14

SYLLABUS FOR

INSTRUMENT MECHANIC (CHEMICAL PLANT)

UNDER

CRAFTSMEN TRAINING SCHEME

&

APPRENTICESHIP TRAINING SCHEME

As approved by

GOVERNMENT OF INDIA

In consultation with

THE NATIONAL COUNCIL FOR VOCATIONAL TRAINING

&

CENTRAL APPRENTICESHIP COUNCIL

Issued by

GOVERNMENT OF INDIA

MINISTRY OF LABOUR

DIRECTORATE GENERAL OF EMPLOYMENT & TRAINING

NEW DELHI

2002 (Revised)

Sole Publishers & Distributors of

LIST OF MEMBERS OF THE TRADE COMMITTEE MEETING FOR THE TRADE OF 'INSTRUMENT MECHANIC (CHEMICAL PLANT), UNDER CTS/ATS HELD ON 22ND DECEMBER, 1999 AT CSTARI, CALCUTTA.

S/Sri

1.	S.R. Majumdar – Director, CSTARI, Calcutta	Chairman
2.	N.K. Mongal – Addl. Director, DGET/H.Q. New Delhi	Member
3.	P.K. Kundu – Sr, Manager (Instru) Haldia Petro Chemical Ltd.	Member
4.	P. Sarkar – Reader, Deptt. of Chemical Engg. Jadavpur University	Member
5.	S. Bondhypadhyay – Reader, Deptt. of I.E. Jadavpur University	Member
6.	R.M. Sinha – Jt. Director, CSTARI, Calcutta	Member
7.	T. Mukhopadhyay, Dy. Director, CSTARI, Calcutta	Member
8.	S. Mondal – Dy. Director, DIT, W.B.	Member
9.	R.N. Bondhyopadhyay, Dy. Director, ATI, Calcutta	Member
10.	T. Selvaraju – Asstt. Director, CSTARI, Calcutta	Member
11.	S.K. Das – Asstt. Director, RDAT, Calcutta	Member
12.	V.K. Saksena – Asstt. Director, CSTARI, Calcutta	Member
13.	P.K. Koley Training. Officer, CSTARI, Calcutta	Member

GENERAL INFORMATION

Name of the Trade	:	INSTRUMENT MECHANIC (CHEMICAL PLANT)
N.C.O. Code No.	:	841:20, 841:70, 851:20
Entry Qualification	:	Passed 10th Class Examination or its equivalent with Science.
Duration of Craftsman Training	:	2 years
Duration of Apprenticeship Training	:	3 years (2 yrs. Basic Training & 1 yr. Plant/Shop floor Trainng)
Rebate	:	2 years. For Ex-ITI Trainees in the trade of Instrument Mechanic (Chemical Plant)
Ratio of Apprentices to Workers	:	1 : 3

Draft Syllabus

FOR THE TRADE OF INSTRUMENT MECHANIC (CHEMICAL PLANT) - UNDER CTS

Trade Theory	Trade Practical	Workshop Science & Calculation	Engineering Drawing
2	3	4	5
ction to Craftsman Train- orkshop safety, Training Jse of fire fighting equip- the workshop and First nportance of cleanliness ument Trade.	Familiarisation of various trades, Issue of workshop dress, hand tool & stationeries. To inculcate cleaning habit of Instruments, Calibrators, and Test Equipment in Instrument Calibration Room/ shop.	Introduction to Workshop Science and Calculation.	Introduction to Engg. Drawing Its relevance to the trade. Use of drawing board and T-square.
[ools : General tools and aterials used in the work- Hacksaw, Screw drivers, rs, Pliers, Vices, Chisel, ey set, Tweezer, Ham- :.	Demonstration & practice on cutting mild steel flat, marking of jobs. Exercise on cutting and chipping.	**Physical Chemistry** (*i*) Introduction to chemistry. (*ii*) Gas Laws. (*iii*) Introduction to ratio activity	Free-hand drawing of straight lines, rectangle, squares, circles, polygons, etc.

		• **Physics** Units and dimensions, Vernier Caliper, Spherometer, Micrometer, Screw gauge, Scalar & Vector quantities, their representation, resultant parallelogram and triangle of vector. • **Mathematics** Solution of Ist & IInd order equations with one or two unknowns algebraic calculations and by Graphs.	
lassification types, magrade of file, marking teel rule, Tri-square, V-Caliper, their uses, care intenance.	Filling: Surfaces, sides, exercise with accuracy up to 0.05 mm. Use of different files-Flat, Round, Half round, Triangular, Square.	(*i*) Atomic structure (*ii*) Classification of elements. • **Physics :** Rest and Motion equation of motion under gravity in a circle with constant angular velocity and acceleration, work, power, Energy.	Free-hand sketches: Simple solid such as cube, cylinder & cones, rectangular blocks etc. and their view when viewed perpendicular to their base or axis.

2	3	4	5
		Mathematics Solution of Ist & IInd order equations with one or two unknown algebraic calculations and by graphs.	
Classification, Types, and al of construction, methuse. **s and Dies**: Types of s, their applications.	Simple exercise of drilling & tapping counter sunk.	Calculation of hole size for drilling and Tapping. **Physics** S.H.M., Rotational motion, moment of inertia, Simple machines.	Use of Set square & other drawing instruments. Reading of Simple Blue Prints.
Drivers, Pliers, Spanners, classification, materials recautions while using	Using proper screw drivers, tighten, open and practice to remove damaged screws.	(*i*) Law of mass action (*ii*) Gas Laws (*iii*) Introduction to radio activity •**Physics** Static and Kinetic friction, their measurement, Elasti-city, Stress, Strain Hook's Law, Determination of Young's modules.	Free-hand sketches of Hand Tools, Screw drivers, Plier, Spanner, Tweezer.
ion Measuring Instru-	Measurement by Vernier Caliper,	• **Physical Chemistry**	Free-hand sketches of Ver-

1	2	3	4	5
	ments: Vernier Caliper, Micrometer, Depth Gauge, Bevel Protractor, Dial Test Indicator, Their principle of measurement, care and maintenance.	Micrometers, Depth Gauge, Bevel protractor, Dial Test Indicator etc.	Surface energy, surface Tension, Angle of contact.	nier Caliper, micrometer, Depth Gauge, Dial Test Indicator, Bevel protractor.
8&9	**Pipes:** Grade, materials of different types of pipes. Use of T-bend, Elbow, Reducer, Coupler, different types of valves, Leakages in pipes joints. Procedure for cold and hot bending Non-Ferrous pipes, Method of bending flaring cutting of copper, aluminum tubes, Sand filled tube bending, compression fitting.	Threading on pipes, Simple pipe joints by using T-bend, Elbow, Reducer, Coupler bending of pipes, Sealing of pipe joint. Practice on cutting, flaring, bending of copper, aluminum pipes, Practice ERMETO & compression fittings.	Metallurgy of iron pipe, its corrosion and treatment. Metallurgy of non-ferrous pipes their anticorrosive treatment.	Free-hand sketch of pipe, its sectional views etc. Free-hand sketch on pipe, and its loops, layout etc.
10	**Introduction to Lathe:** The principle features & main parts of lathe, Tools for dif-	Identification of various parts of lathe, Familiarisation of precision watchmaker's lathe, Fixing of		Free-hand sketch of lathe

1	2	3	4	5
	ferent operations, steps and method of turning. Care and maintenance.	tools, and jobs on lathe, Simple Exercises of plain, step turning. Checking of tool angle.	Metallurgy of Ferrous metals.	and various lathe tools.
11& 12	Procedure of taper turning & boring	Exercises on taper turning and boring.	Calculation of taper angle • **Physics** Hygrometer	Writing single stroke letters & nos. IS : 696-1972 (Rev.)
13 & 14	Different type of threads including NTP methods of thread cutting, Need of cutting fluids. Precaution to be observed.	Turning practice upto accuracy 0.2 mm. Exercises on thread cutting.	Calculation of Gear train for thread cutting **Mathematics** Area of solid surface.	Geometrical construction of lines, angles & triangles.
15	Introduction to Precision Watchmaker's Lathe, Different accessories of Watchmaker Lathe, Its care & maintenance.	Practice on making small parts of Instruments, e.g. Nozzle, Cam etc.	Preparation and properties of Sodium hydroxide and carbonate. • **Physics** Mode of heat transfer, Thermal conductivity and its determination	Geometrical construction of parabola, hyperbola, spiral, etc.
16	**Introduction to Engraving Machine:** Its Pentograph and other parts, letters, numbers, ratio etc.	Operation of Engraving Machine, using suitable size of letters, numbers with adjustment, size and ratio.	Allotropy of hydrogen, carbon, phosphorous and sulfur. • **Physics** Dispersion, Spectrophotometer polarisation.	Different types of lines used in Engineering drawing IS : 969-1972 (Rev)

ring, Brazing & Crimp- Definition to Soldering, ıg & crimping. The Sol- ; station with temperature ɔl.	Simple Soft Soldering practice joining various electrical components, wires, and temperature controlled. Soldering Station. Importance of tinning, Crimping & Precautions.	Manufacturing process of HNO_3, NH_3, HCl and H_2SO_4. • **Physics** (*i*) Preparation, properties and uses of Aluminum Chloride, Potassium Ferro & ferricyanides, bleaching powder, V_2O_5 Glass and Ink. (*ii*) Fuels • **Mathematics** Volume of solids like cube, sphere, prism, cone etc.	Isometric views solid and hollow objects. Orthographic view of simple objects by Ist Angle projection.
ɔsion: Definition, Differ- between corrosion & on, Prevention of Corro- ɔuring of coroded parts.	To study the properties of mixtures (FeS) and compounds (FeS). To study action of pure and salt water on metal and alloys. To study action of acids and bases on metals and alloys. To study corrosion of metals.	Alipathic hydrocarbons-saturated and unsaturated. • **Physics:** corrosion • **Mathematics:** Trigonometry-study of sine, cosine, tangent of angles in a right-angled triangle and application in solving practical problems.	Drawing of orthographic views of simple solid and hollow objects.

2	3	4	5
STRIAL VISIT ıre Measuring Instruments: tion of pressure, Barometssure, Gauge Pressure, Difıal Pressure, Absolute Presheir units. Different type of ıre measuring Instruments, ıeters, Barometers.	Dismalt the pressure Gauge, Testing of Pressure indicators with Standard Calibrator/Dead weight Tester, Precaution to be observed while testing.	(*i*) Alcohols & Acids (*ii*) Halogen Compound of aliphatic (*iii*) Aliphatic aldephydes & ketones • **Physics:** Acids & Alkali, Determination of pH, flash point. Barometer, Atmospheric Pressure, Absolute Pressure. • **Physics:** Tangent Magnetometer, Dip Circle, application of magnets. Charles Law and Boils Law, Preparation of Barograph, error cards.	Free-hand sketch on chemical laboratory apparatus.ISI symbols of pressure Gauges/Indicators. ISI symbols for pressure, Recorders.
ıction and principle of operavarious pressure gauges. Imporf Callibration in Metrology.	Dismantle the pressure gauge and study the construction, adjustments for correct functioning.	(*i*) Ethers and Esters. (*ii*) Carbohydrates.	ISI symbols of pressure indicator cum-Recorder.
ound pressure gauges:Its	Calibration of compound pressure gauges Calibration of Absolute	**Mathematics:** Trigonometry; sine, Cosec of	ISI symbols of pressure indicator cum-Recorder.

ıction, uses Principle of on, construction of Ab-Pressure Gauge Aneroid eter.	pressure Gauge Calibration of Aneroid Altimeter.	angles in a right angled triangle.	
rement of Temperature: **Expansion** Type-Mer-glass thermometer, steel meters, Alcohol in glass meter. **Expansion** Type-Bimetal-mometers. Pressure thermometers.	Carrying out serviceability checks on Temperature Gauges, their routine maintenance, Calibration of expansion thermometers.	Heat Energy-Temperature, units scales/graduations etc. Co-efficient of expansion of solids, liquids and gases.	ISI symbol of temperature indicators.
ıcouple & RTD Thermistor, ıges, construction, principle ation, compensating leads, ers etc.	Calibration, maintenance & reconditioning, Thermocouple pyrometers. Recorders.	Seebek's theory.	Free-hand sketch of Temperature indicator, Recorder.
l Level Measurement ıction to measurement of The principle of operase and construction of	Study construction of Hook type, Sight glass and Float type level measuring instruments of close and open tank. Static pressure level	(*i*) Introduction to aromatic compounds. (*ii*) Benzene and its derivatives.	Free-hand sketch of level measuring instruments.

2	3	4	5
ype, Sight glass type, cy type level indicator and open tank.	measuring instruments, Bubbler system for close and open tank.		
nic Level Measuring ent: Variable capaci-gh and low level alarm/ Ultrasonic and Mag-pe level indicators, ice.	Differential pressure type level m/s check calibration of Electronic Level Indicators, Ultrasonic and admittance type level indicators.	• **Mathematics:** Problems on measurement of liquid quantity by change in height of liquid.	ISI symbols of level measuring instruments.
ment Fluid Flow: lements used for rate of surement, Rotameters.	Study of office plates, Flow nozzles, Pitot tubes, Venturi heads, Their shape and connections etc.	Bernoulli's Theorem: Problems on differential flow measurement using orifices.	Free-hand sketches of various Orifices, Nozzles, Venturi tubes.
Flow Measurement tric type, Gas flow gnetic flow meter.	Study of Oscillating piston type, Rotating vane meter, Nutating disc meter.	• **Mathematics** (*i*) Problems on flow of fluid. (*ii*) Preparation of Oxalic acid.	Free-hand sketches of Gas and water flow meter.
lectricity: Electri-chemical method rimary cell, Storage	Study on cells connected in series, parallel as well as in combination, Determination of currents,	Electrolytes of cell-primary, secondary and Rechargeable battery-their chemical actions.	Orthographic views of Primary, Secondary, Rechargeable battery pack. *Mathematics: Logarithms.

, Lead acid cell, Al- ɔell, Lithium cell etc.	Voltages by Kirchhoff's Law, Determination of specific Resistance using Whetstone's Bridge.	• **Physics** Heating effect of electric current.	Circuit diagrams showing ISI symbols of electrical components.
's Law of Electrolysis: ıtion, Objective, Proce-	Verification of Faraday's first law of Electrolysis. Precautions to be observed in performig experiments. Determination of mechanical equivalent of heat.	• **Physics:** Current electricity by chemical reaction, Cell's magnetic effect of current.	
tion of electricity by tic effect-Principle of ors, AC & DC supplies, f Electricity.	Connections of Simple circuits using Ammeter, Voltmeter, Wattmeter with electrical components in series, parallel and combinations.	Ohm's law. Kirchhoff's Law.	ISI symbols of Generator, Voltmeter, Ammeter, Wattmeter.
nce : Type of resistors, aterials, colour code and **ınce :**Self, Mutual Induc- ductors, Tranformers, **tance :** Type of capacitors, its tion, values, and their uses.	Verification of Ohm's Law, Kirchhoff's law, precaution to be observed while experimenting the laws, Construct of circuits with choke, transformer, relay. capacitor etc.	Inductive Reactance: Calculation of XL, Capacitive Reactance: XE Impedance(Z) Tranformer Ratio.	ISI symbols of Resister, inductor, Capacitor, Transformer etc.

2	3	4	5
ple of Motor: AC and DC s, type and uses in chemi- ants.	Study to construction of motor valves, recorder-motors used in chemical plants-their adjustments and maintenance.	Power factor and its calculations.	Freehand sketches of AC & DC motors.
ıg Coil Instruments: Am- voltmeter, Ohm meter uction, range, sensitivity, ıcy, damping etc.	Measuring of current, voltage in the circuit construct, making of elect. bell, Alarm, power circuits.	Calculation of power factor.	Orthographic views of Ammeter, Voltmeter.
ıg Iron Instrument, ıometer, Wattmeter, Meger, meter-their Principle of ion & Construction.	Use of electrical meters in measuring and their care and maintenance.	Calculation power with the current Voltage measured.	ISI symbols of Ammeter, Voltmeter, Wattmeter, Megger, KWh-meter etc.
ple, operation and con- ion of Electrical Test ment-Multimeter, LCR- , Whetstone's Bridge.	Use of electrical test equipments *e.g.* for measuring the current, voltage etc.	Damping, Accuracy.	Freehand sketches of Multimeter.
on & Test			
uction to Semiconductor es: Semiconductor mate- ntrinsic&Extrinsic, P-	Study the characteristics of conductor, semiconductor & Insulator.	Pressure regulator and steam traps.	Drawing of pressure control process line.

1	2	3	4	5
	type & N-type materials, charge carriers.			
51 & 52	P-N Junction, Depletion zone, Barrier voltage, Diodes, LED, LCD, Zener,.SCRs, DIAC-their application, uses and care.	Making of DC power supply, smooth and regulated output.	Process flow line: pipes their materials, sizes etc. Carryout serviceability checks on DC power supply of Instruments.	Drawing of fluid flow, ISI symbols of Diodes in circuit drawings.
53 & 54	**Bipolar Transistors:** PNP, NPN, types-amplifier circuits, classification, Biasing, coulping, FET, UJT, MOSFET.	Practice on making transistorised amplifiers by soldering on veroboard.	Reciprocating compressors checking for current functioning, carry out functional checks on transisterised Instruments.	Drawing of process flow system, ISI symbols of Transistors used in circuit drawings.
55 & 56	**Binary and Hexadecimal systems:** Logic gates, Circuits, Truth Tables, Boolean Algebra.	Experiments on Logic Gates : AND, NAND, OR, NOR, XNOR using Digital IC-Trainer, Preparation of truth table.	Manufacturing process, Flow sheet of Caustic Soda, Chlorine, Conversion from Hexadecimal to Binary.	ISI symbols of Logic Gates.
57 & 58	**Introduction to Integrated Circuits:** Timer IC, OPAMP, etc. their functions, ICs used in various Instruments.	Experiments on IC 555/IC 556, IC 747 with IC-Trainer.	Types of heat Exchanger, double pipes, Shell & Tube heat Exchanger.	Block diagrams of ICs.

1	2	3	4	5
59 & 60	**Digital ICs, Microprocessor:** Arithmetic Logic unit, Memory, CPU, ROM, RAM, EPROM, etc.	Study of Digital ICs on digital trainer Kit, conversion of Analog to Digital, Digital to Analog.	Steam ejectors, Rotary Vaccuum pump, Centrifugal pump etc.	Designing of PCBs.
61 & 62	**Operational Amplifiers** and their use in Instrumentation, Principle, operation & function of CRT.	Using OP-Amp circuits of Astable, Monstable, Bistable multivibrators, Study by Oscilloscope.	Introcution to Film Co-efficient and over all film co-efficient on Heat Transfer.	Freehand sketches on process instrument.
63	**Application of ICs** in various instruments, Recorders and controllers.	Study and identify various ICs. used in PCBs of different instruments.	Indirect fired Rotary Kiln.	Drawing of pressure, Level flow and temperature control system.
64	Construction of Electronic Industrial controls : ON-OFF controller, Level control, Time control, Photo-control, Fire detecting circuits etc.	Working in PCBs on different circuits, mounting of components, Precautions to be observed while soldering sensitive components on PCBs.	Direct fired Rotary kiln.	Isometric views of ICs and other components on PCB
65	**Recorders:** Mechanical Recorders-pens, charts, inks etc. Principle of operations, recording systems, time travels.	Calibration of mechanical recorders, adjustment of time travels, changing of charts, ink, minor rectification/repairing. Find out errors and adjust.	Manufacturing process and flow sheet of sulfuric acid.	Freehand sketches of mechanical Recorder, its ISI symbol.

ctrical & Electronic Re- s-principle of operations, ing system, chart motor, en, moving element etc. ing and Dot systems, and Adjustment.	Check Calibrate the Elect/Electronic controller for its correct functioning, study its construction for minor rectification, changing of charts, Cleaning of pens, Adjustments of error, if any.	Introduction to Evaporation, Types of evaporators.	Free-hand sketch of Elect-Electronic Recorder, its ISI symbol.
of Integrating system in ing processes variables, pens recorder and cam ements.	Reconditioning of Strip Chart & Circular chart recorders.	Forced circulation evaporator, multiple-effect evaporator.	Free-hand sketches on multiple-pens recorders.
iometric type recorders: ens obtentiometric type er.	Providing different type of recorders trainees to check calibrate individually.	Instrumentation of an evaporator.	Free-hand sketch of potentiometric type recorder.
etering: Telemetering in control, types of transmit- nciple of construction of dif- ressure Transmitters.	Study construction of DP Transmitter pneumatic type, Calibration of DP Cell (Pneumatic) its range charging, Zero adjustment etc.	Manufacturing process and flow sheet of Soda Ash.	Free-hand sketch of DP Transmitter (Pneumatic).
ple, Construction of Elec- DP Transmitter, methods bration and procedure of	Reconditioning of DP Cell, replacement of parts, adjustment and calibration.	Distillation, Introduction, Process.	Layout diagram, connection of DP cell (Electronic).

2	3	4	5
ment of errors.			
ple, Construction, opera- f Temperature Transmit- neumatic).	Calibration of temperature Transmitter, and its adjustments.	Boiling point diagram.	Free-hand sketch of Converters.
erters: Principle, Con- on, operation of current , and pressure to current erters.	Reconditioning and Calibration of current to air and pressure to current converters.	Raoult's Law, Henry's Law and equilibrium curve.	Free-hand sketch of converter.
ple of operation, construc- nd necessity of E.M.F. to t converters, Range adjust- etc.	Reconditioning of E.M.F. to current, current converters and its calibration.	Relative volatility, method of distillation.	Process layout diagram showing converters and other items.
anical type Differential ire Transmitter-Principle, uction, operation.		Rectification, types of distillation columns.	Process diagram PI controllers.
, Tubing connections of Erection of different types nsmitters.	Reconditioning and calibration of DPT converters etc.	Distillation column of process.	Diagram of PID process.
oller's:(Analog & Digital) loop, Closed loop, Feed	Study the construction, Identification of components of ON-OFF	Absorption: Introduction, Equilibrium, Mass transfer	Cascade control system.

2	3	4	5
c control system, Modes of rol system, ON-OFF control em, its operation, function, dvantages.	type controller, Testing and Calibration of ON-OFF type control system of pneumatic, and electronic pressure, Temperature etc.	co-efficient, factor effecting rate of absorption, flooding velocity.	
portional Controller: Prin- of construction, operation, portional Band-Setting, stment.	Check calibration of proportional controller, reconditioning, adjustment, setting of proportional Band.	Different type of absorption columns.	Instrumentation diagram of distillation columns.
portional with Rest action, t of reset, rate of propor- l action.	Setting of restime, proportional Band, Check calibration of controller.	Petroleum Refining.	Instrumentation diagram of PI control system.
rol Lag, Step and Frequency nse, Derivative action of controller.	Observe the step response, frequency response, Lag on PID controller using Simulator.	Extraction : Application of Liquid extraction, theory definitions, choice of solvent.	Instrumentation diagram of distillation columns, evaporator of PID control.
iple of Electronic control- study of circuit diagram, onents, method of calibra-	Repair/Reconditioning of Electronic controllers, Testing and calibration of PID controllers.	Mixer settler extractor, Spray tower.	Process diagram of Heat exchanger of PID.
l control element valve: e valve, Diaphragm valve-	Dismantling, reconditioning, checking and resetting of dia-	Leaching: Introduction and applications.	Instrumentation diagram of Drier, Control valve. Instru-

2	3	4	5
action, parts, sealing, range, ation etc. **control valves:** Types, Split single sealed, double sealed, rfly, Ratio valves etc. **onic control valve:** Type of used for acid and corrosive s. Principle of construction, tion of valve-positioner, its Procedure of calibration.	phragm control valves, calibration of diaphragm control valve. Leak test, Replacement of valve parts like diaphragm, sealing materials, Sealing rings, plugs etc. Griding/Lapping of valve seats, Plug leakage test, calibration of valves, Erection of valve positioner.	Manufacturing process and flow sheet of pulp and paper.	mentation for pump, ejectors, and symbols for electronic equipments.
JSTRIAL VISIT			
rical Instruments: Princi- Construction & function of anent magnet Moving coil s, Ammeters, voltmeters used & DC Principle, Construc- & function of moving coil rs & Digital meters.	Reconditioning of Ammeter Voltmeter, check calibration of PMMC and MI meters with the calibrators.	Drying: Introduction to water vapour pressure curve for water, relative humidity, moisture.	Circuit drawing and layout of calibration of Elect. Meters.
iple, construction and tion of wattmeters, Power r Meters, Energy Meter, gy Meters & KWH meters.	Calibration of Energy Meter, Watt Meter etc. Handling and care.	Rotary drier, Spray drier.	Drawing of Electrical Test circuit of different meters.

1	2	3	4	5
96&97	Optical Instruments: Principle, construction & operation of Binocular, Telescopes, Microscopes.	Reconditioning of different types of Microscope, Telescope, Binocular, Check for correct functioning in moisture and humidity.	Rotary drier, Spray drier.	Free-hand sketch of optical instruments.
98	**Laboratory Instruments:** Principle accessories, operation of Industrial Appliances Analytical balance, Air Damping balances, Automatic Recording, (Self registering balance). Moisture Determination Balance Principle, accessories, operations, function and industrial application of the apparatus.	Practice to use properly- 1. Balances Sedimentation and Decantation. 2. Dorr Thicker. 3. Moisture & Humidity Manufacturing process of paints varnish.	Sedimentation and Decantation, Dorr thicker.	Free-hand sketch of Analytical Balances.
99	Principle, accessories, Function industrial application of the apparatus. Principle, accessories, Function industrial application of the apparatus.	Use Care & Maintenance (*i*) Surface Tension (*ii*) Viscometer (*iii*) Pynometer (*iv*) Microscope (*v*) Potentiometer (*vi*) Conductometer (*vii*) pH-meter (*viii*) Polargraph	Manufacturing of Glass. Centrifugation: Top driven centrifuge.	Diagram of pyrometer. Circuit of Potentiometer.

1	2	3	4	5
100	Principle, accessories, Function industrial application of the apparatus.	(*i*) Calorimeter, (*ii*) Spectrometer, (*iii*) Photo calorimeter, (*iv*) flame photometer.	Centrifugation: Top driven centrifuge.	Circuit of Potentiometer.
101	Principle, accessories, Function industrial application of the apparatus.	(*i*) Refractometer, (*ii*) Polarimeter, (*iii*) Apparatus for Electrophoresis.	Manufacturing process and flow sheet of cement.	Circuit of Potentiometer.
102 to 104	**REVISION AND EXAMINATION**			

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

INSTRUMENT MECHANIC (CHEMICAL PLANT)
General Installations

CLASS ROOM-CUM-INSTRUMENT SHOP

1.	Chalk Board green with sliding sunmica, 3′ - 6″ × 3′ – 0″	01
2.	Desk with sunmica top	01
3.	Chair with Full Table, for training	18
4.	Overhead Projector 3-element lens Twin lamp 2500 lumen.	01
5.	Slide Projector, AF-Remote	01
6.	Colour Monitor, CTv., PAL. With Audio Video IN & OUT	01
7.	VCR, PAL with Audio Video IN & OUT	01
8.	Table Lamps Sodium Vapor, 9/18 watt, 230 volts	16
9.	Voltage Stabilizer Servo-control 5KVA	01
10.	Linear IC-Tester	02
11.	Digital IC-Tester	02
12.	Semiconductor Test set	02
13.	Air Compressor	01
14.	Vacuum Chamber	01
15.	Vacuum Pump	01

SHOP INSTALLATION (MACHINES)

1.	Drill power 3/8″ precision, bench type motorised	01
2.	Grinder double ended bench 7″ high revolution motorised	01
3.	Engraving Machine model, complete with accessories and two sets of master numbers & alphabets	01
4.	Buffing Machine, 36” Spindle	01
5.	Electric Furnace, Twin Chamber	01
6.	Precision Centre Lathe 9′ × 3′ including bed, accessories motorised	02
7.	Instrument Testing Bench with cupboards	08
8.	Bench working 6′ × 3′ × 2.5′ ×	03
9.	Bench working metal top 6′ × 3′ × 2.5′	01
10.	Steel Cupboards 6′ × 3′ × 1.5′	06
11.	Toll Kit Boxes for trainees (steel lockers)	16
12.	Milling Machine Universal (Smallest) with accessories	01

LIST OF TOOLS AND EQUIPMENT FOR A BACH OR UNIT OF 16 TRAINEES

TRADE : INSTRUMENT MECHANIC (CHEMICAL PLANT)

Tools, equipment etc.—wherever size shown in F.P.S. units are to be procured in metric sizes.

Sl. No.	NOMENCLATURE	QTY.

TRAINEES' KIT

1.	Steel Rule flexible 15 cm.	16
2.	Spring Calliper Outside 10 cm.	16
3.	Punch center knurled 10 cm	16
4.	Screw driver set of six, Watchmaker's	16
5.	Screw driver set of five, electrician	16
6.	Plier combination 12 cm.	16
7.	Plier long nose, 10 cm.	16
8.	Nipper side cutting 10 cm.	16
9.	Chisel cold flat 10 cm.	16
10.	Hammer Ball Pain with handle ¼ Ib	16
11.	Tweezer fine point stainless steel 12 cm.	16
12.	Tweezer pivot straighting 12 cm.	16
13.	Tweezer bent point 12 cm.	16
14.	File Half round smooth 12 cm.	16
15.	File hand safe second cut 25 cm.	16
16.	File hand safe smooth 15 cm.	16
17.	File round second cut 15 cm.	16
18.	File triangular cut 10 cm.	16
19.	File square cut 10 cm.	16
20.	Hand vice 10 cm.	16
21.	Scriber 4″ × 3/16 balls end/100 × 5 cm.	16

MEASURING INSTRUMENTS, TOOLS & GENERAL SHOP OUTFIT FOR THE UNIT

1.	Try square with hardened blade 10 cm.	04
2.	Spring Divider 10 cm.	05
3.	Spring Calliper 10 cm	04
4.	Plier side cutting insulated 15 cm.	08
5.	Plier Round Nose 10 cm.	06
6.	Plier snip nose 10 cm.	08
7.	Neon Phase/Line Tester 500 Volts	08
8.	File swiss precision assorted set of 12 Nos.	08
9.	File Feather edge smooth 4″/10 cm.	08

10.	Eye glass 3″ focus, watch-maker 7.5	08
11.	Goggles safety	08
12.	File Bastared, 12″/30 cm.	08
13.	Punch pin 4″ × 3/32″ × 1/8″ or 100 × 2.5 × 3 mm	04
14.	Oil stone triangular 3/8″ × 4″ or 10 × 100 mm.	04
15.	Oil can miogate, pressure delivery	02
16.	Surface, plate 30 × 30 cm.	02
17.	Universial Scribing block 9″ Pillar or 225 mm.	02
18.	V-Block with clamps pair	02
19.	Punch letter set 2 mm.	02
20.	Punch number set 2 mm.	02
21.	Hacksaw frame, adjustable 8″ — 12″/20 cm — 30 cm.	08
22.	Hand drilling machine, motorised 230 V	04
23.	Chisel Cold Flat 4″	04
24.	Chisel Diamond point cold 4″	04
25.	Chisel cross cut 4″	04
26.	Chisel cold round 4″	04
27.	Drill Twist S.S 0-60	01 set
28.	Drill Twist S.S.A-Z	01 set
29.	Taps & Dies (B.A. 0-10)	01 set
30.	Hammer Ball Pen 1.5 ibs. with handle	04
31.	Sprit Level metal 4″/10mm.	02
32.	Cover Glass (Inverted 'U')	08
33.	Soldering Iron 65 watt 230 volts	04
34.	Soldering Iron 125 watt 230 volts	02
35.	Soldering Iron 10 watt 230 volts	04
36.	Screw Driver 8″ Heavy Duty	08
37.	Hot plate single 1000 watt 230/250 volts	02
38.	Scrapper Half-round 4″/10 cm.	04
39.	Scrapper triangular 4″/10 cm.	04
40.	Anvil bench type 13 kg.	02
41.	Vice bench, Jaw 3″/7.5 cm.	12
42.	Vice swivelled base, jaw 4″/10 cm.	04
43.	Vice hand, jaw 1″/2. 5 cm.	08
44.	Vice pipe, jaw 4″/10 cm.	01
45.	Chamois leather 12″ × 12″/30 cm. × 30 cm.	04
46.	Gravers set of six	02 sets
47.	Adaptor morse 1/4″ to 1/2″ set of four	01 set
48.	Chuck lathe dog 6″/15 cm.	04
49.	Chuck lathe self centering 6″/15 cm.	04
50.	Chuck drilling machine, 1/16″-1/4″ cap.	01
51.	Chuck drilling machine, 1/16″-1/4″ cap.	01
52.	Pointer Extractor, Stainless steel fine	12
53.	Glass Dessicators with dessicant	08

54.	Screw Ritch Gauge, B.A. W.W. and metric	01 each type
55.	Vice drilling machine, 4″/100 mm.	01
56.	Hacksaw Midget, 6″/15 cm.	12
57.	Reamers parallel, 1/16″ to 1/4″ by 1/32″ set of 7	02 sets
58.	Broaches, 0 to 90	01 set
59.	Blow Lamps 1 pt. paraffin	02
60.	Center Lathe running tail stock	02
61.	Counter sink 1/4″ dia. 1/4″ shank 60 degree × 90 degree	02
62.	Counter sink 1/16″ dia. 1/2″ shank 0 degree × 90 degree	02
63.	Counter sink 3/16″ dia. 1/2″ shank 90 degree	01
64.	Cutter milling machine side and face, 3″ × 1/4″, 3″ × 5/16″, 3″×3/8″	02
65.	Plier Gas 6″/15 cm.	01
66.	Spanner double ended open B.S.F. 1/4″ × 5/16″	12 each
67.	Spanner, adjustable 11″/22.5 cm.	01
68.	Spanner adjustable, 4″/10 cm.	01
69.	Tools Knurling, revolving head three pairs of wheels for fine medium course with one set of spare wheels	02 sets
70.	Flaring tool kit up to 20 mm.	01
71.	Taps threading hand, B.S.W. 1/2″ set of 3, 1st, 2nd and 3rd. -with Tap wrench	02 sets
72.	Taps threading hand, Metric 5, 6, 8, 10 mm. in set of 3, 1st, 2nd and 3rd. -with Tap wrench	02 sets

Precision Measuring Instruments

01.	Micrometer Outside, 0-20 mm.	01
02.	Micrometer Outside, 0-25 mm.	04
03.	Micrometer Outside, 25-50 mm.	01
04.	Micrometer vernier, 0″-1″	01
05.	Micrometer inside with extension rods, 50-210 mm.	01
06.	Micrometer Depth, 0″-1″	01
07.	Vernier Caliper, 6″/15 cm.	01
08.	Vernier Height Gauge, with Inches 12″ or Metric 300 mm. graduations	01
09.	Vernier Bevel Protractor, with acute attachments	01
10.	Combination set 12″/30 cm.	02
11.	Standard Wire Gauge	04
12.	Dial Test Indicator in mm. with accessories	02
13.	Feeler Gauge leaf type, 0.0015″ to 0.025″	01
14.	Radius Gauge, leaf type 1mm. to 15 mm.	01

ELECTRICAL INSTRUMENTS

01.	Moving coil Voltmeters (various ranges)	04 each
02.	Moving coil Ammeters (various ranges)	04 each
03.	Moving Milliammeters (various ranges)	04 each
04.	Moving Millivoltmeters (various ranges)	04 each
05.	Galvanometer, centre-zero indicating	01 no.
06.	Moving iron AC-Voltmeters, various ranges	04 each
07.	Moving Iron AC-Ammeters, various ranges	04 each
08.	Voltmeter Dynamometer type AC & DC	02 nos.
09.	Ammeter-Dynamometer induction type, AC & DC	02
10.	Wattmeter dynamometer type	01
11.	Power factor meter	01
12.	Hot wire instruments	01
13.	Clamp on AC-Ammeter	01
14.	Ohmmeters multi-ranges	01
15.	Insulation testers (Megger), 500 volts	01
16.	Watt-hour meter	04
17.	Frequency meter, Vibrating reed type	01
18.	Ampere-hour meter	02
19.	Multimeter (AVO)	02
20.	Calibration for Ammeters, Voltmeters, Ohmmeters	01
21.	Calibration for Wattmeters, Energy meters	01
22.	Bridge for Resistance, Capacitance, Inductance	01
23.	Workshop Potentiometer, with Galvo. & std. Cell	01
24.	Regulated power supply with variable DC source	01
25.	Servo operated AC-Voltage Stabiliser, 10 KVA	01

HUMIDITY INSTRUMENTS

1.	Hair Hygrometer	02
2.	Wet & Dry bulb Thermometer Type Hygrometer	02
3.	Sling Psyorometer	02

PRESSURE INSTRUMENTS

1.	Manometer, U-tube	01
2.	Manometer, Inclined tube	01
3.	Manometer, well type	01
4.	Barometer Mercury	01
5.	Barometer Aneroid capsule	01
6.	Gas pressure regulator	02
7.	Pressure Indicator Bourden type, various ranges	16
8.	Pressure Gauge Capsule type, various ranges	16
9.	Pressure Indicator Bellows tube, various ranges	16
10.	Dead Weight Tester, with accessories	01

FLUID FLOW METER

1.	Quantity Flow meter, simple tank type	02
2.	Reciprocating piston type flow meter	04
3.	Flow meter impeller type	04
4.	Bellows type Gas flow meter	02
5.	Magnetic flow meter	02
6.	Orifice type differential flow meter	02
7.	Ventury tube differential flow meter	02
8.	Nozzle type differential flow meter	02
9.	Pitot tube differential flow meter	02
10.	Taper tube Rotameter	02

LEVEL INSTRUMENT

1.	Sight Glass Level Indicator	02
2.	Hook type Level Indicator	02
3.	Float type Level Indicator	02
4.	Static pressure and air purge Level Indicator	01
5.	Show piece Ultra-sonic Level Indicator	01
6.	Variable Capacitance type Level Indicator	01

TEMPERATURE INSTRUMENTS

1.	Mercury-in-Glass Thermometers (various ranges)	06
2.	Alcohol or other liquid in glass Thermometers	02
3.	Mercury in Steel Thermometers, Remote Indicating	02
4.	Vapour pressure Thermometers	02
5.	Bi-Metal thermometers, stem & dial (various ranges)	04
6.	RTD Resistance-bulb Wheatstone Bridge Thermometers	02
7.	Thermo-couple Pyrometers (with different thermocouple)	10
8.	Termo-couple with milli-volt-potentiometer pyrometer	02
9.	Optical Pyrometer	01
10.	Standard Tungsten strip filament lamp for calibration of optical pyrometer	02
11.	Radiation Pyrometer	01

ROTATIONAL SPEED & CIRCULAR VELOCITY INSTRUMENTS

1.	Speedometer (four different popular make)	04 each
2.	Techometer Centrifugal	02
3.	Techometer Drag-cup type	02
4.	Techometer Electrical, Synchronous	02
5.	Stroboscope	01
6.	RPM-Tester/Techo. Tester	01

RECORDERS AND CONTROLLERS

1.	Circular Charts Recorder (Potentiometer type)	02
2.	Strip Charts Recorder (Potentiometer type)	02
3.	Secondary devices for measurement of Temperature, pressure level and flow for above recorders	02 each
4.	2-Position controller (ON-OFF type)	02
5.	Proportional Controller	02
6.	Proportional with RESET type Electronic Controller	02
7.	Pneumatic controllers for pressure, Flow, Temperature, and Level with associated equipment	02 each
8.	Transmitters, Pneumatic, Hydraulic and Electronic for above mentioned controllers, recorders, Process Simulator	02 each

GENERAL ITEMS : UPS, Computers (Latest Configuration) with process software, Printer.

1.	Bench Lamps 20 watt halozen 230 Volts, Philips/GEC/OSRAM	16
2.	Vacuum Lamp with accessories	01
3.	IC-Tester Linear with accessories	02
4.	IC-Tester Digital with accessories	02
5.	Hydrometer	02
6.	Soldering Gun	04
7.	De-Soldering Gun	04
8.	Vacuum Cleaner with accessories	01
9.	Thermo-Couple welders	01
10.	Air compressor with accessories	01
11.	Sensitive Balance with weight and cover	01
12.	Servo-operated Voltage Stabilizer 10 KVA and UPS (1 KVA)	01
13.	Colour Monitor/TV with Audio-Video IN & OUT	01
14.	VCR/VTR with accessories PAL/MSECAM	01
15.	Educational Video Cassettes on Instrumentation	02 sets
16.	Tool Kit Boxes for trainees, steel lockers	16
17.	Over Head Projectors with 3-Element Lens, 2500 Lumen	01
18.	Fire Extinguisher, Soda-Acid, CTC	01
19.	First Aid Box	01
20.	Steel Cupboards 6′ × 4′ × 1.5′	06

21. **Misc. Items (substantial quantities) :**

Suitable containers, cables, resistors, capacitors, inductors/ chokes, diodes transisters, Ics., sockets, plugs, jacks, pivots, bearings, hair-springs, LEDs., magnets, mercury, switches etc. of assorted sizes.

SYLLABUS FOR THE TRADE OF INSTRUMENT MECHANIC (CHEMICAL PLANT)

Under Apprenticeship Training Scheme

Period of Training : 3 years.

The period of training for this trade is 3 years. Consisting of Basic Training for a period of 2 years. and Shop-Floor Training for the remaining period for the apprentices.

The syllabus of this should be considered as guide for imparting Apprenticeship Training according to the facilities available in the industry.

LIST OF OPERATIONS/SKILLS TO BE LEARNT DURING PRACTICAL TRAINING INCLUDING BASIC TRAINING

Note :

1. During the Basic Training for the 10th class pass and Induction Training for B.Sc. degree holders, operations/skills to be taught to the apprentices are indicated under the heading 'Basic Training'. The remaining operation/skills coming in the list should be learnt by the apprentices during the Shop-Floor Training as indicated under the heading 'Shop Training'. The apprentices should have more practice on those operation/skills which are learnt during the Basic Training and additional operations/skills during the Shop-Floor. Training and develop the correct method of doing the week.
2. (*a*) The contents of the 2 years Basic Training in this trade, is exactly the same as in C.T.S. syllabus.
   (*b*) The contents of the 1 year Shop-Floor Training for candidates who have undergone Basic Training in an Industry and for the Ex-I.T.I. trainees in the trade are as indicated under the heading 'Shop-Training'.

BASIC TRAINING : 2 years

(contents are same as the CTS part of 2 years)

SHOP FLOOR TRAINING : 1 YEAR

25. **Operation :**

25.1 The plant and its different products, capacity of production etc. Their activities including process and maintenance.

25.2 Preparing a Schematic Layout of the plant. (material flow & information flow)

25.3 Study of personal & plant safety procedures and use of safety

equipment, fire and fire fighting facilities/techniques, handing of hazardous chemicals and poisons substances.

25.4 Study of the process and operation in brief.

25.5 Reading a (process & instrument) flow sheet of a process. Making a simple flow sheet of a unit.

26 **Instrument Training :**

26.1 Study of location of the various elements like sensing element, transmitter, controller, final control valve of a control loop.

26.2 Study of instruments mountings like Panel mountings, Wall mountings and Yoke mountings. etc.

26.3 Care, safety and proper use of pneumatics fittings, coupling and associated tools.

26.4 Dismantling, Cleaning and Re-assembling of Air-Filters, Air Regulators.

26.5 Giving or Removing Input, Output and Air supply connections of a pneumatic instruments.

26.6 Removal and Re-Fitting of a plant instrument after properly isolating the section of plant. Plant Procedure like work order, clearance Certificates should be noted down by the apprentices.

26.7 Doing simple routine works like, Winding of clocks, Filling of Mercury, Cleaning and changing of Inks, Replacement of charts with drawing and returning of materials to and from stores.

26.8 Learning how to isolate system for connection of Electrical components.

26.9 Use of Continuity Tester, multimeter, Workshop, Potentiometer. Doing simple soldering works.

26.10 Fabrication of thermo-couple (Brazing etc.) using seal pot.

26.11 Soldering practice, metal to metal, wire to wire, wires to plugs, wires to connectors, wires to strokes, wires to terminal blocks.

27. **Instrument Shop**

27.1 Installation and maintenance of circular and strip chart recorder inking system, sensing elements etc.

27.2 Familiarisation, Installation and Maintenance of Control Loops and components (sensing element, single indicator/recorder, controller and final control element), relays and announciater.

27.3 Familiarisation with instrument drawing in sketching, identification of instruments symbols and block diagrams of existing units in the plant.

27.4 Calibration and Installation of other primary elements like thermocouple millivoltmeter, Potentiometer, capillary tube, pH-meter, liquid lever indicator, office meter, pitot tube and other flow meters.

27.5 Removal and Installation of transmission loop connecting sensing element and controller, final control elements etc.

27.6 Instrument and Panel Installation as per Blue Prints.

27.7 Repairing and Fabrication and fitting small parts and componentslike nozzles, bellows, hair-spring, pins etc. to plant instruments.

27.8 Familiarisation with maintenance scheduled & maintenance activity including calibration (Log) followed in the instrument shops.

27.9 Introduction and familiarisation with safe, protective storage procedure and inventry system followed for instruments and their components in the establishments.

27.10 Introduction to the operation of Digital/Analog computers, if available.

27.11 Familiarisation with the analytical laboratory instrument.

Note : The apprentice should not be allowed to work alone in the plant. He will work along with a instrument technician.
The apprentices must maintain a work diary as record of his inplant training.

SYLLABUS FOR RELATED INSTRUCTIONS (3RD YEAR)

The syllabus given for related instruction should be considered as guide :
Subject to be taught to the apprentices are as given here under :

(A.) Trade Theory
(B.) Workshop Calculation & Science
(C.) Engineering Drawing
(D.) Social Studies.

(A.) **Trade Theory**

1. Importance of safety – matters in Industry.
2. Different Safety aspects related to Chemical Industry.
3. Idea of Safety control systems.
4. How to minimise accidents, spl. Mention of techniques used to reduce explostion hazards.
5. Pinpointing some accident prone industries.
6. Basic concepts of Computers & Computer aided control system.
7. Some specific examples of computer aided control system & special mention to touch screen technology.
8. Concept of basic metrology, fundamentals of metrology.
9. Insturmental methods for assisting inspectors in manually gaging parts, workpieces, zigs, etc.
10. Dimentionally oriented motion control systems for machine-tools assembly lines, welding, painting, fabricating etc.
11. Familiarisation with position-sensifire operations-various types of transducers & their field of application. Various enwders. Digital instrumentation.

12. Details of instrumentation arrangement around a distillation column, a digester, Heat Exchanger, reactors, boiler, water treatment plant, power generating plant etc.

B. **Workshop Calculation and Science**

1. Physics (*i*) Units and dimensions (Recap); concept of error, accuracy, precision, how to minimise error handling of an instrument, concept of calculation error. Simple Numerical problems.

(*ii*) Viscosity — definition, experimental, determination etc. Concept of viscosity as an indicative tool of quality of a material.

(*iii*) Properties of fluid & fluid dynamics.

(*iv*) Critical study of physical properties of different metals, polymers & other material of construction of instruments.

2. Chemistry (*i*) Quality of water - Hard, soft etc. Industrial methods of water softening.

(*ii*) Petroleum Chemistry.

Unit operation : Distillation

(*iii*) Ideas of pollution in chemical & other industries, various factors of pollutions & their containment.

Unit process - Petroleum-

Refineries : Petrochemicals

Unit operation : Separation-techniques

(*iv*) Concept of pH and its instrumental technique of measurement.

Unit OP : Membrane technology & its application in instruments.

Unit process : Sweage treatment techniques.

3. Mathematics : (*i*) Techniques of graph plotting & cure fittings.

C. **Engineering Drawing**

1. Revision of silent points of the topics covered in previous two years.
2. Code of practice for engineering drawing to IS : 696.
3. Drawing orthographic views of the actual objects in the workshop.
4. Drawing half sectional view of the actual objects in the workshop.
5. Drawing isometric views of simple objects in the shop floor.
6. Free-hand sketching of the actual components/parts related to the trade.
7. Free-hand sketching and preparation of layout drawings and composition along with lettering and typography.
8. Blue print reading for application in the shop floor.
9. Practice in Auto-CAD.

D. Social Studies

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