

**Syllabus**

**For the trade of**

# **INSTRUMENT MECHANIC**

**Under**

**CRAFTSMEN TRAINING SCHEME (CTS)**

**&**

**APPRENTICESHIP TRAINING SCHEME (ATS)**

**Revised in**

**2010**

**By**

**Government of India  
Ministry of Labour & Employment (D.G.E.&T.)**

**CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE  
EN – 81, Sector – V, Salt Lake City ,**

**Kolkata-700091.**

List of members attended the Trade Committee Meeting for revising the course curriculum under Craftsmen Training Scheme (CTS) and Apprenticeship Training Scheme (ATS) on "Instrument Mechanic" trade held on 08.04.2010 and 09.04.2010 at Industrial Training Institute, Sarkhej, Ahmedabad, Gujarat.

**Shri S.D. Lahiri, Director, C.S.T.A.R.I., Kolkata**

Sr.No.	Name & Designation	Organization	Remarks
1	Mukeshbhai Patel, IMC Chairman, I.T.I. Sarkhej	Managing Director, Bhavani Group of Industries, Sarkhej	Chairman
2	Anup Bhavsar, S.E.	Janatics India Pvt. Ltd. Ahmedabad	Member
3	Amish Bhavsar Business Dev. Manager	Janatics India Pvt. Ltd. Ahmedabad	Member
4	Persottam B. Varia, Engineer	Varia Engg. works Pvt. Ltd., Bavla. Ahmedabad	Member
5	Alpesh M.Chudasma, A.G.M (Power Plant)	Nova Petrochemicals Ltd. Ahmedabad	Member
6	Ompal Bibiyani, A.G.M, HR & Admin.	Nova Petrochemicals Ltd. Ahmedabad	Member
7	Imtiyaz Kureshi, I.C. Engineer	Siddhi Industries, Ahmedabad.	Member
8	Maulik Shelat, Director	Technology Exchange Service Pvt.Ltd. Ahmedabad	Member
9	Kamlesh Prajapati, Manager	Sun Inst. Pvt, Ltd. Ahmedabad	Member
10	Dharmendra K Sharma, M.D.	D.K.Scientific Ind. Ahmedabad	Member
11	Limbachiya Jatin, Officer in Charge	Ahmedabad Ind.Corporation Ahmedabad	Member
12	Mukesh Suthar, Spervisor	Accupatro Chemical. Ahmedabad	Member
13	V.H.Kevadia, Jr. Deputy Manager	Prima Auto. Ahmedabad	Member
14	A.W.Parmar, Sr.Project H.R.	Prima Auto. Ahmedabad	Member
15	Bhavik Patel, Engineer	AIA Engg. Ltd. Changodar Ahmedabad	Member
16	Urmil Thakar, Engineer	Masibus Automation Pvt. Ltd. Ahmedabad	Member
17	Jatin Patel, Engineer	Torrent Power Ahmedabad	Member
18	R.D.Mehta, Lecturer	Govt.Polytechnic For Girls, Navrangpura, Ahmedabad.	Member
19	Dipesh Makwana, Lecturer	L.D.collage of Engg. Ahmedabad	Member
20	Divyangna Gandhi, Lecturer	Ganpat University, Mehsana	Member
21	S.A.Pandav Regional Deputy Director (Trg.)	Regional Deputy Director (Trg.) Rajkot	Member
22	G.N.Parekh, R.D.D., Ahmedabad	R.D.D. (Training), Ahmedabad	Member
23	A.C.Muliyana, Principal Class-I	ITI, Sarkhej	Member
24	P.A.Mistry, Principal	I.T.I., Kurnagar, Ahmedabad	Member
25	N.R.Oza, Principal Class-II	ITI, Sarkhej	Member
26	M.B.Suthar, Principal	I.T.I., Saraspur, Ahmedabad	Member
27	HB Chavda, Sr. Instructor	ITI, Gandhinagar	Member
28	SS Charan, Asst. Apprentice Advisor	ITI Rajkot	Member
29	MD Moodhpatel, Sr. Instructor	ITI, Sarkhej	Member
30	IS Patel, Sr. Instructor	ITI, Sarkhej	Member
31	D Dey, Asstt. Director of Training	A.T.I. Mumbai	Member
32	LK Mukherjee, Deputy Director	C.S.T.A.R.I., Kolkata	Member

## GENERAL INFORMATION

1. Name of the Trade : Instrument Mechanic
2. N.C.O. Code : 7311.10
3. Duration of Craftsmen Training : 02 years
4. Duration of Apprenticeship Training : Three years including two years in craftsmen training.
5. Entry qualification : Passed 10<sup>th</sup> class Exam. under 10+2 system with science or its equivalent.
6. Rebate in Apprenticeship Training : Two years for passed out Craftsmen in the trades of Instrument Mechanic
7. Ratio of apprentices to workers : 1:3
8. Unit size : 20 Trainees
9. Space Required : 80 Sq. mtrs.
10. Power : 8.07 Kw
11. Instructor's Qualification : The faculty should be B.E. or B.Tech in Instrumentation / Instrumentation and Control from recognized university with 1 year experience in the relevant field.

OR

Diploma in Instrumentation / Diploma in Instrumentation & Control from board of technical education with 2 years experience

OR

Possessed NAC/NTC in the trade of Instrument Mechanic with 3 years experience in the relevant field.

Desirable: Completed CITS programme in any of the DGE&T Institute.

## COURSE CONTENTS

<b>Sl. No.</b>	<b>Subject</b>	<b>No of weeks</b>
1	Introduction to trade and safety	01
2	Bench work and Hand tools	05
3	Basic electricity and electrical measuring instruments	19
4	Electronics	19
5	Basic Computer and its fundamental and Net working	03
6	Microprocessor	02
7	Basic Instrumentation concept	05
8	Process Instrumentation	30
9	PLC and HART devices, DCS & SCADA and fundamentals of field bus	10
10	Basics of Hydraulics and pneumatics	06
11	Analytical Instruments	01
12	Quality control and ecological considerations	01
13	Industrial Visit	01
14	Examination	01

## Syllabus for the trade of Instrument Mechanic under Craftsmen Training Scheme (CTS)

**Duration of the training:- Two years**

Week .No.	Topic title	Practical	Theory	Engineering drawing	Work shop calculation and science
1	Introduction to trade and safety	<b>Introduction to the training.</b> Familiarization with the institute. Layout of shop equipment & machineries. Syllabus, system of training, Examination, Types of work done by the trainees. Familiarization with the institutional Rules, discipline, cleaning & forming those habits. 'Elementary First Aid' practice, Artificial respiration practice. Occupational health hazard related to the trade- its causes, consequences, mitigation and control.	Organization of the Institute, Departments various trades & functions. Types of work, responsibility to be undertaken, incentives and future planning of profession. Safety 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.	What is Engineering Drawing? Importance, Familiarization with the drawing equipment.	Basic Mathematics related to Workshop problems.
2	Bench work and Hand tools	<b>Bench Work.</b> Filing practice, Balance of Pressure, Filing surface & side & checking 90 degree by the try square (simple exercises involving filing & saving use of vice)	Basic hand tools, types, classification use & metal cutting fundamentals.	Free hand sketching of hand tools.	-Do-
3	-Do-	Simple filing exercises as per dimension up to an accuracy of +/- 0.5mm. with use of Marking block, Out side & Inside Caliper, Try square, Surface Plate, Angle Plate, "V" Block.	Measurement & measuring instruments. Marking tools, Fasteners & Fastening devices.	Types of lines & its use Dimensioning Method, Geometrical drawing angles, triangles, circle, square, Rectangle, Rhombus, Parallelogram, Pentagon, Hexagon, Heptagon, Regular Polygon.	Review of Fundamental of Algebra & trigonometry.
4	-Do-	Marking & measuring with the help of Vernier Caliper, Vernier Height Gauge, Depth Gauge, Micrometer & Radius Gauge.	Precision Measuring Instruments. gauge blocks, sine bar, dial indicators, vernier calipers, micrometers, bevel protractor, thickness gauges.	-Do-	Properties & use of cast-iron, wrought iron, plain carbon steel, high carbon steel & alloy steel.

5	-Do-	Marking & measurement with combination set, Vernier bevel Protractor & other precision instruments. Template filing. Use sine bar.	Element & types of screw threads used in instruments, Calculation of drill size for tapping.	Geometrical drawing of ellipse, oval etc. Free hand sketch of hand tool.	Applied work shop problems.
6	Tube fitting	Straightening of tube, bending & flaring of tube connection of tube with straight & other couplers. Flare & Ferrule fittings. Checking leakage, use of jigs & fixture etc.	Types of tubes used for instrumentation. Tube cutter, Flaring tools, swedging tools, equipments & fixture required for pipe bending, straightening, thread cutting, method of installation.	Lettering numbers	Mensuration--- Area of rectangles, square, triangle, circle, regular polygons etc.
7	Basic electricity	Basic Electricity. Identification +Ve -Ve polarities. Identifying and use of various electrical components, their symbols. Wire size measurement technique. Measuring current voltage & resistance.	Electrical components- conductor, semiconductor & insulators. Standard wire gauge (SWG). Introduction of electricity- static electricity. Current, voltage, P.D, E.M.F, resistance. Electrical circuit - D.C & A.C circuit differences. Importance of grounding.	Drawing various electrical symbols.	Basic units of electricity and conversion.
8	-Do-	Resistance measured by the colour code. Simple exercise on soldering. By temperature controlled soldering station. Soldering and desoldering of various components in verso boards.	Uses of multimeter. Resistor, Resistivity and colour code. Types of resistors used in instrumentation. Definition and purpose of soldering and desoldering. Soft soldering. Types of soldering irons. Solder & flux. Care & precaution of soldering. De-soldering tools and method of use.	Isometric & oblique view of various jobs. Simple orthographic projection of 1 <sup>st</sup> angle & 3 <sup>rd</sup> angle.	-do-
9	Cells and batteries	Verification of ohm's law. Resistor in series and parallel circuits. Measurement of voltage in series and parallel circuits.	Ohm's law & Kirchhoff's laws. Series & parallel ckts. Primary & secondary cells and batteries. (Liquid & dry). Maintenance free batteries - construction-charging, efficiency-use, advantage.	Isometric & oblique view of various jobs. Simple orthographic projection of 1 <sup>st</sup> angle & 3 <sup>rd</sup> angle.	Simple problems on ohms law and Kirchhoff's laws.
10	Switches.	Familiarize with various types of switches; construct circuits with SPST, SPDT, DPDT switches. Operating and installation of relays. Use of magnetic campus. Study various types of applications like buzzers, solenoid valves.	Switches and types. Magnet and magnetism, magnetic properties. Magnetic campus and its uses. Explanation of Electromagnetism. Advantages, disadvantages-application-types E.M. relays. Types- uses of Solenoids. Circuit breakers and their working.	-do-	Simple problems on series and parallel circuits.
11	AC fundamentals	Simple electrical circuits-simple electrical wiring practice.	Principles of alternating current , A.C & DC electricity , types of wave forms , time period and frequency, peak to peak values, RMS values, Average values,	-do-	Simple problems based on AC fundamentals, calculation of, periodic time,

					frequency, wave length, average value, RMS value.
12	-Do-	Testing of inductor. Measure the values of inductor by inductance (LCR) meter. Measuring Q- factor of inductor. Demonstration on self and mutual induction.	Inductor and Inductance, types of inductors, Factors affecting the value of inductance, self inductance (L), Mutual inductance (M), Inductors in series and parallel, Q factor of the coil.	-do-	Simple problems on inductor series and parallel
13		Testing of capacitor. Measure the values of capacitor by capacitance (LCR) meter. Identifying capacitor value using various techniques Verification of RC time constant.	Capacitance, types of capacitor, unit of capacitance, factors affecting the value of capacitors, , charge, energy stored in capacitors. Capacitors in series and parallel. Capacitors in DC circuit, RC time constant.	-do-	Simple problems on capacitor series and parallel
14	-Do-	Study the characteristics of series and parallel resonance circuits.	A.C.-impedance, Inductive reactance, capacitive reactance. AC current through – R,L,C circuits. Resonance in RLC circuit. Importance – of series and parallel resonance, properties. Impedance, Admittance, Q- factor.	Symbols of switches and relays.	Simple problems on series and parallel RLC circuits.
15 & 16	Generator and motors	Study working of AC and DC motors. Identification, testing & running of Motors and generators.	Introduction of AC and DC generators working principles, construction, operation, field magnets, armature windings, commutator and brushes. EMF equation. Faraday's Law, Lenz's Law, Fleming's left Hand and right hand rules. DC motors working principles, construction, operation, types. Different speed controlling techniques of DC motors. AC motors, induction motors, three phase motors, stepper motors.	Symbols of electrical motors.	
17	Transformers	Experiments on transformer. Measuring current & voltage in primary & secondary windings. Testing auto transformer in its various tapping Care & maintenance & connection of auto transformer and instrument transformer.	Transformer, types, transformation ratio. Open circuit test and short circuit test, regulation Auto transformer. Current measurement. Instrument transformer. Potential transformer and current transformer.	Symbols of various types of transformers.	Problems on transformer ratio.
18	Electrical measuring instruments	Familiarization with the internal construction of instruments. Overhauling & testing of voltmeter & ammeter. Identifying – type of deflecting torque, controlling torque, damping torque etc. and adjustment of zero errors.	<b>Basics of electrical measuring instruments-</b> types – absolute and secondary instruments. Types of secondary instruments. Essential of electrical measuring instruments-deflecting torque, controlling torque, damping torque etc. Types of controlling torques- spring control, gravity control. Types of damping - air friction	Diagram and sketches of electrical measuring instruments, Viz, all types of moving iron and moving coil instruments	Problems on measurements, power, energy, force.

			damping, fluid friction damping, eddy current damping.		
19	-Do-	Familiarization with the construction of PMMC instruments. Overhauling & testing  Testing & calibration of ammeters and voltmeter of various types. Finding meter (FSD) full scale deflection reading, measurement value, meter sensitivity, accuracy, maximum power, capability etc.	<b>DC instruments</b> - 'D' Arsonval meter, PMMC meter- working principle, method of working, moving coil operation. Construction- damping, magnetic shielding, bearings. Terminology -parallax error, (FSD) full scale deflection reading, measurement value, meter sensitivity, accuracy. Meter resistance, maximum power, capability etc. Ideal and practical characteristics of ammeter, voltmeter.	Diagram and sketches of electrical measuring instruments, Viz, all types of moving iron and moving coil instruments.	Problems on conversions of galvanometer to ammeter and voltmeters.
20	-Do-	Making shunt and series resistances of various ranges of ammeters. Making multipliers for different ranges of voltmeter and ammeter. making extension of instrument range. Finding meter resistance.	<b>Meter range extension</b> – converting galvanometer in to ammeter, voltmeter. Range extension of voltmeter, ammeter. Shunt resistance and series resistance value calculation. Meter resistance, meter FSD identification techniques.	-do-	Problems on meter range extension and meter resistance calculation.
21	-Do-	Use of Ohm meter. Calibration of ohm meter, use of megger & earth tester.	<b>Ohm meters</b> - measuring electrical resistance. Basic construction of Ohm meter, working method of ohm meter. Types of Ohm meter – series and shunt type of ohm meters. Megger/insulation tester, earth tester – construction working advantages and disadvantages of various types of ohm meter.	-do-	-do-
22	-Do-	Familiarization with the construction of dynamometer type instruments and MI, overhauling and calibration of dynamometer type instruments. Measurement of power by wattmeter & calibration of wattmeter.	<b>AC instruments</b> – types of AC measuring instruments – MI , electro dynamometer type. Working principle, construction, advantages and disadvantages of MI instruments and electro dynamometer instruments. Various applications.	-do-	-do-
23	-Do-	Familiarization with the construction of energy meter, ampere hour meter overhauling and calibration of ampere hour	Electro dynamometer applications – as voltmeter, ammeter, power measuring instrument, energy measuring instrument, power factor	Orthographic projection, 1 <sup>st</sup> angle and 3 <sup>rd</sup> angle.	-Do-

		meter.	meter etc. AC voltage and current measurement using PMMC meter(rectifier type ).		
24	-Do-	Measurement of three phase and single phase power by voltmeter and ammeter. Overhauling and calibration of KWH meter (Energy meter)	Induction type meters – working principle construction and operation of induction type instruments . Construction and Applications – single phase and three phase energy meter, watt meter. Watt hour meter, Ampere Hour meter, power factor meter etc.	Orthographic projection, 1 <sup>st</sup> angle and 3 <sup>rd</sup> angle.	Problems on cost of repairing/ reconditioning of electrical instruments
25	-Do-	Practical on frequency meter and power factor meters. Use of phase sequence meter & synchroscope.	Special instruments: voltage tester, continuity tester, rotation test, phase sequence indicator, synchronizing, the synchroscope, frequency meter. Thermocouple type ammeters.	Orthographic projection, 1 <sup>st</sup> angle and 3 <sup>rd</sup> angle.	-Do-
26	Electronics basics	Identification of various types of diodes (solid state), checking of diodes. Verification the characteristics of diode.	Semi conductor, Covalent bond, Doping, Intrinsic and extrinsic semiconductor. PN junction diode, Forward and Reverse characteristics. Specification of diodes (data sheets). Applications of diode. Special semiconductor diode-Zener diode, tunnel diode, Photo diode.	Symbols of various electronic components.	Simple problems on diode and transistor.
27	Transistor	Identification of transistors, FET, MOSFET checking of transistors, FET, MOSFET. Verification	<b>Transistors.</b> Defining transistors, NPN & PNP transistor, Symbol, operation, Biasing of Transistor & mode of Application. Transistor CB, CC, CE Amplification. current gain, voltage gain, and power gain. Introduction to FET, MOSFET.	Sectional views.	Simple problems on transistor voltage gain, current gain, and power gain.
28	Power supply unit	Making half wave & full wave rectifiers, center tap & bridge full wave rectifiers. Study of ripple factor in half wave & full wave rectifier with various filter circuits.	<b>Rectifiers:</b> half wave rectifier, full wave (bridge & center tapped) rectifier. Voltage multipliers. <b>Filters:</b> Introduction, purpose and use of ripple filter. Types of filters. Capacitance filter, inductance filters, RC filters, LC filters, voltage dividers	Trade drawing related to rectifiers.	Problems on rectifiers.- efficiency, output voltage. Etc.

			and bypass filters.		
29	-Do-	Hooking up a various types of fixed and variable voltage regulators & determine its characteristics.	<b>Voltage regulators.</b> Introduction & purpose Zener regulators, shunt regulators, series regulators, IC regulators, variable regulators.	Free hand sketches of rectifier and regulated power supply units.	Problems on regulated power supply.
30	-Do-	Assembling of a power supply unit. Trouble shooting of power supply units. Identification of various types thyristor devices, checking of SCR, DIAC and TRIAC	<b>Power Supply units.</b> Introduction, purpose & use. UPS and SMPS, inverters and converters. and their applications <b>Thyristor devices:</b> basic description and applications of SCR, TRIAC, DIAC.	Preparation of schematic diagram of different types of oscillators, operational amplifiers, converter, SCR, TRIAC, DIAC.	
31	-Do-	Layout of components and preparation of PCB's. Surface mounting device (smd ) soldering and disordering.	General characteristics of an amplifier, Concept of amplification. Types of Amplifiers. Effect of temperature . DC load line and AC load line. PCB basic construction, applications. Lay outing circuit on PCB.		
32	Oscillat ors	Study of various types of Oscillator as mentioned theory.	<b>Oscillators</b> oscillations, oscillation frequency, basic working principle and working of Tank circuit, Crystal controlled oscillators, Phase shift oscillators, RC phase shift oscillators, Colpitt, Clapp, Hartely, and IC oscillators.		Problems on oscillators – output frequency.
33	Operati onal Amplifi er.	Study OF various op-amp applications – inverting amplifier, summer, and differential amplifier. V to I and I to V, Instrumentation amplifier	<b>Operational Amplifier.</b> Differential amplifier, ideal op-amp. Op-amp with feed back, advantages of feed back. Inverting and Non inverting and inverting amplifier, Op-amp as summer, differential amplifier. V to I converter and I to V converter, Instrumentation amplifier		Problems on Op- amp gain, summer, subtractor.
34	-Do-	Study various op- amp applications – integrator, differentiator Study timer circuits.	Basics of op- amp applications - integrator, differentiator, Introduction of timers (555) and its applications.	Free hand sketches of op-amp applications circuits.	Number systems, conversions.

35-36	Digital electronics	Verification of truth tables of various logic gates.	<p><b>Number systems:</b> binary, octal, decimal and hexadecimal number system. Conversion of number systems. Boolean algebra, binary addition, subtraction, multiplication and division. 1's and 2's compliment. BCD code, ASCII code, greys code.</p> <p><b>Logic Circuits.</b> Basic gates- AND, OR and NOT gates. De-Morgan's Theorem. Universal gates – NAND and NOR gates. Special gates – Ex-OR, Ex – NOR gates and Buffer and its applications. Basic digital ICs, function, digital application, logic symbols.</p>	Symbols of various digital electronics components.	Boolean algebra
37	-Do-	Verification of truth tables for adders and subtractors. RS and JK Flip flops.	<p>Adders – Half adder, full adder</p> <p>Subtractor – Half subtractor, full subtractor.</p> <p>Flip flops – RS flip flop, clocked RS flip flop, JK flip flop.</p>	-Do-	-Do-
38	-Do-	Introduction of Counters.	<p>Basics of Counters and registers.</p> <p>Multiplexer and demultiplexer.</p> <p>Encoder and decoder. BCD display, BCD to decimal decoder. BCD to 7 segment display circuits.</p>	Free hand sketches of counters and registers.	1's and 2's compliment. Binary addition, subtraction, multiplication and divisions.
39	Digital meters	Study function of BCD to decimal decoder, BCD to 7 segment display circuits	Digital meters: displays: LED, 7 segment display, LCD, CRT, electro-luminescent displays, electro-phoretic image display, liquid vapor display, dot matrix display.		-Do-
40 & 41	-Do-	Study function of D/A and A/D circuits. Study of RS485 to RS232 converter.	<p><b>A/D and D/A converters.</b></p> <p>Introduction, weighted register D / A converter, binary(R-2R) ladder D / A converter, specification for D / A converter, Ramp or counter type A/D converter,</p>	Free hand sketches of A/D and D/A converters.	

			GPIB ( general purpose interface bus) IEEE – 488, RS 232.		
42	-Do-	Operating and installing various types of digital meters.	Digital meters: frequency meter, phase measuring meter, and time measuring instruments. Digital capacitance meter.		
43	-Do-	Measurement voltage, frequency using CRO. Study method of operating storage oscilloscope. Method of using CRO probes.	CRO: introduction and applications of CRO, functional block diagram of CRO, CRT power supply. Various types of probes. Applications of various types of CROs like dual beam CRO, Dual trace CRO, storage oscilloscope.	Free hand sketches of CRO block diagram.	Simple problems on voltage and frequency measurements on CRO.
44	Computer fundamentals	Identification of PC components and devices.	Introduction to Computer, Block diagram of PC, software familiarization of Multi Media System consisting of CD ROMS, DVD ROMS, Sound Cards.		
45-46	-Do-	Basic Computer	Computer Hardware, Computer systems, computer hardware, CPU, CPU operations, ROMs and RAMs, I/P and O/P and peripheral equipments, terminals, printers, MODEMS, Data interface, ADC and DAC	Computer block diagram. Drawing of ADC and DAC	Estimation and calculation on repairing and reconditioning of electronic instruments and microprocessor based equipments.
47 and 48	Micro processors	To familiarize with 8085 Microprocessor kit.	Introduction to microprocessor micro computers, Memories Intel 8085. Architecture, Instruction set of 8085, Microprocessor. 1. Data transfer group. 2. Arithmetic group. 3. Logic group.		
	-Do-	Basic programming on microprocessor	Basic Programming of 8085 such as adding, subtraction of two 8 bit numbers. etc. Block diagram and pin diagram 8255 and its operation. Microprocessor applications.	Simple block diagram of 8085 microprocessor.	-Do-

49	Instrumentation fundamentals	Study various types of measuring instruments constructions and identifying various parts and section.	Scope and necessity of instrumentation. Fundamentals of measurement systems- functional block diagram of measurement system calibration and calibration standards – basic standards, secondary standards, working standards. Fundamental units - The metric system, Base & supplementary units, Derived Units, Multiplying factors and standards of length, mass, time, & frequency. Temperature & electrical units.	Drawing various types of lines used in instrumentation field.	Calculation on volume & weights of solid & hollow bodies. C.G.S. & M.K.S system of units of force, weight etc. Defining work, power energy, torque. Laws of conservation of energy, Forms of energy, kinetic energy & potential energy.
50	-Do-	-Do-	Instrument characteristics Static characteristics – accuracy, precision, sensitivity, resolution dead zone, repeatability, reproducibility, drift, Dead band, backlash, hysteresis. Dynamic characteristics – speed response, fidelity, lag. Error, deviation, true value, data. Types of errors- systematic, random & illegitimate error.	Simple block diagram of measuring instruments.	-Do-
51	-Do-	-Do-	Certainty/ uncertainty, validity of result. Measuring system Response. Introduction, amplitude responses, Phase response, Delay, rise time & slew rate. Damping & its importance.	Symbols of transmitter and sensors indication as per different fields.	<b>Statistical analysis</b> – arithmetic mean, deviation from the mean average deviation, standard deviation
52	Motion measurement	Measuring strain in terms of resistances. Operating load cells, LVDT and capacitive transducer.	Stress & Strain Measurement. Introduction to Strain gauges, types of strain gauges and differences. Applications of strain gauges, load cells. LVDT, RVDT, advantages and limitations.	Functional block diagram of LVDT,	Simple problems on calculation of stress and strain.

53	-Do-	Measuring speed and velocity using various tachometers. Operating stroboscope	Measurement of motion, velocity and acceleration. Difference between tachometer and speedometers. Types of tachometers - Eddy current type, AC and DC tachometer. Stroboscope and its applications. seismic instrument, measurement of velocity with seismic instruments,	Symbols of displacement devices, tachometers. Functional block diagram of tachometer.	Force and motion, source of forces, forces applied to stationary objects. Acceleration, Newton's laws of motion, lever, classes of lever, wheel and axle, gear train, inclined plane, the wedge, mechanical advantages. Problems on acceleration and speed.
54 & 55	Pressure Measurement	<b>Pressure Measurement.</b> Practical on various Pressure sensors and pressure gauges. Repairing, fault finding, Testing & calibration of various types of pressure measuring instruments. Calibration with dead weight tester and comparator. Testing and installation of pressure switches.  Perform practical on pressure simulator or experimental setup (real and package type) Operating and calibrating Pressure transmitters.	Principle of Pressure in Liquids & Gases. Properties of matter Principles of liquid pressure, units of pressure Liquids pressure and volume, density and specific gravity. Factors affecting liquid pressure. Pressure relation with volume, temperature and flow. Units of pressure and unit conversions. Types of pressure: absolute, gauge, atmospheric and vacuum pressures and their relationships. Barometers, manometers types and applications.	Symbols of various pressure sensors. Functional block diagram of pressure indicator and transmitter.	Basic units of pressure and converting units. Problems on a absolute, gauge, atmospheric and vacuum pressures and their relationship.
56 & 57	-do-		Types of pressure sensing elements- bourdon tube, diaphragms, capsules, and bellows. Each on types, shapes, material used for various applications, ranges advantages and limitations. Pressure switches types and applications.		
			Electrical pressure	Free hand	Cam &

			transducers. method of conversion, primary and secondary pressure transducers. potentiometric pr. transducers, Capacitive pr. transducers, reluctance-servo pressure transducers, strain gauge pressure transducers, piezoelectric pressure transducer. Differentials pressure transducers.	sketches of bourdon tube/diaphragm gauges and various pressure measuring devices.	follower devices, socket and pinion, rack pinion, screw jack, pulley and pulley system, various motion transfer mechanisms.
58 & 59	-Do-	-do-	<b>Low Pressure Measurement.</b> Vacuum, gauges, thermal conductivity gauges, pirani gauges, thermocouple gauges, slack diaphragm. Ionization gauge, McLeod gauge, capacitance manometers. Method of pressure instrument calibration. Dead weight tester and comparators/manifolds.	-Do-	Problems on movements.
60			<b>Pressure Instrument Installation &amp; Servicing.</b> Elements of pressure transmitters, Installation components, pressure taps, isolation valve, instrument piping, connections and fittings blow down valve, instrument valve, pulsation damper, diaphragm seal, pressure transmitter, Installation, procedure, locating and mounting, piping, electrical wiring placing into service, guidelines for periodic maintenance, troubles shooting and repair, instrument shop safety.		Calculation on the cost of repairing /reconditioning pressure measuring devices.
61 & 62	Flow measurement	<b>Flow Measurement</b> Checking various types of flow restrictors (orifice, ventury, flow nozzle) and use.	<b>Properties of Fluid Flow.</b> Basic properties of fluids, fluids in motion, getting fluids to flow, units of flow rate and quantity flow, factors affecting flow rate, Reynolds number, relation	Functional block diagram of flow meters.	Basic units of flow rate and quantity flow measurements. Conversion of units

			between flow rate and pressure, area, quantity. Types of flow meters – head type, variable area type, quantitative flow meters. Mass flow meters.		
63	-Do-	Dismantling, checking overhauling and calibration of D.P. cell/transmitter.	Head type of flow meters: working principle, types-venturi tube, orifice plates and it's shapes. Pitot tube, flow nozzles, constructions, tapings, advantages, limitations, applications, materials used for various flows. Types of secondary devices used to measure for flow rates.	Free hand sketches of head type flow meters.	Non ferrous metals-manufacturing process, properties, application and selection criterion.
64	-Do-	<b>Rotameter :</b> Fitting of tapered glass tube checking & testing. V-notches fitting.	Open channel flow meters-principle of open channel flow, weirs, notches and flumes. Various shapes and their applications, maintenance. Variable area type flow meter- rotameter, constructions, working principle, applications. Various shapes of float, type of materials used for body and float. Factors affecting rotameter performance, measuring gas and liquid flow.	Free hand sketches of rotameter, v notches.	-Do-
65	-Do-	Study construction, repairing various types of positive displacement flow meters.	<b>Positive Displacement Meters.</b> Advantages and disadvantages of positive displacement meters, piston meter, oscillating piston meter, rotating vane meter, rotating disk meter, lobed impeller and oval flow meter, calibrating positive displacement meters.	Symbols of various flow sensors, indicators and transmitters.	Composition properties & use of non- ferrous alloys.
66	-Do-	Calibrating and installing turbine flow meter, vortex flow meters	Target flow meters, turbine flow meter, magnetic flow meters, vortex flow meter. Construction, working principle, advantages and disadvantage, applications. Coriolis mass flow meter,	-Do-	Problems on friction.

			thermal flow meters and summary basics of ultra sonic flow meters. The Doppler shift method. The beam deflection method, frequency difference method,		
67	-Do-	Installation maintenance of flow instruments. (Components for flow measurement system, primary flow elements, pressure taps, piping and fitting valve, DP transmitter and miscellaneous items.) Installation of the flow measurement system, pressure taps installation, instrument piping installation, electrical hookup, the final step, installation, maintenance and preventive maintenance.	Metering the flow of solid particles. Measuring volumetric and mass flow rate of solids, volumetric solids flow meter, mass flow meter for solids, belt type solid meters belt type solid meters belt speed sensing and signal processing, slurries, constant weight feeders.	-Do-	Calculation on cost of repairing / reconditioning flow measuring instruments.
68 & 69	Level measurement	Measurement of level performing practical on level measurements, i.e. experimental setup for level measurements/process simulator on level measurement(real type, transparent double tank type, computerized package type) Calibration of level transmitters.	Principles of level measurement. Types of level measurements-solid and liquid, volume and mass, mechanical and electrical type. Surface sensing gauges, storage tank gauges, sight glasses, magnetic gauges, buoyancy, displacement gauges. Factors need to consider for open and closed channel level measurements level switches, mercury level switches in high pressure tank, level detectors, magnetic reed switches.	Free hand sketches of various levels measuring system.	Units of volume. Calculation on volume unit conversions. Calculations on relation between volume, mass and density.
70	-Do-	Level instrument servicing introduction to instrument servicing. Maintenance, repairing and control	Pressure head instruments. Hydrostatic pressure, specific gravity, pressurized fluids, pressure head instrumentation, air bellows, U- tube manometers, air purge systems, liquid purge systems, force balance diaphragm system.	Basic symbols of various level sensors, transmitters and indicators.	-Do-

71	-Do-	Servicing level instruments in the filled gauge glasses float actuated instruments, displacer level gauges, pressure head instruments. Flow diagram method.	Electrical method conductivity and capacitance method for measuring the liquid level, capacitance probes, zero and span adjustments, sonic level detectors, point level detection.	-Do-	Calculation on the cost of repairing / reconditioning level measurements.
72	-Do-	-Do-	Solid level measurement. Using weight to determine level, sonic solid level measurement with microwaves, using capacitance probes to measure solid level, diaphragm switches, nuclear gauges, micro wave solid level detectors.	-Do-	-Do-
73 & 74	Temperature measurement	Temperature measurement. Performing practical on temperature measurement with different sensors as in the theory part, in the temperature controlled oil bath/ furnace for low and high temperature .	Temperature measurement. Temperature, heat, specific heat, changing physical state Fahrenheit and Celsius temperature scales Rankin and Kelvin scales calibration of temperature scales primary and secondary standards. Industrial application of temperature measuring instruments with compensating link & precautions to be taken.	Free hand sketches of various types of filled system thermometers.	Units of temperature. Conversion of temperature units.
75	-Do-	Temperature instrument maintenance and calibration. Primary calibration standards, primary standard instruments, secondary standard instruments, instrument inspection, controlled temperature environments, using triple point baths, other fixed points, temperature references, calibration and testing methods.	Bimetallic and fluid filled temperature instruments. Bimetallic thermometers, liquid-in-glass thermometers, filled system thermometers, thermometer bulbs, capillary & bourdon tube, temperature transmitters for filled system, advantages & disadvantages of filled systems.	Free hand sketches of various temperature sensors and compensating systems.	-Do-
76	-Do-	Perform practical on experimental setup/ temperature simulator (real type and package type) for temperature	Electrical temperature instrument. Resistance thermometer, how it works, RTD bridge circuits, lead wire error, RTD elements,	Symbols of various temperature sensors, indicators and	Calculating on the cost of repairing/ reconditioning temperature

		measurements controls. Practical on Thermocouple and RTD. Practical on optical pyrometer and radiation pyrometer.	protecting wells for RTD, advantages and disadvantages of RTDs, thermistors, thermocouples, Ex-tension wires, compensating for changes in reference junction temperature, construction of thermocouple junction, types of thermocouple, advantages and disadvantages of thermocouples.	transmitters.	measuring instruments.
77	-Do-	Measurement of humidity.	Pyrometry. Molecular activity and electromagnetic radiation, defining pyrometry, effects of emittance, effects of temperature, wave length and radiated energy, pyrometers and wave lengths, using of optical and radiation pyrometer,	Free hand sketches of optical and radiation pyrometers.	-Do-
78	recorders	<b>Recorders and servicing.</b> Overhauling, checking, fault finding, repairing, testing of pneumatic, electrical/ electronic recorders.(single point & multipoint), study of paperless LCD/LED recorder	<b>Recorders.</b> Introduction to recorders. Construction, working principle, various parts installation and use of pneumatic and electronic recorders. Strip chart, circular chart.	Symbols of various types of recorders.	Calculating on the cost of repairing/ reconditioning recorders.
79 to 80	Final control elements	Final control elements. Study of control valves/final control elements and its various components.	Final control elements in process loops. Final control elements, actuators, load set point compensation, feed back loops, control variables, effects of disturbances on performance, parts of final control sub- system, control signal, electric control signals, fluidic control signals.	Free hand sketches of various valve parts.	Control valve terminology. With simple calculations, calculations on the cost to repair and recondition control valves.
		Dismantling, fault finding, repairing, cleaning, reassembling and testing of control valves.	Pneumatic and Hydraulic Actuators. Pneumatic principles effects of changing pressure, pressure/volume/temperature relationship, effects of changing temp. Pneumatic actuators, diaphragm actuator, spring and springless actuators, direct and reverse acting actuator, piston	Symbols of valves.	-Do-

			actuator, positioner, Electrical actuators and their advantages.		
	-Do-	Piping tubing and fitting.	Control valves. Control valves functions and components, types of control valves, based on valve flow characteristics – liner, equal percentage, quick opening valves, globe valves, cage valves, butterfly valves, ball valves, sliding gate valves, diaphragm valves, split body valves, capacitive, inductive type valve, proximity switch, IR switch, micro switch, limit switch, other control valves, control valve mechanical considerations, selecting control valves, valve positioner.	-Do-	-Do-
		Study the cut sections of various types of control valves.	Control elements applications. Feed water control system works, sequential valve control, control and block valves, applying relays in final control elements, relay logic in operation, automatic valve control, controllers and activators, turbine control system, throttle and governor valves and activators. Introduction of internal parts of different types of control valves.	-Do-	-Do-
81 to 83	Process control systems	Controllers. Practical on PID controller trainer on various process parameters.	Introduction to controllers. Basic block diagram of control systems. Advantages Process variable and set point, analog controllers, digital controllers, control ranges and limits, control loop measuring Pv, amplifying signals final control elements, current proportioning. Hunting & its effect on the product.	Simple block diagrams of various types of control systems like feed back, feed forward, ratio, cascade control systems etc.	Calculating on the cost of repairing/ reconditioning control systems.
	-Do-		Types of controller and their operation. Types of controller, range limit of controllers,		

			<p>ON/OFF controllers, direct and reverse acting controllers, proportional controllers, automatic/manual split control, pneumatic control. Adaptive, limiting and batch control, ratio control system, feed forward, feed back control systems and cascade control system.</p> <p>Comparison between pneumatic and electronic control systems.</p> <p>Basic knowledge on communication protocol.</p>		
		Study operation on cascade, ratio, feed forward control trainer.	<p>Controller models and tuning. Controller tuning, setting, controller modes, proportional mode, off-set, integral mode, reset mode, derivative mode(rate), single mode controller, two mode controller, three mode controller, tuning the control loop, step-chnge- response method.</p>		
84 to 87	PLC basics	Basics industrial programmable controllers. Practical on Programmable Logic Controller trainer.	<p>Introduction to programmable controllers. History of programmable controllers, general characteristics of programmable controllers, some limitation of PLCs, method of developing PLC programming.</p>	Basic block diagram of PLC. Simple Wiring diagram.	Calculating on the cost of repairing/reconditioning control PLC.
	-Do-	Basic small programs on PLC – logic gates preparation,	<p>Input/output devices. Definition of input/output devices, I/O interface, input modules, output modules, input devices encoders, output devices, the opto-isolators, safety.</p>		
	-Do-	Small programs on timers and counters.	<p>Processing and programming functions. The processor unit, the memory, memory organization, ladder diagrams, data logger, most used programming symbols, start, stop, station example, other programming symbol timers and counters, data</p>		

			manipulation instructions, alternate PLC symbols.		
88 & 89	HART devices	Installing & Operating HART transmitters/devices (I/O). Calibration of HART devices.	Digital control systems: need of smart devices, HART transmitters futures, advantages, applications. Working method of HART devices, HART protocol. HART communicators and PC based HART device configuration. Steps in calibration of HART devices. Communication fundamentals: modulation and demodulation, signal to noise ratio, digital communication basics – PWM, PCM, FSK	Basic block diagram of HART devices. Symbols of HART devices.	Calculating on the cost of repairing/reconditioning HART devices.
90	Networking	Study various network lines. Preparation network cables and connectors. Testing network cables.	Net working: types of networks used in digital instrument systems. LAN, WAN , Ethernet. Point to point and multi networking. Ring, delta, star connections. Redundant Net. TCP/IP addresses and descriptions. Types of Cable categories (CAT), and their descriptions. Various types of Cable connectors. Advantages and disadvantages of co-axial cable and fiber optic cables. Various tools used in networking- wire cutter, crimp tool, memory blade holder, memory blade cartridge, cable strip tool with blade cassettes. Terminators and extra connectors, taps, calibration tool etc.	Simple block/schematic diagrams of various network systems in instrumentation field.	Estimation preparation for networking.
91 & 92	-Do-	Study and use of DCS & SCADA complete with communication system on process trainer.	Fundamentals of SCADA and DCS. History of DCS development. Basic architecture, block diagram description advantages and disadvantages, applications. Terminology- RTU(remote transmitting unit, central monitoring station, types of	Simple block diagram of DCS and SCADA	-Do-

			communications, field instruments and types		
93 & 94	Fundamentals of field bus	Study various field bus based control system through industrial visit.	field bus: futures, advantages, architecture, basic block diagram, working. Work station, Human Machine interface (HMI). Controller (with basic types), field bus interfacing modules, gateway, network manager, I/O modules, field bus devices(I/O), remote transmission panel(RTP), Ethernet. Electronic device description language (EDDL) and device description (DD). Field bus power supply and its function. Introduction of digital and multi drop communication protocol. Vendors. Need and advantages of redundancy. Futures- library, call up, various visualized futures, reports(alarms, events), history, trading etc.	Simple block diagram of field bus system.	Calculating on the cost of repairing/reconditioning field bus control systems.
95 to 97	Basic Hydraulics	Basic Hydraulics and pneumatics. Practical on Hydraulic trainer.	Basic Hydraulics: Principles of Hydraulics. Fluid power and hydraulics, force, weight and mass, pressure, work, power, energy, incompressibility and non-diffusion, hydrostatic pressure, Pascal's law, transmission of fluid power, fluid flow in pipes, Bernoulli's principle, the effect of heat on liquids. A typical hydraulic power system.	Drawing the sketches of the components of hydraulic system. Block diagram of hydraulic systems.	Simple calculation on hydraulic s.
		Continue practical on trainer.	Hydraulic Fluids. Functions of hydraulic fluids, physical properties, viscosity, viscosity index, viscosity and pressure, power point, fluid selection, component protections, chemical properties, system contamination, water, dissolve		

			air, foaming, corrosion and rusting, types of hydraulic fluids.		
	-Do-	Dismantling and assembling of various valves.	Directional control valves. Directional control valve classification, review of two way valves, globe, gauge, plug, needle, ball, automatic two way valves, check valves, pilot operated check valves, spool valves, three way spool valves, controlling hydraulic motors, NO and NC valves, holding valves, four and five way valves, rotary spool valves, schematic symbols, flow ratings, accessories.	-Do-	-Do-
98 to 100	Basic pneumatics	Basic pneumatics. Pneumatic systems, forces, weight and pressure. Practical on pneumatic training kits.	Pneumatic principles, mass, pressure, work and energy, compressibility, law of pneumatics, transmission of pneumatic fluid power, pneumatic leverage, air properties, air flow in pipe lines, viscosity of air pressure, Bernoulli's law, components of pneumatic power system.	Drawing the sketches of the components of pneumatic system. Block diagram of pneumatic systems.	Simple calculation on pneumatics .
		Practical on air filter regulator.	Primary air treatment. Air treatment, preliminary filtering, relative humidity, effects of moisture, water removal, dew point, moisture separators, oil scrubbers, air dryers, (deliquescent and absorption type) air receivers.		
	-Do-	-Do-	Secondary air treatment. Methods of treatment, contaminate separation, contaminate filtration and filter classification and rating, types of media surface filters, depth filters, absorption filters, lubricating the air.	-Do-	
	-Do-	Instrument pipes, schedules, pipe fittings, union, elbow, sockets, reducing sockets, straight coupling, instrument tube and tube fitting, copper	Piping houses and fittings. Requirement of piping, air flow, piping dimensions and safety factors, piping connections, compressed air piping applications, metallic		

		tube and its fittings air net fittings.	tubing, tubing bending and tube fittings, tube installation, non metallic tube houses, hose fittings and coupling, hose installation.		
	-Do-	Practical on pneumatic trainer.	Pneumatic Cylinders. Descriptions, double acting cylinders, two-position cylinders, cylinder construction, variations in cylinder mounting, pneumatic cylinder selection, reading the performance charts, cushioning devices.		
101	Analytical instruments	Analytical Instruments. Exercises on PH meter, conductivity meter, Online measurement of pH, conductivity and dissolved oxygen.	Analytical Instruments. Exposure to basic analytical instruments. Types of electrodes used for PH measurements. Relation of PH & mV. PH indicator and controllers. conductivity meters. dissolved oxygen meter.	Revision	Revision
102	Quality control and pollution	Quality Control & Ecological Considerations. Practical for assuring quantity products avoiding environmental pollution, preventing wastage of energy.	Quality Control. Methods to be followed for assuring quality products, conservation of energy & preventing pollution.	Revision	Revision
103		Industrial visit/tour	Ecological Consideration. Methods to be followed to avoid environmental pollution.	Revision	Revision
104	EXAMINATIONS				

Achievements Trainees will be able to:

1. Handle electronic equipments.
2. Recondition process measuring devices like pressure, temperature, level, and flow measuring instruments.
3. Recondition analog and digital meters like ammeter, voltmeter, wattmeter and energy meter.
4. Maintain process control instrumentation.
5. Handle digital control equipments.
6. Handle hydraulic and pneumatic equipments.
7. Handle analytical instruments.

## Employability Skill

The syllabus has already been approved and is same for all trades.

**LIST OF TOOLS & EQUIPMENTS REQUIRED FOR THE TRADE OF  
INSTRUMENT MECHANIC UNDER CTS**

**(FOR A BATCH OF 20 TRAINEES)**

S.No.	Item	Number
<b>Trainee's tool kit (To be purchased by trainees)</b>		
1.	Steel Rule 150 mm (metric and English Marking)	1 no each
2.	Watch maker screw driver (set of six)	1 no each
3.	Plier flat Nose 100 mm	1 no each.
4.	Hammer ball pain 250 gms. With handle	1 no each.
5.	Twiser fine point 125 mm	1 no each.
6.	File hand smooth 200 mm	1 no each.
7.	File Flat 2 <sup>nd</sup> cut 200 mm	1 no each.
8.	Screw driver set of 5 pieces	1 no each
9.	Adjustable spanner	1 no each

**Tool, Measuring Instruments & General Shop Outfit for Unit**

1.	Try square hardened blade 100 mm	4 Nos.
2.	Neon (phase) tester 230 volt	4 Nos.
3.	Eye glass 3" focus watch maker	4 Nos.
4.	Surface plate 400×400 mm	2 Nos.
5.	Universal scribing block 250 mm plier	2 Nos.
6.	Angle plate 150×100	2 Nos.
7.	Vee block with clamp pair	2 Nos.
8.	Punch frame set 2 mm	2 Nos.
9.	Hacksaw frame adjustable 200 – 300 mm	8 Nos.
10.	Hammer ball pain 450 gms, with handle	2 Nos.
11.	Electric soldering iron 6 watt pencil tip	4 Nos.
12.	Vice bench jaw 100 mm	4 Nos.
13.	Pointer extractors (puller)	4 Nos.
14.	Screw pitch gauge B.A. & metric each	1 each
15.	Punch center 100×10 mm	2 nos.
16.	Tool maker's clamps 65×15×25 mm opening	2 nos.
17.	Plier side cutting 150 mm	2 nos.
18.	Sine bar 125 mm plate	1 no.
19.	Flaring tool set	1 set
20.	Micrometer outside 0 to 25 mm	2 nos.
21.	Micrometer outside 25 to 50 mm	1 no.
22.	Vernier height gauge 300 mm	2 nos.
23.	Combination set 300 mm	1 no.
24.	Vernier caliper 150 mm	2 nos.
25.	Standard wire gauge	1 no.
26.	Feeler gauge leaf type, 26 blades, eng.& metric	1 no.
27.	Radius gauge leaf type 1 to 15 mm	1 no.
28.	Dial test indicator in mm with accessories.	1 No.
29.	Micrometer inside 25 mm with extension up to 150 mm	1 No.
30.	Combination plier heavy duty 150 mm	6 no.

31. Fire buckets	4 no.
32. Tube cutter	1 no.
33. Tube bender	1 no.
34. Pinching tool	1 no.
35. Allen key set (metric)	2 sets.
36. Allen key set ( English)	2 sets
37. Soldering station (temp. controlled)	2 nos.
38. Screw driver 200 mm	3 nos.
39. Philips screw driver 200 mm	2 sets.
40. Round nose plier 150 mm	4 nos.
41. Magnifying glass 75 mm	2 nos.
42. Slip gauges (workshop grade)	1 set

**LIST OF THE  
MECHANICAL PRECISION INSTRUMENTS**

S.No.	Item	Number
1.	Plug gauge	2 nos.
2.	Ring gauge	1 no.
3.	Snap gauge	1 no.
4.	Surface gauge	2 nos.
5.	Telescopic gauge	1 no.
6.	Vernier bevel protractor	2 nos.
7.	Dividers, 250 mm	3 nos.
8.	Gauge blocks	3 nos.
9.	Monochromatic light source	1 no.
10.	Wire type strain gauge (load cell/cantilever beam) instrument	4 nos.
		(each 2 no)
11.	Vibrometer sensing elements	3 nos.
12.	Accelomerter	2 nos.
13.	Seismic instruments	2 nos.
14.	Load cells of various ranges	2 nos.

**Rotational/velocity Instruments**

1.	Speedometers (at least four different popular make) with adopters of various sizes	1 no. each.
2.	Centrifugal type tachometer	1 nos.
3.	Drag cup type tachometer	1 nos.
4.	Electrical tachometer	1 nos.
5.	Chronometric type tachometer	1 nos.
6.	Digital type tachometer	1 no.
7.	Stroboscope	1 no.

**Precision Instruments**

1.	Digital panel meters, 4 digit	6 nos.
2.	Digital line frequency indicator	2 nos.
3.	D.C. regulated power supply (+/-15V / +/- 30V)	2 nos.
4.	Digital multi signal generator ( 1 MHz) with frequency	

counter ( 8 digit or 10 MHz)	1 no.
5. Digital function generator	1 no.
6. Pulse generator	1 no.
7. Digital insulation tester	1 no.
8. Digital multimeter	2 nos.
9. Analog multimeter	1 no.
10. Digital L.C.R. bridge	1 no.
11. Digital I.C. tester	1 no.
12. Analog CRO 30MHz	1 no.
13. Decade resistance boxes	1 no.
14. Decade capacitance boxes	1 no.
15. Decade inductance boxes	1 no.
16. Transistor tester	1 no.

### GENERAL EQUIPMENT TRAINERS FOR INSTRUMENTATION

S.No.	Item	Number
1.	Instrumentation amplifier trainer	1 no.
2.	Voltage controlled oscillator trainer	1 no.
3.	Frequency to voltage converter trainer	1 no.
4.	Voltage to frequency converter trainer	1 no.
5.	Trainers on linear circuits i.e. operational amplifiers	1 no.
6.	Trainer on basic digital electronics i.e. logic gates Boolean Expression adder subtractor flip flop counter register converter etc.	1 no.
7.	Trainers on stepper motor SCR motor servo motor UJT trigger circuit breaker, timer and alarm.	1 no.
8.	SCR driven/controlled power supply trainer	1 no.
9.	Discreet component trainer	1 no.
10.	Trainer on RS485 to RS232 converter.	1 no. each

### Electrical Instruments

1.	DC moving coil miliammeters( various ranges)	3 nos.
2.	Centre zero galvanometers	2 nos.
3.	AC moving iron type voltmeter (various ranges)	3 nos.
4.	AC moving iron type ammeter (various ranges)	3 nos.
5.	Wattmeter dynamometer type	1 no.
6.	Power factor meter	1 no.
7.	Vibrating reed frequency meter	1 no.
8.	Ampere hour meter	1 no.
9.	Ohm meter	2 nos.
10.	Potentiometer / thermocouple test set	1 no.
11.	Synchroscope	1 no.
12.	Calibration test bench for wattmeter, energy meter and power factor meter	1 no.
13.	Calibration test bench for AC and DC voltmeter, AC and DC Ammeter, ohmmeter	1 no.

### Pressure Instruments

1. "U" tube manometers	1 no.
2. Well type manometer	1 no.
3. Bourdon tube type gauges of various ranges	5 nos.
4. Capsule type pressure gauges	3 nos.
5. Aneroid barometers	2 nos.
6. Dead weight tester	1 no.
7. Pressure regulators with filter and input & output gauges	1 no.
8. Differential pressure transmitter (pneumatic)	1 no.
9. Differential pressure transmitter (electronic -HART/field bus type)	1 no.
10. Pressure transducers training kits	1 no. each
(a) Potentiometer	
(b) Capacitive	
(c) Reluctive	
(d) Strain gauge	
(e) LVDT	
(f) Load cell	
(g) Servo type	
11. Pneumatic indicating controller (PID)	2 nos.
12. Electronic pressure controller(PID)	2 nos.
13. Experimental set up for pressure measurement consisting of air compressor pressure vessel pressure transmitter controller recorder and final control element, computer i.e. closed loop system or full scope system i.e. pressure instrumentation trainer / simulator	1 no.
14. HART device communicator and calibrator	1 No.
15. Pneumatic calibrator	1 no.
16. Electronic (HART/Field bus type device compatible) calibrator	1 no.
17. Pressure switches of various ranges	4 nos.
18. Low pressure measuring gauges such as thermal conductivity gauge and meclod gauge	1 no.
19. P to I and I to P converters	1 no. each.
20. Vacuum tester with pump	1 no. each.
21. Vacuum gauge 100 mm dial bourdon tube type	1 no.

### Flow meters / Instruments

1. Simple tank type quantity meter	1 no.
2. Impeller type flow meter	1 no.
3. Below and liquid seal drum type flow meter	1 no. each.
4. Deflecting and rotating vane type flow meter	1 no. each.
5. Helical and turbine flow meter	1 no.
6. Pitot tube flow meter	1 no.
7. Orifice type flow meter	1 no.
8. Ventury tube flow meter	1 no.
9. Rotameter	1 no.
10. Magnetic flow meter	1 no.
11. Vortex flow meter	1 no.

12. flow control loop set with flow controller recorder,  
D.P. transmitter, receiver, unit control valve and impulse line, computer complete  
experimental set- up for flow measurement 1 no.
13. Experimental closed loop set up for solid flow measurement and  
Control with storage vessel, hopper, solid flow sensor, controller,  
Recorder and final control element. 1 no.
14. Coriolis mass flow meter 1 no.
15. Flow nozzle 1 no.

#### Level Instruments

1. Hook type level indicator 1 no.
2. Sight glass level indicator 1 no.
3. Float type level indicator 1 no.
4. Static pressure air purge type level indicator 1 no.
5. Level transmitter (inter face)(HART/Field bus compatible) 1 no. each
6. level control set up with level transmitters level recorder  
controller& control valve complete Experimental set up or level simulator 1 no.
7. Level measurement equipments for solid, sonic solid level, microwave, capacitance  
probes, diaphragm switches, nuclear gauge, sonic and microwave solid level detectors  
point level detector, conductivity type. 1 no. each.

#### Temperature Instruments

1. Mercury in glass thermometer (various ranges)(consumable item) 3 nos.
2. Alcohol or other liquid in glass thermometers (consumable item) 2 nos.
3. Stem and dial type bimetallic thermometer( various ranges) 2 nos.
4. Mercury in steel remote indicating thermometers 2 nos.
5. Resistance bulb Wheatstone bridge type 2 nos.
6. Thermocouple type pyrometer with milivoltmeter (with  
different types of thermocouples) 1 no.
7. Optical pyrometer with all accessories 1 no.
8. Radiation Pyrometer with all accessories 1 no.
9. Vapour pressure thermometer 2 nos.
10. Temperature transmitter, pneumatic 1 no.
11. Temperature transmitter electronic((input RTD ,TC ) 1 no.
12. Experimental set up for measuring and controlling of temperature-  
Consisting of measuring, controlling, indicating, recording and final  
controlling elements, complete closed loop system with simulator 1 no.
13. Digital calibrator, mV/mA injector and measuring unit 1 no.

### **Recorders**

1. Pneumatic and electronic recorders ( single point and multi point)  
both circular and strip chart types 1 no. each
2. Paperless LCD/LED recorder setup 1 no.

### **Controllers**

1. PID controller trainer consisting of instrument panel,  
digital computer and interface system 1 no.
2. Real PID controller training kit 1 no.
3. Process simulator based on distributed control system  
With HART/Field bus devices, consisting operations of  
feed forward, cascade, ratio controlling 1 no.
4. Programmable logic controller ( micro PLC) trainer 1 no.
5. HART/field bus communicator 1 no.
6. HART/Field devices (pressure/ flow/level) 1 no. each.
7. Multifunction process control system consisting of level, flow ,  
Temperature, pressure with remote set point control, ratio, cascade  
and feed forward with feedback loops with computer interface and  
software 1 no.

### **Final Controlling Elements**

1. Electric actuators 1 no.
2. Pneumatic and hydraulic actuators 1 no.
3. Different type of control valves such as gate valves, globe valves,  
ball valves, diaphragm valves, butterfly valves etc. eclectically actuated,  
pneumatic actuated and hydraulic actuated 1 no. each.
4. Valve petitioners, booster relays, gland pickings etc. 1 no. each.
5. Cut section models of various type of control valve 1 no. each.
6. HART/ field bus final control elements(two different type) 1 no. each

### **Equipment for Microprocessors**

1. Training kits or trainers as available on microprocessors applicable  
to process control and instrumentation and accessories 1 no.
2. Data acquisition system (DAS) 1 no.
3. ADC to DCA cards 4 nos.
4. Digital I/O cards 4 nos.

### **Computer and software**

1. Computers (latest configuration) with tables 04 No.

- (For operating various control system trainers)
- |   |        |
|---|--------|
| 2. Lap top (for convenient to field bus system/control system ) | 02 No. |
| 3. Licensed operating system (latest version)                   | 06 No. |
| 4. Latest Office (licensed version)                             | 01 No. |
| 5. LCD multimedia projector with trolley                        | 01 No. |
| 6. Broad band internet connection                               | 01 No. |
| 7. Printer (Scan/copy)  | 01 No. |
| 8. Networking tool kit  | 02 No. |

#### **Equipment on Hydraulics and pneumatics**

- |                      |       |
|----------------------|-------|
| 1. Hydraulic trainer | 1 no. |
| 2. Pneumatic trainer | 1 no. |

#### **Analytical equipments**

- |  |       |
|--|-------|
| 1. Conductivity meter  | 1 no. |
| 2. pH meter  | 1 no. |
| 3. Experimental set up for online conductivity measurement     | 1 no. |
| 4. Experimental set up for online pH measurement               | 1 no. |
| 5. Experimental set up for online dissolved oxygen measurement | 1 no. |

#### **General Installation**

- |   |       |
|---|-------|
| 1. Work benches (1800 x 900 x 900 mm)                                 | 2 no. |
| 2. Instrument test bench with cup boards                              | 4 no. |
| 3. Steel cup boards with eight lockers for trainees (100×1200×450 mm) | 4 no. |
| 4. Steel cup boards/steel almirah 1800×1200×450(with five shelves)    | 4 no. |
| 5. Steel cup boards with eight lockers for trainees (1800×1200×450mm) | 2 no. |
| 6. Fire extinguishers   | 3 no. |

SYLLABUS FOR THE TRADE OF INSTRUMENT MECHANIC  
UNDER APPRENTICESHIP TRAINING SCHEME  
Period of Training –3 years

Note: The content of the syllabus for the Apprentices during the first year and second Year training will be the same as the content of the first year and the second year Syllabus of the craftsmen Training Scheme for the trade of Instrument Mechanic.

**Third year:**

**SHOP FLOOR TRAINING (PRACTICAL)**

1. Safety precaution to be followed in the workshop/plant of the Industrial Establishment. Prevention of Accidents. Awareness on chemical Hazards.
2. Practice on using precision measuring instruments. Exercises involving mechanical measuring (Metrology).
3. Testing, calibration, using and application of various electrical measuring instruments for industrial purpose related to instrumentation including digital multimeter.
4. Fabrication of power supply units, regulated power supply unit. Testing and trouble shooting.
5. Inspecting, testing, repairing and using of signal generator and frequency generator.
6. Exercises on Flip-flops, registers, shift registers, adder, subtractor multiplexer and de-multiplexer, memory circuits in digital electronics.
7. Fabrication of digital indicating instruments, testing,
8. Exercises on microprocessors, its structure, memory devices, I/O device, and data acquisition system. Industrial application of microprocessors.
9. Testing, calibration, setting & installation of SMART & INTELLIGENT type transmitters.
10. Developing programme of a programmable logic controller.
11. Practice on commanding, controlling, fault finding and repairing of distributed control system. Details working of D.C.S.
12. Practice on working, installation and lining up of T.D.C. Application of TDC in industry.
13. Identify the various type of indicators, sensors and transmitters used in industry.
14. Practice on commanding, controlling, fault finding and repairing of field bus control system. Details working of field bus.
15. Exercises on PH meter. Testing of pH electrodes. Preparation of buffer solution. Testing, calibration and installation of PH measuring and controlling instruments.
16. Exercise on Pneumatic Dryers & Air Compressors.
17. Exercises on Hydraulic Instrumentation & its application in industry.
18. Revision.

## RELATED INSTRUCTIONS

### Trade Theory

1. Safety at work. Prevention of accidents. Observe the rules strictly.
2. Revision of basic mechanics and measuring methods.
3. Revision of 1<sup>st</sup> year, 2<sup>nd</sup> year theory topics.
4. Electrical measuring instruments including digital multimeter, preferably their application for industrial purposes.
5. Revision of various type of level indicators and transmitters used in industry.
6. Deep and detail study and application of electronics measuring devices. Integrated circuits, multi-layer PCBs, power supplies, operational amplifiers and trouble shootings.
7. Signal generator, sweep frequency generator & oscilloscopes.
8. Digital electronics, microprocessors and industrial applications.
9. Developing programmable logic controller programme.
10. Distributed process control system.
11. T.D.C (total distributed control).
12. Smart and HART devices, networking.
13. Field bus control and various international standards and vendors.
14. Analytical instrumentation used in industry.
15. Introduction to PH, PH measuring and controlling instrumentation.
16. Pneumatics and hydraulics, their rule in industrial application.
17. Industrial visits to other than the industries in which the apprentice is being worked.
18. Revision.

## EMPLOYBILITY SKILL

The syllabus has already been approved and is the same for all trades.