Skill India
कौशल भारत - कुशल भारत

INSTRUMENT MECHANIC

NSQF LEVEL- 4.5

SECTOR- ELECTRONICS & HARDWARE

COMPETENCY BASED CURRICULUM

CRAFT INSTRUCTOR TRAINING SCHEME (CITS)

सत्यमेव जयते

GOVERNMENT OF INDIA
Ministry of Skill Development & Entrepreneurship
Directorate General of Training
CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE
EN-81, Sector-V, Salt Lake City, Kolkata – 700091

कौशल बलम्
Directorate General of Training

INSTRUMENT MECHANIC

Also Applicable for – Instrument Mechanic (Chemical Plant)

(Engineering Trade)

SECTOR – ELECTRONICS & HARDWARE

(Revised in 2024)

Version 2.1

CRAFT INSTRUCTOR TRAINING SCHEME (CITS)

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Developed By
Government of India
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CONTENTS

1. COURSE OVERVIEW

The Craft Instructor Training Scheme is operational since inception of the Craftsmen Training Scheme. The first Craft Instructors' Training Institute was established in 1948. Subsequently, 6 more institutes namely, Central Training Institute for Instructors (now called as National Skill Training Institute (NSTI), NSTI at Ludhiana, Kanpur, Howrah, Mumbai, Chennai and Hyderabad were established in 1960's by DGT. Since then the CITS course is successfully running in all the NSTIs across India as well as in DGT affiliated institutes viz. Institutes for Training of Trainers (IToT). This is a competency-based course of one year duration. "Instrument Mechanic" CITS trade is applicable for Instructors of "Instrument Mechanic and Instrument Mechanic (Chemical Plant)" Trades.

The main objective of Crafts Instructor training programme is to enable Instructors explore different aspects of the techniques in pedagogy and transferring of hands-on skills so as to develop a pool of skilled manpower for industries, also leading to their career growth & benefiting society at large. Thus promoting a holistic learning experience where trainee acquires specialized knowledge, skills & develops attitude towards learning & contributing in vocational training ecosystem.

This course also enables the instructors to develop instructional skills for mentoring the trainees, engaging all trainees in learning process and managing effective utilization of resources. It emphasizes on the importance of collaborative learning & innovative ways of doing things. All trainees will be able to understand and interpret the course content in right perspective, so that they are engaged in & empowered by their learning experiences and above all, ensure quality delivery.

2. TRAINING SYSTEM

2.1 GENERAL

CITS courses are delivered in National Skill Training Institutes (NSTIs) & DGT affiliated institutes viz., Institutes for Training of Trainers (IToT). For detailed guidelines regarding admission on CITS, instructions issued by DGT from time to time are to be observed. Further complete admission details are made available on NIMI web portal http://www.nimionlineadmission.in. The course is of one-year duration. It consists of Trade Technology (Professional skills and Professional knowledge), Training Methodology and Engineering Technology/ Soft skills. After successful completion of the training programme, the trainees appear in All India Trade Test for Craft Instructor. The successful trainee is awarded NCIC certificate by DGT.

2.2 COURSE STRUCTURE

Table below depicts the distribution of training hours across various course elements during a period of one year:

S No.	Course Element	Notional Training Hours
1.	**Trade Technology**	
	Professional Skill (Trade Practical)	480
	Professional Knowledge (Trade Theory)	270
2.	**Training Methodology**	
	TM Practical	270
	TM Theory	180
	Total	**1200**

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

3	On the Job Training (OJT)/ Group Project	150
4	Optional Course	240

Trainees can also opt for optional courses of 240 hours duration.

2.3 PROGRESSION PATHWAYS

- Can join as a Technical Instructor in vocational training Institute / technical Institute.
- Can join as a supervisor in Industries.

2.4 ASSESSMENT & CERTIFICATION

The CITS trainee will be assessed for his/her Instructional skills, knowledge and attitude towards learning throughout the course span and also at the end of the training program.

a) The Continuous Assessment (Internal) during the period of training will be done by **Formative Assessment Method** to test competency of instructor with respect to assessment criteria set against each learning outcomes. The training institute has to maintain an individual trainee portfolio in line with assessment guidelines. 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 Method**. The All India Trade Test for awarding National Craft Instructor Certificate will be conducted by DGT at the end of the year as per the guidelines of DGT. The learning outcome and assessment criteria will be the basis for setting question papers for final assessment**.** The external examiner during final examination will also check the individual trainee's profile as detailed in assessment guideline before giving marks for practical examination.

2.4.1 PASS CRITERIA

Allotment of Marks among the subjects for Examination:
The minimum pass percent for Trade Practical, TM practical Examinations and Formative assessment is 60% & for all other subjects is 40%.There will be no Grace marks.

2.4.2 ASSESSMENT GUIDELINE

Appropriate arrangements should be made to ensure that there will be no artificial barriers to assessment. The nature of special needs should be taken into account while undertaking the assessment. While assessing, the major factors to be considered are approaches to generate solutions to specific problems by involving standard/non-standard practices.

Due consideration should also be given while assessing for teamwork, avoidance/reduction of scrap/wastage and disposal of scrap/waste as per procedure,

behavioral attitude, sensitivity to the environment and regularity in training. The sensitivity towards OSHE and self-learning attitude are to be considered while assessing competency.

Assessment will be evidence based comprising of the following:

- Demonstration of Instructional Skills (Lesson Plan, Demonstration Plan)
- Record book/daily diary
- Assessment Sheet
- Progress chart
- Video Recording
- Attendance and punctuality
- Viva-voce
- Practical work done/Models
- Assignments
- Project work

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

Performance Level	Evidence
(a) Weightage in the range of 60%-75% to be allotted during assessment	
For performance in this grade, the candidate should be well versed with instructional design, implement learning programme and assess learners which demonstrates attainment of an ***acceptable standard*** of crafts instructorship with ***occasional*** **guidance** and engage students by demonstrating good attributes of a trainer.	• Demonstration of ***fairly good*** skill to establish a rapport with audience, presentation in orderly manner and establish as an expert in the field. • Average engagement of students for learning and achievement of goals while undertaking the training on specific topic. • A fairly good level of competency in expressing each concept in terms the student can relate, draw analogy and summarize the entire lesson. • Occasional support in imparting effective training.
(b) Weightage in the range of 75%-90% to be allotted during assessment	
For performance in this grade, the candidate should be well versed with instructional design, implement learning programme and assess learners which demonstrates attainment of a ***reasonable***	• Demonstration of ***good*** skill to establish a rapport with audience, presentation in orderly manner and establish as an expert in the field. • Above average engagement of students

standard of crafts instructorship with ***little* guidance** and engage students by demonstrating good attributes of a trainer.	for learning and achievement of goals while undertaking the training on specific topic. • A ***good*** level of competency in expressing each concept in terms the student can relate, draw analogy and summarize the entire lesson. • Little support in imparting effective training.
(c) Weightage in the range of more than 90% to be allotted during assessment	
For performance in this grade, the candidate should be well versed with instructional design, implement learning programme and assess learners which demonstrates attainment of a***high standard*** of crafts instructorship with ***minimal or no support*** and engage students by demonstrating good attributes of a trainer.	• Demonstration of ***high*** skill level to establish a rapport with audience, presentation in orderly manner and establish as an expert in the field. • Good engagement of students for learning and achievement of goals while undertaking the training on specific topic. • A ***high*** level of competency in expressing each concept in terms the student can relate, draw analogy and summarize the entire lesson. • Minimal or no support in imparting effective training.

3. GENERAL INFORMATION

Name of the Trade	**INSTRUMENT MECHANIC-CITS**
Trade code	DGT/4022
NCO – 2015	2356.0100, 7311.0100, 7311.0101, 7311.0400, 7412.0100, 3132.0400, 3133.9900, 3134.0100, 7543.0801
NOS Covered	PSS/N9415, ELE/N9444, ELE/N9445, ELE/N9473, ELE/N9404, ELE/N9474, ELE/N9477, ELE/N9478, ELE/N9479, ELE/N9480, ELE/N9428, ELE/N9483, ELE/N9484, ELE/N9492, ELE/N9420, ELE/N9421, ELE/N9491, PSS/N9411, PSS/N9412
NSQF Level	Level-4.5
Duration of Craft Instructor Training	One year
Unit Strength (No. Of Student)	25
Entry Qualification	Degree in Instrumentation/ Instrumentation and Control Engineering from AICTE/UGC recognized Engineering College/ university. OR 03 years Diploma in Instrumentation/Instrumentation and Control Engineering after class 10th from AICTE/ recognized board of technical education. OR Ex-serviceman from Indian Armed Forces with 15 years of service in related field as per equivalency through DGR. OR 10th class with 02 years NTC/NAC passed in "Instrument Mechanic or other related trade"
Minimum Age	16 years as on first day of academic session.
Space Norms	120 Sq. m
Power Norms	10 KW
Instructors Qualification for	

1. Instrument Mechanic -CITS Trade	B. Voc/ Degree in appropriate branch of Engineering from AICTE/ UGC recognized University with two years experience in relevant field. OR 03 year Diploma in appropriate branch of Engineering from AICTE/ recognized Board/ Institution with five years experience in relevant field. OR Ex-serviceman from Indian Armed Forces with 15 years of service in related field as per equivalency through DGR. Candidate should have undergone methods of Instruction of course or minimum 02 years of experience in technical training institute of Indian Armed Forces. OR NTC/ NAC passed in the Instrument Mechanic with seven years experience in relevant field. **Essential Qualification:** National Craft Instructor Certificate (NCIC) in Instrument Mechanic trade, in any of the variants under DGT.
2. Workshop Calculation& Science	B.Voc/Degree in any Engineering from AICTE/ UGC recognized Engineering College/ university with two years experience in relevant field. **OR** 03 years Diploma in Engineering from AICTE /recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with five years' experience in the relevant field. **OR** NTC/ NAC in any Engineering trade with seven years experience in relevant field. **Essential Qualification:** National Craft Instructor Certificate (NCIC) in relevant trade **OR** NCIC in RoDA or any of its variants under DGT
3. Engineering Drawing	B.Voc/Degree in Engineering from AICTE/ UGC recognized Engineering College/ university with two years experience in relevant field. **OR** 03 years Diploma in Engineering from AICTE /recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with five years' experience in the relevant field. **OR** NTC/ NAC in any one of the 'Electrical group (Gr-II) trades categorized under Engg. Drawing'/ D'man Mechanical / D'man Civil' with seven years experience.

	<u>Essential Qualification:</u> National Craft Instructor Certificate (NCIC) in RoDA / D'man (Mech /civil) or NCIC with equivalent certificate in Engineering Drawing from DGT institutes.
4. Training Methodology	B.Voc/Degree in any discipline from AICTE/ UGC recognized College/ university with two years experience in training/ teaching field. **OR** Diploma in any discipline from recognized board / University with five years experience in training/teaching field. **OR** NTC/ NAC passed in any trade with seven years experience in training/ teaching field. **<u>Essential Qualification:</u>** National Craft Instructor Certificate (NCIC) in any of the variants under DGT / B.Ed /ToT from NITTTR or equivalent.
5. Minimum Age for Instructor's	21 Years

4. JOB ROLE

Brief description of job roles:

Manual Training Teacher/Craft Instructor; instructs students in ITIs/Vocational Training Institutes in respective trades as per defined job role. Imparts theoretical instructions for the use of tools &equipments of related trades and related subjects. Demonstrate process and operations related to the trade in the workshop; supervises, assesses and evaluates students in their practical work. Ensures availability & proper functioning of equipment and tools in stores

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 blue prints.

Mechanic, Precision Instrument, Electrical; Meter Repairer, Electrical repairs and sets electrical parts of precision instruments such as megger, voltmeter, ammeter, condensers, galvanometers, etc., to high accuracy for recording correct readings by reviving, replacements and necessary adjustments. Studies drawings, circuit diagrams and other specifications and examines instrument visually to locate any apparent loose connection, short circuits etc. Dismantles instrument using insulated screw drivers, pliers, special spanners etc., and checks components, insulation wiring, fittings and other features with precision mechanical and electrical measuring instruments to locate wear and tear, short circuits and other defects. Cleans necessary or any fluid used in instrument and their various parts using special brushes. Checks gear shell, bearing jewels and other operating parts and repairs or replaces worn out and damaged ones. Assembles parts, replaces insulation and makes electrical wiring and connections according to diagram and prescribed specification. Examines assembled or repaired instrument by standard tests, makes necessary adjustments and ensures correct reading and desired performance within prescribed limits. Seals cut-outs, meters etc. to avoid manipulation. May wind coils, set new resistance and perform other electrical functions, if required.

Waste Water Treatment Plant Operator; operates sewage treatment, sludge processing, and disposal equipment in wastewater (sewage) treatment plant to control flow and processing of sewage: Monitors control panels and adjusts valves and gates manually or by remote control to regulate flow of sewage. Observes variations in operating conditions and interprets meter and gauge readings and tests results to determine load requirements. Starts and stops pumps, engines, and generators to control flow of raw sewage through filtering, settling, aeration, and sludge digestion processes. Maintains log of operations and records meter and gauge readings. Gives directions to SEWAGE DISPOSAL WORKERS in performing routine operations and maintenance. May collect sewage sample, using dipper or bottle and conduct laboratory tests, using testing equipment, such as colorimeter. May operate and maintain power generating equipment to provide steam and electricity for plant.

Chemical Processing Plant Controllers, Other; include plant controllers who operate and monitor chemical plants and adjust and maintain, processing units and equipment which distil, filter, separate, heat or refine chemicals not elsewhere classified.

Continuous Still Operator, Petroleum; Stillman, Petroleum operates one or more continuous stills for distilling or refining crude oil to obtain fuel gas, gasoline, kerosene, diesel oil, lubricating oil, wax, bitumen, etc. Reads processing schedules, operating logs, test results of oil

samples, and laboratory recommendations to determine changes in equipment controls required to produce specified quantity and quality of product; moves and sets controls, such as knobs, valves, switches, levers, and index arms on control panels to adjust, maintain, and co-ordinate process variables, such as flows, temperatures, pressures, vacuum, time, catalyst, and chemicals, by automatic regulation and remote control of processing units, such as heaters furnaces, compressors, exchangers, recharges, absorbers. Moves controls to regulate valves, pumps, compressors, and auxiliary equipment to direct flow of product, reads temperature and pressure gauges and flow meters, records readings, and compiles operating records; tests products for specific gravity and observes their colour to determine whether processing is being carried out properly; makes minor adjustments to equipment; shuts down still for cleaning and opens it up again; supervises workers who assist in operation of still. May fire oil or gas burning furnace through which oil is run to heat it to processing temperature. May specialize in a particular type of still, kind of oil processed, and be designated according to process involved or plant operated as Absorption Plant Operator; Purification Operator; Stillman; Cracking Unit; Stillman, Polymerization, etc.

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) 2356.0100 – Manual Training Teacher/Craft Instructor
b) 7311.0100 – Mechanic Precision Instrument, General
c) 7311.0101 – Technician Instrumentation
d) 7311.0400 – Mechanic Precision Instrument, Mechanical
e) 7412.0100 – Mechanic, Precision Instrument, Electrical
f) 3132.0400 – Wastewater-Treatment-Plant Operator
g) 3133.9900 – Chemical Processing Plant Controllers, Other
h) 3134.0100 – Continuous Still Operator, Petroleum
i) 7543.0801 – Functional Tester

Reference NOS:

a) PSS/N9415,
b) ELE/N9444,
c) ELE/N9445,
d) ELE/N9473,
e) ELE/N9404,
f) ELE/N9474,
g) ELE/N9477,
h) ELE/N9478,
i) ELE/N9479,
j) ELE/N9480,
k) ELE/N9428,
l) ELE/N9483,
m) ELE/N9484,
n) ELE/N9492,
o) ELE/N9420,
p) ELE/N9421,
q) ELE/N9491,
r) PSS/N9411,
s) PSS/N9412

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 TRADE TECHNOLOGY

1. Recognize and comply with safe working practices, environment regulation and housekeeping. (NOS: PSS/N9415)
2. Monitor electrical/ electronic measurement of single range meters, test and service different batteries used in electronic applications, execute soldering and de-soldering of various electrical components. (NOS: ELE/N9444)
3. Verify characteristics of electrical and magnetic circuits and execute testing, evaluate performance of DC generator, alternator and transformer. (NOS: ELE/N9445)
4. Assemble simple electronic power supply circuit and test for functioning; Plan and construct different power electronic circuits and analyse the circuit functioning. (NOS: ELE/N9473)
5. Construct, test and verify the input/ output characteristics of various analog circuits. (NOS: ELE/N9404)
6. Assemble, test and troubleshoot various digital circuits. (NOS: ELE/N9474)
7. Monitor and test various functional blocks of a microprocessor system, write and execute simple program and Interface a model application with the microprocessor kit and run the application. (NOS: ELE/N9477)
8. Select various electrical/ electronic measurement equipment, identify earthing installation service and calibrate MI instruments, electro dynamometer instruments**,** induction type and special instruments. (NOS: ELE/N9478)
9. Monitor and check basic workshop operations using suitable tools for measuring, holding, cutting, filing, riveting, drilling, reaming and threading, plan and organize the work in familiar predictable/routine environment for different types of welding/riveting/seaming and allied operations. (NOS: ELE/N9479)
10. Determine various physical properties of materials and verify different physical laws by various instruments. (NOS: ELE/N9480)
11. Ensure separation of mixture of liquids and prepare standard solutions; Perform various types of titration and separate elements from mixtures; Measure PH and conductivity of various substances. (NOS: ELE/N9428)
12. Determine various fluid mechanics parameters and verify different characteristics of transportation of fluid field by chemical instruments and fluid pumps. (NOS: ELE/N9483)
13. Plan and operate packed distillation column and carry out maintenance of triple effect evaporator, heat exchanger, chiller and dryer. (NOS: ELE/N9484)

14. Test, calibrate, troubleshoot and repair pressure measuring, flow measuring, level measuring, temperature measuring, indicating and controlling field instruments and analyze the data. (NOS: ELE/N9492)
15. Calibrate, test and repair the various type recorders of different type process parameters. (NOS: ELE/N9420)
16. Plan and execute erection, commissioning, overhaul and repairing of final control elements with accessories. (NOS: ELE/N9421)
17. Identify various components of process control systems viz. PLC, SCADA, DCS etc. And demonstrate their functional applications. (NOS: ELE/N9491)
18. Read and apply engineering drawing for different application in the field of work. (NOS: PSS/N9411)
19. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (NOS: PSS/N9412)

6. COURSE CONTENT

SYLLABUS FOR INSTRUMENT MECHANIC – CITS TRADE			
TRADE TECHNOLOGY			
Duration	**Reference Learning Outcome**	**Professional Skills (Trade Practical)**	**Professional Knowledge (Trade Theory)**
Practical 10 Hrs. Theory 05 Hrs.	Recognize and comply with safe working practices, environment regulation and housekeeping.	1. Recognize importance of trade training, List of tools and Machinery used in the trade. 2. Develop Safety attitude of the trainee by educating them to use Personal Protective Equipment (PPE). 3. Recognize First Aid Method and basic training. 4. Ensure safe disposal of waste materials like cotton waste, metal chips/burrs etc. 5. Perform hazard identification and avoidance. 6. Identify Safety signs for danger, warning, caution and personal safety message. 7. Identify preventive measures for electrical accidents and steps to be taken in such accidents. 8. Use Fire extinguishers. 9. Comply with precautions to be followed while working in fitting jobs. 10. Ensure safe use of tools and equipments used in the trade.	Organization of the Institute, Departments various trades and 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.
Practical 45 Hrs. Theory	Monitor electrical/electronic measurement of single range meters, test and	11. Use the multi meter to measure the various functions (AC V, DC V, DC I, AC I, R).	**Single range meters** Introduction to electrical and electronic measuring instruments.

15 Hrs.	service different batteries used in electronic applications, execute soldering and de-soldering of various electrical components.	12. Apply different types of meter for measuring AC and DC parameters.	Basic principle and parts of simple meters. Specifications, symbols used in dial and their meaning.
		Cells & Batteries 13. Check +ve and –ve terminals of the battery. 14. Test rated output voltage and Ah capacity of given battery. 15. Measure and check the voltages of the given cells/battery using analog/ digital multimeter. 16. Charge and discharge the battery through load resistor. 17. Maintain the secondary cells. 18. Measure the specific gravity of the electrolyte using hydrometer. 19. Test a battery and verify whether the battery is ready for use or needs recharging.	**Cells & Batteries** Construction, types of primary and secondary cells. Materials used, Specification of cells and batteries. Charging process, efficiency, life of cell/battery. Selection of cells / Batteries etc. Use of Hydrometer. Types of electrolytes used in cells and batteries. Series/ parallel connection of batteries and purpose of such connections.
		Soldering/ De-soldering 20. Check soldering on different electronic components, small transformers and lugs. 21. Test soldering on IC bases and PCBs. 22. Ensure de-soldering using pump and wick.	Different types of soldering guns, related to Temperature and wattages, types of tips. Solder materials and their grading. Use of flux and other materials. Selection of soldering gun for specific requirement. Soldering and De-soldering stations and their specifications.
		23. Demonstrate measurement of resistor value by colour code and verify the same by measuring with multimeter. 24. Monitor and check resistors by their appearance and check	Ohm's law and Kirchhoff's Law. Resistors; types of resistors, their construction and specific use, color-coding, power rating. Equivalent Resistance of series parallel circuits. Distribution of V & I in series parallel circuits. Principles of induction,

		physical defects. 25. Measure parameters in combinational electrical circuit by applying Ohm's Law for different resistor values and voltage sources. 26. Measure current and voltage in electrical circuits to verify Kirchhoff's Law. 27. Verify laws of series and parallel circuits with voltage source in different combinations.	inductive reactance. Types of inductors, construction, specifications, applications and energy storage concept. Self and Mutual induction. Behaviour of inductor at low and high frequencies. Series and parallel combination, Q factor. Capacitance and Capacitive Reactance, Impedance. Types of capacitors, construction, specifications and applications. Dielectric constant. Significance of Series parallel connection of capacitors. Capacitor behaviour with AC and DC. Concept of Time constant of a RC circuit. Concept of Resonance and its application in RC, RL and RLC series and parallel circuit. Properties of magnets and their materials, preparation of artificial magnets, significance of electro magnetism, types of cores. Relays, types, construction and specifications etc.
Practical 45 Hrs. Theory 15 Hrs.	Verify characteristics of electrical and magnetic circuits and execute testing, evaluate performance of DC generator, alternator and transformer.	28. Determine the poles and plot the field of a magnet bar. 29. Wind a solenoid and determine the magnetic effect of electric current. 30. Measure induced emf due to change in magnetic field. 31. Determine the direction of induced emf and current. 32. Demonstrate generation of mutually induced emf.	Magnetic terms, magnetic materials and properties of magnet. Principles and laws of electro-magnetism. Self and mutually induced EMFs.

		33. Measure current, voltage and PF and determine the characteristics of RL, RC and RLC in AC series circuits. 34. Measure the resonance frequency in AC series circuit and determine its effect on the circuit. 35. Measure current, voltage and PF and determine the characteristics of RL, RC and RLC in AC parallel circuits. 36. Measure the resonance frequency in AC parallel circuit and determine its effects on the circuit. 37. Measure power, energy for lagging and leading power factors in single phase circuits and compare characteristic graphically. 38. Measure Current, voltage, power, energy and power factor in three phase circuits. 39. Ensure improvement of PF by use of capacitor in three phase circuit.	Comparison and Advantages of DC and AC systems. Related terms frequency, Instantaneous value, R.M.S. value Average value, Peak factor, form factor, power factor and Impedance etc. Sine wave, phase and phase difference. Active and Reactive power. Single Phase and three-phase system. Problems on A.C. circuits.
		40. Perform no load and load test and determine characteristics of series and DC generators. 41. Perform no load and load test and determine characteristics of compound generators (cumulative and differential). 42. Monitor dismantling and assembling in DC compound generator.	Armature reaction, Commutation, inter poles and connection of inter poles. Parallel Operation of DC Generators. Load characteristics of DC generators. Application, losses and efficiency of DC Generators. Routine and maintenance.

		43. Verify terminals, identify components and calculate transformation ratio of single phase transformers. 44. Perform OC and SC test to determine the efficiency of single phase transformer. 45. Determine voltage regulation of single phase transformer at different loads and power factors. 46. Perform series and parallel operation of two single phase transformers. 47. Verify the terminals and accessories of three phase transformer HT and LT side.	Working principle, construction and classification of transformer. Single phase and three phase transformers. Turn ratio and E.M.F. equation. Series and parallel operation of transformer. Voltage Regulation and efficiency. Auto Transformer and instrument transformers (CT and PT).
Practical 35 Hrs. Theory 10 Hrs.	Assemble simple electronic power supply circuit and test for functioning; Plan and construct different power electronic circuits and analyse the circuit functioning.	**Power Supply Circuits** 48. Check different types of diodes and their specifications. 49. Execute testing of given diode using multi meter and determine forward to reverse resistance ratio. 50. Construct and test a half wave, full wave and Bridge rectifier circuit. 51. Measure the voltage and current through a diode in a circuit and verify its forward characteristic. 52. Monitor and test Zener diode. 53. Construct and test Zener based voltage regulator circuit. 54. Calculate the percentage regulation of regulated power supply. 55. Construct and test voltage doublers and Triplers.	Introduction to basic electronics. Types of semiconductor materials. Construction of PN Junction and Barrier potential. Diode function and its constructions. Transistor function and its characteristics. Various Biasing techniques used in transistor circuits. Special semiconductor devices-like tunnel diode, variable capacitance diode, UJT, FET.
		IC Regulators	

		56. Construct and test a +12V fixed voltage regulator. 57. Check the different types of fixed +ve and –ve regulator ICs and the different current ratings (78/79 series). 58. Check different heat sinks for IC based regulators. 59. Execute testing of a 1.2V – 30V variable output regulated power supply using IC LM317T.	
		Power Electronic Components 60. Identify different power electronic components, their specification and terminals. 61. Construct and test a FET Amplifier. 62. Construct and test circuit of SCR using UJT triggering. 63. Identify different heat sinks used in SCRs. 64. Construct a snubber circuit for protecting SCR use freewheeling diode to reduce back emf. 65. Construct a jig circuit to test DIAC. 66. Construct a simple dimmer circuit using TRIAC. 67. Construct UJT based free running oscillator and change its frequency.	
Practical 21 Hrs. Theory 09 Hrs.	Construct, test and verify the input/ output characteristics of various analog circuits.	**Oscillators** 68. Demonstrate Colpitts oscillator, Hartley oscillator circuits and compare the output frequency of the oscillator by CRO. 69. Construct and test a RC phase shift oscillator circuit.	Introduction to positive feedback and requisites of an oscillator. Study of Colpitts, Hartley, Crystal and RC oscillators. Types of multi vibrators and study of circuit diagrams.

		70. Construct and test a crystal oscillator circuit. 71. Demonstrate Astable, monostable, bistable circuits using transistors.	
		Transistor 72. Check and verify different transistors with respect to different package type, B-E-C pins, power, switching transistor, heat sinks etc. 73. Test the condition of a given transistor using ohm-meter. 74. Measure and plot input and output characteristics of a CE amplifier. **Amplifier** 75. Construct and test fixed-bias, emitter-bias and voltage devider-bias transistor amplifier. 76. Construct and Test a common emitter amplifier with and without bypass capacitors 77. Construct and Test common base amplifier. 78. Construct and test class A Tuned amplifier. 79. Construct and test a Class B complementary push pull amplifier. 80. Construct and test class C Tuned amplifier.	Transistor series and shunt regulated power supply. IC fixed and variable regulated power supplies. Amplifiers- Small signal amplifiers. Power amplifiers- class A, class- B, class-C types. Complimentary and symmetry power amplifier and push pull power amplifier.
Practical 22 Hrs. Theory 08 Hrs.	Assemble, test and troubleshoot various digital circuits.	**Basic Gates** 81. Demonstrate Logic Gates (AND, OR, NAND, NOR, EX-OR, EX-NOR, NOT ICs) by the number printed on them. 82. Verify the truth tables of all Logic Gate ICs by connecting switches and	Number systems. Conversion of number systems. Boolean Algebra. ASCII code, Grey code, BCD code Basic gates. Logic families and their comparison, logic levels of TTL and CMOS.

		LEDs. 83. Construct and verify the truth table of all the gates using NAND and NOR gates. 84. Use digital IC tester to test the various digital ICs (TTL and CMOS). **Combinational Circuits** 85. Construct Half Adder circuit using ICs and verify the truth table. 86. Construct the adder cum subtractor circuit and verify the result. 87. Construct Half Substractor and full substractor circuit using ICs and verify the truth table.	Universal gates. Adder and subtractor.
		Flip Flops 88. Differentiate Flip-Flop (ICs) by the number printed on them. 89. Construct and test four bit latch using 7475. 90. Construct and test R-S flip-flop using IC7400 with clock and without clock pulse. 91. Verify the truth tables of Flip-Flop ICs (RS, D, T, JK, MSJK) by connecting switches and LEDs. **Counter and shift Registers** 92. Construct and test a four bit asynchronous binary counter using 7493. 93. Construct and test 7493 as a modulus-12 counter. 94. Construct and test a four bit Synchronous binary counter using 74163. 95. Construct and test synchronous Decade	Various types of flip flops - RS, clocked RS, D-flip flop, T- flip flop, JK flip flop, clocked JK flip flop, master slave JK flip flop. Synchronous and Asynchronous circuits. Counters (UP/DOWN) Shift registers.

		counter. 96. Construct and test an up/down synchronous decade counter using 74190 and monitor the output on LEDs. 97. Construct a shift register using RS/D/JK flip flop and verify the result. 98. Construct and test bidirectional shift registers.	
Practical 20 Hrs. Theory 10 Hrs.	Monitor and test various functional blocks of a microprocessor system, write and execute simple program and interface a model application with the microprocessor kit and run the application.	99. Demonstrate various ICs and their functions on the given Microprocessor Kit. 100. Execute addressing range of RAM and ROM. 101. Verify the port pins of the processor and configure the ports for Input and Output operation. 102. Connect 8 LED to the port, blink the LED with a switch using 8085 microprocessor. 103. Demonstrate instruction set of 8085 microprocessor Data transfer group, Arithmetic group and Logic group. 104. Write a programme in assembly language data to load two 8 bit data into two memory locations and add the result to be store in another memory location. 105. Select different parts, pins diagram, function and operation of 8255.	Introduction to 8085 microprocessor. Architecture of microprocessor. Instruction set and programming. Various interfacing circuits for 8085 microprocessor Introduction to 8255 PPI and its application.
Practical 20 Hrs. Theory 10 Hrs.	Select various electrical/electronic measurement equipments, identify earthing installation	106. Plan and operate PMMC instruments with proper functioning. 107. Check the accuracy, sensitivity and maximum	Operate and testing of PMMC, MI, Electrodynamometer, power factor meter and induction type. Finding the range of unknown

	service and calibrate MI instruments, electro dynamometer instruments, induction type and special instruments.	power capability of ammeter and voltmeter. 108. Test the shunt and series resistance of various range of ammeter. 109. Plan and operate multipliers for different range extension of voltmeter and ammeter. 110. Select different types of Ohm meter. 111. Test and calibrate various type of Ohm meter. 112. Plan and Prepare pipe earthing and measure earth resistance by earth tester / megger. 113. Select different parts, its function and operation of Dynamometer type instrument and MI. 114. Overhaul, check and fault find Dynamometer type instrument. 115. Test and calibrate Dynamometer type instrument. 116. Measure the power using wattmeter. 117. Test and calibrate wattmeter. 118. Construct energy meter and ampere hour meter. 119. Overhaul, check and fault find ampere hour meter. 120. Test and calibrate ampere hour meter. 121. Overhaul and maintain KWH meter and energy meter. 122. Test and calibrate KWH meter and energy meter. 123. Measure power factor in three phase circuit by	meter and determine the meter resistance. Calculate the resistance, connect and test the accuracy of ammeter shunts, voltmeter multiplier. Calibration of AC and DC meters Recondition given kilowatt hour meter and calibrate it. Make a shunt and series ohm meter with permanent magnet moving coil moment. Troubles shoot multimeter circuit. Study of megger and earth tester. DPM based experiments.

		using power factor meter and verify the same with voltmeter, ammeter and wattmeter readings.	
Practical 22 Hrs. Theory 08 Hrs.	Monitor and check basic workshop operations using suitable tools for measuring, holding, cutting, filing, riveting, drilling, reaming and threading; plan and organize the work in familiar predictable/routine environment for different types of welding/ riveting/ seaming and allied operations.	**Hand tools and their uses** 124. Select proper tools for operation and ensure precautions in operation. 125. Conduct simple fitting job in workshop, fitting and drilling. 126. Cut square size job as per drawing from MS flat by using hacksaw blade. 127. Hold the job using bench vice and measure the selected job using steel rule, calipers and Vernier calliper. 128. Construct simple step fitting job (male and female) and drilling position on a job. 129. Operate centre drill for drilling a hole. 130. Determine the reaming drill size and demonstrate counter sinking and counter boring. 131. Determine the tap drill size for internal threading. 132. Construct BSW or Metric thread using die.	Description, construction and uses of different hand tools such as Files, Chisels, Hacksaw and Hammer, etc. Description, construction and uses of different marking tools such as steel rule, caliper, punches, scribing block, etc. Job Holding Devices: Description, construction and uses of different job holding devices such as vice, 'V' Block. Linear Measurement: Description, construction, calculation and uses of different Linear Measuring Instruments - Vernier Caliper, Vernier Depth gauge, Height gauge, Micrometer outside, Bevel protector. Drilling, Reaming and Threading: Nomenclature and uses of Drill, Reamer, and Thread. Threads: Description, nomenclature and uses of different types of threads - metric, BSW, BSF, BSP etc. Calculation of tap drill size.
		133. Apply safety equipment and take general precautions in welding workshop. 134. Demonstrate copper tube fitting ferrule joint and fit nut and bolt over pipe flanges. 135. Construct riveting on metal sheet and seaming.	Gas Welding Safety: Safetyand General precautions observed in welding workshop. Importance of Welding in maintenance of chemical plant and equipment's. Welding terms and their definition. Types of welding METALJOINING METHOD: General introduction about

		136. Perform lightening, carburizing flame adjustment, Neutral flame adjustment, Oxidize flame adjustment. 137. Demonstrate edges using file, try square, steel rule, vernier caliper etc. 138. Demonstrate edge joint using arc welding/gas welding with or without filler rod.	Mechanical method (Riveting, Nut bolting, Seaming etc.) Thermal method (Soldering, Brazing and Welding)
Practical 20 Hrs. Theory 10 Hrs.	Determine various physical properties of materials and verify different physical laws by various instruments.	139. Verify law of parallelogram of force using mechanical board. 140. Determine co-efficient of static friction by inclined plane. 141. Determine mechanical advantage, velocity ratio and percentage efficiency of Simple Machine. 142. Demonstrate simple machine e.g. Lever, Pulley, Block and Screw Jack. 143. Determine Young's Modulus by Searle's apparatus. 144. Determine specific resistance using Wheatstone bridge. 145. Verify Faraday's first law of electrolysis. 146. Determine mechanical equivalent of heat by Joule's method. 147. Determine co-efficient of expansion of solid. 148. Determine co-efficient of expansion of liquid. 149. Determine co-efficient of thermal conductivity of metal rod. 150. Determine density of solid.	**Physics** Introduction to Physics, Measurement with Vernier caliper, Micrometer, Wire gauge. Scalar and Vector quantities, their representation, resultant. Triangle and parallelogram laws of forces. Inertia, force, momentum, types of force. Friction- definition, unit, types of friction, laws of friction, advantages and disadvantages of friction **Elasticity:** Stress, strain, elastic limit, Hooke's law. Types of modulus of elasticity, work done in a stretching wire, determination of Young's modulus Specific resistance, Wheatstone bridge, applications of Wheatstone bridge.

		151. Determine density of liquid.	
Practical 10 Hrs. Theory 05 Hrs.	Ensure separation of mixture of liquids and prepare standard solutions; Perform various types of titration and separate elements from mixtures; Measure PH and conductivity of various substances.	152. Demonstrate glassware used in chemical lab. 153. Monitor and check action of acids and bases on metals and alloys. 154. Determine PH of different solutions by using Ph paper and PH meter. 155. Determine boiling point of different liquids. 156. Determine melting point of different solids. 157. Measure conductivity of different liquids using conductivity meter.	Atom, molecule, Element, compound, mixture, Physical change, chemical change, Acids, bases, salts-their properties. Molecular weight, equivalent weight, atomic weight, Normality, molarity. Metals and Non-Metals Atom, molecule, Element, compound, mixture, Physical change, chemical change, Acids, bases, salts-their properties. Molecular weight, equivalent weight, atomic weight, Normality, molarity. Metals and Non-Metals Water- sources, hard and soft water, causes and removal of hardness, water for industrial purposes. Introduction to Effluent treatment plant (CETP). Corrosion- causes, effects and prevention. Allotropy of hydrogen, carbon, phosphorus and sulphur Organic Chemistry: Introduction, purification processes, organic reactions-substitution, addition, Elimination, rearrangement reactions, examples. Nomenclature-Basic rules for Common name and IUPAC name system for alkanes, alkenes and alkynes, their examples, Definition of pH, pH scale, measurement of pH. Conductivity
Practical 20 Hrs. Theory	Determine various fluid mechanics parameters and verify different	158. Determine Reynolds Number at different Velocities. 159. Determine Coefficient of	**<u>Unit Operation (UOP)</u>** Introduction to Unit Operations in Chemical Industries. **Fluid mechanics** Viscosity,

10 Hrs.	characteristics of transportation of fluid field by chemical instruments and fluid pumps.	Discharge of Venturimeter, Orifice meter and Pitot tube. 160. Verify Characteristics Curves for Pumps such as Centrifugal Pump, Reciprocating Pump, Gear Pump.	Newtonian and non- Newtonian fluids, Reynold's Number and its Significance, Pressure , Manometers, Various flow meters for flow measurement and their industrial Applications . **Transportation of Fluid** Introductory Knowledge of various types of pumps, Vacuum Pumps, Compressors, Fans, Blowers, Vacuum Creating devices. **Unit Process(UPR)** Introduction of Unit Processes in Chemical Industries. Introduction to Quality Awareness and Quality Standards. Importance and Use of Symbols, Colour Coding, Block diagram, Flow Sheeting and Specification Sheet in Chemical. Process Industries
Practical 20 Hrs. Theory 10 Hrs.	Plan and operate packed distillation column and carry out maintenance of triple effect evaporator, heat exchanger, chiller and dryer.	161. Demonstrate function of Shell and Tube Heat Exchanger. 162. Carry out maintenance of heat exchanger. (shell and tube). 163. Carry out maintenance of chiller. Carry out maintenance of stream trap. 164. Demonstrate packed distillation column with DCS/PLC system. 165. Separate Binary mixture by a Simple Distillation unit. 166. Demonstrate triple effect evaporator. 167. Plan and operate Tray Drier and Find Rate of Drying curve showing	**UOP- Heat Transfer** Modes of heat transfer Introductory Knowledge of different types of Heat Transfer Equipments, Boiler and Boiler Accessories, Steam, steam Traps, Different types of Evaporators and their Industrial Applications, Instrumentation diagram of an Evaporator **UOP- Distillation** Relative volatility, methods of distillation, Reflux Ratio and its Importance ,types of distillation Columns ,Instrumentation diagram of distillation column **UPR**-Process classification, raw materials, chemical reactions, process description, flow- sheet and uses of Sulphuric acid and Caustic Soda , Ammonia and

		drying rates.	Urea **UOP-Drying** Purpose of drying, different types of drying Equipments and their Industrial Applications. Instrumentation diagram of a tray drier. **UPR-**Introductory Knowledge of ISO : 9001(QMS) and ISO 14001(EMS), OHSAS-18001(OHSMS) Standards in Chemical Industries.
Practical 70 Hrs. Theory 20 Hrs.	Test, calibrate troubleshoot and repair pressure measuring, flow measuring, level measuring, Temperature measuring indicating and controlling field instruments and analyze the data.	**Pressure Measurement** 168. Demonstrate different type of pressure sensing elements. 169. Dismantle, assemble and test pressure gauge. Test main fold. Explain construction and working of precision pneumatic calibrator. 170. Recondition U tube manometer, well type manometer. 171. Rectify fault of aneroid barometer. Demonstrate the construction and operation of dead weight tester. 172. Calibrate pressure gauges using dead weight tester. 173. Recondition test and calibrate Bourdon tube diaphragm, capsule type pressure gauge. Demonstrate and calibrate the pressure switches. Demonstrate construction and operation of bellows type pressure gauges. Repair and adjust barometer recorder.	What is pressure, definition of density, specific gravity, absolute pressure, gauge pressure and differential pressure. Conversion of pressure units. Manometer Description, Maintenance and use of U tube manometer, well type and inclined manometers. Working principle and construction dead weight tester. Study principle construction and operation of C, spiral and helical - bourdon tube pressure gauges. Study Diaphragm and capsule type pressure. Error and adjustments of pressure gauges. Calibration of bourdon tube pressure gauge. Study seal and purge system. Necessity and working of seal and purge system. Study of advanced pressure transducers like strain gauge, capacitive type, inductive type, LVDT etc. Comparative safety features of various pressure transducers.

		Construct and operate DP cell. Conduct experiments based on advanced pressure transducers.	
		Flow Measurement: 174. Test and calibrate oscillating type, piston type flow meter. 175. Test and calibrate rotating vane type flow meter. 176. Test and calibrate venturi tube flow meter. 177. Demonstrate pitot tube flow meter. 178. Recondition, test and calibrate rotameter. 179. Recondition anemometer. 180. Thread the pipes and connect the orifice assembly. 181. Make the nipple connect and find the characteristics of orifice. 182. Recondition various flow meters.	Theory of flow, description about stream flow, turbulent flow, viscosity, density and velocity. Reynolds number and Bernoulli's theorem. Simple tank type and reciprocating piston type flow meter. Bellows type flow meter. Liquid seal type flow meter oscillating piston type flow meter. Rotating vane type flow meters. Helical vane and turbine type flow meters. Venturi tube flow meter, principle and construction. Different types of Orifice and its tapping. Flow calculation and hints about orifice plate. Pitot tube, flow nozzle and differential pressure flow meters. Rotameter principle and construction. Magnetic flow meter working principle and construction. Mass Flow Meter and Ultra sonic flow meter, turbine flow meter etc.
		Level Measurements. 183. Connect and test sight glass type level indicator, buoyancy type level indicator, static pressure type level indicator, air trap type level indicator, air purge bubbler level indicator. 184. Test and calibrate capacitive type level	Working principle and construction of hook type and sight glass level instruments. Float type level instrument, types, principle, construction, operation and repairing. Static pressure and differential pressure level measurements (transmitters) Level measurement using radar. Airpurge type level measuring

		indicator, resistive type level indicator, strain gauge type level indicator.	instruments. Working principle and construction of Displacement and capacitance type level instrument. Safety features of level instruments.
		Temperature measurement: 185. Calibrate bi-metallic thermometer. Calibrate mercury in steel filled system thermometer. 186. Calibrate CHR-AL temperature indicating controller. Calibrate thermocouple, RTD (PT-100) Fabricate thermocouple and calibrate it. Test and calibrate filled system temperature indicator. 187. Demonstrate electrical and thermal characteristics of thermistor. 188. Calibrate the CHR-AL pyrometer multi-range (°C,°F). 189. Calibrate digital temperature indicating instruments. 190. Demonstrate construction and operation of optical pyrometer.	Types of temperature scale and their conversion. Relationship between temperature, volume and pressure. Liquid in glass thermometer, Liquid in metal thermometer, Vapour pressure thermometers, Bimetallic thermometer principle, construction and operation. Resistance temperature detector (RTD), principle construction and operation. Thermo-electric pyrometer, definition of pyrometer. Principle of thermocouple. Compensating leads, necessity of compensating leads its material. Cold junction compensation necessity and types. Installation and testing of thermocouples and thermopiles moving coil pyrometer. Construction, repairing and testing potentiometer pyrometer, principle construction operation repairing and testing of it. Principle construction, operation of different types Optical pyrometer. Radiation pyrometer principle and operation. Liquid and Dry block temperature bath.
Practical 20 Hrs.	Calibrate, test and repair various	191. Calibrate strip chart Recorder, setting zero	RECORDERS Study of different types of

Theory 10 Hrs.	recorders for different process parameters.	andspan adjustments. 192. Calibrate Multi-pen Recorder and setting for correct operation.	Recorder like single pen, Multi pen, strip chart, Circular chart Recorders. Potentiometric Temperature Recorder. Driving mechanism, various types of charts, pens in recorders.
Practical 45 Hrs. Theory 15 Hrs.	Plan and execute erection, commissioning, overhaul and repairing of final control elements with accessories.	**FINAL CONTROL ELEMENTS** 193. Demonstrate construction and operation of various types of motors used in chemical plants. **Controllers:** 194. Demonstrate and calibrate I/P, P/I converters, DP, HART (Hart Addressable Remote Transmitter) transmitter.	Electric motors, stepper motors, Study the construction and operation of Diaphragm control valve. Open loop, and closed loop control system. Terminology- process signal, set point, controlling signal, error, and final control element in a closed loop control system. Signal conditioning. Converters: I/P, P/I converters, DP, HART transmitter.
		195. Demonstrate the characteristics of ratio, equal percentage, linear control valve. 196. Demonstrate the working of proximity sensors and switches.	Control valves: Characteristics and working of ratio, equal percentage, linear control valves. Valve positioner. Gate valve, globe valve, butterfly valve, needle valve, split body valve. Proximity sensors- capacitive type,inductive type, IR type, micro switches, limit switches.
		197. Operate flow controller, level controller, pressure controller and temperature controller on various P, I, D values. 198. Demonstrate cascade operation on flow,level, pressure and temperature ontrolling.	Types of controllers: ON- OFF controller, proportional, P+I, P+I+D controller. Multi loop operations, Working of Cascade control, and feed forward, and ratio control systems.
Practical 35 Hrs. Theory 10 Hrs.	Identify various components of process control systems viz. PLC, SCADA, DCS etc. and demonstrate their	**Programmable logic controller:** 199. Identify various parts in PLC and programming devices interfacing with PC	PLC overview, operation and architecture. PLC configuration using ladder programming.

	functional applications.	and other devices. 200. Write small programs using timers and counters.	
		201. Select and verify various components and parts of DCS through Industrial visit.	DCS overview, operation and architecture
		202. Demonstrate the function of Data Acquisition system (DAS), distributed control system (DCS). Demonstrate SCADA system components and develop small application using SCADA software.	Working, operation of Data Acquisition system (DAS), distributed control system (DCS), SCADA overview operation and architecture.
ENGINEERING DRAWING: 45 HRS.			
Theory ED- 45 Hrs.	Read and apply engineering drawing for different application in the field of work.	**CIRCLES, TANGENTS AND ELLIPSE:** Practical applications procedure for constructing tangent to given circle-lines- loop pattern--tangential circles- external tangents- internal tangents ellipse **PARABOLIC CURVES, HYPERBOLA:** Involutes - Properties and their application. Procedure for constructing parabolic curve-hyperbolic curve-in volute curve. epicycloids, hypocycloid, Involutes, spiral & Archimedes spiral **TECHNICAL DRAWING/ SKETCHING OF COMPONENTS' PARTS:** Views of object Importance of technical sketching-types of sketches-Isometric drawing sketching- Oblique drawing sketching. **PROJECTIONS:** Theory of projections (Elaborate theoretical instructions), Reference planes, orthographic projections concept 1st Angle and 3rd Angle, Projections of points, Projections of Lines–determination of true lengths & inclinations. Projections of plane, determination of true shape. Exercises on missing surfaces and views. Orthographic drawing or interpretation of views. Introduction to first angle projections of solids. **ISOMETRIC VIEWS**: Fundamentals of isometric projections (Theoretical Projections) Isometric views from 2 to 3 given orthographic views. Preparation of simple working drawing of Furniture items like table, stool and any job prepared in the	

		workshop. **FASTENERS:** Sketches of elements of screw threads, Sketches of studs, cap screws machine screws, set screws, Locking devices, bolts, Hexagonal & square nuts & nut bolt & washer assembly. Sketches of plain spring lock, toothed lock, washers, cap nut, check nut, slotted nut, cassel nut, sawn nut, wing nut, eye blot, tee bolt & foundation bolt. Sketches of various types of rivet heads (snap–pan–conical– countersunk) Sketches of keys (sunk, flat, saddle, gib head, woodruff) Sketches of hole &shaft assembly. Sign and Symbols of Electrical, Electronics and related trades Electrical and Electronics or trade related wiring diagram/ Layout diagram Electrical, Electronics/ trade related circuit diagram Block diagram of Instruments/ equipment of related trades Practice of blue print reading on Electrical / Electronics / Computer or IT related drawing etc., ISO Standards.
WORKSHOP CALCULATION & SCIENCE: 45 HRS.		
Theory WCS- 45 Hrs.	Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	**<u>WORKSHOP CALCULATION:</u>** **Fraction:** Concept of Fraction, Numbers, Variable, Constant, **Ratio & Proportion**: - Trade related problems **Percentage:** Definition, changing percentage to decimal and fraction and vice versa. Applied problems related to trade. Estimation and cost of product. **Algebra:** Fundamental Algebraic formulae for multiplication and factorization. Algebraic equations, simple & simultaneous equations, quadratic equations and their applications. **Mensuration 2D:** Concept on basic geometrical definitions, basic geometrical theorems. Determination of areas, perimeters of triangles, quadrilaterals, polygons, circle, sector etc. **Mensuration 3D:** Determination of volumes, surface areas of cube, cuboids cylinders, hollow cylinder, sphere prisms, pyramids cone spheres, frustums etc. Mass, Weight, Volume, Density, Viscosity, Specific gravity and related problems.

		Trigonometry: Concept of angles, measurement of angles in degrees, grades and radians and their conversions. Trigonometrical ratios and their relations. Review of ratios of some standard angles (0, 30,45,60,90 degrees), Height & Distances, Simple problems. **Graphs:** basic concept, importance. Plotting of graphs of simple linear equation. Related problems on ohm's law, series-parallel combination. **Statistics:** Frequency tables, normal distribution, measure of central tendency – Mean, Median & Mode. Concept of probability. Charts like pie chart, bar chart, line diagram, Histogram and frequency polygon. **WORKSHOP SCIENCE:** **Units and Dimensions:** Conversions between British & Metric system of Units. Fundamental and derived units in SI System, Dimensions of Physical Quantities (MLT)-Fundamental & Derived. **Engineering Materials:** Classification properties and uses of ferrous metals, non-ferrous metals, alloys etc. Properties and uses of non-metals such as wood, plastic, rubber, ceramics industrial adhesives. **Heat & Temperature:** Concepts, differences, effects of heat, different units, relation, specific heat, thermal capacity, latent heat, water equivalent, mechanical equivalent of heat. Different Temperature measuring scales and their relation. Transference of heat, conduction, convection and radiation. Thermal Expansion related calculations. **Force and Motion**: Newton's laws of motion, displacement, velocity, acceleration, retardation, rest & motion such as linear, angular. Force – units, different laws for composition and resolution of forces. Concept on centre of gravity and equilibrium of forces in plane. Concept of moment of inertia and torque. **Work, power & energy**:

		Definitions, units, calculation & application. Concept of HP, IHP, BHP and FHP – related calculations with mechanical efficiency. S.I. unit of power and their relations. **Friction:** Concept of friction, laws of friction, limiting friction, coefficient of friction and angle of friction. Rolling friction & sliding friction with examples. Friction on inclined surfaces **Stress & Strain:** Concepts of stress, strain, modulus of elasticity. Stress- strain curve. Hook's law, different module of elasticity like Young's modulus, modulus of rigidity, bulk modulus and their relations. Poisson's ratio. **Simple machines:** Concept of Mechanical Advantage, Velocity Ratio, Efficiency and their relations. Working principles of inclined plane, lever, screw jack, wheel and axle, differential wheel and axle, worm and worm wheel, rack and pinion. Gear train. **Electricity:** Basic definitions like emf, current, resistance, potential difference, etc. Uses of electricity. Difference between ac and dc. Safety devices. Difference between conductors and semiconductors and resistors, Materials used for conductors, semiconductors and resistors. Ohm's Law. Series, parallel and series-parallel combination of resistances. Concept, definitions and units of electrical work, power and energy with related problems. **Fluid Mechanics:** Properties of fluid (density, viscosity, specific weight, specific volume, specific gravity) with their units. Concept of atmospheric pressure, gauge pressure, absolute pressure, vacuum and differential pressure.

SYLLABUS FOR CORE SKILLS
1. Training Methodology (Common for all CITS trades) (270Hrs. + 180 Hrs.)

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

7. ASSESSMENT CRITERIA

LEARNING OUTCOME	ASSESSMENT CRITERIA
TRADE TECHNOLOGY	
1. Recognize & comply with safe working practices, environment regulation and housekeeping. (NOS: PSS/N9415)	Follow and maintain procedures to achieve a safe working environment in line with occupational health and safety regulations and requirements and according to site policy.
	Recognize and report all unsafe situations according to site policy.
	Identify and take necessary precautions on fire and safety hazards and report according to site policy and procedures.
	Identify, handle and store/ dispose of dangerous goods and substances according to site policy and procedures following safety regulations and requirements.
	Identify and observe site policies and procedures withregard to illness or accident.
	Identify safety alarms accurately.
	Report supervisor/ Competent of authority in the event of accident or sickness of any staff and record accident details correctly according to site accident/injury procedures.
	Identify and observe site evacuation procedures according to site policy.
	Identify Personal ProtectiveEquipment (PPE) and use the same as per related working environment.
	Identify basic first-aid and use them under different circumstances.
	Identify different fire extinguisher and use the same as per requirement.
2. Monitor electrical/ electronic measurement of single range meters, test & service different batteries used in electronic applications, execute soldering & de-soldering of various electrical components.	Demonstrate using of multi meter to measure the AC V,DC V, DC I, AC I, R.
	Apply different types of meter for measuring AC & DC parameters.
	Check the +ve /–ve terminals of the battery.
	Test rated output voltage and Ah capacity of given battery.
	Check measurement of voltages of the given cells/battery using analog/ digital multimeter.
	Measure the specific gravity of the electrolyte using hydrometer.
	Soldering on different electronic components, small transformer and

(NOS: ELE/N9444)	lugs.
	Test soldering on IC bases and PCBs
	Ensure de-soldering using pump and wick.
	Measure the resistor value by colour code and verify the same by measuring with multimeter.
	Monitor and check resistors by their appearance and check physical defects.
	Ensure measurement of parameters in combinational electrical circuit by applying Ohm's Law for different resistor values and voltage sources.
	Ensure measurement of current and voltage in electrical circuits to verify Kirchhoff's Law.
	Verify laws of series /parallel circuits with voltage source in different combinations.
3. Verify characteristics of electrical and magnetic circuits and execute testing, evaluate performance of DC generator alternator and transformer. (NOS: ELE/N9445)	Determine the poles and plot the field of a magnet bar.
	Wind a solenoid and determine the magnetic effect of electric current.
	Measure induced emf due to change in magnetic field.
	Demonstrate generation of mutually induced emf
	Measure current, voltage and PF and determine the characteristics of RL, RC and RLC in AC series circuits.
	Measure the resonance frequency in AC parallel circuit and determine its effects on the circuit.
	Measure power, energy for lagging and leading power factors in single phase circuits and compare characteristic graphically.
	Ensure improvement of PF by use of capacitor in three phase circuit.
	Perform no load and load test and determine characteristics of series and DC generators.
	Monitor dismantling and assembling in DC compound generator.
	Verify terminals, identify components and calculate transformation ratio of single phase transformers.
	Test OC and SC test to determine and efficiency of single phase transformer
	Verify the terminals and accessories of three phase transformer HT and LT side.
4. Assemble simple	Check different types of diodes and their specifications.

electronic power supply circuit and test for functioning; Plan and construct different power electronic circuits and analyse the circuit functioning. (NOS: ELE/N9473)	Execute testing of given diode using multi meter and determine forward to reverse resistance ratio.
	Construct and test a half wave, full wave and Bridge rectifier circuit.
	Measure the voltage and current through a diode in a circuit and verify its forward characteristic.
	Construct and test of voltage doublers and Tripler
	Construct and test a +12V fixed voltage regulator.
	Check the different types of fixed +ve and –ve regulator ICs and the different current ratings (78/79 series)
	Check different heat sinks for IC based regulators.
	Construct and test a FET Amplifier.
	Construct a test circuit of SCR using UJT triggering.
	Construct a snubber circuit for protecting SCR use freewheeling diode to reduce back emf.
5. Construct, test and verify the input/ output characteristics of various analog circuits. (NOS:ELE/N9404)	Demonstrate colpitts oscillator, Hartley oscillator circuits and compare the output frequency of the oscillator by CRO.
	Construct and test a RC phase shift oscillator circuits.
	Demonstrate astable/monostable/bistable circuits using transistors.
	Check and verify different transistors with respect to different package type, B-E-C pins, power, switching transistor, heat sinks etc.
	Test the condition of a given transistor using ohm-meter.
	Construct and test fixed-bias, emitter-bias and voltage divider-bias transistor amplifier.
	Construct and Test a common emitter amplifier with and without bypass capacitors
	Construct and test class A/B/C Tuned amplifier.
6. Assemble, test and troubleshoot various digital circuits. (NOS: ELE/N9474)	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 circuit and verify the truth table.
	Construct a decoder and encoder, multiplexer and de-multiplexer circuits and verify the truth table.
	Construct a multiplexer and de-multiplexer and verify the truth

	table.
	Construct and verify the truth table of various flip flop, counter and shift register circuits.
7. Monitor & test various functional blocks of a microprocessor system, write and execute simple program and Interface a model application with the microprocessor kit and run the application. (NOS: ELE/N9477)	Demonstrate various ICs & their functions on the given Microprocessor Kit.
	Execute addressing range of RAM & ROM.
	Verify the port pins of the processor & configure the ports for Input & Output operation.
	Demonstrate instruction set of 8085 microprocessor Data transfer group/Arithmetic group/Logic group.
	Identify different parts/ pins diagram/ function of 8255.
	Execute operation of 8255.
8. Select various electrical/ electronic measurement equipment, identify earthing installation service and calibrate MI instruments, electro dynamometer instruments**,** induction type and special instruments. (NOS: ELE/N9478)	Operate PMMC instruments with proper functioning.
	Check the accuracy/sensitivity /maximum power capability of ammeter / voltmeter.
	Test the shunt and series resistance of various range of ammeter.
	Test and calibrate of various type of Ohm meter.
	Test and calibrate Dynamometer type instrument.
	Test and calibrate wattmeter.
	Construct energy meter /ampere hour meter.
	Overhaul/ fault find of ampere hour meter.
	Test and calibrate ampere hour meter.
	Test and calibrate KWH meter and energy meter.
9. Monitor and check basic workshop operations using suitable tools for measuring, holding, cutting, filing, riveting, drilling, reaming and threading, Plan and organize the work in familiar predictable/ routine environment for different types of welding/ riveting/	Select basic hand tools for fitting/riveting/drilling etc. with due care and safety.
	Fix surface mounting type of accessories in a panel board.
	Connect electrical accessories.
	Make and Wire up of a test board and test it.
	Copper tube fitting ferrule joint.
	Fit nut and bolt with over pipe flanges.
	Construct lightening, carburizing flame adjustment, Neutral flame adjustment, Oxidize flame adjustment.
	Prepare edges using file, try square, steel rule, vernier caliper etc.
	Prepare edge joint using arc welding/gas welding with or without

seaming and allied operations. (NOS: ELE/N9479)	filler rod.
10. Determine various physical properties of materials and verify different physical laws by various instruments. (NOS: ELE/N9480)	Verify law of parallelogram of force using mechanical board.
	Determine co-efficient of static friction by inclined plane.
	Operate simple machine e.g. Lever, Pulley, Block & Screw Jack.
	Determine Young's Modulus. By Searle's apparatus.
	Determine specific resistance using Wheatstone's bridge
	Determine mechanical equivalent of heat by Joule's method.
	Determination of density of solid.
	Determination of density of liquid.
11. Ensure separation of mixture of liquids and prepare standard solutions; perform various types of titration and separate elements from mixtures; Measure PH and conductivity of various substances. (NOS: ELE/N9428)	Demonstrate glassware used in chemical lab.
	Monitor & check action of acids & bases on metals and alloys.
	Determine PH of different solutions by using Ph paper & PH meter.
	Determine boiling point of different liquids.
12. Determine various fluid mechanics parameters and verify different characteristics of transportation of fluid field by chemical instruments and fluid pumps. (NOS: ELE/N9483)	Determine Reynolds Number at different Velocities**.**
	Determine Coefficient of Discharge of Venturimeter/Orifice meter /Pitot tube.
	Verify Characteristics Curves for Pumps such as Centrifugal Pump/Reciprocating Pump/Gear Pump.
13. Plan and operate packed distillation column and carry out maintenance of triple effect evaporator,	Demonstrate function of Shell and Tube Heat Exchanger
	Carry out maintenance of heat exchanger. (shell and tube).
	Carry out maintenance of chiller.
	Carry out maintenance of stream trap.

heat exchanger, chiller and dryer. (NOS: ELE/N9484)	Operate packed distillation column with DCS/PLC system.
	Separate Binary mixture by a Simple Distillation unit
	Operate triple effect evaporator.
14. Test, calibrate, troubleshoot and repair pressure measuring, flow measuring, level measuring, temperature measuring, indicating and controlling field instruments and analyze the data. (NOS: ELE/N9492)	Test/ calibrate /troubleshoot of different type of pressure sensing elements.
	Dismantle/ assemble / test pressure gauge.
	Construct/ working of precision pneumatic calibrator.
	Reconditioning of U tube manometer/well type manometer.
	Rectify fault of aneroid barometer
	Calibrate pressure gauges using dead weight tester.
	Recondition test & calibrate Bourdon tube diaphragm, capsule type pressure gauge.
	Construction & operation of DP cell.
	Test /calibrate oscillating type/piston type flow meter.
	Test/calibrate rotating vane type flow meter.
	Test/calibrates venturi /pitot tube tube flow meter.
	Recondition test & calibrate rotameter.
	Thread the pipes and connect the orifice assembly.
	Construct/operate/calibrate turbine type flow meter.
	Connect & test sight glass type level indicator/ buoyancy type level indicator/ static pressure type level indicator.
	Test & calibrate capacitive type level indicator/ resistive type of level indicator/ strain gauge type level indicator.
	Calibrate the given bi metallic thermometer.
	Calibration of mercury in steel filled system thermometer.
	Calibration of CHR-AL temperature indicating controller.
	Calibrate the given thermocouple, RTD (PT-100) Fabricate thermocouple & calibrate it.
	Construct / operate optical pyrometer.
15. Calibrate, test and repair various recorders for different process parameters. (NOS: ELE/N9420)	Calibration of strip chart Recorder.
	Setting zero & span adjustments.
	Calibration of Multi-pen Recorder/ setting for correct operation.
16. Plan and execute	Construct /operate various types of motors used in chemical plants.

erection, commissioning, overhaul and repairing of final control elements with accessories. (NOS: ELE/N9421)	Calibrate I/P, P/I converters, DP, HART (Hart Addressable Remote Transmitter) transmitter.
	Characteristics of ratio/ equal percentage/linear control valve.
	Demonstrate working of proximity sensors and switches.
	Operate flow controller/level controller/ pressure controller/ temperature controller on various P, I, D values.
	Operate cascade on flow /level controlling, pressure and temperature.
17. Identify various components of process control systems viz. PLC, SCADA, DCS etc. and demonstrate their functional applications. (NOS: ELE/N9491)	Ensure identifying various parts in PLC and programming devices.
	Check performance inter facing with PC and other devices.
	Writing small programs using timers and counters.
	Select & verify various components and parts of DCS through Industrial visit.
	Demonstrate function of Data Acquisition system (DAS)/distributed control system (DCS).
	Demonstrate SCADA system components.
18. Read and apply engineering drawing for different application in the field of work. (NOS:PSS/N9411)	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.
19. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study. (NOS: PSS/N9412)	Solve different mathematical problems
	Explain concept of basic science related to the field of study

8. INFRASTRUCTURE

LIST OF TOOLS AND EQUIPMENT FOR INSTRUMENT MECHANIC- CITS TRADE			
for batch of 25 candidates			
S No.	**Name of the Tool &Equipment**	**Specification**	**Quantity**
A. TRAINEES TOOL KIT			
1.	Screw driver set	5 bit minimum	6 Nos.
2.	Combination Pliers	150 mm	6 Nos.
3.	Soldering Iron	25 watt	6 Nos.
4.	Spanner set (open end type)	minimum 12 Nos. of various size	6 Nos.
5.	Adjustable spanner	1.5 inch or above	6 Nos.
6.	Wire cutter		6 Nos.
7.	Hammer	250 grams with handle	6 Nos.
8.	Desoldering pumps		6 Nos.
9.	Twizer	fine point, 125 mm	6 Nos.
10.	Hand drill machine (mechanical)	12 mm drill size	6 No.
11.	Electrician knife	100 mm length or above	6 Nos.
12.	Watchmaker screw driver set	set of six	6 Nos.
13.	Allen key	set of six	6 Nos.
B. GENERAL SHOP OUTFIT			
14.	Fire extinguishers	class A, class B, class C	Each 2 Nos.
15.	Pipe vise	150 mm or above	1 No.
16.	Pipe die set	with half inch, ¾ inch, one inch dies, BSP Standard	1 No.
17.	Digital Multimeter (auto ranging) ISO standard	possible to measure 0-1000 voltage, 0-20 A current, 0- 2Mohm resistance, diode, transistor, continuity etc	2 Nos.
18.	Digital Multimeter (manual ranging) ISO standard	possible to measure 0-750 V(AC and DC) voltage, 0- 20 A current, 0- 2M ohm resistance, diode, transistor, continuity etc	2 Nos.
19.	Analog Multimeter, ISO standard	possible to measure 0-1000 V voltage, 0- 20 A current, 0- 2M ohm resistance, continuity etc	2 Nos.
20.	Temperature controlled soldering station		4 Nos.

21.	LCR meters		2 Nos.
22.	Simple generator and motor trainer		2 Nos.
23.	Current transformer	as convenient or primary range 50-25-10 A	2 Nos.
24.	Variac (variable transformers/auto transformer)	10 A or above , 230 V input, 0- 120 % variation	4 Nos.
25.	DC ammeter (PMMC type)	0-25 mA, 0-100 mA, 0-500 mA, 0-1 A	2 Nos. each
26.	DC voltmeter (PMMC type) various range	0-1V, 0-10V, 0-30V, 0-100 V	2 Nos. each
27.	AC ammeter (MI/ electro dynamometer) various range	0-1A, 0-5A, 0-10 A	2 Nos. each
28.	AC voltmeter (MI/ electro dynamometer) various range	0-10V,0-50V, 0-150V, 0-300V	2 Nos. each
29.	Energy meter (single phase)	230V, 10 A	4 Nos.
30.	Energy meter (3 phase)	500 V, 10 A	2 Nos.
31.	Watt meters	(electro dynamometer type) (0-300V - 600V, 0-5A-10 A)	2 Nos.
32.	Megger	(10 M ohms , 1000 V or above) analog display, hand driven	2 Nos.
33.	Earth tester	(10 ohms, 500V or above) with 4 spikes, analog display, with 40meters cable length, wire dia. 1.5 sq. mm minimum.	2 Nos.
34.	Dual trace CRO	30 MHz or above	4 Nos.
35.	DC regulated power supply	0- 30 V, 2 A dual channel or above	4 Nos.
36.	Function generator	0- 10 MHz or above, sine, square, triangle, saw tooth, pulse signal etc generation	4 Nos.
37.	Frequency counter	10 MHz or above	2 Nos.
38.	Storage oscilloscope	0- 30 MHz or above , LCD/LED Display, minimum dual beam	2 Nos.
39.	Digital panel meters (current measurement)	0-20 mA, DC 0-50 mA, DC 0-250 mA, DC 0-5 A, AC	2 Nos. each
40.	Digital panel meters (voltage measurement)	0-20V, DC 0-100V, DC 0-250V, DC 0-300V, AC	2 Nos. each

41.	Digital IC tester	compatible for testing CMOS, TTL ICs, Analog IC like op-amp, 555 etc	2 Nos.
42.	Electrical trainer	consisting ohms law, Kirchhoff's law, bridge circuits, solenoid testing, resonance circuits, capacitor and inductor properties, RL LC, RC, RLC series, parallel properties etc	2 Nos.
43.	Electronic trainers	consisting diode and Zener diode characteristic, rectifiers, filter circuits, IC regulators various types of diodes & transistors, CE amplifier, cascade amplifiers, oscillators,multivibrators , class B and C power amplifiers, SCR, TRIAC and DIAC characteristics etc	2 Nos.
44.	Digital Trainers	consisting basic gates, universal gates, adders, subtractors, flip flops, counters, registers, BCD converter, 7 segment display etc	2 Nos.
45.	Linear IC trainer	consisting various OP-amp allocation circuits, 555 timer application circuits, square, triangle wave generation etc	2 Nos.
46.	8085 micro processor trainer and instrumentation application modules	like temperature indication, 2 position level control, stepper motor operation, LED display, traffic light control, photo detector pulse counting etc.	2 Nos.
Pressure Measurement			
47.	Pressuremesurement trainer	a. Consisting one pressure process vessel minimum 20 litre capacity b. Bourden tube pressure gauge (C and spiral type one each) (0-7 kg/cm^2) c. Diaphram type pressure gauge (0-7 kg/cm^2) d. Electronic pressure transmitter (input 0- 7 Kg/cm^2, output 4 to 20 mA) e. Pnumatic pressure trasmitter(input 0-7 kg/cm^2, output 3 to 15 psi) f. Pressure switch(0-7 kg/cm^2) g. Absolute pressure gauge (7 kg/cm^2) h. FRL unit with input and output gauge All the instruments are with safety	2 Units

		hand valve , flanged arrangement for easy assembling and dismantling, with all necessary accessories and meters for operating and measurement. Tank consisting two extra tapping for connecting any other measurements.	
48.	Bourdon tube pressure gauges (C type) with 6inch dial	0-1 kg/cm^2, 0-10 kg/cm^2, 0- 100kg/cm^2	2 Nos. each
49.	Diaphragm pressure gauges various range(6 inch dial minimum)	0-15 kg/cm^2, 0-30 kg/cm^2	2 Nos. each
50.	Capsule pressure gauges various range(6 inch dial minimum)	0 – 150 mmWc, 0 – 300 mmWc,0 – 600 mmWc,0 – 1200 mmWc,0 – 1500 mmWc	2 Nos. each
51.	Vacuum pressure gauge	6 inch dial minimum	2 Nos.
52.	U tube manometer	mercury filled, 600-0-600 mm	2 Nos.
53.	Well type manometer	mercury filled, 0-30 inch	2 Nos.
54.	Inclined manometer	mercury filled,500 mm	2 Nos.
55.	Aneroid barometer	100 mm dial	2 Nos.
56.	DP transmitter (electronic)	input : as convenient, output 4 to 20 mA	2 Nos.
57.	DP transmitter(pneumatic)	input : as convenient, output 3 to 15 psi	2 Nos.
58.	I to P and P to I converter trainer	I to P converter (input 4 to 20 mA, output 3 to 15 psi) P to I converter (input 0- 10 Kg/cm^2, output 4 to 20 mA) With pressure gauge0- 10 Kg/cm^2, current meter and current source 0 to 20 mA, FRL unit	2 Nos.
59.	Pressure comparator/ manifold		2 Nos.
60.	Dead weight tester (capacity/ range- 0- 30 Kg/ cm ^{2}above, with floor balancing screws, minimum 6 inch gauges)		2 Nos.
61.	Electronic pressure calibrator	consisting pressure and current measurement, pressure hand/ motored	2 Nos.

		pump to generate pressure, mA current and voltage sourcing, wide range of selectable measurement units for pressure, simultaneous pressure and current measurement	
62.	Pneumatic pressure calibrator	with high accurate pressure gauge, precision regulator, have to measure static and differential pressure, measure gauge, vacuum pressure	1 Nos.
63.	FLR (filter+ Lubricator+ regulator) Unit with input and output gauges, fluid:Air		4 Nos.
64.	Vacuum pump with 6inch gauge	minimum 0.5 HP	1 No.
Flow and level measurement			
65.	Head type and quantitative Flow measurement and calibration setup with level measurement and calibration setup	[consisting a. Rotameter b. Venturi tube(bronze) 1 inch size c. Orifice flow setup d. Flow nozzle (bronze) e. Pitot Tube f. U tube manometer g. Electronic DP transmitter/indictor h. Oscillation piston flow meter i. Rotating van flow meter j. Process tank consisting following level measurement setup (with flanged setup and hand valve protection) i. Sight glass level indicator (open channel and close channel setup both) ii. Float type level measurement iii. Air purge level indicator iv. Static pressure type level indicator (open channel and closed channel both) (pressure gauge type) with minimum one inch pipe dia, one SS process tank(100 liters capacity or above) and one SS reservoir tank(150 liter capacity or above) pump should be above one HP, with all necessary accessories and meters for operating	 1 No. 1 No. 1 No. 1 No. 1 No. 1 No. 1 No. 1 No. 1 No.

		and measurement, all the meters are flanged arrangement for easy assembling and dismantling]	
66.	Electronic flow measurement and calibration setup with level measurement setup	a. Magnetic flow meter b. Vertex flow meter c. Turbine flow meter d. Ultrasonic flow meter k. Process tank consisting following level measurement setup (with flanged setup and hand valve protection) i. Static pressure type (electronic pressure transmitter type) (open channel and close channel setup both) ii. Capacitance type level transmitter iii. Non contact type level transmitter with minimum one inch pipe dia, one SS process tank (100 liters capacity or above) and one SS reservoir tank (150 liters capacity or above) pump should be above one HP, with all necessary accessories and meters for operating and measurement, all the meters are flanged arrangement for easy assembling and dismantling]	1 No. 1 No. 1 No. 1 No.
67.	Mass flow meter	With necessary piping system with suitable reservoir for fluid with minimum 0.5 HP pump. Complete setup to demonstrate principle of mass flow meter with all accessories	1 No.
Temperature measurement			
68.	Mercury glass thermometer (consumable) various range and sizes		1 No.
69.	Alcoholic glass thermometer (consumable) various range and sizes		2 Nos. each
70.	Bimetallic thermometer	0 to 100 C, 0 – 200 C	2 Nos. each
71.	Mercury in steel thermometer		2 Nos. each
72.	Thermocouples (minimum 4 types)		1 No.

73.	RTD (minimum 2 types)		1 No. each
74.	RTD temperature transmitter/ indicator	compatible PT, Ni, Cu etc RTDs with digital display	1 No. each
75.	Thermocouple temperature transmitter/ indicator	Compatible J,K,T,E,S, R, etc thermocouples with digital display	2 Nos.
76.	Thermocouple welder	AC supply 230V, compatible to fabricate J,K,T,E,S, R, etc thermocouples, eye protection glass and safety holder	2 Nos.
77.	Thermistor temperature indicator / transmitter		1 No.
78.	Optical Pyrometer (digital display, hand held type, filters)	3000 C	1 No.
79.	Radiation pyrometer	3000 C	1 No.
80.	Temperature calibrator	[measure popular RTD (Ni, PT, Cu etc), THERMOCOUPLE(J,K,T,E,S, R, etc) , measures- resistance, volts, current of sensors and transmitters, act as source/ simulate to thermocouples, RTDs measuring instruments and transmitter.]	1 No.
81.	Thermal imager	temperature measuring range -20 to 300 C(with laser beam, protection filters, LCD/LED display, multi-scaling)	1 No.
Final control elements			
82.	Control valve trainer	[consisting Different type of control valves such as gate valves, globe valves, Ball valves, diaphragm valves, butterfly valves etc. (with at least one with eclectically actuated, pneumatic actuated and hydraulic actuated) Liner, equal percentage, ratio type control valve . Consisting one Rotameter, one valve positioned fitted with any one valve , I/P converter , minimum 0.5 HP hydraulic pump with oil tank, with minimum one inch pipe dia, one SS process tank(50 liters capacity or above) and one SS reservoir tank(100 liters capacity or above) pump should be above one HP , with all necessary accessories and meters for operating	1 Unit.

		and measurement ,all the valves are flanged arrangement for easy assembling and dismantling]	
83.	Cut section models of control valve		1 No.
84.	Proximity sensor trainer	Capacitive, inductive, resistive etc	1 No. each
Control systems			
85.	Electronic Pressure control trainer	Complete unit consisting PID controller, HART Transmitter, control valve, I/P converter , FRL unit and process tank/vessel ,with gauges computer inter face and software, with all necessary accessories and piping systems	1 No.
86.	Pneumatic pressure control trainer	Complete unit consisting pneumatic PID controller- transmitter, control valve, FRL unit and process tank/vessel with gauges with all necessary accessories and piping systems	1 No.
87.	Flow and level control trainer	Complete unit consisting PID controllers, HART Transmitters, FRL unit, process and reservoir tank minimum 50 ltrs capacity, minimum 1 HP motor. feed forward, feedback, Ratio and cascade control loop arrangement with computer inter face and software with all necessary accessories and piping systems	1 No.
88.	Temperature control trainer	Complete unit consisting PID controller, HART transmitter, final control element and furnace (0-600 C or above) type process, computer inter face and software with all necessary accessories	1 No.
89.	Process automation controller or DCS with SCADA development software for process control.		1 No.
90.	Universal process calibrator		1 No.
91.	HART Calibrator		1 No
92.	HART/FIELDBUS/PROFIBUS Devices (pressure/ flow/ temperature) (Note: can also		1 No. each

	purchase in above concerned measurement tools, No need to purchase separately)		
C. GENERAL INSTALLATION			
93.	Work benches	48 inch x 24 inch x 30 inch (lxbxh)	5 Nos.
94.	Instrument test bench with cup boards	48 inch x 24 inch x 30 inch (lxbx h)	5 Nos.
95.	Steel cup boards with 6 lockers for trainees	6 x 2 x 1feet above	2 Nos.
96.	Steel cup boards/ alminrah(with five shelves)	6 x 2 x 1feet above	3 Nos.
97.	4 Fire buckets with stand		1 set.
98.	Student chairs		25 Nos.
99.	Master chair and table	48 inch x 36 inch x 30 inch (lxbx h)	1 No.
100.	Hand drill machine (electrical)	0 – 10 mm size	1 No.
101.	Electric furnace (max 1200 C) dry block (with digital temperature indicator and temperature control, safety lock, industrial standard)		2 Nos.
102.	Air Compressor	Working pressure 150psig, hydraulic testing pressure 225 psig, 500 liters tank capacity or above, with pressure switch, pressure gauge	1 No.
103.	Air compressor (small)	Working pressure 150psig, hydraulic testing pressure 225 psig, 100 liters tank capacity or above, with pressure switch, pressure gauge	1 No.
104.	Air dryer	Maximum pressure 15 Kg/cm^2, single or double stage drying, dew point temp 40 C, with filter, blower and heater minimum 2 K watt.	1 No.
D. IT EQUIPMENTS AND SOFTWARE			
105.	Computers (latest configuration) with tables (For operating various control system trainers)	CPU: 32/64 Bit i3/i5/i7 or latest processor, Speed: 3 GHz or Higher. Cache Memory: - Minimum 3 MB or better. RAM:-8 GB DDR-III or Higher. Hard Disk Drive: 500GB or Higher, 7200 rpm (minimum) or Higher, Wi-Fi	03 No.

		Enabled. Network Card: Integrated Gigabit Ethernet (10/100/1000) - Wi-Fi, USB Mouse, USB Keyboard and Monitor (Min. 17 Inch), Standard Ports and connectors. DVD Writer, Speakers And Mic. Licensed Windows Operating System / OEM Pack(Preloaded), Antivirus / Total Security	
106.	Lap top (for convenient to control system)		01 No.
107.	Licensed/free operating system (latest version)		04 Nos.
108.	Latest Office (licensed/free version)		04 Nos.
109.	LCD multimedia projector with trolley/installation arrangement		01 No.
110.	Printer (Scan/copy)		01 No.
111.	Networking tool kit		02 Nos.
112.	Air Conditioner		As Required


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