresis. Dynamiccharacteristics– speed response,fidelity,lag. Error,deviation,true value, data. Types of errors- systematic, random& illegitimateerror. Certainty/uncertainty, validity Of result.Measuring system Response.Introduction, amplitude responses, Phase

		288. Measure the load using strain gauge instrument. [using half (two), quarter(one), full (four) strain gauges on bridge]. (04 hrs.) 289. Determine the sensitivity, liner range of strain gauge measurement. (04 hrs.) 290. Make null balance and gain adjustment. Calibrate strain gauge instrument by adjusting zero and span. (04 hrs.) 291. Identifying the various parts of LVDT. Study the specification of LVDT like range, exiting frequency, voltage, sensitivity etc. (04 hrs.) 292. Identifying the coils in LVDT. Verifying the connection of secondary coils. Testing the LVDT coils using multimeter. (03 hrs.) 293. Verify the LVDT characteristics by changing the displacement. (04 hrs.) 294. Determine the liner range and sensitivity, resolution of LVDT. (04 hrs.) 295. Measure the phase difference of LVDT secondary coils on CRO. (04 hrs.) 296. Calibrate the LVDT by adjusting zero and span. (03 hrs.) 297. Identify Construction	response, Delay,risetime&slew rate. Damping&its importance. Statisticalanalysis – arithmetic mean,deviation fromthe meanaverage deviation, standard deviation. Stress &Strain Measurement. Introduction toStrain gauges, types ofstraingaugesand differences. Applicationsof straingauges,load cells. LVDT, RVDT,advantages andlimitations. (27hrs.)

		&Operation of instruments used for Displacement, Acceleration, and Thickness. (03hrs.) 298. Test and calibrate displacement meter, accelerometer and thickness instruments. (05hrs.)	
Professional Skill 50 Hrs. Professional Knowledge 18 Hrs.	Select, Installs, services and calibrate instruments for motion, speed, position, acceleration, vibration & record the data.	299. Identify different parts, its function &Operation of vibrometers and accelerometer and Study of Construction. (07hrs.) 300. Measure the vibration of motor/ machine. (06hrs.) 301. Servicing and maintenance vibrometers & accelerometer. (07hrs.) 302. Identify different parts, its function &Operation of mechanical tachometer and Study Construction. (06hrs.) 303. Measure the speed of motor. (05hrs.) 304. Identify different parts, its function &Operation of eddy current, type AC and DC tachometer. (08 hrs.) 305. Servicing and maintenance of mechanical and electrical tachometer. (06 hrs.) 306. Identify different parts/section, its function &Operation and useStroboscope and find motion of object. (05hrs.)	Measurementofmotion, velocity / vibrometersand acceleration. Difference betweentachometer and speedometers. Types oftachometers-Eddy currenttype, AC and DC tachometer.Stroboscope and its applications. seismic instrument. (18 hrs.)
Professional Skill 150Hrs.	Identify different unit of pressure,	307. Familiar with different unit of pressure and conversion.	PrincipleofPressurein Liquids&Gases.Propertiesof

Professional Knowledge 54Hrs.	terms and operation of basic instruments. Perform maintenance, Servicing calibration and installation of field pressure gauges, switches, electronic pressure indicators and transmitters for absolute, atmospheric, gauge, vacuum and differential pressure measurement.	(02 hrs.) 308. Study the specifications, construction and identifying various parts of android barometer. (04 hrs.) 309. Measure the atmospheric pressure using barometer. (04 hrs.) 310. Check the changes in barometer by applying the air using suction and blow pumps (simple pumps). (03 hrs.) 311. Identify the various types of manometers. (02 hrs.) 312. Identify specification and construction of each manometer and find their range, scale type, resolution, type of liquid using, tube material, isolation valve types, fitting types and sizes, zero adjustment and spirit bubbler etc. (02 hrs.) 313. Measure the differential pressure, gauge pressure and vacuum pressure using U tube manometer. (02 hrs.) 314. Measure gauge and vacuum pressure using well type and inclined manometer. (02 hrs.) 315. Dismantle and assemble the manometer. Cleaning the glass tube, aligning the gravity balances etc. (02 hrs.)	matterPrinciplesofliquid pressure, units of pressure Liquids pressureandvolume, densityand specificgravity. Factorsaffecting liquid pressure.Pressure relationwith volume,temperatureandflow. Units ofpressureand unit conversions. Types ofpressure:absolute, gauge, atmospheric andvacuum pressuresand their relationships. Barometers,manometerstypes andapplications. (09hrs.)

		316. Calibrate the manometer using standard gauge. (02 hrs.)	
		317. Identify the various types of pressure gauges – gauge pressure, vacuum pressure, absolute, compound etc.(04 hrs.) 318. Identify the basic specifications of gauge like range, resolution, size of dial, type of sensor (symbol), sealed type, liquid filled or dry, number scales, connection type, threading size and type-(male, female NPT/SAE), body material, mounting type (back or bottom) etc. (03 hrs.) 319. Dismantle and assemble the pressure gauge (bourdon tube, diaphragm type), Identify the various parts like sensing element, link, liver, pinion gear, hair spring, pointer size shape material, sensor material etc.(03 hrs.) 320. Measurement of gauge pressure and vacuum pressure using bourdon tube / diaphragm gauge.(03 hrs.) 321. Measurement of differential pressure using diaphragm/ capsule gauge.(02 hrs.) 322. Identify specifications of pressure switch – range, differential pressure span,	Types of pressure sensing elements-bourdon tube, diaphragms, capsules, and bellows. Eachontypes, shapes, material used for various applications, ranges advantages and limitations. Pressureswitches typesand applications. (09hrs.)

		contact types, contacts current rating, number of contacts etc.(02 hrs.) 323. Dismantle and assemble the pressure switch – identify the various parts- sensing elements, control spring, pressure and differential pressure adjustment screws, shaft arrangement pivoting, contacts relay operation and change of contacts. Type of material using for various parts etc. (04 hrs.) 324. Connect and operate the pressure switch with load at various pressure and differential pressure settings. Make adjust the errors screws. (04 hrs.)	
		325. Identify the basic specifications of pressure indictor/ transmitter (electronic) like range, resolution, size of display, type of sensor (symbol), sealed type, number scales, connection type, tap threading size and type- (male, female NPT/SAE), body material, mounting type (back or bottom) etc. (05 hrs.) 326. Test and operating the pressure transmitter with supply, milli ammeter, pressure source (pneumatic/hydraulic).	Electricalpressure transducers. Method of conversion, primary and secondary pressure transducers. Potentiometricpr. Transducers, Capacitivepr. transducers, reluctance-servo pressure transducers, strain gauge pressure transducers, piezo electric pressure transducer. Differentials pressure transducers. (09hrs.)

		Finding the resolution, accuracy etc.(04 hrs.) 327. Familiar with pressure calibrator controls and settings. (04 hrs.) 328. Calibrating the pressure gauge using standard meter/ pressure calibrator. (04 hrs.) 329. Measuring gauge, vacuum and differential pressure using DP transmitter. (04 hrs.) 330. Calibrating the DP transmitter using standard meter / pressure calibrator. (04 hrs.)	
		331. Study the specification, construction and identification of various parts in Mcleod Gauge. (03 hrs.) 332. Measuring low pressure/ vacuum using McLeod gauge. (03 hrs.) 333. Study construction, Operation and use of thermalconductivity gauges& measure the vacuum. (04hrs.) 334. Study construction, & Operation of piranigauges, & measure the vacuum. (04hrs.) 335. Study specifications, construction, Operation of Standard Calibrator/Dead weight Tester. (03hrs.) 336. Test & calibrate of Pressure	Low Pressure Measurement. Vacuum, gauges, thermal conductivity gauges, pirani gauges, thermocouple gauges, slack diaphragm. Ionization gauge, McLeod gauge, capacitance manometers. Method ofpressure instrument calibration. Dead weight tester and comparators/manifolds. (09hrs.)

		gauges, indicators, transmitters with Dead weight Tester. (04 hrs.) 337. Test & calibrate of Pressure gauges, indicators, transmitters with comparator Tester. (04 hrs.)	
		338. Familiar with pressure Installation components, impulse line, safety guideline and accessories. (06 hrs.) 339. Installation of pressure gauge in pipeline with safety valve and pig tail /siphon etc. measuring pressure in flow line. (07 hrs.) 340. Installation and testing of pressure switch and pressure relief valve with compressor. (08 hrs.) 341. Installation and testing of pressure switch with solenoid and alarm in process line. (06 hrs.) 342. Fault finding in pressure gauge. (08 hrs.) 343. Simple fault finding in pressure transmitter. (08 hrs.) 344. Fault finding in pressure process line. (07hrs.)	Pressure Instrument Installation and Servicing. Elements of pressure transmitters, Installationcomponents, pressuretaps, Isolation valve, instrument piping, connections and fittings blow down valve, instrument valve, pulsation damper, diaphragm seal, pressure transmitter, Installation, procedure, locating and mounting, piping, electrical wiring placing into service, guidelines for periodic maintenance, troubles shooting and repair, instrument shop safety. (18hrs.)
Professional Skill 100Hrs. Professional Knowledge 36Hrs.	Recognize the fundamental of fluid flow, terms, different unit of flow, read specification of flow	345. Familiar with flow units on instruments and converting in various forms. (01hr) 346. Familiar with specifications of flow meter.(02 hrs.) 347. Measurement of pressure in	Properties of Fluid Flow. Basic properties of fluids, fluids in motion, getting fluids to flow, units of flow rate and quantity flow, factors affecting flow rate, Reynolds number,

	meters. And fluid pump. Perform the maintenance, Servicing and calibration and installation of variable DP flow meters / head flow meters, variable area flow meters, positivedisplacemen tmeters, Electronic type flow meters and mass flow meters for fluids flow measurement.	flow line with different flow rates. (03 hrs.) 348. Measurement of flow rate using fixed volume tank. (02hrs.) 349. Operating fluid pump and observing the pressure at input and output. verifying flow variation by adjusting bypass line. (02hrs.) 350. Study the construction of venturi tube. Measuring inlet outlet thought, tap sizes. Identifying material end connection types etc. (02hrs.) 351. Identifying various types of orifices. Identifying various parts. (02hrs.) 352. Identifying the flow nozzle and identifying various parts. (02hrs.) 353. Identifying the pitot tube and its parts. (01hr) 354. Measurement of DP of venturi and orifice using manometer. (02hrs.) 355. Measurement of DP using DP gauge. (02 hrs.) 356. Adjusting the valves of manifold and observing the changes in DP gauge. (02 hrs.) 357. Calibrating the pneumatic DP transmitter for flow rate measurement. (02 hrs.) 358. Calibration electronic DP transmitter for flow rate. Verifying the square root	relation between flow rate and pressure, area, quantity. Typesof flow meters –head type, variable area type, quantitative flow meters. Mass flow meters. Head type of flow meters: working principle, types- venturi tube, orifice plates and its shapes. Pitot tube, flow nozzles, constructions, tapings, advantages, limitations, applications, materials used for various flows. Types of secondary devices used to measure for flow rates. Open channel flow meters- principle of open channel flow, weirs, notches and flumes. Various shapes and their applications, maintenance, Variable area type flow meter- Rota meter, constructions, working principle, applications. Various shapes of float, type of materials used for body and float. Factors affecting rotameter performance, measuring gas and liquid flow. Positive Displacement. Meters. Advantages and disadvantages of positive displacement meters, piston meter, oscillating piston meter, rotating vane meter, notating disk meter, lobed impeller and oval flow meter, calibrating positive displacement meters.

		relation and linear relation of DP. (02 hrs.) 359. Installing a head type flow meter with venturi or orifice, manifold and DP, milli ammeter or indicator, supply. Measuring flow rate in line. (02hrs.) 360. Calibrating head type flow meter with standard volumetric tank. (02hrs.) 361. Dismantling, checking, overhauling and calibration of D.P.cell/ transmitter. (Pneumatic & electronic). (02hrs.) 362. Identify and carry out preventive maintenance. (02hrs.) 363. Study of construction of weirs,notches andflumes theirshapeandconnectionsa nd use. (03hrs.) 364. Study of construction and identifying various parts of rotameter. (03 hrs.) 365. Dismantling,checking overhauling andcalibration of Rota meters. (05hrs.) 366. Identify and carry out preventive maintenance of Rota meters. (04 hrs.) 367. Install and testing of Rota meters in flow line. Vertical alignment. (04 hrs.) 368. Measurement of flow rate and calibrating rotameter. (03 hrs.) 369. Identification of various	Target flow meters, turbine flow meter, magnetic flow meters, vertex flow meter. Construction, working principle, advantages and disadvantage, applications. Carioles mass flow meter, thermal flow meters and summary basics of ultrasonic flow meters. The Doppler hit method. The beam deflection method, frequency difference method. (36hrs.)

		types of quantitative flow meter. Read the specification of various typesofpositivedisplacemen tmeters. (03hrs.) 370. Dismantle, identify different parts, its function, AND operation of various typesof positivedisplacement meters. (04hrs.) 371. Study the dial of flow meters and calculating flow indicated on display. (03hrs.) 372. Installation, testing and calibrating quantitative flow meter. (03hrs.) 373. Dismantle andassemble quantitative flow meters like Oscillatingpiston type, Rotating vane meter, Lobed impeller andoval flow meter. (03hrs.) 374. Identify and carry out preventive maintenance ofpositivedisplacement flow meters. (03hrs.) 375. Study the specifications, construction and identify the various parts of turbine flow meter. (04hrs.) 376. Installation, testing and calibration of turbine flow meter. (04hrs.) 377. Study the specifications, construction and identify the various parts of vortex flow meter. (04hrs.) 378. Installation, testing and	

		calibration of vortex flow meter. (04hrs.) 379. Study the specifications, construction and identify the various parts of ultrasonic flow meter. (04hrs.) 380. Installation, testing and calibration of ultrasonic flow meter. (04hrs.)	
Professional Skill 25 Hrs. Professional Knowledge 09 Hrs.	Identify, operate, maintain, troubleshoot and calibrate the devices for solid flow measuring system & verify the result within standard.	381. Study the specifications, construction and identify the various parts of mass flow meter. (04 hrs.) 382. Installation, testing and calibration of mass flow meter. (04 hrs.) 383. Measuring semi solid liquid flow rate using flow meter. (04 hrs.) 384. Calibrating and adjustment of flow meter for solid flow. (04 hrs.) 385. Identify and carry out maintenance& preventive maintenance of solid flow measuring system. (05 hrs.) 386. Service and calibrate solid flow meter. (04hrs.)	Meteringtheflowofsolid particles.Measuring volumetricand mass flow rate of solids,volumetricsolids flow meter, mass flow meterfor solids, belt type solid metersbelttypesolidmeters beltspeedsensingand signal processing, slurries, constant weight feeders. (09 hrs.)
Professional Skill 75Hrs. Professional Knowledge 27Hrs.	Identify, select, wire & Execute the operation of different types of level instruments use for liquid level and solid level. Carry out maintenance, Servicing,calibration and Installation.	387. Familiar with open and closed process vessel for liquid and solid measuring system. (02 hrs.) 388. Measurement of liquid level using stick gauge and converting liquid level into volume and mass (using specific gravity). (03 hrs.) 389. Study the construction and	Principles of level measurement. Types of level measurements-solid and liquid, volume and mass, mechanical and electrical type. Surface sensing gauges, storage tank gauges, sightglasses, magnetic gauges, buoyancy, displacement gauges. Factors need to

		operation of various types of sight glasses. (03 hrs.) 390. Installation, testing and calibration of liquid level indicator. (03 hrs.) 391. Cleaning the glass tube and operating the isolation valves, calibrating zero adjustments. (03 hrs.) 392. Identify different parts, its function, and operation of various types of floats and displacers liquid level indicators. (03 hrs.) 393. Calibrating and Measuring the liquid level using float type, displacer type level systems. (03 hrs.) 394. Identify test and use different types of level switches for liquid vessel. (03 hrs.) 395. Identify and carry out maintenance& preventive maintenance of displacers liquid level indicators and switches. (03 hrs.) 396. Measuring the liquid level of open and close tank using pressure / DP gauge. Converting liquid height into pressure using liquid density. (03 hrs.) 397. Calibrating DP transmitter for liquid level measurement. Adjusting square root to linear scale display. (03 hrs.) 398. Installation, testing	consider for open and closed channel level measurements level switches, mercury level switches in high pressure tank, level detectors, magnetic reed switches. Pressure head instruments. Hydrostatic pressure, specific gravity, pressurized fluids, pressure head instrumentation, air bellows, U- tube manometers, air purge systems, liquid purge systems, force balance diaphragm system. Electrical method conductivity and capacitance method for. measuring the liquid level, capacitance probes, zeroand span adjustments, sonic level detectors,point level detection. Solid level measurement Using weight to determine level, sonic solid level measurement with microwaves, using capacitance probes to measure solid level, diaphragm switches, nuclear gauges, microwave solid level detectors. (27hrs.)

		measurement of liquid level using air purge level measurement. (03 hrs.) 399. Service and calibrate different types level indicators and transmitters. (02 hrs.) 400. Identify and carry out maintenance& preventive maintenance of above level indicators and transmitters. (02 hrs.) 401. Construct and operate conductivity probe Level indicator. (03 hrs.) 402. Construction and operation of capacitanceprobes indicating transmitters and sonic level detector. (03 hrs.) 403. Install and test capacitanceprobes indicating transmitters and sonic level detector. (03 hrs.) 404. Service and calibrate capacitance probes indicating transmitters and sonic level detector. (03 hrs.) 405. Identify and carry out maintenance& preventive maintenance of above level indicators and transmitters. (04 hrs.) 406. Study the construction, operation and use of load cell technique todetermine solid level in vessel. (04 hrs.)	

		407. Study the construction, operation and use of different types of solid level switches. (04 hrs.) 408. Study the construction, and operation of capacitance probes transmitters, microwave level detector / gauges. (04 hrs.) 409. Install and test various types of solid level indicating transmitters and sonic level detector. (04 hrs.) 410. Service and calibrate various types of solid level indicating transmitters and sonic level detector. (02 hrs.) 411. Identify and carry out maintenance& preventive maintenance of above level indicators and transmitters. (02 hrs.)	
Professional Skill 25 Hrs. Professional Knowledge 09 Hrs.	List out different unit of temperature, terms and read specification of temperature instruments. Perform measurement,maintenance, Servicing and calibration ofBimetallic and filled system thermometers &thermo switches.	412. Identifying temperature scales on instruments and their ranges Familiar with different unit of temperature and conversion into other. (04hrs.) 413. Identify different types of heating sources and their controls and study the safety futures. (04hrs.) 414. Study the construction, operation and use of temperature-controlledoilbath/furnacefo	Temperature measurement. Temperature,heat, specific heat, changing physical state Fahrenheit and Celsius temperature scales Rankin and Kelvin scales, calibration of temperature scales primary and secondary standards. Industrial application of temperature measuring instruments with compensating link & precautions to be taken. Bimetallic and fluid filled temperature instruments.

		rlowandhightemperature. (02hrs.) 415. Identify different types of thermometers and measure the temperature &Check the accuracy. (02hrs.) 416. Dismantling identify different parts, its function, adjustment, assemble and operation of Bimetallic and fluidfilled (liquid, gas and vapour) system thermometers & thermo switches. (03hrs.) 417. Install and test various types of thermometers and switches. (02hrs.) 418. Service and calibrate various types of thermometers and switches. (03hrs.) 419. Identify and carry out maintenance& preventive maintenance of thermometers and switches. (05 hrs.)	Bimetallic thermometers, liquid-in-glass thermometers, filled system thermometers, thermometer bulbs, capillary & bourdon tube, temperature transmitters for filled system, advantages & disadvantages of filled systems. (09 hrs.)
Professional Skill 50Hrs. Professional Knowledge 18Hrs.	Identify, select, evaluate performance, install, service and calibrate temperature Indicators, Transmitters (RTD'S, Thermistors and Thermocouples types) various type of pyrometers and instruments for humidity.	420. Identify and check different types of RTD's, and Thermistors for temperature measurement. (02hrs.) 421. Verify the characteristics of different types of RTD's, and Thermistors. (03hrs.) 422. Study circuit operation of signal conditioner for RTD's, and Thermistors. (03 hrs.) 423. Install and test various	Electrical temperature instrument. Resistance thermometer, how it works, RTD bridge circuits, lead wire error, RTD elements. (06hrs.)

		types of two and three wire RTD transmitters. (03hrs.) 424. Service and calibrate various types of RTD transmitters using temperature calibrator or resistors. (03hrs.) 425. Identify and carry out maintenance& preventive maintenance of various types of RTD transmitters. (03hrs.)	
		426. Identify and check different types of Thermo-couples,Ex-tension wires and protecting wells. (02hrs.) 427. Verify the characteristics of different types of Thermocouples. (02hrs.) 428. Study circuit operation of signal conditioner for Thermocouples based indicator and transmitters. (03 hrs.) 429. Install and test various types of Thermocouples based indicator and transmitters. (03hrs.) 430. Service and calibrate various types of Thermocouples based indicator and transmitters using temperature calibrator or milli volt source. (03 hrs.) 431. Identify and carry out maintenance& preventive maintenance. (03hrs.)	protecting wells for RTD, advantages and disadvantages of RTDs, thermistors, thermocouples, Ex-tension wires,compensating for changes in reference junction temperature, construction of thermocouple junction, types of thermocouple, advantages and disadvantages of thermocouples. (06hrs.)

		432. Construct and Operate Optical and Radiation pyrometer. (02hrs.) 433. Measure high temperature using Optical and Radiationpyrometer. (02 hrs.) 434. Identify and carry out maintenance& preventive maintenance for Optical and Radiation pyrometer. (02 hrs.) 435. Identify and check different types of humidity sensors. (02 hrs.) 436. Measure the relative humidity using humidity sensors. (03hrs.) 437. Identify specifications, controls and construction of thermal imager. (03hrs.) 438. Measure the various points like motor, drilling point, hill person temperature etc. using thermal imager. (03hrs.)	Pyrometry. Molecular activity and electromagnetic radiation, defining pyrometry, effects of emittance, effects of temperature, wavelength and radiated energy, pyrometers and wavelengths, using of optical and radiation pyrometer, Measurement of humidity. Thermal imagers. (06hrs.)
Professional Skill 25 Hrs. Professional Knowledge 09 Hrs.	Identify, select, Operate, maintain, Service and calibrate different types of recorders.	439. Identify different types of recorders and their connections and controls. (02 hrs.) 440. Practice recording of variable signal. (03 hrs.) 441. Study the construction, operation and use of circular chart recorder for temperature or pressure or mV or mA. (04hrs.) 442. Study the construction, operation and use strip	Recorders. Introduction to recorders, Construction, working principle, various parts installation and use of pneumatic and electronic recorders.Strip-chart, circular chart. (09 hrs.)

		chart recorder-pneumaticand electronic recorders. (04hrs.) 443. Calibrating electronic recorder. (02 hrs.) 444. Calibrating pneumatic recorder. (03 hrs.) 445. Overhaul, check, fault find, repair, test of pneumatic, electronic recorders. (single point &multipoint). (03hrs.) 446. Studyof paperlessLCD/LED recorder. (02hrs.) 447. Identify and carry out maintenance& preventive maintenance. (02 hrs.)	
Professional Skill 50Hrs. Professional Knowledge 18Hrs.	Identify different types ofFinal control elements and role.Identify different valve body, constructional feature, Dismantle, inspectparts, replace parts, recondition, check, andresettingof control valves with actuators, convertors & positioners. Install and test the performance.	448. Identify different final control elements in process control loop. (02 hrs.) 449. Identifying valve regulator, dismantlingand checking various parts.(02hrs.) 450. Study the specifications and construction of valve actuator. (02hrs.) 451. Installation and testing valve actuator (pneumatic) with control valve. (01 hr.) 452. Calibrating valve positioner with control valve.(01 hr.) 453. Study the construction and specifications current to pressure converter.(01 hr.) 454. Calibrating current to pressure converter.(01 hr.) 455. Calibrating voltage to current converter.(01 hr.) 456. Study the specifications and constructions of electro	Final control elements in process loops. Final control elements, actuators, load set Point compensation, feedback loops, control variables, effects of disturbances on performance, parts of final control sub-system, control signal, electric control signals, fluidic control signals, Pneumatic and Hydraulic Actuators. Pneumatic principles, effects of changing pressure, pressure /volume/ temperature relationship, effectsof changing temp. Pneumatic actuators, diaphragm actuator, spring and springless actuators, direct and reverse acting actuator, piston actuator, positioner, Electrical actuators and their advantages. (06hrs.)

		pneumatic positioner.(01 hr.) 457. Installation and testing electro pneumatic positioner with control valve.(01 hr.) 458. Calibrating electro pneumatic positioners with control valve. (01 hr.) 459. Dismantle, fault finding, repair, clean, reassemble and test of actuators and positioners.(01 hr.)	
		460. Identifying various pneumatic Piping tubing andfitting.(01 hr.) 461. Identifying various types of valves. Examine the specifications, construction and various parts of globe, ball, butterfly rotary, split body valves. (02hrs.) 462. Identify the cut sections ofvarious types ofcontrolvalves and identify internal parts and its function.(01 hr.) 463. Record specification of linear, equal, percentage quick opening control valves.(01 hr.) 464. Record the characteristic of control valves.(01 hr.) 465. Remove and install control valves with service line. (02 hrs.) 466. Dismantling, reconditioning, checking, replacing parts and resetting of control	Control valves. Control valves functions and components, types‘ of control valves, based on valve flow characteristics-liner, equal percentage, quick openingvalves, globe valves, cage valves, butterfly valves, ball valves, sliding gate valves, diaphragm valves, split body valves, capacitive, inductive type valve, proximity switch, IR switch, micro switch, limit switch, other control valves, control valve mechanical considerations, selecting control valves, valve positioner.(06hrs.)

		valves. (02 hrs.) 467. Carry out maintenance of control valves. (01hr) 468. Identifying the proximity switch and study the specifications, constructions, No. of contacts etc. (02 hrs.) 469. Installation and testing micro and limit switches with the load. Verifying its function. (02 hrs.) 470. Installation and testing capacitance or inductive proxy with the load (buzzer/ indicator etc). testing its function. (02 hrs.) 471. Installation and testing, adjusting the range of IR or ultrasonic proxy with load. (02 hrs.) 472. Installation of proxy with relay and operating high current load (like motor or AC lamp etc.). (02 hrs.)	
		473. Identify cut sections of various types of control valves. (02 hrs.) 474. Identify Feed water control system. (02 hrs.) 475. Identify final control elements in system and manually control feed water rate at desire value. (02hrs.) 476. Operate of, sequential. Control and block valves. (02hrs.) 477. Operate of electromechanical and	Control elements applications. Feed water control system works, sequential. valve control, control and block valves, applying relays in final control elements, relay logic in operation, automatic valve control, controllers and activators, turbine control System, throttle and governor valves and activators. Introduction of internal parts of different types of control valves.(06hrs.)

		solid-state relay. (01 hr.) 478. Service & test and use electromechanical and solid-state relay. (01 hr.) 479. Design and test sequential. Logic operation using relay. (03hrs.) 480. Identify turbine control system operation. (01 hr.)	
Professional Skill 50 Hrs. Professional Knowledge 18 Hrs.	Identify fundamental of automatic control system and various functional elements in control loop. Identify, select, Install, wire, configure, test the performance, maintain, and service various types of ON-OFF and PID controllers (electronicand pneumatic).	481. Familiar with process control system and identify various functional elements. (03 hrs.) 482. Study construction & operation of thermostatic pressure and humidity switches. (02 hrs.) 483. Service and maintenance above switches. (04 hrs.) 484. Install, wire up and test the control operation. (04 hrs.) 485. Study construction & operation of ON-OFF Electronic and pneumatic Controllers. (02 hrs.) 486. Service and maintenance of ON-OFF Electronic and pneumatic Controllers. (04 hrs.) 487. Install, wire up, test and monitor the performance of control operation using ON-OFF Electronic and pneumatic Controllers. (03 hrs.) 488. Practical on PID controller trainer on various process parameters. (03 hrs.)	Introduction tocontrollers. Basic block diagram of control systems. Advantages Process variable and set point, analog controllers, digital controllers, control angles and limits, control loop measuring Pv, amplifying signals final control elements, current proportioning. Hunting&its effect onthe product. Typesofcontrollerandtheir operation. Types of controller, range limit of controllers. (09 hrs.)
		489. Study construction &	ON/OFF controllers, direct and

		operation of PID Electronic / DIGITAL Controllers. (02 hrs.) 490. Service and maintenance of PID Electronic/ DIGITAL Controllers. (04 hrs.) 491. Install, wire up, Configure, test the control operation using PID Electronic / DIGITAL Controllers. (03 hrs.) 492. Verify the steady state and transient responses of PID Electronic / DIGITAL Controllers in P, PI, PD, PID. (04hrs.) 493. Study construction & operation of PID pneumatic Controllers. (02 hrs.) 494. Service and maintenance Of PID pneumatic Controllers. (03 hrs.) 495. Install, connect pneumatic signal, align and test the control operation using PID pneumatic Controllers. (03 hrs.) 496. Verify the steady state and transient responses of PID pneumatic Controllers in P, PI, PD, PID. (04 hrs.)	reverse acting controllers proportional controllers, automatic/manual split control, pneumatic control. Adaptive, limitingand batch control, ratio control system, feed forward, feedback control systems and cascade control system. Comparison between pneumatic and electronic control systems. Basic knowledge on communication protocol.(09 hrs.)
Professional Skill 25 Hrs. Professional Knowledge 09 Hrs.	Tune controller mode and evaluate performance of control loops as per specification and system application	497. Familiar with feed forward and feedback process control system check loop and identify various functional elements. (04 hrs.) 498. Perform the control operation in manual and	Controller models and tuning. Controller tuning, setting, controller modes, proportional mode, off-set, integral mode, reset mode, derivative mode(rate),single, mode controller, two mode controller, three mode

		automatic mode. (04 hrs.) 499. Familiar with Cascadeand ratio process control system. (04 hrs.) 500. Check loop and identify various functional elements. (04 hrs.) 501. Perform the control operation in manual and automatic mode. (05 hrs.) 502. Set "optimum setting for unit process in PID Controller (Electronic and pneumatic). (04 hrs.)	controllers, tuning the control loop, step-change- response method.(09 hrs.)
Professional Skill 50 Hrs. Professional Knowledge 18Hrs.	Identify modules of PLC, its function, Wire and connect the digital I/OS field devices to the I/O Module of PLC,install Software, Hardware and configure plc for operation. Write and execute simple logic and real application programs.	503. Identify each module in a rack and mount in the specified slot. (03 hrs.) 504. Wire and connect the digital I/OS field devices to the I/O Module of PLC. (06 hrs.) 505. Install PLC Programming software and establish communication with PC and PLC. (06 hrs.) 506. Hardware configuration and Prepare the input and output addresses for each slot. (05 hrs.) 507. Prepare and download ladder programs for various switching Gates. (05 hrs.)	Introduction to programmable controllers. History of programmable controllers, general characteristics of programmable controllers, some limitation of PLCs, method of developing PLC programming.(09 hrs.)
		508. Write and execute program logic control operation. (04 hrs.) 509. Develop programs using arithmetic, / data copy operation and execute. (04 hrs.) 510. Write and execute program	Input/output devices. Definition of input /output devices, I/O interface, input modules, output modules, input devices encoders, output devices, the opto-isolators, safety.(09 hrs.)

		on sequence control using timers and counters. (05 hrs.) 511. Develop programs using shift bit operation. (04 hrs.) 512. Interface analog I/p module of plc with sensor. (04 hrs.) 513. Interface analog o/p module of plc with actuator, relay. (04 hrs.)	
		514. Prepare programs based on on-delay and off-delay timers making on and off of a single LED taking one input and one output. (04 hrs.) 515. Two LEDs on and off using pushbutton as an input. first LED on for 3 sec and off for 2 sec, and second Led on for 2 sec and off for 3 sec for continuous cycle till stop is pressed. (04 hrs.) 516. Sequencer task using three LEDs as output and two input pushbuttons one as input (NO) for start and other for stop (NO). (04 hrs.) 517. Configuring the project using analog input and output instructions and implement a on off closed loop control for the given process. (05 hrs.) 518. Development of ladder logic for various tasks related to timers and counter based industrial applications. (04	Processing and programming functions. The processor unit, the memory, memory organization, ladder diagrams, data logger, most used programming symbols, start, stop, station example, other programming symbol timers and counters, data manipulation instructions, alternate PLC symbols. (09 hrs.)

		hrs.) 519. Development of the ladder logic for the running a traffic control with the different display indication. (04 hrs.)	
Professional Skill 50 Hrs. Professional Knowledge 18 Hrs.	Operate, maintain, service, configure, install, WIRE and test HART transmitters /devices (I/O). And Net-working system for instrumentation.	520. Familiar with facilities, function, operation and use HART communicators. (05 hrs.) 521. Study the DD files and uploading DD files.(04 hrs.) 522. Installing & OperatingHART transmitters/devices (I/O).(10 hrs.) 523. Creating tag, measuring the parameter, configuring the parameter values in Hart transmitter using communicator. (04 hrs.) 524. Measure various trends. (02 hrs.)	Digital control systems: need of smart devices, HART transmitters futures, advantages, applications. Working method of HART devices, HART protocol. HART communicators and PC based HART device configuration. Stepsin calibration ofHART devices. Communication. (09 hrs.)
		525. Identify the cables and network components. (02 hrs.) 526. Study various network lines. (02hrs.) 527. Preparation network cables and connectors. Testing network cables. (04 hrs.) 528. Preparation of network cables - serial (RS232/485 standards or equivalent) and Ethernet. (05 hrs.) 529. Connect network connectivity hardware and check for its functioning.	Networking: types of networks used in digital instrument systems. LAN, WAN, Ethernet. Point to point and multi networking. Ring, delta, star connections. Redundant Net. TCP/IP addresses and descriptions. Types of Cable categories (CAT), and their descriptions. Various types of Cable connectors. Advantages and disadvantages of co-axial cable and fiber optic cables. Various tools used in

		(02 hrs.) 530. Dismantle and assemble the desktop computer system. (02 hrs.) 531. Study the operation of Pulse Code Modulation and Demodulation. (03 hrs.) 532. Connect any one data output of the decade counter to the Data Inputs of the FSK Modulator and measure output waveform. (03hrs.) 533. Identify and adjust the frequency of the sampling pulse generator and level of modulating signal to obtain the PWM waveform on CRO. (02 hrs.)	networking- wire cutter, crimp tool, memory blade holder, memory blade cartridge, cable strip tool with blade cassettes. Terminators and extra connectors, taps, calibration tool etc. fundamentals: modulation and demodulation, signal to noise ratio, digital communication basics-PWM, PCM, FSK. (09 hrs.)
Professional Skill 50 Hrs. Professional Knowledge 18 Hrs.	Identify the different modules of DCS, function, Wire and connect I/OS field devices to the I/O Modules, install Software, Hardware and configure DCS for operation with HMI. Write and execute DCS AND SCADA programs FOR real application.	534. Familiar with different faculties and function of DCS system. (03hrs.) 535. Identify the different modules of DCS and different process instruments in process plant. (03hrs.) 536. Wire and connect the I/O Module of DCS to field signals. (04 hrs.) 537. Install DCS Programming software and establish communication with PC and DCS. (05hrs.) 538. Set the communication between DCS and SCADA System. (03hrs.) 539. Concept of Tag/Points Generation. (04 hrs.)	Fundamentals of SCADA and DCS. History of DCS development. Basic architecture, description advantages and disadvantages, applications. Terminology- RTU (remote transmitting unit, central monitoring station, types of communications, field instruments and types. (09 hrs.)

		540. Attaching points to the display Element. (03 hrs.)	
		541. Practice HMI, operator panel and touch panel operation and related software. (10hrs.) 542. Set up and configure HMI with PLC. (05hrs.) 543. Animate objects on a HMI screen to monitor motor status. (05hrs.) 544. Use security features to do tag logging and command execution. (05hrs.)	Field bus: futures, advantages, architecture, basic block diagram, working. Work station, Human Machine Interface (HMI). Controller (with basic types), filed bus interfacing modules, gateway, network manager, I/O modules, field bus devices (I/0), remote transmission panel (RTP), Ethernet. Electronic device description language (EDDL) and device description (DD). Field bus power supply and its function. Introduction of digital and multi drop communication protocol Vendors. Futures- library, call up, various visualized futures, Reports (alarms, events), history, trading etc. (09 hrs.)
Professional Skill 50 Hrs. Professional Knowledge 18 Hrs.	Identify, check constructional Feature and function of hydraulic pump, and hydraulic power system, accumulator, hydraulic hoses and fitting, Hydraulic components. Build AND test hydraulic control circuit.	545. Familiarization of - Hydraulics trainer and safety measure to handle hydraulic system. (02hrs.) 546. Practice symbolic representation of Hydraulic components. (04hrs.) 547. Familiar with hydraulic hoses and fitting. (04hrs.) 548. Feature and function of hydraulic pump and hydraulic power system. (5hrs.) 549. Feature and function of	BasicHydraulics: Principles of Hydraulics.Fluid power andhydraulics, force, weight and mass,pressure,work,power, energy,incompressibility and non-diffusion,hydrostatic pressure, Pascal'slaw, transmission of fluid power, fluid flow in pipes, Bernoulli's principle, the effect of heat on liquids. A typical hydraulic power system. Hydraulic Fluids. Functions of

		hydraulic accumulator. (5hrs.) 550. Identification Hydraulic components and check its function. (03hrs.) 551. Service and test different types of valves. (02hrs.)	Hydraulic fluids, physical properties, viscosity, viscosity index, viscosity and pressure, power point, fluid selection, component protections, chemical properties, system contamination, water, dissolve air, foaming, corrosion and rusting, types of hydraulic fluids. (09 hrs.)
		552. Design hydraulic circuit for double acting cylinder actuation. (04 hrs.) 553. Calculation relating to cylinder motion. (02 hrs.) 554. Design hydraulic circuit using Pilot operated check valve. (04 hrs.) 555. Design hydraulic circuit using Pressure reducing Valve. (04 hrs.) 556. Design hydraulic circuit Using Pressure relief & Pressure regulating valve. (04 hrs.) 557. Design hydraulic Pressure sequencing circuit. (04 hrs.) 558. Design hydraulic circuit using Pressure compensated flow control. (03 hrs.)	Directional control valves. Directional control valve classification, review of two way valves, 'globe, gauge, plug, needle, ball, automatic two way valves, check valves, pilot operated check valves, spool valves, three ways pool valves, controlling hydraulic motors, NO and NC valves, holding valves, four and five way valves, rotary spool valves, schematic symbols, flow ratings, accessories. (09 hrs.)
Professional Skill 50 Hrs. Professional Knowledge 18 Hrs.	Lay out construction feature, operate, maintain of air compressor, air Distribution system, pneumatic associate components, piping,	559. Study construction operation and use of air compressor. (04 hrs.) 560. Identify different devices in air Distribution system and study construction. (04 hrs.) 561. Operation and use of air	Pneumatic principles, mass, pressure, work and energy, compressibility, law of pneumatics, transmission of pneumatic fluid power, pneumatic leverage, air properties, airflow in pipelines,

	tubing and fitting. Build and test pneumatic control circuit.	filters, regulators and lubricator. (6 hrs.) 562. Practice and use ofPneumatic Piping, tubingandfitting. (Metallic and non-metallic.) (5 hrs.) 563. Draw Symbolic representation of different Pneumatic components, various supply elements such as Compressors, pressure regulating valve, service unit etc. (6 hrs.)	viscosity of air pressure, Bernoulli'slaw, components of pneumatic power system. Primaryairtreatment.Air treatment,preliminary filtering, relative. Humidity, effects of moisture, waterremoval, dew point,moisture separators,oil scrubbers, air dryers, (deliquescent and absorption type) air receivers. Secondary air treatment. Methods of treatment, Contaminate separation, contaminate filtration and filter classification and rating, types ofmedia surface filters, depth filters, absorption filters,Lubricatingtheair. (09 hrs.)
		564. Set up a system to provide Pneumatic (air) supply of 20 psi output from the available compressor. (02 hrs.) 565. Build a pneumatic circuit of a single acting cylinder being controlled by 3 way 2 position directional control valves.(02hrs.) 566. Build a pneumatic circuit of a double acting cylinder being controlled by 5 way 2 position directional control valves.(02 hrs.) 567. Build a pneumatic AND,OR circuit by 3 way 2 position directional control valves to operate double acting	Piping houses and fittings. Requirement of piping, airflow, piping dimensions and safetyfactors, piping connections,compressed air piping applications, metallic tubing, tubing bending and tubefitting, tube installation, nonmetallic tube houses, hose fittings and coupling, hose installation. (09 hrs.)

		cylinder.(02 hrs.) 568. Build a pneumatic circuit of a pilot controlled double acting cylinder of being controlled by 3 way **2** position directional control valves and **5** way **2** positions valve. (04 hrs.) 569. Build a pneumatic circuit to test logical latch circuit by 5 way 2 position, 3 way **2** valve direction control valves. (03hrs.) 570. Build a pneumatic circuit to control oscillation of piston by pilot operated 5 way 2 position, 3 way **2** direction control valves. (04 hrs.) 571. Cutting the metallic tube as per dimensions using tube cutter.(02hrs.) 572. Bending the tube in to $90^0$and 45^0 using pipe bending tools.(02hrs.) 573. Installation of simple piping diagram.(02hrs.)	
Professional Skill 25 Hrs. Professional Knowledge 09 Hrs.	Identify constructional feature, operate, maintain, service and calibrate of Analyticalinstruments.	574. Study the circuit operation of pH meter conductivity meter and dissolved oxygen Meter.(02 hrs.) 575. Wire up pH meter electrode to pH meter. (02 hrs.) 576. Calibrate pH meter using buffer solution. (05 hrs.) 577. Determination of pH (by pH meter). (05 hrs.) 578. Wire up conductivity meter to electrode and find the electrolytic conductivity of	Analyticalinstruments. Exposuretobasicanalytical instruments. Typesof electrodesusedforPH measurements.RelationofPH andmV.PHindicatorand controllers.Conductivity meters.Dissolvedoxygenmeter . (09 hrs.)

		solution. (06 hrs.) 579. Service and maintenance of conductivity meter&Dissolvedoxygen meter. (05 hrs.)	

Project Work/Industrial Visit

Broad areas:

a) Automatic waterlevelcontroller.
b) On- Off temperature controller.
c) Speed controller.
d) Steppermotorcontrol.
e) Safety alarm system.
f) Automatic door system.
g) Event control.
h) Humidity control.
i) Built a pneumatic control for double acting cylinder.
j) Regulated & Unregulated Power Supply
k) BatteryMonitor& Charger
l) EmergencyLight
m) Electronic Fan Regulator
n) SCR Using UJT Trigger Circuit.
o) Dimmer circuit using Triac and Diac.
p) DancingLEDs
q) DigitalClock
r) EventCounter
s) A to D Convertor.

SYLLABUS FOR CORE SKILLS
1. Workshop Calculation &Science (Common for two year course) (80Hrs. + 80 Hrs.)
2. Engineering Drawing (Common for Group-II (Electrical, Electronics & IT Trade Group))(80Hrs. + 80 Hrs.)
3. Employability Skills (Common for all CTS trades) (160Hrs. + 80 Hrs.)

Learning outcomes, assessment criteria, syllabus and Tool List of Core Skills subjects which is common for a group of trades, provided separately in www.bharatskills.gov.in

ANNEXURE-I

List of Tools & Equipment			
INSTRUMENT MECHANIC (For batch of 24 Candidates)			
S No.	**Name of the Tools and Equipment**	**Specification**	**Quantity**
A. TRAINEES TOOL KIT			
1.	Steel Rule	150 mm (metric and English Marking)	25 (24+1) Nos.
2.	Watch maker screw driver (set of six)	Minimum to maximum	25 (24+1) Nos.
3.	Plier flat Nose	100 mm	25 (24+1) Nos.
4.	Hammer ball peen	250 gms. With handle	25 (24+1) Nos.
5.	Twiser fine point	125 mm	25 (24+1) Nos.
6.	File hand smooth	200 mm	25 (24+1) Nos.
7.	File Flat 2nd cut	200 mm	25 (24+1) Nos.
8.	Screw driver	set of 5 pieces	25 (24+1) Nos.
9.	Adjustable spanner	Different sizes	25 (24+1) Nos.
B. SHOP TOOLS, INSTRUMENTS – For 2 (1+1) units no additional items are required			
Lists of Tools:			
10.	Try square hardened blade	100 mm	05 Nos.
11.	Neon (phase) tester	230 volt	05 Nos.
12.	Eye glass	3” focus watch maker	05 Nos.
13.	Universal scribing block	250 mm plier	02 Nos.
14.	Surface plate	400×400 mm	02 Nos.
15.	Angle plate	150×100	02 Nos.
16.	Vee block	with clamp pair	02 Nos.
17.	Punch frame set	2 mm (No of six Set)	02 Sets.
18.	Electric soldering iron	15/25 watt pencil tip	05 Nos.
19.	Vice bench jaw	100 mm	05 Nos.
20.	Pointer extractors (puller)	12”	05 Nos.
21.	Screw pitch gauge B.A. & metric each	As per requirement	01 Each
22.	Punch center	100×10 mm	02 Nos.
23.	Tool maker’s clamps	65×15×25 mm opening	02 Nos.
24.	Plier side cutting	150 mm	02 Nos.

25.	Sine bar	125 mm plate	01 No.
26.	Flaring tool set	(No of six set) up to 20 mm	01 set.
27.	Micrometre outside	0 to 25 mm	02 Nos.
28.	Micrometre outside	25 to 50 mm	01 No.
29.	Vernier height gauge	300 mm	02 Nos.
30.	Combination set	different sizes	01 set.
31.	Vernier caliper	150 mm	02 Nos.
32.	Standard wire gauge	Inch/mm	01 No.
33.	Feeler gauge leaf type, 26 blades, Eng.& metric	(Set of 12)	01 Set.
34.	Radius gauge leaf type	1 to 15 mm	01 No.
35.	Dial test indicator	In mm with accessories.	01 No.
36.	Micrometre inside	25 mm with extension up to 150 mm	01 No.
37.	Tube cutter		01 No.
38.	Tube bender		01 No.
39.	Pinching tool		01 No.
40.	Allen key set (metric)	Set of six	02 Set.
41.	Allen key set (English	Set of six	02 Set.
42.	Soldering station (temp. controlled) with necessary accessories	With stand and changeable 5 bits	02 Nos.
43.	Screw driver	200 mm	04 Nos.
44.	Philips screw driver	200 mm	02 Nos.
45.	Round nose pliers	150 mm	05 Nos.
46.	Magnifying glass	75 mm	02 Nos.
47.	Slip Gauges	(workshop grade)	02 Nos.
48.	Fire extinguishers	(Dry Chemical powder)/CO_2	02 Nos.
49.	Fire extinguishers	(Foam type)	01 No.
50.	Fire buckets		05 Nos.
C. MECHANICAL PRECISION INSTRUMENTS			
51.	Plug gauge		02 Nos.
52.	Ring gauge		01 No.
53.	Snap gauge		01 No.
54.	Surface gauge		02 Nos.
55.	Telescopic gauge		01 No.
56.	Vernier bevel protractor		02 Nos.
57.	Dividers	250 mm	03 Nos.

58.	Gauge blocks		03 Nos.
59.	Monochromatic light source		01 No.
60.	Wire type strain gauge (load cell/cantilever beam)		05 Nos.
61.	Load cells of various ranges		02 Nos.
D. ROTATIONAL/VELOCITY INSTRUMENTS			
62.	Speedometers (at least four different popular make) with adopters of various sizes		01 No. each
63.	Electrical tachometer		01 Nos.
64.	Digital type tachometer	0-10000 Counts	01 No.
65.	Stroboscope		01 No.
E. PRECISION INSTRUMENTS			
66.	Digital panel meters	3 ½“ digit LED display	06 nos.
67.	Digital line frequency indicator	3 ½“ digit LED display	02 nos.
68.	D.C. regulated power supply	(+/-15V / +/- 30V) 0-3 Amp display for voltage and current. 0-30 V , 0-2 A, dual power supply with digital display	02 nos.
69.	Digital multi signal generator	(1 MHz) with frequency counter (8 digit or 10 MHz)	01 No.
70.	Digital function generator	1 MHz -10 MHz Function-Pulse – Modulation Generator with Built in 40MHz Frequency Counter	01 No.
71.	Pulse generator		01 No.
72.	Digital insulation tester		01 No.
73.	Digital multimeter	3 ½ “digit LED display, current, volt, resistance, transistor, diode measurement facility	02 Nos.
74.	Analog multimeter	current, volt, resistance measurement facility	01 No.
75.	Digital L.C.R. bridge	Instrument capable to measuring inductance, L, capacitance, C, and resistance, R. Quality factor Q	01 No.

76.	Digital I.C. tester		01 No.
77.	Analog dual trace CRO	30MHz, dual trace	01 No.
78.	DSO	4 Channel, 70MHz Real Time Sampling 1G Samples/Sec, more than 20 mpts Memory with PC Interface USB, LAN and math function includes +, -, FFT, differential, integral, abs, log and advanced triggering I2C, SPI, UART etc.	01No.
79.	Decade resistance boxes		01 No.
80.	Decade capacitance boxes		01 No.
81.	Decade inductance boxes		01 No.
82.	Transistor tester	Capable to test all type of transistor	01 No.
F. GENERAL EQUIPMENT TRAINERS FOR INSTRUMENTATION			
83.	Instrumentation amplifier trainer	Instrument capable to Study Op-amp as a differential amplifier and observe its output, I-V Converter, V-I Converter, Inverting Summer, Inverting Average, Inverting Scaler, non-inverting Average, non-inverting Summer, Integrator, Differentiator	01 No.
84.	Trainer on basic digital electronics i.e. logic gates Boolean Expression adder, sub tractor, flip flop, counter register, converter etc.	Instrument with Fixed DC Power Supplies : +5V / 1.5A; -5V / 0.3A; +12V / 0.3A. Adjustable DC Power Supply : 0 to 15V / 0.5A., Clock Signal Generator : 1 Hz to 1MHz (in 6 Ranges). 16 SPDT switches as HI / Low Inputs., 2 Nos. pulsar switch with Q and Q' o/p with denounce circuit. Trainer on basic digital electronics i.e. Logic gates, Boolean	01 No.

		Expression, adder , sub tractor, Flip-flop, counter, register, converter, 2 digit BCD coded thumbwheel Switch.16 sets of independent LED's to indicate high & low logic state. 4 sets of independent 7 segment LED display with BCD to Seven Segment Decoder driver. Logic Probe: TTL and CMOS level with 5mm LED Display to display “Low” and “High”, An 8 ohm / 0.5W speaker, Breadboard Module	
85.	Trainers on power supplier's half wave rectifier, full wave rectifier	IC based DC Reg. : + 12 V / 500 mA (fixed and with facility to vary from 0 to +12 V). Power Supplies : - 12 V / 500 mA (fixed and with facility to vary from 0 to -12 V). + 5V / 500mA (fixed). AC Supplies : 9 - 0 - 9 V AC / 500 mA. resistor, capacitor, diode, IC 7805, IC 7905,IC 7812,IC 7912,IC 317.	01 No. each
86.	SCR driven/controlled power supply trainer	Study of basic firing circuit. phase control, controlled power supply,. Effect of resistive load and Effect of inductive load.	01 No.
87.	Discreet component trainer	On board DC power supply : +5V/1A(fixed), ±15V/1A(fixed), ±15V/200mA (variable) On board AC supply : 9v-0-9v; resistor, capacitor, inductor, relay, diode.	01 No.
88.	Trainer on RS485 to RS232	Trainer with software for test	01 No. each

	converter.	communication with computer, Signal Conversion RS 485-RS232, Power supply 230 VAC/50Hz, Working mode 2-wire half-duplex Transmission distance: RS232: Typical: 15 FT (5m), RS485: Typical 4000FT (1200m) Maximum Baud Rate: 100 Kbit/ s to 10 Mbit/s, "Receive" and "Transmit" modes LED indicators.	
G. ELECTRICAL INSTRUMENTS			
89.	DC moving coil mili-ammeters (various ranges)		03 Nos.
90.	Centre zero galvanometers		02 Nos.
91.	AC moving iron type voltmeter (various ranges)		03 Nos.
92.	AC moving iron type ammeter (various ranges)		03 Nos.
93.	Wattmeter dynamometer type		1 no.
94.	Power factor meter		1 no.
95.	Watt hour meter induction type 1 phase		2 nos.
96.	Ampere hour meter		1 no.
97.	Ohm meter series and shunt type	Dial size 100 mm minimum.	1no. each
98.	Potentiometer / thermocouple test set	Precision Potentiometer for resistance feeding For RTD transmitter with digital display. Milli volt source for voltage feeding to thermocouple transmitter. Measurement of milli volt and resistance of sensors. Heating source with temperature change and	1 no.

		display like muffle furnace or dry block type up to temperature range 6000 or above. Two types(each) of thermocouple and RTD sensors for testing.	
99.	Autotransformer 1Ø and 3Ø	0 to 120 % or above, 5A or above current rating	1 no. each
100.	Calibration test bench for AC and DC voltmeter, AC and DC Ammeter, ohmmeter	Complete test bench with self-powered which produces and measures of Voltages, current, and resistances. Calibrator for calibration and testing of A.C. Millimeters, Ammeters, Voltmeters and D.C. Millimeters, Ammeters, Millivolt meters, Voltmeters and Ohmmeters (Resistance) AC Voltage range: 0 -250 v, 0 - 500 v & 0 - 1000 v, AC Current ranges: 0-1 A, 0-5 A, 0-10 A, 0-25 A & 0-50 A, DC Voltage ranges: 0- 250 mv, 0- 500 mv & 0- 1000 mv , 0-250 v, 0 - 500 v & 0-1000 volts, DC Current ranges: 0- 250 ma, 0- 500 ma & 0 -1000 ma, 0-1 a, 0-5a, 0-10a, 0-25a & 0-50 amps,Resistance measuring circuit range: 0-2000 μω, 0-20 Mohm, 0-2000 Mohm, 0-20ohm,0-200ohm,0-2000ohm & 0-20 Kohm.	1no.
H. PRESSURE INSTRUMENTS			
101.	" U" tube manometers	Glass tube type 500 mm, with protecting case, safety over flow wells, scale adjustment	1 no.

		facility, ground balance with spirit leveler.	
102.	Well type manometer	Glass tube type 500 mm with protecting case, safety over flow wells, scale adjustment facility, ground balance with spirit leveler.	1 no.
103.	Inclined limb manometers	Glass tube type 500 mm with protecting case, safety over flow wells, scale adjustment facility	1 no.
104.	Bourdon tube type gauges of various ranges	0-7 kg /Cm² 4 " dial	6 nos.
105.	Capsule type pressure gauges	0-7 kg /Cm² 4 " dial	3 nos.
106.	Aneroid barometers		1 no.
107.	Dead weight tester & comparator	Range of 0.5 – 30 kg/ cm2, Step Size of 0.1 kg/cm2, Accuracy of 0.2 to 0.1 %, to study the calibration of pressure gauge. Comparator having standard gauge.	1 each.
108.	Pressure regulators with filter and input & output gauges	¼ "or 1/8" connection with air filter regulator and 4" dial pressure gauges	1 no.
109.	Differential pressure transmitter (pneumatic)	Differential pressure transmitter (pneumatic) Max. Air Supply: 30 psi, Output: 0.2 - 1.0 Kg/cm2, S.S. Orifice plate assembly, Pneumatic PID controller, control valve, actuator, valve positioner, rotameter, air regulator. To study the working principal of pneumatic DP Transmitter and functioning of it with working.	1no.
110.	Differential pressure transmitter (electronic -HART/field bus type)	Differential pressure transmitter with HART/field	1 no.

		bus facility, S.S. Orifice plate assembly, S.S. tank, S.S. body pump, control valve, actuator, valve positioner, rota meter, air regulator. To study the working principal of DP Transmitter and functioning of it with HART/field bus on suitable frame structure.	
111.	Diaphragm type pressure gauges of various ranges	Glycerin filled Various Type having dial size 4" or above, any four ranges, connection ½" or 3/8"	2 nos.
112.	Pressure transducers training kits Potentiometer Capacitive Reluctive strain gauge LVDT Load cell Servo type Piezo resistive	All transducers having range such that change in output of each can be identify. With Small compressor.	1 no. each
113.	Experimental set up for pressure measurement consisting of air compressor pressure vessel pressure transmitter controller recorder and final control element, computer i.e. closed loop system or full scope system i.e. pressure instrumentation process control trainer / simulator	Pressure transmitter 0-1 bar or above. Auto- Manual PID controller with digital display for PV, set point (with three term facility), PC communication facility. Pneumatic control valve, I/P converter with regulator and gauges, pressure vessel, circular chart recorder, SCADA software with necessary fitting to run the set up.	1 no.
114.	HART device communicator and calibrator	Microprocessor base HART Communicator calibrator with Full multi-bus communicator for HART, Touch Screen LCD display, for calibration of	1 No.

		various HART transmitters.	
115.	Pneumatic calibrator	For calibration of vacuum gauges, pressure gauges, pressure switches, pressure transmitters, etc. Alpha Numeric LCD/LED Display, Switch Test Facility, Zero setting, Units Selectable, up to 25 Ma Measurement & Voltage Measurements and Pneumatic hand pump for Pressure & Vacuum. -0.85 to 10 Bar Range, Rechargeable Battery.	1 no.
116.	Pressure switches of various ranges		4 nos.
117.	Low pressure measuring gauges such as thermal conductivity gauge, McLeod gauge	Digital display of pirani type (thermal conductivity type) Vacuum measurement, mercury in glass tube,McLeod gauge with inclination provision, close vessel for create vacuum, fitted on framework.	1 no.
118.	P to I and I to P converters	P/I converter : Input : 0 – 15 PSI or above Output : 4 – 20 mA Span and zero adjustment facility. With Air filter regulator : 0- 2 Kg/cm2 range with pressure indicator Digital Ammeter:0 – 20 mA range (for output read out) I/P converter : output : 3 – 15 PSI input put : 4 – 20 mA Span and zero adjustment facility. Air supply : 25 PSI	1 no. each.

		Air filter regulator : 0- 2 Kg/cm2 range with pressure indicator Digital Ammeter :0 – 20 mA range or above Variable Current source: 4- 20 mA Pressure gauge : 2 kg/cm2, having dial 150 mm dia. or above	
119.	Vacuum tester with pump	Two stage vacuum pump 50 LPM & Ultimate Vacuum 0.05 mm of Hg, Vacuum Tester based on High Frequency Spark Unit (Tesla), 230 Volt supply, 20 kV High Frequency Output, MS Vacuum Chamber mounted on stand.	1 no. each.
120.	Vacuum gauge	Vacuum gauge with dial 6 inch or above. Sensor SS made. Precision high accuracy.	1 no.
I. FLOW METERS / INSTRUMENTS			
121.	Simple tank type quantity meter	SS tank with sight glass tube level indicator and scale for level measurement in quantity with necessary fitting.	1 no.
122.	Impeller type flow meter	Impeller Flow meter type of Suitable range for Water or Viscous fluid with Pulse or 4-20 mA DC or DC Voltage Output with S.S. measuring and sump tank, SS pump fitted on stand for working of flow meter.	1 no.
123.	Helical and turbine flow meter	Helical & Turbine type Flow with Suitable range for Water or Viscous fluid with Pulse or 4-20 mA DC or DC Voltage Output with SS measuring and	1 no.

		sump tank, SS body pump fitted on stand for working of flow meter, mounted on suitable frame structure.	
124.	Pitot tube flow meter	Suitable range pitot tube flow meter for air velocity measurement, with Perspex, long smooth walled pipe, air blower, inclined cum vertical manometer, all fitted on framework.	1 no.
125.	Orifice type flow meter Venturi tube flow meter Rota meter	Rotameter, Orifice plate assembly of SS & brass venturi all suitable for 1" pipe line, SS sump tank, SS measuring tank, SS body pump, mercury manometer with scale with required all fittings accessories and mounted on stand to understand working of all three flow meters.	1 no.
126.	Magnetic flow meter	Magnetic flow meter with HART communication facility & 4-20 mA output along with SS sump tank, SS measuring tank, SS body pump and with required all fittings accessories and mounted on stand.	1 no.
127.	Vortex flow meter	SS sump tank, SS measuring tank, SS body pump, flow meter with HART Communication & 4-20 mA output and with required all fittings accessories and mounted on stand.	1 no.
128.	Flow control loop set with flow controller recorder, D.P. transmitter, receiver, unit control valve and impulse line, computer	DP transmitter with HART, Auto- Manual PID controller (with three term facility), communication facility, control	1 no.

	complete experimental set- up for flow measurement	valve, I/P converter, S.S. sump tank, rotameter, circular chart recorder, SCADA software with necessary fitting to run the set up.	
129.	Experimental closed loop set up for solid flow measurement and Control with storage vessel, hopper, solid flow sensor, controller, Recorder and final control element	Microwave based Solid flow sensor, Hopper, collection tray, control valve/FCE, PID controller, electronic circuit chart recorder, current meter, and seamless data transfer unit. Complete working set up mounted on suitable frame structure.	1 no.
130.	Coriolis mass flow meter	Coriolis mass flow meter with HART communication facility, output 4-20 mA along with sump Tank, Measuring Tank, Pump, and accessories with stand, mounted on suitable frame structure.	1 no.
131.	Flow nozzle	SS Flow nozzle flange Type mounting with manifold assembly, sump tank, measuring tank, pump, mercury manometer, mounted on suitable frame structure.	1 no.
J. LEVEL INSTRUMENTS			
132.	Static pressure and air purge type level indicator	Static pressure and air purge Level Indicator with glass tube, SS purge pipe. Fixed on tank having minimum height of 1000 mm height. Static Pressure gauge air purge gauge with 6 inch dial and isolation valves. FR unit for air supply and reference bubble column used	1no.

		for air purge.	
133.	Level transmitter (interface) (HART/Field bus/profibus compatible)	To study the Interface between two Different Immiscible Medium. Min. measuring range 1100 mm, SS sump tank, suitable measuring tank, S.S. body pump, with hardware and fitting to understand level Interface measurement.	1no.each
134.	Level control set up with level transmitters level recorder Controller & control valve complete Experimental set up or level simulator	Level transmitter, Auto-Manual PID controller (with three term facility), communication facility, control valve, I/P converter, S.S. sump tank, measuring tank of suitable height with sight glass, S.S. body pump, circular chart recorder, SCADA software with necessary fitting to run the setup, mounted on suitable frame structure.	1 no.
135.	Level measurement equipment for solid, sonic solid level, microwave, capacitance probes, point level detector, Vibrating fork type	Ultrasonic level detector, Microwave level detector Vibrating fork type level switch, Capacitance probe level detector, Point type level Detector, All transmitters and sensors with individual Container as measuring tank suitable to transmitters and mounted common stand such as experimental kit, with switches and indicators.	1 no. each
136.	Mercury in glass thermometer (various ranges)	0-1000C , 0-1500C, 0-2500C	1 no. each
K. TEMPERATURE INSTRUMENTS			

137.	Alcohol or other liquid in glass thermometers (consumable item)	Range: 0-110 Deg. C	2 nos. (consumable item)
138.	Stem and dial type bimetallic thermometer (various ranges)	Range: 0 to 100, 0-150 and 0-200 Deg. C	2 nos.
139.	Mercury in steel remote indicating thermometers (various ranges)	Range: 0 to 100, 0-150 and 0-200 Deg. C	2 nos.
140.	Resistance bulb Wheatstone bridge type		2 nos.
141.	Thermocouple type pyrometer with millivoltmeter (with different types of thermocouples)	Pyrometer (Digital Indicator) Range : as available Sensor type : thermocouple with display and milli voltmeter. Temperature source (Water bath, heater, PID, temperature indicator, thyristor drive, agitator, different thermocouples like J, K, E, N pyrometer.)for measurement.	1 no.
142.	Optical pyrometer with all accessories	Digital /Analog display, 800°C to 1500°C or above Measurement Range with accessories	1 no.
143.	Radiation Pyrometer with all accessories	250 to 900 Deg. C or above Temp. range, DC Power Supply, scalable 4 – 20 mA Output.	1 no.
144.	Vapour pressure thermometer		2 nos.
145.	Temperature transmitter, pneumatic	Scale for Set Point & Process, output 0.2 to 1.0 Kg/cm2 and Input 0 to 100 Deg. C, Selectable Control Mode & Control Action, control valve works on 3 to 15 psi, steam generator, rota meter, S.S. sump tank & S.S. jacketed measuring tank, S.S. body pump, stand with hardware	1 no.

		fittings & electrical accessories, mounted on suitable frame structure.	
146.	Temperature transmitter electronic ((input RTD, TC)	Type: Thermocouple j & K type, RTD Pt-100/Pt-1000, 3 wire. Output: 4 to 20 mA, with mA indicator. Mounting: Head Mounting.	1 no.
147.	Experimental set up for measuring and controlling of temperature- Consisting of measuring, controlling, indicating, recording and final controlling elements, complete closed loop system with simulator	temperature transmitter, Auto- Manual PID controller (with three term facility), communication facility, control valve, I/P converter, rotameter, S.S. body pump, S.S. sump tank, water supply tanks, circular chart recorder, SCADA software with necessary fitting to run the set up.	1 no.
148.	Digital temperature calibrator, mV/mA injector and measuring unit	DC mV Source & Sink 0 to 199.99mV Range, 0.01mV Resolution ± 0.1% Of F.S Accuracy DC mA Source & Sink 0 to 25 mA Range, 0.01mA Resolution, ±0.25% Of F.S Accuracy, RTD and thermocouple output measurement to calibration of temperature transducers.	1 no.
L. RECORDERS			
149.	Paperless LCD/LED recorder setup	Min. 4 channels, universal Input, with alarm Relay, with storage memory, RS 232 through RS 485 Converter Communication facility, heating and stirring for water bath, PID, 4 nos. of	1 no.

		thermocouples, necessary wiring and fittings.	
150.	Strip chart and Pneumatic recorder both single and multi-point	Digital current source, air regulator, pressure gauge and temperature transducers, Pneumatic Chart Recorder Single Point & multi point 0-100 % range, input 3-15 psi, Electrical chart drive, zero adjustment, wall mounted, Electronic Strip Chart Recorder Single Point & multi point 0-100 % range, any one fix input for each channel RTD, Thermocouple or 4-20 mA, All fitted on panel and stand, with electrical accessories	1 no.
M. CONTROLLERS			
151.	Real PID controller training kit	Pump, sump tank, Heater tank, PC based PID controller module with all three (P+I+D) mode and Auto and manual mode facility to study the PID control action mounted on suitable frame structure.	1 no.
152.	Programmable logic controller (micro PLC) trainer	At least digital 8 input & 8 Output, 4 analog input & output with simulation software and hardware for understanding PLC programming and functioning	1 no.
153.	HART/Field devices (pressure/ flow/level)	All Transmitters should be with HART / Field Bus computable and having 4-20 mA output and mA indicator and necessary Power supply to operate	1 no. each.
154.	Multifunction process control	True distributed control	1 no

	system consisting of level, flow, Temperature, pressure with remote set point control, ratio, cascade and feed forward with feedback loops with computer interface and software	system having dedicated redundant function controller, power supply, communication modules, and integrated software modules, algorithms for complex process control. With Level transmitter, pressure transmitter, flow transmitter, temperature transmitter, Control valve, I/ P converter, to study the all type of controls, suitable pipes and fittings, seamless data transfer unit, SCADA, Computer .	
N. FINAL CONTROLLING ELEMENTS			
155.	Pneumatic and hydraulic actuators	Travel: 50 mm, Type: Hydraulic Cylinder, Action: Double Acting, Power Pack, Complete arrangement to be fitted on MS fabricated powder coated Table with necessary piping and wiring.	1 no.
156.	Different type of control valves such as gate valves, globe valves, Ball valves, diaphragm valves, butterfly valves etc. eclectically actuated, pneumatic actuated and hydraulic actuated	Control valves such as gate valves, globe valves, Ball valves, diaphragm valves, butterfly valves etc. Each valve is actuated with any one type of eclectically actuated/ pneumatic actuated/ hydraulic actuated (3 types of actuations should available with any one type of valve) with working condition and mounted on MS fabricated Stand. With suitable source and fittings.	1 no. each.
157.	Valve petitioners, booster relays, gland pickings etc.	Pneumatic and electro pneumatic valve positioners and booster relays, packing	1 no. each.

158.	Cut section models of various type of control valve	Cut section of gate valve (hydraulically operated), cut section of butterfly valve (electrically operated), cut section of ball type (electrically operated), cut section of globe valve: (pneumatically type), cut section of diaphragm valve (pneumatically operated).minimum size 1 " to show the internal construction of valves.	1 no. each.
159.	HART/ field bus final control elements (two different type)	HART / Field bus Valve positioner with two different characteristics control valve. Operated with mA source. Electro pneumatic positioner having facility of auto tuning, suitable with both fail safe modes and auto and manual mode facility. S.S. measuring tank, S.S. sump tank, S.S. body pump to full flange operation mounted on suitable frame structure.	1 no. each
O. EQUIPMENT FOR MICROPROCESSORS			
160.	Data acquisition system (DAS)	S.S. measuring tank, S.S. sump tank, S.S. body pump, four type of transmitter (pressure, flow, temperature and level), with data acquisition module hardware as well as software With fitting on stand.	1 no.
161.	ADC to DAC cards	Analog to Digital Converter 8 channel study card and Digital to Analog Converter study card with necessary attachment to complete experiment.	2 nos.

162.	Digital I/O cards	Power supply 24 VDC, 16 Inputs source or sink type, with transistorized or relay based 16 outputs. Operated with human machine interface and Minimum 5 experimental modules. Having communication facility of RS-485 or RS-232.	2 nos.
163.	Microprocessor trainer kit	Microprocessor Trainer 6.144 MHz Operating Frequency, 8 K ROM, 8 K RAM, ASCII Keyboard Input, LCD Display with interface with ADC / DAC modules, application modules like Seven Segment Display, Stepper Motor Controller, Traffic Light Controller, Elevator Simulator, Temperature measurement, DC Motor controller. Trainer with simulation software	2 nos.
P. COMPUTER AND SOFTWARE			
164.	Lap top (for convenient to field bus system/control system)		02 Nos.
165.	Licensed operating system (latest version)		02 Nos.
166.	Latest Office (licensed version)		01 No.
167.	LCD multimedia projector		01 No.
168.	Broad band internet connection		01 No.
169.	Printer (Scan/copy)		01 No.
170.	Networking tool kit		02 No.
Q. EQUIPMENT ON HYDRAULICS AND PNEUMATICS			
171.	Hydraulic trainer	Hydraulic Trainer with Equipment trays - 2nos., Pressure gauges, Hydraulic Motor, 4/2 & 4/3 (with	1 no.

		different mid position) way hand lever valve - 3nos each, Pressure sequence valves & pressure reducing valve – 2 nos each, pressure relief valves, flow control valves & Non-return valves-2 Nos Each (one each sub plate type), Shut-off valves, Diaphragm accumulator, Weight up to 10 kg- 1 no., 2/2 way plunger / stem actuated – 2 nos., Standard hoses with quick connectors, Flow dividing valve – 1 no., 5-way distributor with pressure gauge - 1no.s All components should be mounted on Aluminum profile plate on working condition.	
172.	Pneumatic trainer	Pneumatic trainer consists with Pressure Gauge, Pneumatic Motor, Single Acting Cylinder, Double Acting Cylinder, Air Filter Regulator Lubricator with Pressure Gauge Hand Lever Operated Valves: 2 Nos, 5/2 way& 3/2-way, Solenoid Valve: 2 Nos, 5/2 way& 3/2 way, Pilot Operated Valve: 5/3 Spring Centered, 5/2Spring Returned, 3/2 Pilot Operated. Palm Operated Valve: 3/2-way Valve,Roller Lever Valve: 5/2 way, 3/2-way Valve,Shuttle Valve: OR Valve,AND Valve: Dual Pressure Valve, Flow Control Valve,Non-Return Valve, Block Manifold: 6 ways,	1 no.

		Plastic Tubing as per require, Quick Push-Pull connectors, Air Compressor. All components should be mounted on Aluminum profile plate on working condition.	
R. ANALYTICAL EQUIPMENTS			
173.	Conductivity meter & TDS meter	Conductivity meter Microprocessor based, auto ranging, Automatic End point function, LCD display, Accuracy ±1% F.S., up to 3-point calibration, reset function, conductivity buffer option, Hold and Auto off function, temperature compensation. T.D.S. Analyzer: Microprocessor based, Auto ranging, Automatic End point function, LCD display, Accuracy ±1% F.S., TDS factor 0.1 to 1.0, selectable TDS conversion factor and temp. units, Reset function, Hold and Auto off function, temperature compensation.	1 no.
174.	pH meter (Digital) portable	Digital, with PH range of 0 – 14 pH, Millivolt Range of 0 - + 1999 mV, Temp. Compensation Auto /Manual with auto calibration facility and electrodes.	1 no.
175.	Experimental set up for online conductivity measurement	Online conductivity meter with 4-20 mA output, Conductivity sensor, SS Reactor tank, SS feed tanks, variable speed pump, stirrer, hardware and electrical accessories mounted	1 no.

		on good quality frame work with software.	
176.	Experimental set up for online pH measurement	Online PH meter with 4-20 mA output, PH electrode, SS Reactor tank, SS feed tanks, variable speed pump , stirrer, hardware and electrical accessories on stand with software.	1 no
177.	Experimental set up for online dissolved oxygen measurement	SS Measuring Tank, Dissolved oxygen Meter, dissolved oxygen sensor, mini air compressor, hardware and electrical accessories on stand	1 no.
S. WORKSHOP FURNITURE:			
178.	Instrument test bench with cup boards	The overall dimensions of Workbench should be not less than W = 1500 mm; D = 900 mm; H = 1500 mm, 3 nos. - MS drawers with handle & separate lock on each drawer should be provided. Leveling screws on the base of the legs should be provided. Instrument Workbench with 30 MHz Oscilloscope, Function Generator with Frequency Range of Sine wave 1mHz - 10MHz,Dual DC Power Supply, 0-32 V, 0-2 Amp with color LCD for Voltage and Current readout.,4 ½ Digit LCD Large display Digital Multi meter,1KHz LCR Meter with LCD Display, I to p Convertor with air regulator and gauge, Temperature controlled Soldering and De soldering	1 no.

		station with SMD Iron , Components bin – Bin with various general components like Resistor, Capacitor, Inductor, Pot etc., Variac - Single Phase with 5Amp current rating in separate housing., Tool Kit – Should comprise with a set of general purpose tools like Mains Tester, Screw Driver, Tweezer, and Plier.	
179.	Steel cup boards with eight lockers for trainees		2 no.
180.	Steel cup boards/ almirah	(100x1200x450 mm)	4 no.
181.	Steel cup boards with eight lockers for trainees	1800x1200x450(with five shelves)	2 no.
182.	Steel cup boards with eight lockers for trainees	(1800x1200x450mm)	2 no.
Note: 1. *Internet facility is desired to be provided in the class room.*			

ANNEXURE-II

The DGT sincerely acknowledges contributions of the Industries, State Directorates, Trade Experts, Domain Experts, trainers of ITIs, NSTIs, faculties from universities and all others who contributed in revising the curriculum.

Special acknowledgement is extended by DGT to the following expert members who had contributed immensely in this curriculum.

List of Expert members participated/ contributed for finalizing the course curriculum of Instrument Mechanic at ITI, Ambernath, Maharashtra and ITC, Vadodara, Gujarat.			
S No.	**Name & Designation Shri. /Mr./Ms.**	**Organization**	**Mentor Council Designation**
Industry Expert			
1.	LaxmidasHinduja, MD	Transpek Industries ltd, Gujarat	Chairman
2.	S. A. Pandav, RDD, Vadodara	DET, Gujarat	Coordinator
3.	L. K. Mukherjee, DDT	CSTARI, Kolkata	Coordinator
4.	AkashVergurlekar, Mechanical Maintenance Executive	VVF India Ltd. Taloja, Raigad	Member
5.	JayeshKarnik, Instrumentation Maintenance Executive- Engg. Service	-do-	Member
6.	Pradeep Kumar Pandey, Asst. Deputy Manager	Century Rayon, Mumbai	Member
7.	Deepak M Kanitkar, Executive	Huhtamaki PPL Ltd, Bansri, Thopoli, Rigad	Member
8.	Atul D. Taksande, Sr. Executive P&A	Bombay Dyeing & Manufacturing Co., Patulganga	Member
9.	K. M. Unni Krishnan, Sr. Manager HR & Admin.	ASB International Pvt. Ltd., Ambernath	Member
10.	Ajit D. Bagwe, Manager- Molding	-do-	Member
11.	Rohan Kadlay, General Manager	Siemens Ltd. Mumbai	Member
12.	VidyadharTakle, Asst. Manager- Engg. Service	Godrej Industries Ltd., Ambernath	Member
13.	RoshanVagade, QC- Engineer	Indore Composite Pvt. Ltd. Mumbai	Member
14.	Sandip D. Pisal, Asso. Chief Manager- Painter	Godrej & Boyce Manufacturing Co. Ltd, Mumbai	Member
15.	RajendraAgashe, Manager- HR	Asian Paints India ltd. Taloja	Member

16.	Mahesh Bandekar, Coating Officer	Indore Composite Pvt. Ltd. Mumbai	Member
17.	Prashant A Bhosale, Sr. Manager-Production	Jubilant Life Science Ltd., N-34 Additional, Ambernath	Member
18.	UdayrajRansing, Dy. Manager Engg.	-Do-	Member
19.	Haresh P Chavda Manager	Transpek Ind. Ekalbara Vadodara	Member
20.	M H Patel SR Officer	NirmaLimited, Alindra , Ta Savli , Di.Vadodara	Member
21.	Rinkesh Jadhav , SrExcucative	Lupin Limited , Vadodara	Member
22.	P H Nasit , Manager	GACL , Vadodara	Member
23.	Rajendra Mandora , Director	Nish Group ,Hajivala Industry , Surat	Member
24.	Rakesh B Mahajan , DY. Manager	Sud Chemical ,Nandesari , Vadodara	Member
DGT & Training Institute			
25.	S B Sarvaiya , Principal	ITI Savli, Vadodara	Member
26.	Nilesh H Patel , Supervisor Instructor	ITI Tarsali , Vadodara	Member
27.	Manan G Shah , Supervisor Instructor	ITI Tarsali , Vadodara	Member
28.	N C Gohil , Principal	ITI Gotri , Vadodara	Member
29.	S B Sarvaiya , Principal	ITI Savli, Vadodara	Member
30.	J.T.PATEL, Principal	ITI Vasad, , Vadodara	Member
31.	PK Bairagi, TO	CSTARI Kolkata	Member

ABBREVIATIONS

CTS	Craftsmen Training Scheme
ATS	Apprenticeship Training Scheme
CITS	Craft Instructor Training Scheme
DGT	Directorate General of Training
MSDE	Ministry of Skill Development and Entrepreneurship
NTC	National Trade Certificate
NAC	National Apprentice Certificate
NCIC	National Craft Instructor Certificate
LD	Locomotor Disability
CP	Cerebral Palsy
MD	Multiple Disabilities
LV	Low Vision
HH	Hard of Hearing
ID	Intellectual Disabilities
LC	Leprosy Cured
SLD	Specific Learning Disabilities
DW	Dwarfism
MI	Mental Illness
AA	Acid Attack
PwD	Person with disabilities


कौशलं बलम्