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

COMPETENCY BASED CURRICULUM

INSTRUMENT MECHANIC

(Duration: Two Years)
Revised in July 2022

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL- 4

SECTOR – ELECTRONICS AND HARDWARE

कौशलं बलम्
Directorate General of Training

INSTRUMENT MECHANIC

(Engineering Trade)

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CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL- 4

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 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 courses delivered 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 (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.

Trainee broadly needs to demonstrate that 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)	840	840
2	Professional Knowledge (Trade Theory)	240	300
5	Employability Skills	120	60
	Total	**1200**	**1200**

Every year 150 hours of mandatory OJT (On the Job Training) at nearby industry, wherever not available then group project is mandatory.

4	On the Job Training (OJT)/ Group Project	150	150

Trainees of one-year or two-year trade can also opt for optional courses of up to 240 hours in each year for 10th/ 12th class certificate along with ITI certification, or, add on short term courses.

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 DGT from 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 DGT from 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%.

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 some of 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
- Computer based multiple choice question examination
- Practical Examination

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 for formative assessment:

Performance Level	Evidence
(a) Mark in the range of 60%-75% to be allotted during assessment	
For performance in this grade, the candidate should produce work which demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and practices	• Demonstration of good skill in the use of 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) Mark 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) Mark 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. Examines instrument for defects. 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 for checking functions of manufactured industrial equipment such as UPS, inverter, energy meter, PLC, oscilloscope, control panel. The individual at work tests specified 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

Reference NOS: --

a) CSC/N0304
b) ELE/N9410
c) ELE/N9411
d) ELE/N9412
e) ELE/N9413
f) PSS/N6001
g) ELE/N9413
h) ELE/N9402
i) PSS/N2406, PSS/N2407
j) ELE/N9414
k) ELE/N9415
l) ELE/N9404
m) ELE/N7202
n) ELE/N5102
o) ELE/N9407
p) ELE/N9405
q) ELE/N9416
r) ELE/N9417
s) ELE/N9418
t) CSC/N9401
u) CSC/N9402
v) ELE/N9408
w) ELE/N9419
x) ELE/N9420
y) ELE/N9421
z) ELE/N9422
aa) ELE/N9422
bb) ELE/N9423
cc) ELE/N9424
dd) ELE/N9425
ee) ELE/N9426
ff) ELE/N9427
gg) ELE/N9428

hh) ELE/N9429
ii) ELE/N9430
jj) ELE/N9431
kk) ELE/N9432
ll) ELE/N9433
mm) ELE/N9434
nn) CSC/N9401
oo) CSC/N9402

4. GENERAL INFORMATION

Name of the Trade	**INSTRUMENT MECHANIC**
Trade Code	DGT/1024
NCO – 2015	7311.0100, 7311.0101, 7311.0400, 7543.0801
NOS Covered	CSC/N0304, ELE/N9410. ELE/N9411. ELE/N9412, ELE/N9413, PSS/N6001, ELE/N9402, PSS/N2406, PSS/N2407, ELE/N9414, ELE/N9415, ELE/N7202, ELE/N5102, ELE/N9407, ELE/N9405, ELE/N9416, ELE/N9417, ELE/N9418 CSC/N9401, CSC/N9402, ELE/N9408, ELE/N9419, ELE/N9420, ELE/N9421, ELE/N9422, ELE/N9423, ELE/N9424, ELE/N9425, ELE/N9425, ELE/N9426, ELE/N9427, ELE/N9428 ELE/N9429, ELE/N9430, ELE/N9431, ELE/N9432, ELE/N9433 ELE/N9434,
NSQF Level	Level-4
Duration of Craftsmen Training	Two Years (2400 hours + 300 hours OJT/Group Project)
Entry Qualification	Passed 10th class examination with Science and Mathematics or with vocational subject in same sector 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 Regular / RPL variants of National Craft Instructor Certificate (NCIC) 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:** Regular / RPL variants of National Craft Instructor Certificate (NCIC) in relevant trade **OR** Regular / RPL variants 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 Mechanical group (Gr-I) trades categorized under Engg. Drawing'/ D'man Mechanical / D'man Civil' with three years' experience. **Essential Qualification:** Regular / RPL variants of National Craft Instructor Certificate (NCIC) in relevant trade **OR** Regular / RPL variants of 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. (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.
(v) Minimum Age for Instructor	21 Years
List of Tools and Equipment	As per Annexure – I

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] CSC/N0304*
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] ELE/N9410
3. Identify, test the cable and measure the electrical parameters. ELE/N9411
4. Test various electrical passive and active components using proper measuring instruments and compare the data using standard parameter. ELE/N9412
5. Identify, test and use of various types of switches, E.M. relays, Circuit breaker and construct electrical circuits. ELE/N9413
6. Estimate, Assemble, install and test wiring system. PSS/N6001
7. Verify characteristics of resonance circuits. ELE/N9413
8. Plan, execute commissioning, testing and evaluate performance of AC & DC motors and generators. ELE/N9402
9. Execute testing, evaluate performance and maintenance of transformer. PSS/N2406, PSS/N2407
10. Plan, select, and carry out measurement, extension of range, overhauling, testing and calibration of D′Arsonval meter, PMMC meter. ELE/N9414
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. ELE/N9415
12. Identify, Test various analog and power electronics components, Construct, test and analyze the circuit functioning. ELE/N9404
13. Detect the faults and troubleshoot SMPS, UPS, inverter, converter and Thyristor family. ELE/N7202

14. Identify, place, solder and de-solder and test different SMD, discrete components with due care and following safety norms using proper tools/setup. ELE/N5102
15. Construct and test different circuits using operational amplifiers circuits and execute the result. ELE/N9407
16. Identify, test and verify all digital ICs. Assemble, test and troubleshoot various digital circuits and digital instruments. ELE/N9405
17. Measure the various parameters by CRO and execute the result with standard one. ELE/N9416
18. Install and setup operating system and related software in a computer & Practice with MS office and application software related to instruments. ELE/N9417
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. ELE/N9418
20. Read and apply engineering drawing for different application in the field of work. CSC/N9401
21. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. CSC/N9402

SECOND YEAR:

22. 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. ELE/N9408
23. Select, Installs, services, and calibrate instruments for motion, speed, acceleration and vibration. ELE/N9419
24. 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. ELE/N9420
25. 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. ELE/N9421
26. Identify, operate, maintain, troubleshoot and calibrate the devices for solid flow measuring system & verify the result within standard. ELE/N9422
27. 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. ELE/N9423

28. 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. ELE/N9424
29. Identify, select, Evaluate performance, install, service and calibrate temperature Indicators, Transmitters(RTD'S, Thermistors and Thermocouples types); various type of pyrometers. ELE/N9425
30. Identify, select, Operate, maintain, Service and calibrate different types of recorders. ELE/N9426
31. 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. ELE/N9427
32. 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). ELE/N9428
33. Tune controller mode and evaluate performance of control loops as per specification and system application. ELE/N9428
34. 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. ELE/N9429
35. Operate, maintain, service, configure, install, wire and test HART transmitters / devices (I/O). And Net-working system for instrumentation. ELE/N9430
36. 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. ELE/N9431
37. 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. ELE/N9432
38. 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. ELE/N9433
39. Identify constructional feature, operate, maintain, service and calibrate of analytical instruments. ELE/N9434
40. Read and apply engineering drawing for different application in the field of work. CSC/N9401
41. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. CSC/N9401

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] CSC/N0304*	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 leakage. [range of skills- cutting, threading, flaring, bending and joining] ELE/N9410	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.
	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. ELE/N9411	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 and electronic instruments for electrical measurement.
	Measure the value of resistance, voltage and current using Analog/ digital multimeter
4. Test various electrical passive and active *components* using proper measuring instruments and	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.

compare the data using standard parameter. ELE/N9412	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 breaker and construct electrical circuits. ELE/N9413	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, identify parts, 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. PSS/N6001	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. ELE/N9413	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. ELE/N9402	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. PSS/N2406, PSS/N2407	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. ELE/N9414	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 Familiar with the internal Construction and operation of'D[1] Arsonval meter, PMMC meter for current and voltage measurement.
	Identify types of deflecting torque, controlling torque, & 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 PMMC instruments 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. ELE/N9415	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 an armoured 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 and earth-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 operation of 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. ELE/N9404	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 and instruments for carrying out the 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 and Thyristor family. ELE/N7202	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. ELE/N5102	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. ELE/N9407	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 digital instruments. ELE/N9405	Illustrate to practice the digital trainer kit with safety.
	Identify various digital ICs, test IC using digital IC tester and verify the truth table
	Construct and verify the truth table of all gates using NOR and NAND gates
	Construct an adder cum subtractor circuits and verify the truth table
	Construct and verify the truth table of various flip flops, counters and shift register circuits
	Construct a decoder and encoder, multiplexer and de-

	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. ELE/N9416	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 & Practice with MS office and application software related to instruments. ELE/N9417	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. 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. ELE/N9418	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.
20. Read and apply engineering drawing for different application in the field of	Read & interpret the information on drawings and apply in executing practical work.
	Read &analyze the specification to ascertain the material

work. CSC/N9401	requirement, tools and assembly/maintenance parameters.
	Encounter drawings with missing/unspecified key information and make own calculations to fill in missing dimension/parameters to carry out the work.
21. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. CSC/N9402	Solve different mathematical problems
	Explain concept of basic science related to the field of study
SECOND YEAR	
22. 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. ELE/N9408	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 using analog/ digital standard voltmeter and ammeter.
	Check the repeatability, reproducibility, drift, dead band, back 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 proximity sensors
	Identify and study the instrument specification and the circuit operation of analog/ 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.
23. Select, Installs, services, and calibrate instruments for motion, speed, acceleration and vibration. ELE/N9419	Identify sensors used for motion, speed, and acceleration and vibration measurement and verify 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 use of stroboscope and find motion of object.
24. 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. ELE/N9420	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 the construction, circuit operation of Different types electronic pressure indicators and transmitters: (potentiometricpr. transducers, Capacitivepr. transducers, strain gauge pressure transducers, piezoelectric pressure 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 breakdown maintenance of pressure and vacuum gauges, transmitters, impulse line etc. As per guidelines.
25. 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	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 of various types of flow restrictors (orifice, venturi, flow nozzle, pitot tube) and tapings

meters / head flow meters, variable area flow meters, positive displacement meters, Electronic type flow meters and mass flow meters for fluids flow measurement. ELE/N9421	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 constructional feature of weirs, notches and flumes their shape and connections and measure the Open channel flow rates using manometer and DP Transmitters
	Dismantling, checking overhauling and calibration of D.P. cell/ transmitter. (pneumatic & electronic)
	Study of construction of Rotameter and measure fluid flow rate by Rota meters.
	Dismantling, checking, overhauling and calibration of 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 positive displacement meters.
	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
26. Identify, operate, maintain, troubleshoot and calibrate the devices for solid flow	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

measuring system & verify the result within standard. ELE/N9422	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.
27. 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. ELE/N9423	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 of electrical level indicators and transmitters
	Service and calibrate electrical type's level indicators and transmitters.
	Identify and carry out maintenance of level indicators and transmitters and switches for liquid and solid level.
28. List out different unit of temperature, terms and read specification of temperature instruments. Perform measurement, maintenance, Servicing and calibration of Bimetallic and filled system	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

thermometers & thermo switches. ELE/N9424	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.
29. Identify, select, evaluate performance, install, service and calibrate temperature Indicators, Transmitters (RTD'S, Thermistors and Thermocouples types); various type of pyrometers. ELE/N9425	Identify and check different types of RTD's, Thermistors, Thermocouples, Ex-tension wires. and protecting wellsfor temperature measurement.
	Verify the characteristic of different types of RTD'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 indicators and transmitters (analog and digital version)
	Identify parts/ section and its function, circuit operation of analog/ digital type Optical and Radiation pyrometer.
	Install, WIRE and test Optical and Radiation pyrometer as per guidelines.
	Measure high temperature using optical and Radiation 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.
30. Identify, select, Operate, maintain, Service and calibrate different types of recorders. ELE/N9426	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.
31. 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. ELE/N9427	Identify final control element in process control loop and types of electric and fluidic control signals for operation of final control elements.525
	Identify parts, its function, operation, service, and calibrate various types of converters.
	Construction, operation and use of various types of pneumatic 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.
32. 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). ELE/N9428	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 operation using 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.
33. Tune controller mode and evaluate performance of control loops as per specification and system application ELE/N9428	Familiar with feed forward, and feedback process control system, check loop 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).
34. Identify modules of PLC, its	Identify each module in a rack and mount in the specified slot.

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. ELE/N9429	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.
35. Operate, maintain, service, configure, install, WIRE and test HART transmitters /devices (I/O). And Net-working system for instrumentation. ELE/N9430	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.
36. 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. ELE/N9431	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.
37. 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 ELE/N9432	Familiar with hydraulic trainer and safety measure to handle hydraulic system.
	Practice symbolic representation of hydraulic components.
	Familiar with hydraulic hoses and fitting.
	Study Constructional Feature Function of hydraulic pump and hydraulic power system.
	Study Features 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 using pilot operated check valve, pressure reducing valve, pressure relive and pressure regulating valve, pressure sequencing circuit, pressure compensated flow control etc.
38. Lay out construction feature, operate, maintain of air compressor, air Distribution system, pneumatic associate components, piping, tubing	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

and fitting. Build and test pneumatic control circuit. ELE/N9433	output from the available compressor.
	Draw Symbolic representation of different Pneumatic components, various supply elements such as Compressors, pressure regulating valve, service unit 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.
39. Identify constructional feature, operate, maintain, service and calibrate of Analytical instruments. ELE/N9434	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.
40. Read and apply engineering drawing for different application in the field of work. CSC/N9401	Read & interpret the information on drawings and apply in executing practical work.
	Read &analyze the specification to ascertain the material requirement, tools and assembly/maintenance parameters.
	Encounter drawings with missing/unspecified key information and make own calculations to fill in missing dimension/parameters to carry out the work.
41. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. CSC/N9401	Solve different mathematical problems
	Explain concept of basic science related to the field of study

7. TRADE SYLLABUS

SYLLABUS FOR INSTRUMENT MECHANIC TRADE			
FIRST YEAR			
Duration	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
Professional Skill 90 Hrs. Professional Knowledge 16 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] CSC/N0304*	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. (03 Hrs.) 4. Safe disposal of waste materials like cotton waste, metal chips/burrs etc. (03 Hrs.) 5. Safety signs for Danger, Warning, caution & personal safety message. (03 Hrs.) 6. Preventive measures for electrical accidents & steps to be taken in such accidents. (04 Hrs.) 7. Use of Fire extinguishers. (03 Hrs.) 8. Practice and understand precautions to be followed	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. (06 Hrs.)

		while working in fitting jobs. (05 Hrs.) 9. Safe use of tools and equipments used in the trade. (05 Hrs.)	
		10. Demonstration and uses of hand tools- screwdrivers, pliers, spanners, tweezers, tester, wire stripper, electrician knife, steel rule, scriber, punches, hammer. (06 Hrs.) 11. Visual inspection of raw material for rusting, scaling, corrosion etc. (05 Hrs.) 12. Filing- flat & square (Rough finish). (05 Hrs.) 13. Filing practice, surface filing, side and checking 90^0 by try square. (05 Hrs.) 14. Marking out lines, filling and saving use of vice to given dimensions. (05 Hrs.) 15. Filing- Flat, square and Parallel to an accuracy of 0.5mm. (05 Hrs.) 16. Measurement of Length, Height & Diameter by Vernier callipers and Micrometers. (05 Hrs.)	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. (05 Hrs.)
		26. Select drill bits, reamers and tapes. (02 Hrs.) 27. Drill through holes and blind holes. (10 Hrs.) 28. Form external thread with dies to standard size. (10 Hrs.)	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. (05 Hrs.)

Professional Skill 25 Hrs. Professional Knowledge 04 Hrs.	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] ELE/N9410	29. Flaring of tube and tube joints. (06 Hrs.) 30. Cutting and threading of tube length. (06 Hrs.) 31. Fitting of tube and per sketch observing conditions used for tube work. (06 Hrs.) 32. Fit and assemble tubes, PI arc and ferrule fittings. (07 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. (04 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 05 Hrs.	Identify, test the cable and measure the electrical parameters. ELE/N9411	33. Construct a test lamp and use it to check mains healthiness. (02 Hrs.) 34. Measure the voltage between phase and ground and rectify earthing. (03 Hrs.) 35. Prepare terminations, skin the electrical wires /cables using wire stripper and cutter. (03 Hrs.) 36. Measure the gauge of the wire using SWG and outside micrometre. (03 Hrs.) 37. Refer table and find current carrying capacity of wires. (03 Hrs.) 38. Measure AC and DC voltages using multi meter. (03 Hrs.) 39. Use the multi meter to measure the various functions (AC V, DC V, DC I, AC I, R). (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. (05 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 05 Hrs.	Test various electrical passive and active components using proper measuring instruments and	40. Measure the resistor value by colour code and verify the same by measuring with multi-meter. (02 Hrs.) 41. Practice soldering on IC bases and PCBs. (03 Hrs.)	Uses of multimeter. Resistor, Resistivity and colour code, Types of resistors used in instrumentation. Definition and purpose of soldering and desoldering. Soft soldering.

	compare the data using standard parameter. ELE/N9412	42. Practice de-soldering using pump and wick. (02 Hrs.) 43. Join the broken PCB track and test. (02 Hrs.) 44. Practice on measurement of parameters in combinational electrical circuit by applying Ohm's Law for different resistor values and voltage sources. (03 Hrs.) 45. Measurement of current and voltage in electrical circuits to verify Kirchhoff's Law. (02 Hrs.) 46. Verify laws of series and parallel circuits with voltage source in different combinations. (02 Hrs.) 47. Measure the resistance, Voltage, Current through series and parallel connected networks using multi meter. (02 Hrs.) 48. Measure and test the voltages of the given cells/battery using analog/digital multi-meter. (02 Hrs.)	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. (05 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 04 Hrs.	Identify, test and use of various types of switches, E.M. relays, Circuit breaker and construct electrical circuits. ELE/N9413	49. Dismantle and identify the different parts of a relay. (04 Hrs.) 50. Connect a timer relay in a circuit and test for its working. (04 Hrs.) 51. Connect a contactor in a circuit and test for its working. (04 Hrs.) 52. Construct and test series and parallel resonance circuit. (04	Switches and types. Magnet and magnetism, magnetic properties. Magnetic campus and its uses. Explanation of Electro-magnetism, Advantages, disadvantages-application-types E.M. relays. (04 Hrs.)

		Hrs.) 53. Make a panel board using different types of switches for a given application. (04 Hrs.)	
Professional Skill 20 Hrs. Professional Knowledge 04 Hrs.	Estimate, Assemble, install and test wiring system. PSS/N6001	54. Practice cutting, threading of different sizes & laying Installations. (05 Hrs.) 55. Draw layouts and practice in PVC Casing-capping, Conduit wiring with minimum to a greater number of points of minimum 15 mtrs. (05 Hrs.) length. (05 Hrs.) 56. Wire up PVC conduit wiring to control one lamp from two different places. (05 Hrs.) 57. Draw layouts and practice Wiring for instrument panel. (05 Hrs.)	Principles of alternating current, A.C & DC electricity, types of wave forms, time period and frequency, peak to peak values, RMS values, Average values. (04 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 04 Hrs.	Test various electrical passive and active components using proper measuring instruments and compare the data using standard parameter. ELE/N9412	58. Measure the inductor value by written/colour code and verify the same by measuring with LCR meter. (10 Hrs.) 59. Measure charge, energy store of capacitor in series and parallel circuits with voltage source in different combination. (10 Hrs.)	Inductor and Inductance, types of inductors, Factors affecting the value of inductance, self-inductance (L), 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. (04 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 05 Hrs.	Verify characteristics of resonance circuits. ELE/N9413	60. Measure capacitive and inductive reactance with increase/decrease the input frequency of the circuit. (05 Hrs.) 61. Measure current & voltage and determine the characteristics of RL, RC and	A.C.-impedance, Inductive reactance, capacitive reactance. AC current through - R, L, C circuits. Resonance in RLC circuit. Importance - of series and parallel resonance. (05 Hrs.)

		RLC in AC series circuits. (05 Hrs.) 62. Measure the resonance frequency in AC series circuit and determine its effect on the circuit. (05 Hrs.) 63. Measure current & voltage and determine the characteristics of RL, RC and RLC in AC parallel circuits. (05 Hrs.)	
Professional Skill 46 Hrs. Professional Knowledge 10 Hrs.	Plan, execute commissioning, testing and evaluate performance of AC & DC motors and generators. ELE/N9402	64. Start, run and reverse the direction of rotation of single-phase AC motors. (07 Hrs.) 65. Practice on speed control of single-phase AC motors. (06 Hrs.) 66. Install, connect and determine performance of single-phase DC motors. (07 Hrs.) 67. Start, run and reverse the direction of rotation of single-phase DC motors. (06 Hrs.) 68. Install an alternator, identify parts and terminals of alternator. (07 Hrs.) 69. Perform speed control of DC motors - field and armature control method. (06 Hrs.) 70. Connect, start and run three phase induction motors by using DOL, star-delta and auto-transformer starters. (07 Hrs.)	Introduction of AC and DC generators working principles, construction. Operation, field magnets, armature windings, 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. (10 Hrs.)
Professional Skill 20 Hrs. Professional	Execute testing, evaluate performance and maintenance of	71. Perform OC and SC test to determine and efficiency of single-phase transformer. (05 Hrs.)	Transformer, types, transformation ratio. Open circuit test and short circuit test, regulation Auto

Knowledge 05 Hrs.	transformer. PSS/N2406, PSS/N2407	72. Determine voltage regulation of single-phase transformer at different loads and power factors. (05 Hrs.) 73. Verify and measure voltage regulation of auto transformer at different loads. (05 Hrs.) 74. Perform series and parallel operation of two single phase transformers. (05 Hrs.)	transformer. Current measurement. Instrument transformer. Potential transformer and current transformer. (05 Hrs.)
Professional Skill 40 Hrs. Professional Knowledge 06 Hrs.	*Plan, select, and carry out measurement, extension of range, overhauling, testing and calibration of 'D´ Arsonval meter, PMMC meter. ELE/N9414*	75. Overhaul, check, fault find, repair, test of voltmeter and ammeter. (07 Hrs.) 76. Study the construction circuit operation and adjustment for correct functioning of zero errors on voltmeter and ammeter. (06 Hrs.) 77. Find the minimum and maximum measurable range of the meter. (07 Hrs.) 78. Test the shunt and series resistance of various range of ammeter. (07 Hrs.) 79. Practice multipliers for different range extension of voltmeter and ammeter. (07 Hrs.)	**Basics of electrical measuring instruments-** Types - absolute and secondary instruments. Types of secondary instruments, **DC** instruments - 'D[1] Arsonval meter, PMMC meter- working principle, method of working, moving coil operation. (FSD) full scale deflection reading, measurement value, meter sensitivity, accuracy. Meter resistance, maximum power, capability etc. **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. (06 Hrs.)
Professional Skill 60 Hrs.	Select, perform electrical/electronic	80. Prepare plate earthing and measure earth resistance	**Ohm meters-** measuring electrical resistance. Basic

Professional Knowledge 10 Hrs.	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. ELE/N9415	by earth tester / megger. (05 Hrs.) 81. Test earth leakage by ELCB and relay. (05 Hrs.) 82. Measure the power using wattmeter. (05 Hrs.) 83. Test and calibrate wattmeter. (05 Hrs.) 84. Familiar with the construction of energy meter and ampere hour meter. (03 Hrs.) 85. Overhaul, check and fault find of ampere hour meter. (05 Hrs.) 86. Test and calibrate ampere hour meter. (05 Hrs.) 87. Measure power in single and three phase circuit using voltmeter & ammeter. (05 Hrs.) 88. Overhaul and maintenance of KWH meter and energy meter. (05 Hrs.) 89. Test and calibrate KWH meter and energy meter. (05 Hrs.) 90. Measure power factor in three phase circuit by using power factor meter and verify the same with voltmeter, ammeter and wattmeter readings. (05 Hrs.) 91. Practice of use voltage tester to Test electrical power in circuit, to test for proper grounding, to determine whether	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. Induction type meters - working principle construction and operation of induction type instruments. Construction and Applications - single phase and three phase energy meter, watt meter. Walt hour meter, Ampere Hour meter, power factor meter etc. Special instruments: voltage tester, continuity tester, rotation test, phase sequence indicator, synchronizing, the synchroscope, _ frequency meter. Thermocouple type ammeters. (10 hrs.)

		adequate voltage is present in a wire. (05 Hrs.) 92. Determines the phase sequence of the three-phase supply system using Phase sequence indicator. (02 Hrs.)	
Professional Skill 80 Hrs. Professional Knowledge 16 Hrs.	Identify, Test various analog and power electronics components, Construct, test and analyze the circuit functioning. ELE/N9404	93. Test the power diode, Zener diode, tunnel diode, photo diode using multi meter and determine forward to reverse resistance ratio. (05 Hrs.) 94. Determine V-I characteristics of semiconductor diode. (05 Hrs.) 95. Measure the voltage and current through a diode in a circuit and verify its forward characteristic. (05 Hrs.) 96. Measure the voltage and current through a Zener diode in a circuit and verify its forward and reverse characteristic. (05 Hrs.) 97. Construct and test fixed-bias, emitter-bias and voltage divider-bias transistor amplifier. (05 Hrs.) 98. Construct and Test a common emitter amplifier with and without bypass capacitors 99. Construct a single stage amplifier and measure current gain, voltage gain & power gain. (05 Hrs.)	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 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,

		100. Construct and test a FET Amplifier. (04 Hrs.) 101. Construct and test a half wave, full wave and Bridge rectifier circuit. (05 Hrs.) 102. Construct and test different filter circuit used in rectifier and measure output voltage with load. (05 Hrs.) 103. Construct and test Zener based voltage regulator circuit. (03 Hrs.) 104. Construct and test Zener and transistor-based series regulator. (03 Hrs.) 105. Construct and test a +12V fixed voltage regulator. (05 Hrs.) 106. Construct and test a fixed +15ve and –15ve voltage regulator using ICs. (05 Hrs.) 107. Construct and test a 1. (05 Hrs.)2V – 30V variable output regulated power supply using IC LM317T and its characteristics. (05 Hrs.)	series regulators, IC regulators, variable regulators. (16 hrs.)
Professional Skill 20 Hrs. Professional Knowledge 04 Hrs.	Detect the faults and troubleshoot SMPS, UPS, inverter, converter and Thyristor family. ELE/N7202	179. List the defect and symptom in the faulty SMPS. (02 Hrs.) 180. Measure / Monitor major test points of computer SMPS. (02 Hrs.) 181. 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. (05 Hrs.)	**Power Supply units.** Introduction, purpose & use. UPS and SMPS, inverters and converters and their applications. (04 Hrs.)

		182. Open top cover of a UPS; identify its isolator transformers, the UPS transformer and various circuit boards in UPS. (03 Hrs.) 183. Perform load test to measure backup time. (03 Hrs.) 184. Install and test an inverter. (02 Hrs.) 185. Troubleshoot the fault in the given inverter unit. Rectify the defects and verify the output with load. (03 Hrs.)	
Professional Skill 20 Hrs. Professional Knowledge 04 Hrs.	Identify, place, solder and desolder and test different SMD, discrete components with due care and following safety norms using proper tools/setup. ELE/N5102	186. Measure and plot input and output characteristics of a CE amplifier. (05 Hrs.) 187. Check for cold continuity of PCB. (03 Hrs.) 188. Solder the SMD components from the given PCB. (04 Hrs.) 189. De-solder the SMD components in the same PCB. (04 Hrs.) 190. Repair solder mask and damage pad. (04 Hrs.)	General characteristics of an amplifier, Concept of amplification. PCB basic construction, applications. Lay outing circuit on PCB. (04 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 05 Hrs.	Identify, Test various analog and power electronics components, Construct, test and analyze the circuit functioning. ELE/N9407	**Oscillators** 191. Demonstrate Colpitts oscillator, Hartley oscillator circuits and compare the output frequency of the oscillator by CRO. (08 Hrs.) 192. Construct and test a RC phase shift oscillator circuits. (06 Hrs.) 193. Construct and test a crystal-	**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. (05 Hrs.)

		controlled oscillator circuit. (06 Hrs.)	
Professional Skill 44 Hrs. Professional Knowledge 10 Hrs.	Construct and test different circuits using operational amplifiers circuits and execute the result. ELE/N9407	194. Use analog IC tester to test the various analog ICs. (07 Hrs.) 195. Construct and test various Op-Amp circuits Inverting, Non-inverting and Summing Amplifiers. (05 Hrs.) 196. Construct and test Differentiator and Integrator circuits. (05 Hrs.) 197. Construct and test a voltage to current and current to voltage converter circuit using Op-amp. (05 Hrs.) 198. Construct and test Instrumentation amplifier. (04 Hrs.) 199. Construct and test Astable timer circuit using IC 555. (06 Hrs.) 200. Construct and test mono stable timer circuit using IC 555. (06 Hrs.) 201. Construct and test 555 timers as pulse width modulator. (06 Hrs.)	**Operational Amplifier.** Differential amplifier, ideal op-amp. Op-amp with feedback, advantages of feedback. 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. (10 Hrs.)
Professional Skill 125 Hrs. Professional Knowledge 20 Hrs.	Identify, test and Verify all digital ICs. Assemble, test and troubleshoot various digital circuits and digital instruments. ELE/N9405	202. Verify the truth tables of all Logic Gate ICs by connecting switches and LEDs. (05 Hrs.) 203. Construct and verify the truth table of all the gates using NAND and NOR gates. (05 Hrs.) 204. Use digital IC tester to test the various digital ICs (TTL and CMOS). (05 Hrs.)	**Number systems;** binary, octal, decimal and hexadecimal number system. Conversion of number systems. Boolean algebra, binary addition, subtraction, multiplication and 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.

		205. Construct and verify the truth table of all the gates using DTL circuit. (05 Hrs.) 206. Construct Half Adder circuit using ICs and verify the truth table. (05 Hrs.) 207. Construct Full adder with two Half adder circuit using ICs and verify the truth table. (05 Hrs.) 208. Construct Half subtractor and full subtractor circuit using ICs and verify the truth table. (05 Hrs.) 209. Construct the adder cum subtractor circuit and verify the result. (05 Hrs.) 210. Construct and test R-S flip-flop using IC7400 with clock and without clock pulse. (06 Hrs.) 211. Verify the truth tables of JK Flip-Flop using ICs by connecting switches and LEDs. (06 Hrs.) 212. Construct and test 7493 as a modulus-12 counter. (06 Hrs.) 213. Construct and test seven segment LED display decoder with IC 7447. (06 Hrs.) 214. Measure current flowing through a resistor and display it on LED Module. (06 Hrs.)	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. Digital meters: displays: LED, 7 segment display, LCD, CRT, electro- luminescent displays, electro-phoretic image display, liquid vapor display, dot matrix display. (10 Hrs.)
		215. Construct and test Digital to Analog (D/A) Binary Weighted resistor converter	**A/D and D/A converters,** Introduction, weighted register D / A converter, binary(R-2R)

		by using op-amps. (06 Hrs.) 216. Construct and test Digital to Analog (D/A) converter using R-2R ladder network circuit. (06 Hrs.) 217. Perform the interfacing of IEEE 488.2 standard with a single controller can control up to 15 different instrument connected star topology. (06 Hrs.) 218. Perform the interfacing of RS232 to the PC. (06 Hrs.) 219. Convert RS-485 signals to RS-232 signals using RS-485 to RS-232 converter. (06 Hrs.)	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. (06 Hrs.)
		220. Display a word on a two-line LED. (05 Hrs.) 221. Measure/current flowing through a sensor and display it on a LED module (DPM). (05 Hrs.) 222. Practice on measuring instruments in single and three phase circuits e.g. (05 Hrs.) Phase sequence meter and Frequency meter etc. (05 Hrs.) 223. 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. (04 Hrs.)
Professional Skill 20 Hrs. Professional Knowledge 05 Hrs.	Measure the various parameters by CRO and execute the result with standard one. ELE/N9416	224. Measure the Amplitude, Frequency and time period of typical electronic signals using CRO. (10 Hrs.) 225. Take a print of a signal from DSO by connecting it	CRO: introduction and applications of CRO, functional block diagram of CRO, CRT power supply. Various types of probes. Applications of various types of CROs like dual beam

		to a printer and tally with applied signal. (10 Hrs.)	CRO, Dual trace CRO, storage oscilloscope. (05 Hrs.)
Professional Skill 70 Hrs. Professional Knowledge 10 Hrs.	Install and setup operating system and related software in a computer &Practice with MS office and application software related to instruments. ELE/N9417	226. Practice on windows interface and navigating windows. (07 Hrs.) 227. Customize the desktop settings and manage user accounts. (07 Hrs.) 228. View system properties and control panel details. (07 Hrs.) 229. Install necessary application software for windows i.e. office package and media player. (07 Hrs.) 230. Burn data, video and audio files on CD/DVD using application software. (07 Hrs.)	Introduction to Computer, Block diagram of PC, software familiarization of Multimedia System consisting of CD ROMS, DVD ROMS, Sound Cards. (05 Hrs.)
		231. Dismantle and assemble the desktop computer system. (07 Hrs.) 232. Replace RAM and ROM from CPU. (07 Hrs.) 233. Identify different parts, its function and operation of modem. (07 Hrs.) 234. Install a modem to the computer to send and receive data over a telephone line or a cable or satellite connection. (07 Hrs.) 235. Construct and test DAC and ADC using computer network circuit. (07 Hrs.)	Computer Hardware, Computer systems, computer hardware, CPU, CPU operations, ROMs and RAMs, I/P and O/P and peripheral equipments, terminals, printers, MODEMS, Data interface, ADC and DAC. (05 Hrs.)
Professional Skill 40 Hrs.	Identify various functional blocks of a microprocessor	236. Measure the crystal frequency, connect it to the processor. (10 Hrs.)	Introduction to microprocessor microcomputers, Memories Intel 8085. Architecture

Professional Knowledge 10 Hrs.	system, identify various I/O Ports, write and executive simple program and Interface a model application with the microprocessor kit and run the application. ELE/N9418	237. Use 8085 microprocessor, connect 8 LED to the port, blink the LED with a switch. (10 Hrs.)	Instruction set of 8085, Microprocessor. 1. Data transfer group. 2. Arithmetic group. 3. Logic group. (05 Hrs.)
		238. Perform addition and subtraction of two 8-bit numbers using 8085 microprocessors. (10 Hrs.) 239. Demonstrate entering of simple programs, execute &monitor the results. (10 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. (05 Hrs.)
Engineering Drawing: 40 hrs.			
Professional Knowledge ED-40 Hrs.	Read and apply engineering drawing for different application in the field of work. CSC/N9401	**ENGINEERING DRAWING:** Introduction to Engineering Drawing and Drawing Instrument – • Conventions • Sizes and layout of drawing sheets • Title Block, its position and content • Drawing Instrument Free hand drawing of – • Geometrical figures and blocks with dimension • Transferring measurement from the given object to the free hand sketches. • Free hand drawing of hand tools. Drawing of Geometrical figures: • Angle, Triangle, Circle, Rectangle, Square, Parallelogram. • Lettering & Numbering – Single Stroke Symbolic representation – • Different Electronic symbols used in therelated trades Reading of Electronic Circuit Diagram. Reading of Electronic Layout drawing.	
Workshop Calculation & Science: 38 hrs.			
Professional Knowledge WCS-38 Hrs.	Demonstrate basic mathematical concept and principles to perform practical operations.	**WORKSHOP CALCULATION & SCIENCE:** **Unit, Fractions** Classification of unit system Fundamental and Derived units F.P.S, C.G.S, M.K.S and SI units Measurement units and conversion. Factors, HCF, LCM and problems. Fractions - Addition, substraction,	

	Understand and explain basic science in the field of study. CSC/N9402	multiplication & division. Decimal fractions - Addition, subtraction, multiplication & division. Solving problems by using calculator. **Square root, Ratio and Proportions, Percentage** Square and suare root. Simple problems using calculator. Applications of pythagoras theorem and related problems. Ratio and proportion. Ratio and proportion - Direct and indirect proportions Percentage Percentage - Changing percentage to decimal and fraction. **Material Science** Types metals, types of ferrous and non ferrous metals. Introduction of iron and cast iron. **Mass, Weight, Volume and Density** Mass, volume, density, weight and specific gravity Related problems for mass, volume, density, weight and specific gravity **Speed and Velocity, Work, Power and Energy** Speed and velocity - Rest, motion, speed, velocity, difference between speed and velocity, acceleration and retardation Speed and velocity - Related problems on speed & velocity Work, power, energy, HP, IHP, BHP and efficiency **Heat & Temperature and Pressure** Concept of heat and temperature, effects of heat, difference between heat and temperature, boiling point & melting point of different metals and non-metals Scales of temperature, celsius, fahrenheit, kelvin and conversion between scales of temperature Heat &Temperature - Temperature measuring instruments, types of thermometer, pyrometer and transmission of heat - Conduction, convection and radiation Concept of pressure - Units of pressure, atmospheric pressure, absolute pressure, gauge pressure and gauges used for measuring pressure **Basic Electricity** Introduction and uses of electricity, molecule, atom, how electricity is produced, electric current AC,DC their comparison, voltage, resistance and their units Conductor, insulator, types of connections - series and parallel. Ohm's law, relation between V.I.R & related problems. Electrical power, energy and their units, calculation with assignments. Magnetic induction, self and mutual

		inductance and EMF generation Electrical power, HP, energy and units of electrical energy **Trigonometry** Measurement of angles Trigonometrical ratios

Project Work/Industrial Visit (optional)

Broad Areas:

a) Regulated & Unregulated Power Supply
b) Battery Monitor & Charger
c) Emergency Light
d) Electronic Fan Regulator
e) SCR, Using UJT Trigger Circuit.
f) Dimmer circuit using Triac and Diac.
g) Dancing LEDs
h) Digital Clock
i) Event Counter
j) A to D Convertor.

SYLLABUS FOR INSTRUMENT MECHANIC TRADE			
SECOND YEAR			
Duration	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
Professional Skill 68 Hrs. Professional Knowledge 18 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. ELE/N9408	240. Finding the range, span and accuracy of instrument (example- ammeter, voltmeter etc. (04 Hrs.) 241. Test the voltmeter/ ammeter using std. voltage/ current source for total range. Check the dead zone, repeatability, reproducibility, drift, Dead band, backlash, hysteresis. (05 Hrs.) 242. Identify the strain gauge type, cantilever or load cell specification. (04 Hrs.) 243. Check the strain gauge using ohm meter / multimeter. (03 Hrs.) 244. Measure the load using strain gauge instrument. [using half (two), quarter(one), full (four) strain gauges on bridge]. (06 Hrs.) 245. Determine the sensitivity,	Scope and necessity of instrumentation. Fundamentals of measurement systems- functional block diagram of measurement system. Calibration and calibration standards– basic standards, secondary standards, working standards. Fundamental units - The metric system, Base& supplementary units, Derived Units, Multiplying factors and standards of length, mass, time & frequency. Temperature & electrical units. Instrument characteristics Static characteristics– accuracy, precision, sensitivity, resolution dead zone, repeatability, reproducibility, drift, Dead band, backlash, hysteresis. Dynamic characteristics– speed response, fidelity, lag. Error,

		liner range of strain gauge measurement. (06 Hrs.) 246. Make null balance and gain adjustment. Calibrate strain gauge instrument by adjusting zero and span. (05 Hrs.) 247. Identifying the various parts of LVDT. Study the specification of LVDT like range, exiting frequency, voltage, sensitivity etc. (05 Hrs.) 248. Identifying the coils in LVDT. Verifying the connection of secondary coils. Testing the LVDT coils using multimeter. (05 Hrs.) 249. Verify the LVDT characteristics by changing the displacement. (05 Hrs.) 250. Determine the liner range and sensitivity, resolution of LVDT. (05 Hrs.) 251. Measure the phase difference of LVDT secondary coils on CRO. (05 Hrs.) 252. Calibrate the LVDT by adjusting zero and span. (05 Hrs.) 253. Test and calibrate displacement meter, accelerometer and thickness instruments. (05 Hrs.)	deviation, true value, data. Types of errors- systematic, random& illegitimate error. Certainty/uncertainty, validity Of result. Measuring system Response. Introduction, amplitude responses, Phase response, Delay, rise time &slew rate. Damping & its importance. Statistical analysis – arithmetic mean, deviation from the mean average deviation, standard deviation. Stress &Strain Measurement. Introduction to Strain gauges, types of strain gauges and differences. Applications of strain gauges, load cells. LVDT, RVDT, advantages and limitations. (18 hrs.)
Professional Skill 36 Hrs.	Select, Installs, services and calibrate	254. Measure the vibration of motor/ machine. (06 Hrs.) 255. Servicing and maintenance	Measurement of motion, velocity / vibrometers and acceleration. Difference

Professional Knowledge 10 Hrs.	instruments for motion, speed, position, acceleration, vibration & record the data. ELE/N9419	vibrometers & accelerometer. (06 Hrs.) 256. Measure the speed of motor. (06 Hrs.) 257. Identify different parts, its function &Operation of eddy current, type AC and DC tachometer. (06 Hrs.) 258. Servicing and maintenance of mechanical and electrical tachometer. (06 Hrs.) 259. Identify different parts/section, its function &Operation and use Stroboscope and find motion of object. (06 Hrs.)	between tachometer and speedometers. Types of tachometers-Eddy current type, AC and DC tachometer. Stroboscope and its applications. seismic instrument. (10 Hrs.)
Professional Skill 120 Hrs. Professional Knowledge 35 Hrs.	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. ELE/N9420	260. Measure the atmospheric pressure using barometer. (03 Hrs.) 261. 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. (05 Hrs.) 262. Measure the differential pressure, gauge pressure and vacuum pressure using U tube manometer. (05 Hrs.) 263. Dismantle and assemble the manometer. Cleaning the glass tube, aligning the gravity balances etc. (05 Hrs.)	Principle of Pressure in Liquids & Gases. Properties of matter Principles of liquid pressure, units of pressure Liquids pressure and volume, density and specific gravity. Factors affecting liquid pres-sure. Pressure relation with volume, temperature and flow. Units of pressure and unit conversions. Types of pressure: absolute, gauge, atmospheric and vacuum pressures and their relationships. Barometers, manometers types and applications. (07 Hrs.)

		264. 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. (06 Hrs.) 265. Measurement of gauge pressure and vacuum pressure using bourdon tube / diaphragm gauge. (04 Hrs.) 266. Measurement of differential pressure using diaphragm/ capsule gauge. (04 Hrs.) 267. Identify specifications of pressure switch – range, differential pressure span, contact types, contacts current rating, number of contacts etc. (05 Hrs.) 268. 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. (05 Hrs.) 269. Connect and operate the pressure switch with load at various pressure and differential pressure	Types of pressure sensing elements-bourdon tube, diaphragms, capsules, and bellows. Eachontypes, shapes, material used for various applications, ranges advantages and limitations. Pressure switches types and applications. (07 Hrs.)

		settings. Make adjust the errors screws. (05 Hrs.)	
		270. 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.) 271. Test and operating the pressure transmitter with supply, milli ammeter, pressure source (pneumatic/hydraulic). Finding the resolution, accuracy etc. (05 Hrs.) 272. Familiar with pressure calibrator controls and settings. (03 Hrs.) 273. Calibrating the pressure gauge using standard meter/ pressure calibrator. (05 Hrs.) 274. Measuring gauge, vacuum and differential pressure using DP transmitter. (05 Hrs.) 275. Calibrating the DP transmitter using standard meter / pressure calibrator. (05 Hrs.)	Electrical pressure transducers. Method of conversion, primary and secondary pressure transducers. Potentiometric pr. Transducers, Capacitive pr. transducers, reluctance-servo pressure transducers, strain gauge pressure transducers, piezo electric pressure transducer. Differentials pressure transducers. (07 Hrs.)
		276. Measuring low pressure/ vacuum using McLeod	Low Pressure Measurement. Vacuum, gauges, thermal

		gauge. (05 Hrs.) 277. Test & calibrate of Pressure gauges, indicators, transmitters with Dead weight Tester. (05 Hrs.) 278. Test & calibrate of Pressure gauges, indicators, transmitters with comparator Tester. (05 Hrs.)	conductivity gauges, pirani gauges, thermocouple gauges, slack diaphragm. Ionization gauge, McLeod gauge, capacitance manometers. Method of pressure instrument calibration. Dead weight tester and comparators/manifolds. (07 Hrs.)
		279. Installation of pressure gauge in pipeline with safety valve and pig tail /siphon etc. measuring pressure in flow line. (05 Hrs.) 280. Installation and testing of pressure switch and pressure relief valve with compressor. (05 Hrs.) 281. Installation and testing of pressure switch with solenoid and alarm in process line. (05 Hrs.) 282. Fault finding in pressure gauge. (05 Hrs.) 283. Simple fault finding in pressure transmitter. (05 Hrs.) 284. Fault finding in pressure process line. (05 Hrs.)	Pressure Instrument Installation and Servicing. Elements of pressure transmitters, Installation components, pressure taps, Isolation valve, instrument piping, connections and fittings blow down valve, instrument valve, pulsation damper, diaphragm seal, pressure transmitter, Installation, procedure, locating and mounting, piping, electrical wiring placing into service, guidelines for periodic maintenance, troubles shooting and repair, instrument shop safety. (07 Hrs.)
Professional Skill 88 Hrs. Professional Knowledge 27 Hrs.	Recognize the fundamental of fluid flow, terms, different unit of flow, read specification of flow meters. And fluid pump. Perform the	285. Measurement of pressure in flow line with different flow rates. (04 Hrs.) 286. Measurement of flow rate using fixed volume tank. (04 Hrs.) 287. Operating fluid pump and observing the pressure at	Properties of Fluid Flow. Basic properties of fluids, fluids in motion, getting fluids to flow, units of flow rate and quantity flow, factors affecting flow rate, Reynolds number, relation between flow rate and pressure, area, quantity.

	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. ELE/N9421	input and output. verifying flow variation by adjusting bypass line. (04 Hrs.) 288. Measurement of DP of venturi and orifice using manometer. (04 Hrs.) 289. Measurement of DP using DP gauge. (04 Hrs.) 290. Adjusting the valves of manifold and observing the changes in DP gauge. (04 Hrs.) 291. Calibrating the pneumatic DP transmitter for flow rate measurement. (04 Hrs.) 292. Calibration electronic DP transmitter for flow rate. Verifying the square root relation and linear relation of DP. (04 Hrs.) 293. Installing a head type flow meter with venturi or orifice, manifold and DP, milli ammeter or indicator, supply. Measuring flow rate in line. (04 Hrs.) 294. Calibrating head type flow meter with standard volumetric tank. (04 Hrs.) 295. Dismantling, checking, overhauling and calibration of D. (04 Hrs.)P. cell/ transmitter. (Pneumatic & electronic). (04 Hrs.) 296. Identify and carry out preventive maintenance. (04 Hrs.) 297. Study of construction of weirs, notches and flumes	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. Target flow meters, turbine flow meter, magnetic flow

		their shape and connections and use. (04 Hrs.) 298. Install and testing of Rota meters in flow line. Vertical alignment. (04 Hrs.) 299. Measurement of flow rate and calibrating rotameter. (04 Hrs.) 300. Dismantle, identify different parts, its function, AND operation of various types of positive displacement meters. (04 Hrs.) 301. Installation, testing and calibrating quantitative flow meter. (04 Hrs.) 302. Dismantle and assemble quantitative flow meters like Oscillating piston type, Rotating vane meter, Lobed impeller and oval flow meter. (04 Hrs.) 303. Identify and carry out preventive maintenance of positive displacement flow meters. (04 Hrs.) 304. Installation, testing and calibration of turbine flow meter. (04 Hrs.) 305. Installation, testing and calibration of vortex flow meter. (04 Hrs.) 306. Installation, testing and calibration of ultrasonic flow meter. (04 Hrs.)	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. (27 hrs.)
Professional Skill 29 Hrs. Professional	Identify, operate, maintain, troubleshoot and calibrate the devices	307. Installation, testing and calibration of mass flow meter. (05 Hrs.) 308. Measuring semi solid liquid	Metering the flow of solid particles. Measuring volumetric and mass flow rate of solids, volumetric solids flow

Knowledge 09 Hrs.	for solid flow measuring system & verify the result within standard. ELE/N9422	flow rate using flow meter. (06 Hrs.) 309. Calibrating and adjustment of flow meter for solid flow. (06 Hrs.) 310. Identify and carry out maintenance& preventive maintenance of solid flow measuring system. (06 Hrs.) 311. Service and calibrate solid flow meter. (06 Hrs.)	meter, mass flow meter for solids, belt type solid meters belt type solid meters belt speed sensing and signal processing, slurries, constant weight feeders. (09 Hrs.)
Professional Skill 68 Hrs. Professional Knowledge 20 Hrs.	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. ELE/N9423	312. Measurement of liquid level using stick gauge and converting liquid level into volume and mass (using specific gravity). (04 Hrs.) 313. Study the construction and operation of various types of sight glasses. (04 Hrs.) 314. Installation, testing and calibration of liquid level indicator. (04 Hrs.) 315. Cleaning the glass tube and operating the isolation valves, calibrating zero adjustments. (04 Hrs.) 316. Calibrating and Measuring the liquid level using float type, displacer type level systems. (04 Hrs.) 317. Measuring the liquid level of open and close tank using pressure / DP gauge. Converting liquid height into pressure using liquid density. (04 Hrs.) 318. Calibrating DP transmitter for liquid level measurement. Adjusting	Principles of level measurement. Types of level measurements-solid and liquid, volume and mass, mechanical and electrical type. Surface sensing gauges, storage tank gauges, sight glasses, magnetic gauges, buoyancy, displacement gauges. Factors need to consider for open and closed channel level measurements level switches, mercury level switches in high pressure tank, level detectors, magnetic reed switches. Pressure head instruments. Hydrostatic pressure, specific gravity, pressurized fluids, pressure head instrumentation, air bellows, U- tube manometers, air purge systems, liquid purge systems, force balance diaphragm system. Electrical method conductivity and capacitance method for. measuring the liquid level,

		square root to linear scale display. (04 Hrs.) 319. Installation, testing measurement of liquid level using air purge level measurement. (04 Hrs.) 320. Service and calibrate different types level indicators and transmitters. (04 Hrs.) 321. Identify and carry out maintenance& preventive maintenance of above level indicators and transmitters. (04 Hrs.) 322. Construct and operate conductivity probe Level indicator. (04 Hrs.) 323. Construction and operation of capacitance probes indicating transmitters and sonic level detector. (04 Hrs.) 324. Install and test capacitance probes indicating transmitters and sonic level detector. (04 Hrs.) 325. Service and calibrate capacitance probes indicating transmitters and sonic level detector. (04 Hrs.) 326. Study the construction, operation and use of load cell technique to determine solid level in vessel. (04 Hrs.) 327. Study the construction, operation and use of	capacitance probes, zero and span adjustments, sonic level detectors, point level detection. Solid level measurement Using weight to determine level, sonic solid level measurement with microwaves, using capacitance probes to measure solid level, diaphragm switches, nuclear gauges, microwave solid level detectors. (20 hrs.)

		different types of solid level switches. (02 Hrs.) 328. Study the construction, and operation of capacitance probes transmitters, microwave level detector / gauges. (02 Hrs.) 329. Install and test various types of solid level indicating transmitters and sonic level detector. (04 Hrs.) 330. Service and calibrate various types of solid level indicating transmitters and sonic level detector. (04 Hrs.)	
Professional Skill 29 Hrs. Professional Knowledge 09 Hrs.	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. ELE/N9424	331. Study the construction, operation and use of temperature-controlled oil bath/furnace for low and high temperature. (03 Hrs.) 332. Dismantling identify different parts, its function, adjustment, assemble and operation of Bimetallic and fluid filled (liquid, gas and vapour) system thermometers & thermo switches. (10 Hrs.) 333. Install and test various types of thermometers and switches. (08 Hrs.) 334. Service and calibrate various types of thermometers and switches. (08 Hrs.)	Temperature measurement. Temperature, heat, specific heat, changing physical state Fahrenheit and Celsius temperature scales Rankin and Kelvin scales, calibration of temperature scales primary and secondary standards. Industrial application of temperature measuring instruments with compensating link & precautions to be taken. Bimetallic and fluid filled temperature instruments. Bimetallic thermometers, liquid-in-glass thermometers, filled system thermometers, thermometer bulbs, capillary & bourdon tube, temperature transmitters for filled system, advantages & disadvantages of

			filled systems. (09 Hrs.)
Professional Skill 29 Hrs. Professional Knowledge 09 Hrs.	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. ELE/N9425	335. Verify the characteristics of different types of RTD's, and Thermistors. (02 Hrs.) 336. Study circuit operation of signal conditioner for RTD's, and Thermistors. (02 Hrs.) 337. Install and test various types of two and three wire RTD transmitters. (03 Hrs.) 338. Service and calibrate various types of RTD transmitters using temperature calibrator or resistors. (03 Hrs.)	Electrical temperature instrument. Resistance thermometer, how it works, RTD bridge circuits, lead wire error, RTD elements. (03 Hrs.)
		339. Verify the characteristics of different types of Thermocouples. (02 Hrs.) 340. Study circuit operation of signal conditioner for Thermocouples based indicator and transmitters. (02 Hrs.) 341. Install and test various types of Thermocouples based indicator and transmitters. (03 Hrs.) 342. Service and calibrate various types of Thermocouples based indicator and transmitters using temperature calibrator or milli volt source. (03 Hrs.)	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. (03 Hrs.)
		343. Measure high temperature using Optical and Radiation pyrometer. (03 Hrs.) 344. Measure the relative	Pyrometry. Molecular activity and electromagnetic radiation, defining pyrometry, effects of emittance, effects of

		humidity using humidity sensors. (03 Hrs.) 345. Measure the various points like motor, drilling point, hill person temperature etc. using thermal imager. (03 Hrs.)	temperature, wavelength and radiated energy, pyrometers and wavelengths, using of optical and radiation pyrometer, Measurement of humidity. Thermal imagers. (03 Hrs.)
Professional Skill 29 Hrs. Professional Knowledge 09 Hrs.	Identify, select, Operate, maintain, Service and calibrate different types of recorders. ELE/N9426	346. Practice recording of variable signal. (05 Hrs.) 347. Study the construction, operation and use of circular chart recorder for temperature or pressure or mV or mA. (03 Hrs.) 348. Study the construction, operation and use strip chart recorder- pneumatic and electronic recorders. (03 Hrs.) 349. Calibrating electronic recorder. (04 Hrs.) 350. Calibrating pneumatic recorder. (04 Hrs.) 351. Overhaul, check, fault find, repair, test of pneumatic, electronic recorders. (single point &multipoint). (06 Hrs) 352. Study of paperless LCD/LED recorder. (04 Hrs.)	Recorders. Introduction to recorders, Construction, working principle, various parts installation and use of pneumatic and electronic recorders. Strip-chart, circular chart. (09 Hrs.)
Professional Skill 29 Hrs. Professional Knowledge 09 Hrs.	Identify different types of Final control elements and role**.** Identify different valve body, constructional feature, Dismantle, inspect parts, replace parts, recondition, check,	353. Installation and testing valve actuator (pneumatic) with control valve. (02 Hrs.) 354. Calibrating valve positioner with control valve. (01 Hr.) 355. Calibrating current to pressure converter. (01 Hr.) 356. Calibrating voltage to current converter. (01 Hr.) 357. Installation and testing	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,

	and resetting of control valves with actuators, convertors & positioners. Install and test the performance. ELE/N9427	electro pneumatic positioner with control valve. (02 Hrs.) 358. Calibrating electro pneumatic positioners with control valve. (01 Hr.) 359. Dismantle, fault finding, repair, clean, reassemble and test of actuators and positioners. (02 Hrs.)	Pneumatic and Hydraulic Actuators. Pneumatic principles, effects of changing pressure, pressure /volume/ temperature relationship, effects of changing temp. Pneumatic actuators, diaphragm actuator, spring and springless actuators, direct and reverse acting actuator, piston actuator, positioner, Electrical actuators and their advantages. (03 Hrs.)
		360. Record specification of linear, equal, percentage quick opening control valves. (01 Hr.) 361. Record the characteristic of control valves. (01 Hr.) 362. Remove and install control valves with service line. (01 Hr.) 363. Dismantling, reconditioning, checking, replacing parts and resetting of control valves. (02 Hrs.) 364. Carry out maintenance of control valves. (01 Hr.) 365. Identifying the proximity switch and study the specifications, constructions, No. of contacts etc. (01 Hr.) 366. Installation and testing micro and limit switches with the load. Verifying its function. (01 Hr.) 367. Installation and testing capacitance or inductive	Control valves. Control valves functions and components, types‘ of control valves, based on valve flow characteristics- liner, equal percentage, quick opening valves, globe valves, cage valves, butterfly valves, ball valves, sliding gate valves, diaphragm valves, split body valves, capacitive, inductive type valve, proximity switch, IR switch, micro switch, limit switch, other control valves, control valve mechanical considerations, selecting control valves, valve positioner. (03 Hrs.)

		proxy with the load (buzzer/ indicator etc). testing its function. (01 Hr.) 368. Installation and testing, adjusting the range of IR or ultrasonic proxy with load. (01 Hr.) 369. Installation of proxy with relay and operating high current load (like motor or AC lamp etc. (01 Hr.)	
		370. Operate of, sequential. (01 Hr.) Control and block valves. (02 Hrs.) 371. Operate of electromechanical and solid-state relay. (02 Hrs.) 372. Service & test and use electromechanical and solid-state relay. (02 Hrs.) 373. Design and test sequential. Logic operation using relay. (01 Hr.)	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. (03 Hrs.)
Professional Skill 29 Hrs. Professional Knowledge 09 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	374. Install, wire up and test the control operation. (03 Hrs.) 375. Study construction & operation of ON-OFF Electronic and pneumatic Controllers. (02 Hrs.) 376. Service and maintenance of ON-OFF Electronic and pneumatic Controllers. (03 Hrs.) 377. Install, wire up, test and monitor the performance of control operation using ON-OFF Electronic and	Introduction to controllers. Basic block diagram of control systems. Advantages Process variable and set point, analog controllers, digital controllers, control angles and limits, control loop measuring Pv, amplifying signals final control elements, current proportioning. Hunting & its effect on the product. Types of controller and their operation. Types of controller, range limit of controllers.

	(electronic and pneumatic). ELE/N9428	pneumatic Controllers. (03 Hrs.) 378. Practical on PID controller trainer on various process parameters. (03 Hrs.)	(05 Hrs.)
		379. Study construction & operation of PID Electronic / DIGITAL Controllers. (02 Hrs.) 380. Service and maintenance of PID Electronic/ DIGITAL Controllers. (03 Hrs.) 381. Install, wire up, Configure, test the control operation using PID Electronic / DIGITAL Controllers. (03 Hrs.) 382. Verify the steady state and transient responses of PID Electronic / DIGITAL Controllers in P, PI, PD, PID. (02 Hrs.) 383. Install, connect pneumatic signal, align and test the control operation using PID pneumatic Controllers. (03 Hrs.) 384. Verify the steady state and transient responses of PID pneumatic Controllers in P, PI, PD, PID. (02 Hrs.)	ON/OFF controllers, direct and reverse acting controllers proportional controllers, automatic/manual split control, pneumatic control. Adaptive, limiting and batch control, ratio control system, feed forward, feedback control systems and cascade control system. Comparison between pneumatic and electronic control systems. Basic knowledge on communication protocol. (04 Hrs.)
Professional Skill 29 Hrs. Professional Knowledge 09 Hrs.	Tune controller mode and evaluate performance of control loops as per specification and system application ELE/N9428	385. Perform the control operation in manual and automatic mode. (15 Hrs.) 386. Set “optimum setting for unit process in PID Controller (Electronic and pneumatic). (14 Hrs.)	Controller models and tuning. Controller tuning, setting, controller modes, proportional mode, off-set, integral mode, reset mode, derivative mode(rate),single, mode controller, two mode controller, three mode

			controllers, tuning the control loop, step-change- response method. (09 Hrs.)
Professional Skill 58 Hrs. Professional Knowledge 14 Hrs.	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. ELE/N9429	387. Wire and connect the digital I/OS field devices to the I/O Module of PLC. (04 Hrs.) 388. Install PLC Programming software and establish communication with PC and PLC. (04 Hrs.) 389. Hardware configuration and Prepare the input and output addresses for each slot. (04 Hrs.) 390. Prepare and download ladder programs for various switching Gates. (04 Hrs.)	Introduction to programmable controllers. History of programmable controllers, general characteristics of programmable controllers, some limitation of PLCs, method of developing PLC programming. (04 Hrs.)
		391. Write and execute program logic control operation. (04 Hrs.) 392. Develop programs using arithmetic, / data copy operation and execute. (04 Hrs.) 393. Write and execute program on sequence control using timers and counters. (04 Hrs.) 394. Develop programs using shift bit operation. (04 Hrs.) 395. Interface analog o/p module of plc with actuator, relay. (04 Hrs.)	Input/output devices. Definition of input /output devices, I/O interface, input modules, output modules, input devices encoders, output devices, the opto-isolators, safety. (04 Hrs.)
		396. 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.)	Processing and programming functions. The processor unit, the memory, memory organization, ladder diagrams, data logger, most used programming symbols, start,

		397. 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.) 398. Sequencer task using three LEDs as output and two input pushbuttons one as input (NO) for start and other for stop (NO). (04 Hrs.) 399. Configuring the project using analog input and output instructions and implement a on off closed loop control for the given process. (05 Hrs.) 400. Development of ladder logic for various tasks related to timers and counter based industrial applications. (05 Hrs.)	stop, station example, other programming symbol timers and counters, data manipulation instructions, alternate PLC symbols. (06 Hrs.)
Professional Skill 58 Hrs. Professional Knowledge 14 Hrs.	Operate, maintain, service, configure, install, WIRE and test HART transmitters /devices (I/O). And Net-working system for instrumentation. ELE/N9430	401. Installing & Operating HART transmitters/devices (I/O). (10 Hrs.) 402. Creating tag, measuring the parameter, configuring the parameter values in Hart transmitter using communicator. (10 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. Steps in calibration of HART devices. Communication. (04 Hrs.)
		403. Preparation network cables and connectors. Testing network cables. (07 Hrs.)	Networking: types of networks used in digital instrument systems. LAN, WAN, Ethernet. Point to point

		404. Preparation of network cables - serial (RS232/485 standards or equivalent) and Ethernet. (07 Hrs.) 405. Connect network connectivity hardware and check for its functioning. (07 Hrs.) 406. Dismantle and assemble the desktop computer system. (07 Hrs.) 407. Study the operation of Pulse Code Modulation and Demodulation. (03 Hrs.) 408. Connect any one data output of the decade counter to the Data Inputs of the FSK Modulator and measure output waveform. (07 Hrs.)	and multi networking. Ring, delta, star connections. Redundant Net. TCP/IP addresses and descriptions. Types of Cable categories (CAT), and their descriptions. Various types of Cable connectors. Advantages and disadvantages of co-axial cable and fiber optic cables. Various tools used in networking- wire cutter, crimp tool, memory blade holder, memory blade cartridge, cable strip tool with blade cassettes. Terminators and extra connectors, taps, calibration tool etc. fundamentals: modulation and demodulation, signal to noise ratio, digital communication basics-PWM, PCM, FSK. (10 Hrs.)
Professional Skill 58 Hrs. Professional Knowledge 14 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. ELE/N9431	409. Wire and connect the I/O Module of DCS to field signals. (06 Hrs.) 410. Install DCS Programming software and establish communication with PC and DCS. (06 Hrs.) 411. Set the communication between DCS and SCADA System. (06 Hrs.) 412. Concept of Tag/Points Generation. (06 Hrs.) 413. Attaching points to the display Element. (06 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. (04 Hrs.)
		414. Practice HMI, operator panel and touch panel operation and related	Field bus: futures, advantages, architecture, basic block diagram, working. Work

		software. (10 Hrs.) 415. Set up and configure HMI with PLC. (06 Hrs.) 416. Animate objects on a HMI screen to monitor motor status. (06 Hrs.) 417. Use security features to do tag logging and command execution. (06 Hrs.)	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. (10 Hrs.)
Professional Skill 29 Hrs. Professional Knowledge 09 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. ELE/N9432	418. Practice symbolic representation of Hydraulic components. (02 Hrs.) 419. Familiar with hydraulic hoses and fitting. (02 Hrs.) 420. Feature and function of hydraulic pump and hydraulic power system. (02 Hrs.) 421. Feature and function of hydraulic accumulator. (02 Hrs.) 422. Service and test different types of valves. (03 Hrs.)	Basic Hydraulics: Principles of Hydraulics. Fluid power and hydraulics, 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 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. (05 Hrs.)
		423. Design hydraulic circuit for double acting cylinder actuation. (03 Hrs.) 424. Design hydraulic circuit using Pilot operated check valve. (03 Hrs.) 425. Design hydraulic circuit using Pressure reducing Valve. (03 Hrs.) 426. Design hydraulic circuit Using Pressure relief & Pressure regulating valve. (03 Hrs.) 427. Design hydraulic Pressure sequencing circuit. (03 Hrs.) 428. 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. (04 Hrs.)
Professional Skill 29 Hrs. Professional Knowledge 09 Hrs.	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. ELE/N9433	429. Study construction operation and use of air compressor. (02 Hrs.) 430. Operation and use of air filters, regulators and lubricator. (02 Hrs.) 431. Practice and use of Pneumatic Piping, tubing and fitting. (Metallic and non-metallic). (02 Hrs.)	Pneumatic principles, mass, pressure, work and energy, compressibility, law of pneumatics, transmission of pneumatic fluid power, pneumatic leverage, air properties, airflow in pipelines, viscosity of air pressure, Bernoulli's law, components of pneumatic power system. Primary air treatment. Air treatment, preliminary filtering, relative. Humidity, effects of moisture, water removal, dew point, moisture

			separators, oil scrubbers, air dryers, (deliquescent and absorption type) air receivers. Secondary air treatment. Methods of treatment, Contaminate separation, contaminate filtration and filter classification and rating, types of media surface filters, depth filters, absorption filters, Lubricating theair. (06 Hrs.)
		432. Set up a system to provide Pneumatic (air) supply of 20 psi output from the available compressor. (02 Hrs.) 433. Build a pneumatic circuit of a single acting cylinder being controlled by 3 way 2 position directional control valves. (03 Hrs.) 434. Build a pneumatic circuit of a double acting cylinder being controlled by 5 way 2 position directional control valves. (03 Hrs.) 435. Build a pneumatic AND, OR circuit by 3 way 2 position directional control valves to operate double acting cylinder. (03 Hrs.) 436. 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. (02 Hrs.) 437. Build a pneumatic circuit to	Piping houses and fittings. Requirement of piping, airflow, piping dimensions and safety factors, piping connections, compressed air piping applications, metallic tubing, tubing bending and tube fitting, tube installation, nonmetallic tube houses, hose fittings and coupling, hose installation. (03 Hrs.)

		test logical latch circuit by 5 way 2 position, 3 way **2** valve direction control valves. (02 Hrs.) 438. Build a pneumatic circuit to control oscillation of piston by pilot operated 5 way 2 position, 3 way **2** direction control valves. (02 Hrs.) 439. Cutting the metallic tube as per dimensions using tube cutter. (02 Hrs.) 440. Bending the tube in to $90^0$and 45^0 using pipe bending tools. (02 Hrs.) 441. Installation of simple piping diagram. (02 Hrs.)	
Professional Skill 25 Hrs. Professional Knowledge 09 Hrs.	Identify constructional feature, operate, maintain, service and calibrate of Analytical instruments. ELE/N9434	442. Operation of pH meter conductivity meter and dissolved oxygen Meter. (04 Hrs.) 443. Wire up pH meter electrode to pH meter. (04 Hrs.) 444. Calibrate pH meter using buffer solution. (04 Hrs.) 445. Determination of pH (by pH meter). (04 Hrs.) 446. Wire up conductivity meter to electrode and find the electrolytic conductivity of solution. (04 Hrs.) 447. Service and maintenance of conductivity meter & Dissolved oxygen meter. (05 Hrs.)	Analytical instruments. Exposure to basic analytical instruments. Types of electrodes used for PH measurements. Relation of PH and mV. PH indicator and controllers. Conductivity meters. Dissolved oxygen meter. (09 Hrs.)
Engineering Drawing: 40 hrs.			
Professional Knowledge	Read and apply engineering drawing for different	**ENGINEERING DRAWING** • Reading of Electronics Sign and Symbols. • Sketches of Electronics components.	

ED-40 Hrs.	application in the field of work. CSC/N9401	• Reading of Electronics wiring diagram and Layout diagram. • Drawing of Electronics circuit diagram. Drawing of Block diagram of Instruments & equipment of trades.
Workshop Calculation & Science: 18 Hrs.		
Professional Knowledge WCS-18 Hrs.	Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. CSC/N9402	**WORKSHOP CALCULATION & SCIENCE:** **Friction** Friction - Advantages and disadvantages, Laws of friction, co-efficient of friction, angle of friction, simple problems related to friction Friction – Lubrication Friction - Co- efficient of friction, application and effects of friction in workshop practice **Algebra,** Addition, Subtraction, Multiplication & Divisions. Algebra – Theory of indices, Algebraic formula, related problems. **Estimation and Costing** Simple estimation of the requirement of material etc., as applicable to the trade. Problems on estimation and costing.

Project Work/Industrial Visit

Broad areas:

a) Automatic water level controller.
b) On- Off temperature controller.
c) Speed controller.
d) Stepper motor control.
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) Battery Monitor & Charger
l) Emergency Light
m) Electronic Fan Regulator
n) SCR Using UJT Trigger Circuit.
o) Dimmer circuit using Triac and Diac.
p) Dancing LEDs
q) Digital Clock
r) Event Counter
s) A to D Convertor.

SYLLABUS FOR CORE SKILLS
1. Employability Skills (Common for all CTS trades) (120Hrs. + 60 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/dgt.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 TOOLKIT			
1.	Steel Rule	150mm(metric and English Marking)	25(24+1)Nos.
2.	Plier flat Nose	100mm	25(24+1)Nos.
3.	Hammer ball peen	250gms.Withhandle	25(24+1)Nos.
4.	Screwdriver	setof5pieces	25(24+1)Nos.
5.	Adjustable spanner	Different sizes	25(24+1)Nos.
B. SHOP TOOLS, INSTRUMENTS–For2(1+1) units no additional items are required			
Lists of Tools:			
6.	Neon (phase) tester	230 volt	05Nos.
7.	Electric soldering iron	15/25watt pencil tip	05Nos.
8.	Tube cutter		01No.
9.	Allen keyset(metric)	Set of six	02Set.
10.	Allen keyset(English	Set of six	02Set.
11.	Soldering station(temp. controlled) with necessary accessories	Withstandandchangeable5 bits	02Nos.
12.	Screwdriver	200mm	04Nos.
13.	Philips screwdriver	200mm	02Nos.
14.	Round nose pliers	150mm	05Nos.
16.	Fire extinguishers	Arrange all proper NOCs and equipments from Municipal/Competent authorities.	
C. MECHANICAL PRECISION INSTRUMENTS			
18.	Wire type strain gauge (load cell/cantilever beam)		05Nos.
19.	Load cells of various ranges		02Nos.

D. ROTATIONAL/VELOCITY INSTRUMENTS			
20.	Digital type tachometer	0-10000 Counts	01No.
E. PRECISION INSTRUMENTS			
21.	Digital panel meters Voltage & Current	3½ digit LED display Voltmeter 0-10V Current 4-20mA	 03Nos 03Nos
22.	Digital line frequency indicator	3½DigitLEDdisplay	02nos.
23.	D.C. regulated power supply	DC Output : 0-30V/ 0-5A Ripple <1mVrms / 4mVp-p High Resolution 1mV & 1mA Load Regulation : 0.01% ± 5mV TFT Display 0-30V,0-2A, dual power Supply with digital display Ripple < 1mVrms Line / Load Regulation : 0.05% ± 10mV	01No. 01No.
24.	Digital insulation tester		01No.
25.	Digital Multimeter 51/2 Digit Bench Top Digital Multimeter	33/4 Digit Handheld DMM Measurement Functions: DC &AC Voltage, DC&AC Current, 2-wire & 4-wire Resistance, Cap, Diode, Connectivity, Frequency, Period, supports sensor such as Thermocouple, DC Voltage, DC Current, Resistance ,PC Interface USB Host, USB Device, Measurement Speed 120 readings/sec	02Nos.
26.	Digital L.C.R. bridge	Instrument capable to measuring inductance, L, capacitance, C, and resistance, R. Quality factor Q	01No.
27.	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 & decoding I2C, SPI, UART etc.	01No.
28.	Decade resistance boxes		01No.
29.	Decade capacitance boxes		01No.
30.	Decade inductance boxes		01No.
F. GENERAL EQUIPMENT TRAINERS FOR INSTRUMENTATION			
31.	Operational Amplifier Trainer	Instrument capable to Study Op-amp as a Inverting Amplifier ,Non - inverting Amplifier ,Buffer, Comparator, Adder, Substractor, Square Wave Generator ,Differentiator and its working as High Pass Filter ,Integrator and its working as Low Pass Filter, Logarithmic Amplifier ,I-V Converter, V-I Converter Fixed DC Power Supply : +12V, Regulated -12V, Regulated +5V, Regulated -5V, Regulated Built-in Function Generator with Sine , Square WAVE , Triangular Output. Teaching Simulation Software	01No.
32.	Trainer on basic digital electronics i.e. logic gates Boolean Expression adder, sub tractor, flip flop, counter register, converter etc.	Breadboard for Circuit design with necessary DC Power Supply, Graphical LCD for displaying virtual	01No.

		Digital Circuits to be interfaced with real time I/O's. Clock Frequency 4 different steps, Data Switches: 8 Nos, LED Display: 8 Nos. (TTL), Seven Segment Display, Teaching Simulation Software	
33.	Trainers on power supplier's half wave rectifier, full wave rectifier	IC based DC Reg.:+12V/500mA (fixed and with facility to vary from 0to+12V). Power Supplies: - 12 V / 500 mA (fixed and with facility to vary from 0 to -12 V). + 5V /500 mA (fixed). AC Supplies: 9-0-9VAC/ 500mA. resistor, capacitor, diode, IC7805, IC7905, IC7812, IC7912, IC317. Power Supply Trainer to study Transformers working, Two diode Full Wave Rectifier, Full Wave Bridge Rectifier, Demonstration Bridge, Ripple Factor, LC filter, Bleeder Resistor, Zener Diode as Regulator ,Positive Voltage Regulated Supply, Negative Voltage Regulated Supply, Adjustable Regulated Supply ,Line Regulation , Load Regulation Zener diodes : 10V, 5.6V Regulators : +12V regulated -12V regulated 1.8 to 17V adjustable	01 No. each
34.	SCR driven/controlled power	Study of basic firing circuit.	01No.

	supply trainer	Phase control, controlled power supply,. Effect of resistive load and Effect of inductive load.	
35.	Discrete component trainer with following Seven Basic Modules • Diode Characteristics (Si, Zener, LED) Rectifier Circuit • Diode as Clipper Circuit • Diode as Clamping Circuit • Zener as voltage regulator. • Transistor Type NPN & PNP and CE Characteristics • Transistor as a switch	Onboard DC power supply: +5V/1A (fixed), ±15V/1A (fixed), ±15V/200mA (variable) On board AC supply: 9v-0-9v; resistor, capacitor, inductor, relay, diode. Bread board for Circuit design DC power supply: +5V,1A (Fixed); +12V, 500mA (Fixed); ±12V, 500mA (Variable) AC power Supply: 9V-0V-9V, 500mA Function Generator: Sine, Square, Triangle (1Hz to 100KHz) Modulating Signal Generator: Sine, Square, Triangle (1Hz to 10KHz). Voltage, current and frequency on board LCD display. PC Interface – Acquisition from two analog input channel Simulation Software	01No.
36.	Trainer on RS485 to RS232 Converter.	Trainer with software for test communication with computer, Signal Conversion RS485-RS232, Power supply 230VAC/50Hz, Working mode 2-wire half-duplex Transmission distance: RS232: RS485, Maximum Baud Rate: 100 Kbit/sto10Mbit/s, "Receive" and "Transmit" modes LED indicators.	01 No. each
G. ELECTRICAL INSTRUMENTS			

37.	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 display like muffle furnace or dry block type up to temperature range 600 deg or above. Two types (each) of thermocouple and RTD Sensors for testing.	1no.
38.	Autotransformer1Øand3Ø	0to120%orabove,5Aor Above current rating	1no.each
39.	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 with built-in **4½ AC/DC Multi-Function Site Calibrator** **Input Power**:230 V AC,50 Hz **DC Voltage Ranges**: 200mV, 2V, 20V, 200V, 1000V **AC Voltage Ranges:** 200mV, 2V, 20V, 200V, 1000V **DC Current Ranges**: 2mA, 20mA, 200mA, 2A, 50A **AC Current Ranges**: 2mA,20mA,200mA,2A, 50A **Frequency:** 45Hz to 1 kHz **Fixed Resistance**: 1 Ω,10 Ω, 100 Ω, 1k Ω, 10k Ω, 100k Ω, 1M Ω, 10 MΩ,100 MΩ.	1no.
H. PRESSURE INSTRUMENTS			

40.	"U" tube manometers	Glass tube type with protecting case, safety over wall mounting , scale120-0-120 ,	1no.
41.	Well type manometer		1no.
42.	Inclined limb manometers	Glass tube type 500 mm with protecting case, safety over flow wells, scale adjustment facility	1no.
43.	Bourdon tube type gauges of Various ranges	0-10kg/Cm²4“dial	6nos.
44.	Capsule type pressure gauges	0-10kg/Cm²4“dial	3nos.
45.	Dead weight tester & comparator	Range of 0.5–30kg/cm2, Step Size of 0.1kg/cm2, Accuracy of 0.2to0.1%, to study the calibration of pressure gauge. Comparator Having standard gauge.	1each.
46.	Pressure regulators with filter and input & output gauges	¼“or1/8”connectionwithairfilterregulatorand63mm dial pressure gauges	1no.
47.	Differential pressure transmitter	Differential pressure transmitter Max. Air Supply:30 psi, Output: 0.2 - 1.0Kg/cm2, S.S. Orifice plate assembly, 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. Controller for controlling valves	1no.
48.	Differential pressure transmitter (electronic-HART/field bus type)	Differential pressure transmitter with HART/RS485 facility, S.S. Orifice plate assembly, S.S. tank, S.S. body pump, control valve, actuator, valve positioner, rotameter, air	1no.

		regulator. To study the working principal of DP Transmitter and functioning of it with HART/ fieldbus/ RS485 on suitable Frame structure.	
49.	Sensor Trainer Kit containing following sensors RTD,NTC Thermistor,LM35 , Thermocouple j ,k type and AD590 Photovoltaic, Photoconductive , phototransistor and photodiode Air humidity and Temperature	IoT enabled Android based 7" Graphical touch LCD with in built processor & DAQ for acquiring analog data and software for viewing the output waveforms with USB storage and HDMI output. Ethernet port to connect real world. Inverting, Non – Inverting, Power, Current, Instrumentation and Differential Amplifier, F to V, V to F, I to V, V to I Converter, High Pass and Low Pass Filter, Buffer, LED, Buzzer	2nos.
50.	Diaphragm type pressure gauges of various ranges	Glycerin filled Various Type having dial size 4"or above, any four ranges,connection½" or3/8"	2nos.
51.	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.	1no.each
52.	Experimental setup 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, software with necessary fitting	1no.

		To run the setup.	
53.	HART device communicator and calibrator	Microprocessor base HART Communicator calibrator with Full multi-bus communicator for HART, LCD display, for calibration of various HART transmitters.	1No.
54.	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.	1no.
55.	Pressure switches of various ranges	O to 10 Bar	4nos.
56.	P to I and I to P converters Training Platform	P/I converter: Input:0–15 PSI or above Output: 4–20mA Span and zero adjustment facility. With Air filter regulator: 0-2Kg/cm2 range with pressure indicator Digital Ammeter:0–20m Arange (for output read out) I/Pconverter: output : 3 – 15 PSI input put: 4–20mA Span and zero adjustment facility. Air supply: 25 PSI Air filter regulator : 0- 2Kg/cm 2 range with pressure indicator	1no.each.

		Digital Ammeter: 0–20 m Arange or above Variable Current source: 4-20mA Pressure gauge: 2kg/cm2, Having dial 150 mm dia. Or above	
57.	Vacuum tester with pump	Two stage vacuum pump 50LPM & Ultimate Vacuum 0.05 mm of Hg, MS Vacuum Chamber mounted on stand.	1no.each.
58.	Vacuum gauge	Vacuum gauge with dial 6 inch or above. Sensor SS made. Precision high accuracy.	1no.
I. FLOWMETERS/ INSTRUMENTS			
59.	Simple tank type quantity meter	SS tank with sight glass tube level indicator and scale for level measurement in quantity With necessary fitting.	1no.
60.	Impeller type flow meter	Impeller Flow meter type of Suitable range for Water or Viscous fluid with Pulse or 4-20mA DC or DC Voltage Output with S.S. measuring and sump tank, SS pump fitted on stand For working of flow meter. with 10 bit controller device with analog & digital IOs, USB, PC software for data monitoring, logging and control with current and historical data.	1no.
61.	Helical and turbine flow meter	Helical & Turbine type Flow with Suitable range for Water or Viscous fluid with Pulse or4-20mADCorDCVoltage Output with SS measuring and sump tank, SS body pump fitted on stand for working of	1no.

		flow meter, mounted on Suitable frame structure with 10 bit controller device with analog & digital IOs, USB, PC software for data monitoring, logging and control with current and historical data.	
62.	Orifice type flow meter Venturitube flow meter Rota meter	Rota meter, Orifice plate assembly of SS & brass venture all suitable for 1" pipe line, SS sump tank, SS measuring tank, SS body pump, manometer with scale with required all fittings accessories and mounted on stand to understand working of all three flow meters.	1no.
63.	Magnetic flow meter	Magnetic flow meter with HART/RS-485 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.	1no.
64.	Vortex flow meter	Magnetic flow meter with HART/RS-485 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.	1no.
65.	Flow control loop set with flow controller recorder, D.P. transmitter, receiver, unit control Valve and impulse line, computer	DP transmitter with HART/RS485, Orifice meter Auto-Manual PID controller (with three term facility) and communication facility, control	1no.
66.	Complete experimental set-up for	Valve with built-in I/P	1no.

	flow measurement	converter, S.S. sump tank, rotameter, PC software with necessary fitting to run the setup. with 10 bit controller device with analog & digital IOs, USB, PC software for data monitoring, logging and control with current and historical data.	
67.	Experimental closed loop set up for solid flow measurement and Control with storage vessel, hopper, solid flow sensor, controller,	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. with 10 bit controller device with analog & digital IOs, USB, PC software for data monitoring, logging and control with current and historical data.	1no.
68.	Coriolis mass flow meter	Coriolis mass flow meter withHART/RS485communicationfacility,output4-20mAalongwithsumpTank,MeasuringTank,Pump,andaccessorieswithstand,mountedonsuitableframestructure.	1no.
69.	Flow nozzle	SS Flow nozzle flange Type mounting with mani fold assembly, sump tank, measuring tank, pump, DPT mounted on suitable frame structure.	1no.
J. LEVEL INSTRUMENTS			
70.	Static pressure and air purge type level indicator	Static pressure and air purge Level Indicator with glass tube, SS purge pipe.	1no.

		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 for air purge.	
71.	Level transmitter (interface)(HART/Field bus/profi bus compatible/RS485)	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
72.	Level control set up with level transmitters Controller & control valve complete Experimental setup or level simulator	Level transmitter, Auto-Manual PID controller(with three term facility), communication facility, control valve with I/P converter, S.S. sump tank, measuring tank of suitable height with sight glass, pump, PC software with necessary fitting to run the setup, mounted on suitable frame structure. with 10 bit controller device with analog & digital IOs, USB, PC software for data monitoring, logging and control with current and historical data.	1no.
73.	Level measurement equipment for solid, sonic solid level, microwave, capacitance probes, point level detector, Vibrating for k type	Ultrasonic level detector, Microwave level detector Vibrating fork type level switch, Capacitance probe level detector, Point type level	1no.each

		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.	
74.	Mercury in glass thermometer (various ranges)	0-100^{0}C , 0-150^{0}C,0-250^{0}C Degree Centigrade	1no.each
K. TEMPERATURE INSTRUMENTS			
75.	Alcohol or other liquid in glass thermometers (consumable item)	Range:0-110Deg.C	2 nos. (consumable item)
76.	Stem and dial type bimetallic thermometer(various ranges)	Range:0to100,0-150and0-200Deg.C	2nos.
77.	Mercury in steel remote indicating Thermometers (various ranges)	Range: 0to100, 0-150 and 0-200Deg.C	2nos.
78.	Thermocouple type pyrometer with milli voltmeter (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.	1no.
79.	Optical pyrometer with all accessories	Digital /Analog display, 800°C to 1500°C or above Measurement Range with accessories	1no.
80.	Radiation Pyrometer with all accessories	250 to 900Deg.C or above Temp. range.	1no.
81.	Vapour pressure thermometer		2nos.
82.	Temperature transmitter, pneumatic	Scale for Set Point & Process, output 0.2 to 1.0Kg/cm 2 and Input 0 to 100 Deg. C,	1no.

		Selectable Control Mode & Control Action, control valve works on 3 to 15psi, steam generator, rotameter, S.S. sump tank & S.S. jacketed measuring tank, pump, stand with hardware Fittings & electrical accessories, mounted on suitable frame structure.	
83.	Temperature transmitter electronic (input RTD,TC)	Type: Thermocouple j&K type, RTDPt-100/Pt-1000, 3wire. Output: 4 to 20mA, with mA indicator. Mounting: Head Mounting.	1no.
84.	Experimental set up for measuring and controlling of temperature- Consisting of measuring, controlling, indicating, and final controlling elements, complete closed loop system with simulator	Temperature transmitter, Auto-Manual PID controller (with three term facility), communication facility, control valve with I/P converter, rotameter, S.S. body pump, S.S. sump tank, water supply tanks, PC software with necessary fitting to run the set Up and 10 bit controller device with analog & digital IOs, USB, PC software for data monitoring, logging and control with current and historical data.	1no.
85.	Digital temperature calibrator, mV/mA injector and measuring unit	DC mV Source & Sink 0 to199.99mV 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.	1no.

L. RECORDERS			
86.	Paperless LCD/LED recorder setup	Min. 4 channels, universal Input, with alarm Relay, with storage memory, RS232 through RS485 Converter Communication facility, heating and stirring for water bath, PID, 4 nos. of thermocouples, necessary wiring and fittings.	1no.
87.	Pneumatic both single and multi-point	Digital current source, air regulator, pressure gauge and temperature transducers, Single Point & multipoint 0-100 % range, input 3-15 psi, Electrical chart drive, zero adjustment, wall mounted, Single Point & multipoint 0-100% range, anyone fix input for each channel RTD, Thermocouple or 4-20mA, All fitted on panel and stand, with electrical accessories	1no.
M. CONTROLLERS			
88.	Real PID controller training kit	Set up should have Industrial PID Controller for RTD (PT100), K type Thermocouple input & performs 3 actions PID & ON/OFF, Forward for cooling and reverse for heating relay action. Set should be comprises of Sump Tank, Measuring Tank, Temperature Sensor, Thermocouple Sensor, Solenoid Valve, Level Transmitter, Data Acquisition System.	1no.
89.	Programmable logic	PLC with at least 12 digital	1no.

	controller(micro PLC)station	inputs, 8 digital outputs, 4 analog inputs and 2 analog outputs and PLC with 8 digital input , 6 digital output , 2 analog input and 1 analog output , 7" Human Machine Interface (HMI) display, Toggle switches, push to ON switch, proximity sensor, selector switch, visual indicator, audio indicator, DC motor, relay card, contactor and voltage display for PC based ladder and HMI programming and having facility to connect PLC to cloud using Ethernet and Wifi , Real time interface of web SCADA with PLC Detailed teaching and learning digital content with animation.	
90.	HART/Field devices (pressure –flow - level)	All Transmitters pressure , level , flow should be with HART / Field Bus / RS485compatible andhaving4-20mAoutputandmAindicatorandnecessaryPowersupplytooperate	1no.each.
91.	Multifunction process control 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	True distributed control 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	1no

		type of controls, suitable pipes and fittings, seamless data transfer unit, PC Based control and monitoring software , with 10 bit controller device with analog & digital IOs, USB, PC software for data monitoring, logging and control with current and historical data. with intuitional practical set up	
N. FINAL CONTROLLING ELEMENTS			
92.	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.	1no.
93.	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. 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.	1no.each.
94.	Valve positioners booster relays, gland pickings etc.	Pneumatic and electro pneumatic valve positioners and booster relays, packing	1no.each.
95.	HART/ field bus/ RS485 final control elements (two different type)	HART/Field bus Valve positioned with two different characteristics control valve.	1no.each

		Operated with mA source. Electro pneumatic positioned 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, pump to full flange operation mounted on suitable frame structure.	
O. EQUIPMENT FOR MICROPROCESSORS			
96.	Data acquisition system (DAS)	**Multifunction Process Workbench should have following** • Temperature, Flow, Level, and Pressure Measurement • Should use Industrial Process Control elements like Capacitive Level Transmitter, Temperature Transmitter, Flow Transmitter , Pressure Transmitter, RTD and K Type ,Thermocouple Sensor, Rotameter and PID Controller ,Solenoid Valve • M.S Powder Coated Electrical Control Panel contain Start , Stop , Pump, Solenoid Valve , Stirrer button ,Indicators for Pump, Heater, Stirrer, Solenoid Valve, Audio Indicator, Visual Indicator , Ammeter • Real-time Ethernet based DAQ interface with ADC & Digital input/output To perform RTD ,Thermocouple ,Temperature Transmitter ,Level Transmitter, Flow Transmitter, characteristics	1no.

		,Industrial PID Controller to ON/Off , P , PI , PID for Temperature	
97.	ADC to DAC cards	Analog to Digital Converter 4 channel study card and Digital to Analog Converter study card with necessary attachment to complete experiment. 12 bit, 4 channel Dual ADC and conversion of 2 ADC Input Channels. 2 Channel Analog output, 1 Channel ADC can be configured as 4-20mA input, 1 Channel DAC can be configured as 4-20mA O/P. Relevant software	2nos.
98.	Digital I/O cards	Power supply 24VDC, 16 Inputs source or sink type, with transistorized or relay based 16 outputs. Operated with human machine interface and Minimum 5 experimental modules. Havin g communication facility of RS-485 or RS-232. Detailed teaching and learning digital content with animation.	2nos.
99.	Microcontroller Development Platform	Core 8051, ready to run programmer for AT89C51/52 &55, programming modes Key Pad and PC circuits. Detailed learning content through simulation Software with following application modules 1. Input Interface : 4x4 Matrix Keypad, ASCII Key PAD, Four Input	2nos.

		Switch 2. Display Module 16X2 LCD, Seven Segment, LED Bar Graph 3. ADC/DAC Module with most popular DC/DAC0808 4. Motor Drive: DC, Servo, Stepper 5. DAQ: Data Acquisition to Sense different sensors signals 6. Differential Input Pressure Transducer Temperature Sensor interface	
P. COMPUTERAND SOFTWARE			
100.	Laptop (for convenient to field bus system/control system)		02Nos.
101.	Licensed operating system (latest version)		02Nos.
102.	Latest Office(licensed version)		01No.
103.	LCD multimedia projector		01No.
104.	Broadband internet connection		01No.
105.	Printer(Scan/copy)		01No.
106.	Networking toolkit		02No.
Q. EQUIPMENT ON HYDRAULICS AND PNEUMATICS			
107.	Hydraulic trainer	Hydraulic Trainer with Equipment trays -2nos., Pressure gauges, Hydraulic Motor, 4/2 & 4/3 (with Different mid position) way hand lever valve – 3 nos each, Pressure sequence valves & pressure reducing valve–2 nos each, pressurere life valves, flow control valves & Non-return valves-2 Nos Each (one	1no.

		each sub plate type), Shut-off valves, Diaphragm accumulator, Weight up to 10 kg-1no., 2/2 way plunger/stem actuated–2nos., 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.	
108.	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, 5/2 Spring Returned,3/2Pilot 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: 6ways, Plastic Tubing as per require, Quick Push-Pull connectors, Air Compressor. All components should be mounted on Aluminum profile plate on working condition.	1no.

R. ANALYTICAL EQUIPMENTS			
109.	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 Endpoint 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.	1no.
110.	pH meter (Digital) portable	Digital, with PH range of 0 – 14pH, Milli volt Range of 0-+1999 mV, Temp. Compensation Auto/ Manual with auto calibration facility and electrodes.	1no.
111.	Experimental setup for conductivity measurement	Conductivity meter with4-20m A output, Conductivity sensor, SS Reactor tank, SS feed tanks, variable speed pump, stirrer, hardware and electrical accessories mounted on good quality framework with software.	1no.
112.	Experimental setup for pH measurement	PH meter with 4-20 mA output, PH electrode, SS Reactor tank, SS feed tanks, variable speed pump , stirrer,	1no

		hardware and electrical accessories on stand with software.	
113.	Experimental set up for dissolved oxygen measurement	SS Measuring Tank, Dissolved oxygen Meter, dissolved oxygen sensor, mini air compressor, hardware and electrical accessories on stand	1no.
S. WORKSHOP FURNITURE:			
114.	Instrument test bench with cupboards	The overall dimensions of Workbench should be not less than W = 1500 mm; D = 900mm; 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 read out., 4½ Digit LCD Large display Digital Multimeter, 1KHz LCR Meter with LCD Display, It op Convertor with air regulator and gauge, Temperature controlled Soldering and De soldering Station with SMD Iron, Components bin–Bin with various general components like Resistor, Capacitor, Inductor, Pot etc., Variac-Single Phase with 5Amp current	1no.

		rating in separate housing., Tool Kit–Should comprise with a set of general purpose tools like Mains Tester, Screw Driver, Tweezer, and Plier.	
115.	Steel cup boards with eight lockers for trainees		2 no.
116.	Steel cup boards with eight lockers for trainees	(100x1200x450mm)	4 no.
117.	Steel cup boards with eight lockers for trainees	1800x1200x450(with five shelves)	2 no.
118.	Steel cup boards with eight lockers for trainees	(1800x1200x450mm)	2 no.
Note: *1.Internet facility is desired to be provided in the classroom.*			

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