

**Syllabus**  
**Instrument Mechanic**  
**(Chemical Plant)**

**2000**

**Under**  
**Craftsmen Training Scheme**  
**&**  
**Apprenticeship Training Scheme**  
**Year – 2000**

**Government of India**  
**Ministry of Labour, DGE&T**  
**Central Staff Training and Research Institute**  
**EN Block, Sector-V, Salt Lake**  
**Calcutta-700 091**

**GENERAL INFORMATION**

<b>1. Name of the trade</b>	<b>: INSTRUMENT MACHANIC (CHEMICAL PLANT)</b>
<b>2. N.C.O. Code no.</b>	<b>: 841:20,841:70,851:20</b>
<b>3. Entry qualification</b>	<b>: Passed 10th class Exam. Or its equilent with science.</b>
<b>4. Duration of Craftsman Training</b>	<b>: 2 years</b>
<b>5. Duration of Apprenticeship Training</b>	<b>: 3 years (2 yrs. Basic Training and 1 yr. plant/shop floor Training)</b>
<b>6. Rebate</b>	<b>: 2 yrs. For Ex-ITI Trainees in the trade of Instrument Mechanic (Chemical Plant)</b>
<b>7. Ratio of Apprentices to workers</b>	<b>1:3</b>

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

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|---|----------|
| 1. S. R. Majumdar-Direcotr, CSTARI, Calcutta                            | Chairman |
| 2. M. K. Mongal-Addl. Director, DGET/H.Q.<br>New-Delhi                  | Member   |
| 3. P. K. Kudu - Sir, Manager (Instructs)<br>Haldia Petrol Chemical Ltd. | ”        |
| 4. P. Sarkar - Reader, Deptt.of chemical Engg.<br>Jadavpur University”  | ”        |
| 5. S. Bondhyopadhyay - Reader, Deptt. of I.E.<br>Jadavpur University    | ”        |
| 6. R. M. Sinha-Jt. Director, CSTARI/Cal.                                | ”        |
| 7. T. Mukhopadhhay, Dy. Dire ctor, CSTARI/Cal.                          | ”        |
| 8. S. Mondal-Dy.Director, DIT/W.B.                                      | ”        |
| 9. R. N. Bondhyopadhyay, Dy.Director, ATI/Cal.                          | ”        |
| 10. T. Selvaraju – Asstt. Director, RDAT/Cal.                           | ”        |
| 11. S. K. Das – Asstt. Director,CSTARI/Cal.                             | ”        |
| 12. v. K. Saksena- Asstt. Director, CSTARI/Cal.                         | ”        |
| 13. P.K. Koley, T.O. CSTARI/Cal.  | “        |

## Draft Syllabus

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

Week no.	Trade Theory	Trade Practical	Workshop science & Calculation	Engineering Drawing
1	<p>Introduction to crafts man training :Workshop safety, Training rules ,use of fire fighting equipments in the workshop and first aids. Importance of cleanliness in Instrument Trade.</p>	<p>Familisation of various trades, issue of workshop dress, hand tools &amp; stationeries. To inculcate cleaning habit of Instuments, Calibrators, and Test Equipment in Instrument Calibration Room/Shop .</p>	<p>Introduction to workshop science and calculation.</p>	<p>Introduction to Engg. Drg. Its relevance to the trade. Use of drawing board and T-Square.</p>
2.	<p><u>Hand Tools</u> General Tools and their materials used in the workshop; Hacksaw, Screw drivers, Spanners, Pliers, Vices, Chisel, Allen-Key set, Tweezer, Hammers etc</p>	<p>Demonstration &amp; practice on cutting mild steel flat, marking of jobs. Exercise on cutting and chipping.</p>	<p><u>Physical chemistry</u></p> <ol style="list-style-type: none"> <li>1. Introduction to chemistry.</li> <li>2. Gas Laws.</li> <li>3. Introduction to ratio activity. <ul style="list-style-type: none"> <li>• <u>Physic</u></li> </ul> </li> </ol> <p>Units and dimensions , Vernier Caliper, Spherometer, Micrometer, Screw guage, Scalar and Vector quantities, their representation , resultant parallelogram and triangle of vector.</p> <ul style="list-style-type: none"> <li>• <u>Mathematic</u></li> </ul> <p>§ Solution of 1st &amp; IInd order equations with one or two unknowns algebraic calculations and by graphs.</p>	<p>Free hand drawing of straight lines, rectangle, squares, circles, polygons, etc.</p>

3	<p><u>Files-</u> Classification ,types, material, grade of file, marking tools, steel rule, Tri-square , V-block, Caliper, their uses, care and maintenance .</p>	<p>Filing : Surface, sides, exercise with accuracy up to 0.05 mm. Use of different file s-flat , round , half-round, triangular, square.</p>	<p>1. Atomic structure 2. classification of elements. <u>* Physics:</u> Rest and Motion , equation of motion under gravity in a circle with constant angular velocity and acceleration , work , power, energy <u>* Mathematics:</u> solution of 1st &amp; 2nd order equations with one or two unknown algebraic calculations and by graphs.</p>	<p>hand sketches: solid such as cylinder &amp; cones, angular blocks and their view viewed perpendicular to their axis.</p>
4	<p><u>Drills:</u> Classification Types, and material of construction, methods of use. <u>Types and Dies:</u> Types of threads, their applications.</p>	<p>Simple exercise of drilling &amp; tapping counter sunk.</p>	<p>Calculation of hole size for drilling and Tapping. <u>Physics</u> S.H.M. Rotational motion moment of inertia, simple machines.</p>	<p>Set of set square &amp; drawing. Instruments, Reading simple Blue Prints.</p>
5	<p>Screw drivers, Pliers, Spanners, their classification, materials and precautions while using them.</p>	<p>Using proper screw drivers tighten, open and practice to remove damaged screws.</p>	<p>1. Law of mass action 2. Gas laws. 3. introduction to radio activity. <u>* Physics:</u> Static and Kinetic friction, their measurement, Elasticity, Stress, Strain Hook's Law , Determination of Young' s modules.</p>	<p>Freehand sketches of hand tools, screw drivers, Pliers, spanner, Tweezer.</p>

6 & 7	<u>Precision Measuring Instruments:</u> Vernier caliper, Micrometer, Depth Guage, Bevel Protractor, Dial Test Indicator, Their principle of measurement , care and maintenance.	Measurement by venire caliper, Micrometers, Depth guage, Bevel protector, Dial Test indicator etc.	*Physics: Surface energy, surface Tension, Angle of contact.	Free-hand sketches of Vernier Caliper micrometer Depth Guage 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 fitting.	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	<u>Introduction to lathe :</u> The principle feature & main parts of lathe, tools for different operations, steps and method of turning, Care and maintainance.	Identification of various parts of lathe Familiarisation of precision watchmaker's lathe, Simple exercises of plain, step turning Checking of tool angle.	Metallurgy of ferrous metals.	free-hand sketch of lathe and various lathe tools.
11 & 12	Procedure of taper turning & boring.	Exercises on taper turning and boring.	Calculatio of taper angle * <u>Physics</u> : 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 0.2mm. Exercises on thread cutting.	Calculation of gear train for thread cutting . <u>Mathematics</u> : Area of solid surface.	Geometrical construction of lines, angles & triangles.

15	Introduction to Precision Watch maker'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	<u>Introduction to Engraving Machine:</u> 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 polarization.	Different types of line used in Engineering drawing IS:696-1972 (Rev)
17 & 19	<u>Soldering, Brazing and Crimping:-</u> Definition to soldering, brazing, & crimping. The soldering station with temperature control.	Simple soft soldering practice joining various electrical components, wires, and temperature controlled soldering station. importance of tinning, Crimping and precautions.	Manufacturing process of $\text{HN03}$ , $\text{NH}_3$ , $\text{HCL}$ and $\text{H}_2\text{SO}_4$ . * Physics I. preparation properties and uses of Aluminum Chloride, Potassium Ferro & ferricyanides, bleaching powder, V2 O5 Glass and Ink. Fuels  * <u>Mathematics:</u> Volume of solids like cube, sphere, prism, cone etc.	Isometric views solid and hollow objects.  Orthographic view of simple objects by 1st Angle projection.

20 to 25	<p><b><u>Corrosion:-</u></b>  <b>Definition, difference between corrosion &amp; erosion Prevention of Corrosion , curing of corroded parts.</b></p>	<p>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.</p>	<p>Aliphatic hydrocarbons-saturated and unsaturated .          * <b><u>Physics</u></b> : corrosion          * <b><u>Mathematics:</u></b>          Trigonometry-study of sine, cosine, tangent of angles in a right-angled triangle and the application in solving practical problems.</p>	<p>Drawing of orthographic views of simple solid and hollow objects.</p>
26	<p><b><u>INDUSTRIAL VISIT</u></b>          pressure measuring instrument definition of pressure differential pressure , absolute pressure , their units .different type of pressure measuring I struments, manometers , barometers.</p>	<p>Dismall the pressure Gauge ,Testing of pressure indicators with Standard Calibrator /Dead weight Tester ,Precaution to be observed while testing.</p>	<p>(i) Alcohols&amp; Acids          (ii) Haiogen Compound of aliphatic          (iii) Aliphatic aidehydyes &amp; ketones.          * <b><u>Physics:</u></b> Acids&amp; Alkali, Determination of ph, flash point.          Barometer,Atmospheric Pressure, Absolute Pressure.          * <b>Physics</b> : Tangent Magnetometer, Dip Circle, application of magnets.          Charles Law and Boils Law, Preparation of Barograph,error cards.</p>	<p>Free-hand sketch on chemical laboratory apparatus's symbols of pressure Gauges/indicators . ISI symbols for pressure ,Recorders.</p>

27	Construction and principle of operation of various pressure gauges. Importance of callibration in Metrology.	Dismantle the pressure guage and study the construction , adjustments for correct functioning.	I Ethers and Esters. ii Carbohydrates.	ISI symbols of pressure indicator-cum-recorder.
28	Compound pressure gauges: Its construction, uses Principle of operation, construction of Absolute Pressure Guage, Aneroid Barometer.	Calibration of compound pressure gauges Calibration of Absolute pressure Guage  Calibration of Aneroid Altimeter.	<u>Mathematics:</u> Trigonometry; sine , cosine , cosec of angles in a right angled triangle.	-Do-

29 & 30	Measurement of Temperature: <u>Liquid Expansion</u> Type-Mercury in glass thermometer, steel thermometers,Alcohol in glass thermometer, <u>Solid Expansion:</u> Type – Bimetallic thermometers. Vapour Pressure thermometers.	Carrying out serviceability checks on Temperature Gauges, their routine maintenance, Calibrations of expansion thermometers.	Heat Energy- Temperature, units scales/graduations etc. Co-efficient of expansion of solids, liquids and gases.	ISI symbol of temperature indicators.
31	Thermocouple & RTD Themistor, their ranges, construction, principle of operation, compensating leads , recorders etc.	Calibration, maintenance & reconditioning, Thermocouple pyrometers, Recorders.	Seebek's theory.	Freehand sketch of level measuring instruments.
32	Liquid Level Measurement Introduction to measurement of level. The principle of operation, use and construction of Hook type, sight glass type, Buoyancy type level indicator to close and open tank.	Study construction of Hook type, Sight glass and Float type level measuring instruments of close and open tank.	I Introduction to aromatic compounds. ii Benzene and its derivatives.	Free-hand sketch of level measuring instruments.

33 & 34	<u>Electronic level</u> <u>Measuring Instrument :</u> Variable capacitance, high and low level alarm/ON-OFF Ultrasonic and Magnetic type level indicators , Admittance.	Differential pressure type level m/s, check calibration of Electronic level indicators, Ultrasonic and admittance type level indicators.	* <u>Mathematics :</u> problems on measurement of liquid quantity by change in height of liquid.	ISI symbols of level measuring instruments.
35 & 36	<u>Measurement Fluid Flow :</u> Primary elements used for rate of flow measurement, Rotameters.	Study of orifice 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.
37 & 38	<u>Quantity Flow Measurement-</u> Volumetric type, Gas Flow meter, magnetic flow meter.	Study of Oscillating piston type Rotating vane meter, Nutating disc meter.	* <u>Mathematics :</u> i. Problems on flow of fluid. ii. Preparation of Oxalic acid.	Free-hand sketches of Gas and water flow meter.
39	Basic Electricity : Electricity by chemical method type of primary cell, storage, Battery, lead acid cell, Alkaline cell , Lithium cell etc,	Study on cells connected in series, parallel as well as in combination, Determination of currents, Voltages by Kirchhoff's Law, Determination of specific Resistance using Whetstone's Bridge.	Electrolytes of cells- primary, secondary and Rechargeable battery- their chemical actions.  * <u>Physics:</u> Heating effect of electric current.	Orthographic views of Primary, Secondary, Rechargeable battery pack.  * Mathematics Logarithms.
40	Faraday's law of Electrolysis; Explanation, Objective, Procedure .	Verification of Faraday's first law of Electrolysis. Precautions to be observed in performing experiments. Determination of mechanical equivalent of heat.	* <u>Physics :</u> Current electricity by chemical reaction, Cell's magnetic effect of current.	Circuit diagrams showing ISI symbols of electrical components.

41	Generation of electricity by magnetic effect-Principle of generators, AC & DC supplies, Units of 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.
42 & 43	<u>Resistance</u> - Type of resistors, their materials, colour code and uses. <u>Inductance</u> - Self Mutual Induction – Inductors, Transformers, Relays, <u>Capacitance</u> - type of capacitors, its construction, 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) Transformer Ratio.	ISI symbols of Resistor, Inductor, Capacitor, Transformer etc.
44	<u>Principle of Motor</u> : AC & DC Motors, type and uses in chemical plants.	study to construction of motor valves, recorder-motors used in chemical plants their adjustments and maintenance.	Power factor and its calculations.	Free-hand sketches of AC & DC motors.
45	<u>Moving Coil Instruments</u> :- Ammeter, voltmeter, Ohm meter construction , range, sensitivity, accuracy, damping etc.	Measuring of current, voltage in the circuit , making of elect, bell, Alarm, power circuits.	Calculation of power factor.	Orthographic views of Ammeter, Voltmeter.
46	Moving Iron Instrument, Dynamometer, Wattmeter, megger, Energy meter – their principle of operation & construction.	Use of electrical meters in maintenance.	calculation power with the current voltage measured.	ISI symbols of Ammeter, Voltmeter, watt meter , megger, Kwh- meter etc.

47	Principle, operation and construction of Electrical Test Equipment- Multimeter,LCR-bridge,whestone,s bridge.	use of electrical test equipments e.g. for measuring the current, voltage,etc.	Damping, Accuracy.	Free-hand sketches of multimeter.
48 & 49	Revision & Test			
50	introduction to semiconductor Devices: semiconductor materials-intrinsic &Extrinsic-Type &n-type materials, charge carriers.	study the characteristics of conductor, semiconductor &insulator.	pressure regulators and steam traps.	Drawing of pressure control process line.
51 & 52	P-N junction, Depletion zone,Barrier voltage,Diodes,LED,L CD,zener,SCRs,DIAC- their application, uses and care.	Making of Dcpower 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 line,ISI symbols of Diodes in circuit drawings.
53& 54	<u>Bipolar Transistors:</u> PNP, NPN types- amplifier circuits, classification, Biasing , coupling, FET,UJT,MOSFET.	practice on making transistorized amplifiers by soldering on veroboard.	Reciprocating compressors checking for current functioning, carry out functional checks on transistorized instrument.	Drawing of process flow systemize symbols of Transistors used in circuit drawings.
55 & 56	<u>Binary and Hexadecimal systems:</u> Logic gates , Circuits, Truth Table , 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	<u>Introduction to integrated Circuits</u> Timer IC , OPAMP, etc their functions,Ics used in various instruments.	Experiments on IC .555/IC556, IC,747 with IC-Trainer.	Types of heat Exchanger, double pipes, Shell& Tube heat Exchanger,	Block diagrams of Ics.
59 & 60	<u>Digital Ics , Microprocessor: Arithmetic Logic unit, Memory, CPU, ROM, RAM, EPROM&lt; etc.</u>	Study of Digital Ics on digital trainer Kil, conversion of Analog to Digital, Digital to Analog.	Steam ejectors, Rotary vacuum pump, Centrifugal pump etc.	Designing of PCBs.
61 & 62	<u>Operational Amplifiers</u> and their use in instrumentation, Principle, operation & function of CRT.	Using OP- Amp circuits of Astable,Monistable, Bitable multivibrators, Study by Oscilloscope.	Introduction to Film Co-efficient and over al l film co-efficient on Heat Transfer.	Free-hand sketches on process instrument.
63	<u>Application of Ics</u> 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	<u>Construction of Electronic industrial controls: ON-OFF controller, Level control, Fire detecting circuits etc.</u>	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 another components on PCB
65	<u>Recorders:</u> I. Mechanical Recorders-pens, charts inks, etc, Principles 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.	Free-hand sketches of mechanical recorder, its ISI symbol.

66 & 67	ii. <u>Electrical &amp; Electronic Recorders</u> - principle of operations, recording system, chart motor, ink, pen, moving element etc. Punching and Dot systems, Errors and Adjustment.	Check, Calibrate the Elect/Electronic controller for its correct functioning, study its construction for minor rectification, changing of charts, cleaning of pens, adjustment of error, if any.	Introduction to Evaporation, Types of evaporators.	Free-hand sketch of Elect/Electronic Recorder, its ISI symbol.
68 & 69	Theory of Integrating system in recording processes variables, Multi-pens recorder and cam arrangements.	Reconditioning of strip chart & circular chart recorders.	Forced circulation evaporator, multiple – effect evaporator.	Free-hand sketches on multiple-pens recorders.
70	Potentiometer type recorders multiples obtentiometric type recorder.	Providing different types of recorders trainees to check calibrate individually.	Instrumentation of an evaporator.	Free-hand sketch of DP' Transmitter (Pneumatic)
71	<u>Telemeter:</u> Telemetering in process control, types of transmitters, principle of construction of diff.pressure 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).
72	Principle, Construction of Electronic DP Transmitter, methods of calibration and procedure of adjustment of errors.	Reconditioning of DP cell, replacement of parts, adjustment and calibration.	Distillation, Introduction, Process.	layout diagram, connection of DP cell (Electronic).
73	principle, construction, operation of temperature transmitter (pneumatic)	Calibration of temperature transmitter, and its adjustments.	Boiling point diagram.	Freehand sketch of converter.

74	Converters: Principle, construction, operation of current to air and pressure to current converters.	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.
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75 & 76	Principal of operation construction and necessity of E.M.F to current converters, range adjustment 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
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77	Mechanical type Differential pressure Transmitter- Principle, construction, operation.		Rectification , types of distillation columns	Process diagram PI controllers.
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78	Piping, Tubing connections of DTP, Erection of different tips of transmitter.	Reconditioning and calibration of DTP converters etc.	Distillati on column of process.	Diagram of PID Process.
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79	Controllors: (Analog and Digitl) Open loop, Closed loop, Feed back control system, Modes of control system, ON – OFF control system, its operation, function, disadvantages.	Study the construction, Identification of components of ON-OFF type controller, Testing and Calibration of ON-OFF type control system of pneumatic, and electronic pressure , Temperature etc.	Absorption : Introduction, Equilibrium, Mass transfer co-efficient, factor effecting rate of absorption, flooding velocity.	Cascade control system.
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80.	<u>Proportional Controller</u> : Principle of construction, operation. Proportional Band-setting, adjustment.	Check calibration of proportional controller, reconditioning, adjustment, setting of proportional Band.	Different type of absorption columns.	Instrumentation diagram of distillation columns.
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81.	<u>Proportional with Rest</u> : action, effect of reset, rate of proportional action.	Setting of res time, proportional Band, Check calibration of controller.	Petroleum Refining.	Instrumentation diagram of PI control system.
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82.	Control Lag, Step and Frequency response, Derivative action of PID 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 o. PID control.
83. & 84.	Principle of Electronic controller, study of circuit diagram, components, method of calibration.	Repair/Reconditioning of Electronic controllers, Testing and Calibration of PID controllers.	Mixer settler extractor, Spray tower.	Process diagram of Heat exchanger of PID.
85. to 90.	(Final control) Globe vale, Diaphragm valve-its function, parts, seating, range, calibration etc. <u>Final control valves :</u> Types, Split body, single sealed, double sealed, Butterfly, Ratio valves etc. <u>Electronic control valve :</u> Type of valve use for acid and corrosiye Liquids Principle of construction, Operation of valve- postioner, its uses, Procedure of calibration.	Dismantling, reconditioning, checking and resetting of diaphragm control valves, calibration of diaphragm control vale. Leak test, Replacement of vale parts like diaphragm, sealing materials, Sealing rings, plugs etc. Grinding/Lapping of valve seats, plug leakage test, calibration of valves, Erection of vale positioner.	Leaching: Introduction and applications. Manufacturing process and fiow sheet of pump and paper.	Instrumentation diagram of Drier, Control valve. Instrumentation for pump, ejectors, and symbols for electronic equipments.
91.	<u>INDUSTRIAL VISIT</u>			
92. & 93.	<u>Electrical Instruments :</u> Principle, Construction & function of permanent magnet Moving coil meters, Ammeters, voltmeters, used in AC & DC Principle, Construction & function of moving coil meters & 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.

94. & 95.	Principle, Construction and operation of wattmeters, Power Factor Meters, Energy Meters & KHW meters.	Calibration of Energy Meter, Watt Meter etc. Handling and care.	Rotary drier, Spray drier.	Drawing of Electrical Test circuit of different meters.
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 & Humidity.	-Do_	Free-hand sketch of optical instruments.
98.	<u>Laboratory Instruments :</u> Principle accessories, operation of Industrial Appliances Analytical Balance, Air Damping balances, Automatic Recording balances, Automatic Recording, (Self registering balance), Moisture Determination Balance Principle, accessories, operations, function and Industrial application of the apparatus.	Practice to use property- i) Balances Sedimentation and Decantation. ii) Dorr Thicker. iii) 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.  - do-	Use Care & Maintenance i) Surface Tension ii) Viscometer iii) Pynometer iv) Microscope v) Potentiometer i) Conduct meter ii) PH-meter iii) Polagraph. iv) polargraph	Manufacturing of Glass.  Centrifugation: Top driven centrifuge.	Diagram of Pyrometer.  Circuit of Poentionmeter.

100.	-Do-	i) Calorimeter, ii) Spectrometer, iii) Photo calorimeter, iv) flame photometer.	-Do-	-Do-
101.	-Do-	i) Refractometer, ii) Polarimeter, iii) Apparatus for Electrophoresis.	Manufacturing process and flow sheet of cement.	-Do-
102. & 103.	REVISION AND EXAMINATION			

**Social studies :**

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

## INSTRUMENT MECHANIC (CHAMICAL PLANT )

### General Installations

#### **CLASS ROOM – CUM – INSTRUMENT SHOP:**

1. Chalk Board green with sliding sunmica, 3'-6" X 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. Slider 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 5	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 motorized	01
2. Grinder double ended bench 7" high revolution motorized	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 Center Lathe 9' X 3' including bed ,accessories motorized	02
7. Instrument Testing Bench with cupboards	08
8. Bench working 6' X3' X2.5'	03
9. Bench working metal top 6' X3' X2.5'	01
10. Steel Cupboards 6' X 3' X 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
<b><u>TRAINEES' KIT:</u></b>		16
1.	Steel Rule flexible 15 cm.	16
2.	Spring Calliper Outside 10 cm.	16
3.	Punch center knurled 10cm	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 Bail Pain with handle ¼ lb	16
11.	Tweezer fine point stainless steel 12 cm	16
12.	Tweezer point straighting 12cm	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" X 3/16 baills end/100 X 5 cm.	16

**MEASURING INSTRUMENT, TOOLS & GENERAL SHOP OUTFIT FOR THE UNIT:**

01	Try square with hardened blade 10 cm.	04
02	Spring Divider 10 cm	05
03	Spring Callper 10 cm	04
04	plies side cutting insulated 15cm	08
05	plies Round Nose 10cm	06
06	Piles snip nose 10 cm.	08
07	Neon phase/line tester 500volts	08
08	File swiss precision assorted sat of 12 nos.	08
09	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 * 3mm	04
14	Oil stone triangular 3/8" X 4" or 10 X 100 mm.	04

15	Oil can miogate, pressure delivery	02
16	Surface plate 30 X 30 cm.	02
17	Universal Scribing block 9" Pillar or 225 mm.	02
18	V-Block with blamps pair	02
19	Punch letter set 2 mm	02
20.	Punch number set 2 mm.	02
21.	Hacksaw frame, adjustable 8" – 12"/20cm – 30cm.	08
22.	Hand Drilling machine, motorized 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"/10 mm.	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 wet 230 volts	04
36.	Screw Driver 8" Heavy Duty	08
37.	Hot plate single 1000 watt 230/250	02
38.	Scraper Half-round 4"/10 cm.	04
39.	Scraper triangular 4"/10 cm.	04
40.	Anvil bench type 13 kg.	02
41.	Vice bench, Jaw 3"/7.5 cm.	12
42.	Vice swiveled 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" x 12"/30cm. x 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"/15cm.	04
49.	Chuck lathe self centering 6"/15cm.	04
50.	Chuck drilling machine 0 to 1/4" cap.	01
51.	Chuck drilling machine, 1/16" – 1/4" Or 1.5 – 12mm.	01
52.	Pointer Extractor, Stainless steel fine	12
53.	Glass Desiccators with desiccant	08
54.	Screw pitch Gauge, B.A., W.W. and metric	01 each type
55.	Vice drilling machine, 4"/100 mm.	01
56.	Hacksaw Midget, 6"/15cm.	12
57.	Reamers parallel, 1/16" to 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 x 90 degree	02
62.	- do - 1/16" dia. 1/2" shank, 0 degree x 90 degree	02
63.	- do - 3/16" dia. 1/2" shank, 90 degree	01
64.	Cutter milling machine side and face, 3" x 1/4", 3" x 5/16", 3" x 3/8"	02
65.	Rlier Gas 6"/15cm.	01
66.	Spanner double ended open B.S.F. 1/4" x 5/16"	12 each
67.	Spanner, adjustable 11"/22.5cm.	01
68.	Spanner adjustable, 4"/10cm.	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	02sets
72	Taps threading hand ,metric 5,6,8,10MM. in set of 3,1st ,.2nd .and 3rd –with tap wrench	02sets

<b>Precision Measuring Instrument:</b>		
01	Micrometer out side ,0-20mm.	01
02	-do -do 0-25mm	04
03	-do- -do- 25-50mm	01
04	-do- Vernier, 0" – 1"	01
05	-do- Inside with extension rods, 50-210mm.	01
06	-do- Depth, 0"-1"	01
07	Vernier Caliper, 6"/15cm.	01
08	-do- Height Gauge, with Inches 12" or Metric 300mm. Graduations.	01
09	Vernier Bevel Protractor, with acute attachments	01
10	Combination set 12"/30cm.	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 15mm.	01

**ELECTRICAL INSTRUMENTS:**

01	Moving coil Voltmeters (Various ranges)	04 each
02	Moving coil Ammeters (Various ranges)	04 each
03	Moving coil Millimeters(various ranges)	04 each
04	Moving Mill voltmeters (various ranges)	04 each
05	Galvanometer, centre-zero indication	01 No.
06	Moving iron AC-Voltmeters, Various ranges	04 each
07	Moving iron AC-Ammeters, various ranges	04each
08	Voltmeter Dynamometer type AC & dc	04each.
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, vibration reed type	01
18	Ampere-hour meter	02
19	Multimeter, (AVO)	02
20	Calibration for Ammeters, Voltmeter, Ohmmeters	01
21	Calibration for Wattmeter's, Energy meters	01
22	Bridge for Resistance , Capacitance, Inductance	01
23	Workshop power supply with various DC source	01
24	Regulated power supply with variable DC source	01
25	Servo operated AC- Voltage Stabilizer, 10KVA	01

**HUMIDITY INSTRUMENTS:**

01	Hair Hygrometer	02
02	Wet-Dry bulb Thermometer Type Hygrometer	02
03	Sling Pyrometer	02

**PRESSURE INSTRUMENTS :**

01	Manometer U-tube	01
02	Manometer Inclined tube	01
03	Manometer, well type	01
04	Barometer Mercury	01
05	Barometer Anehpil capsule	01
06	Gas pressure regulator	02
07	Pressure Indicator Burden tube, various ranges	16
08	Pressure Gauge, Capsule type, various ranges	16
09	Pressure Indicator, Bellows type, various ranges	16
10	Dead Weight Tester, with accessories	01

**FLUID FLOW METER :**

01.	Quantify Flow meter, simple tank type	02
02.	Reciprocating piston type flow meter	04
03.	Flow meter impeller type	04
04	Bellows type Gas flow meter	02
05	Magnetic flow meter	02
06.	Orifice type differential flow meter	02
07.	Venture tube –do- flow meter	02
08.	Nozzle type differential flow meter	02
09.	Pitot tube –do- flow meter	02
10.	Taper tube Rotameters	02

<b>LEVEL INSTRUMENT :</b>		
01.	Sight Glass Level Indicator	02
02.	Hook type level indicator	02
03.	Float type Level Indicator	02
04.	Static pressure air purge Level Indicator	01
05.	Show piece Ultra sonic Level Indicator	01
06.	Variable Capacitance type Level Indicator	01

<b>TEMPERATURE INSTRUMENTS :</b>		
01.	Mercury- in- Glass Thermometers (various ranges)	06
02.	Alcohol or other liquid in glass Thermometers	02
03.	Mercury in Steel Thermometer, Remote Indicating	02
04.	Vapour pressure Thermometers	02
05.	Bi-Metal thermometers, stem & dial (various ranges)	04
06.	RTD Resistance-bulb Wheatstone Bridge Thermometers	02
07.	Thermo-couple Pyrometers (with different thermocouple)	10
08.	Termo-couple with milli-volt-potentimeter pyrometer	01
09.	Optical Pyrometer	02
10.	Standard Tungsten strip filament lamp for calibration of optical pyrometer	02
11.	Radition Pyrometer	01

<b>ROTATIONAL SPEED &amp; CIRCULAR VELOCOTY INSTRUMENTS :</b>		
01.	Speedometer (four different popular make)	04 each
02.	Techometer Centrifugal	02
03.	Techometer Drag-cup type	02
04.	Techometer Electrical, Synchronous	02
05.	Stroboscope	01
06.	RPM- Tester/Techno. Tester	01

<b>RECORDERS AND CONTROLLERS :</b>		
01.	Circular Charts Recorder (Potentiometer type)	02
02.	Strip Charts Recorders (Potentiometer type)	02
03.	Secondary devices for measurement of Temperature, pressure, level and flow for above recorders	02 each
04.	2. Position controller (ON-OFF) type	02
05.	Proportion controller	02
06.	Proportional with RESET type Electronic Controller	02
07.	Pneumatic controllers for pressure, Flow, Temperature, and Level with associated equipment	02 each
08.	Transmitters Pneumatic, Hydraulic and Electronic for above mentioned controllers, recorders, Process Simulator	02 each

<b>GENERAL ITEMS : UPS, Computers (Latest Configuration) with process software, Printer.</b>		
01.	Bench Lamps 20 watt/halozen 230 Volts, Philips/GEC/OSRAM	16
02.	Vacuum Lamps with accessories	01
03.	IC-Tester Linear with accessories	02
04.	IC-Tester Digital with accessories	02
05.	Hydrometer	02
06.	Soldering Gun	04
07.	De-Soldering Gun	04
08.	Vacuum Cleaner with accessories	01
09.	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 (1KVA)	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 Extenuator, Soda-Acid, CTC	01
19.	First Aid Box	01
20.	Steel Cupboards, 6' x 4' x 1.5'	06
21.	Misc. Items (substantial quantities) :	
	Suitable containers, cables, resistors, capacitors, inductors/chokes, diodes transistors, Ics, sockets, plugs, jacks, pivots, bearing, hair-springs, LEDs., magnets, mercury, switches. Of assorted sizes.	

## **SYLLABUS FOR THE TRADE OF INSTRUMENT MECHANIC**

### **(CHEMICAL PLANT)**

#### **Under Apprenticeship Training Scheme**

#### **Period of training: 3 yrs.**

The period of training for this trade is 3 yrs. consisting of Basic Training for a period of 2 yrs. and shop-floor training for the remaining period for the apprentices.

The syllabus of this trade 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.s.c 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 work.
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 years shop-floor Training for candidates who have undergone Basic Training in an Industry and for the Ex-I.I.I. trainees in the trade are as indicated under the heading 'Shop-Training'.

#### **BASIC TRAINING: 2yrs.**

(Contents are same as the CTS part of 2 yrs.)

#### **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 Lay-out 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, handling 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 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 Lops and components (sensing element, single indicator/recorder, controller and final control element), relays and annunciator.
- 27.3 Familiarisation with instrument drawing in sketching, identification of instruments symbols and blocks diagrams of existing units in the plant.
- 27.4 Calibration and capillary tube, pH-meter, liquid level indicator, orifice meter, Venturimeter, pitot tube and other flow meter.
- 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 components like nozzles, bellows, hair-spring, etc. to plant instruments.
- 27.8 Familiarisation with maintenance scheduled & maintenance activity including calibration (Log) followed in the instrument shops.
- 27.9 Introduction and familiarization with safe, protective storage procedure and inventory system followed for instruments and their components in the establishments.
- 27.10 Introduction to the operation of Digital/Analog computer, 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 an instrument technician.

The apprentices must maintain a work diary as record of his in plant-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 as given her 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 minimize accidents, spl. Mention of techniques use to reduce explosion 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. Instrumental method s for assisting inspectors in manually gagging parts, work pieces, zigs, etc.
10. Dimensionally oriented motion control systems for machine tools assembly lines welding, painting, fabricating etc.
11. Familiarisation with position - signifier operations – various types of transducers & their field of application. Various enders. Digital instrumentation.
12. Details of instrumentation arrangement around a distillation column, a digester, Heat Exchanger, reactor, 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 minimize error during 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: - Petrochemicals.

Unit operation: Separation-techniques

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

**Unit OP:** Membranes technology & its application in instruments.

Unit process: Swage treatment techniques.

3. Mathematics: (I) Techniques of graph plotting & curve 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 isometric views of simple objects in the shop floor.
6. Free-hand sketching of the actual components/parts related to the trade.
  5. Free-hand sketching and preparation of layout drawings and composition along with lettering and typography.
  6. Blue print reading for application the shop floor.
  7. Practice in Auto-CAD.

D. Social Studies

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