

Syllabus for the trade

of

INSTRUMENT MECHANIC (CHEMICAL PLANT)

(SEMESTER PATTERN)

UNDER

CRAFTSMAN TRAINING SCHEME

Designed in: 2013

By

Government of India

Central Staff Training and Research Institute

Directorate General of Employment & Training
Ministry of Labour & Employment
EN -81, Sector-V, Salt Lake City,
Kolkata-700091

List of the Members of Trade Committee Meeting for the trade of “**INSTRUMENT
MECHANIC (CHEMICAL PLANT)**” held on 13th & 14th Sep.2011 at ATI, Mumbai

Sl. No.	Name and Designation ,Shri	Organization	Remarks
1.	S/Shri R. K. Pathak Director In Charge/HOD	ATI, Mumbai	Chairman
2.	Ujjwal Biswas Dy. Director of Trg	ATI, Mumbai	Member
3.	Abhinoy Nandi Dy. Director of Trg	ATI, Mumbai	Member
4.	P.S. More, Training Officer	ATI, Mumbai	Member
5.	S. J. Wakde, Training Officer	ATI, Mumbai	Member
6.	Smt. Kavita K. Phadnis, Training Officer	ATI, Mumbai	Member
7.	A.R.H. Shaikh, Training Officer	ATI, Mumbai	Member
8.	N.V.Nare, Training Officer	ITI, Mahad	Member
9.	J.H.Suryawanshi, Training Officer	ITI, Mahad	Member
10.	D. N. More, Training Officer	ITI, Mahad	Member
11.	A. N. Mancharkar, Instructor	IT I_ Ambarnath	Member
12.	S. Z. Rajput, Instructor	IT I_ Ambarnath	Member
13.	P.R.Patil, Instructor	ITI, Nagathane, Roha	Member
14.	S.S.Barve, Instructor	ITI, Mahad	Member
15.	R.S.Wagh, Instructor	ATI, Mumbai	Member
16.	D. M. Basha, Instructor	ATI, Mumbai	Member

List of members attended the Workshop to finalize the syllabi of existing CTS into Semester Pattern held from 6th to 10th May'2013 at CSTARI, Kolkata.

Sl. No.	Name & Designation	Organisation	Remarks
1.	R.N. Bandyopadhyaya, Director	CSTARI, Kolkata-91	Chairman
2.	K. L. Kuli, Joint Director of Training	CSTARI, Kolkata-91	Member
3.	K. Srinivasa Rao, Joint Director of Training	CSTARI, Kolkata-91	Member
4.	L.K. Mukherjee, Deputy Director of Training	CSTARI, Kolkata-91	Member
5.	Ashoke Rarhi, Deputy Director of Training	ATI-EPI, Dehradun	Member
6.	N. Nath, Assistant Director of Training	CSTARI, Kolkata-91	Member
7.	S. Srinivasu, Assistant Director of Training	ATI-EPI, Hyderabad-13	Member
8.	Sharanappa, Assistant Director of Training	ATI-EPI, Hyderabad-13	Member
9.	Ramakrishne Gowda, Assistant Director of Training	FTI, Bangalore	Member
10.	Goutam Das Modak, Assistant Director of Trg./Principal	RVTI, Kolkata-91	Member
11.	Venketesh. Ch. , Principal	Govt. ITI, Dollygunj, Andaman & Nicobar Island	Member
12.	A.K. Ghate, Training Officer	ATI, Mumbai	Member
13.	V.B. Zumbre, Training Officer	ATI, Mumbai	Member
14.	P.M. Radhakrishna pillai, Training Officer	CTI, Chennai-32	Member
15.	A.Jayaraman, Training officer	CTI Chennai-32,	Member
16.	S. Bandyopadhyay, Training Officer	ATI, Kanpur	Member
17.	Suriya Kumari .K , Training Officer	RVTI, Kolkata-91	Member
18.	R.K. Bhattacharyya, Training Officer	RVTI, Trivandrum	Member
19.	Vijay Kumar, Training Officer	ATI, Ludhiana	Member
20.	Anil Kumar, Training Officer	ATI, Ludhiana	Member
21.	Sunil M.K. Training Officer	ATI, Kolkata	Member
22.	Devender, Training Officer	ATI, Kolkata	Member
23.	R. N. Manna, Training Officer	CSTARI, Kolkata-91	Member
24.	Mrs. S. Das, Training Officer	CSTARI, Kolkata-91	Member
25.	Jyoti Balwani, Training Officer	RVTI, Kolkata-91	Member
26.	Pragna H. Ravat, Training Officer	RVTI, Kolkata-91	Member
27.	Sarbojit Neogi, Vocational Instructor	RVTI, Kolkata-91	Member
28.	Nilotpal Saha, Vocational Instructor	I.T.I., Berhampore, Murshidabad, (W.B.)	Member
29.	Vijay Kumar, Data Entry Operator	RVTI, Kolkata-91	Member

GENERAL INFORMATION

1. Name of the Trade : **INSTRUMENT MECHANIC**
(Chemical Plant)
2. NCO Code No. :
3. Duration : 2 years (Four Semesters)
4. Power Norms : 8 Kw
5. Space Norms : 6.50 Sq Meter / Trainee
6. Entry qualification : Passed 10th class examination under 10+2 system of education with Science and Mathematics or its equivalent.
7. Unit Size (No. of Trainees) : 16
8. Instructor's/ Trainer's Qualification : a) Tenth Class Passed + NTC + NAC
: b) Preference will be given to a candidate With Craft Instructor Certificate

Note : At Least One Instructor must have Degree/Diploma in Instrumentation / Process Control Instrumentation.

Syllabus for the Trade of

“INSTRUMENT MECHANIC (CHEMICAL PLANT)” under C .T.S. (Semester Code No. IMC-01) SEMESTER – I

Week No.	Trade Practical	Trade Theory	Engineering Drawing	Workshop Calculation & Science
1.	Fitting Induction, Training: Familiarization with Institute. Importance of trade training. Introduction about machineries & equipments used in chemical trade & work done by trainee. Introduction to safety equipment, first aid & fire fighting equipments and their uses in the section.	Introduction to general safety, personal safety, electrical safety & general precautions observed in the workshop. Fire prevention and fire control in chemical industries. Study of personal protection equipments (PPEs) used in chemical plant. First aid in chemical plant. Role of attendant operator in the Chemical Industries	Introduction to engineering drawing. Its relevance to the trade. Use of drawing board, T-Square, etc.	Introduction to Workshop Calculation and Science Units and conversion classification of units, conversion of units : British system to metric system ,SI System and vice –versa
2.	Use of vice clamps, holding the job in the vice and practice of metal sawing with hacksaw and filing the edges maintaining squareness of all the faces. Marking practice using hermaphrodite caliper, surface gauge, engineers' try square, marking off table etc.	Introduction and use of job holding devices & marking tools in the fitting shop. Description and specification to different types of hammer. Surface gauge its description & construction. use and care of V –Blocks, Marking table, Try Square, Hacksaw frame & Blades, universal scribing block etc	Use of set squares/mini drafter and other drawing instruments. Method of fixing a drawing sheet on the board.	Arithmetic: Fundamental Operation General Simplifications LCM / GCM - Shop problems
3.	Filing flat surface and checking the flatness and squareness with engineers' try square. Filing four edges, checking all dimensions with outside caliper and steel rule	Files-their types, grades, cut, convexity, specifications, their use and care. Chisel its type & uses.	Layout of drawing sheet (Borderline title block etc.) Use of different scales mm., inch	Graph: rules of drawing graph. drawing and reading of simple graph , graph of simple equations and compound equations

4.	Filing adjoining sides/surfaces maintain the right angle between the sides. Marking of parallel lines using dot punch. Chiseling practice as per marking lines	Study of angle plate, parallel blocks, surface plate & their uses. Drill – types, nomenclature, specification, and their functions	Free hand drawings of straight line, rectangle, square, circle, polygon etc.	Square and Square Roots – methods of finding out square roots, Pythagoras theorem, Shop problem.
5.	Making a job on step fitting (Male & female). Marking out the position of holes for drilling. Grinding of drill bits. Use of centre drill for drilling operations. Find out inside and outside diameter and thickness of given pipe using vernier caliper	Common faults on drill grinding and its effect on drilling. Study of drill chuck, drifts, sleeves etc. Introduction of drilling machine its - type, parts & specification. Principle, construction and calculation of least count of vernier caliper, vernier height gauge	Free hand drawing of simple solids such as cube, rectangular blocks, cylinders, cones etc. and their views when viewed perpendicular to their base or axis.	Ratio & Proportion: Shop problems related to ratio, direct and indirect proportion
6	Marking the job using height gauge. Practice of through & blind hole drilling to a specific depth. Practice of enlargement of drill holes, countersinking, counter boring, spot facing and reaming etc.	Principle, construction and calculation of least count of micrometer, bevel protector.	Writing single stroke letters and numbers as per IS: 1972 (II nd Revision).	Percentage: Changing Percentage to Decimal and Fraction and vice versa. Applied problems. Average
7	Grinding practice of drills, chisels and punches etc. Practice of drilling, tapping and dieing of BSW, and metric threads for various sizes. Practice of radius (convex & concave) filing, checking with radius gauge	Uses care and error adjustment of measuring instruments. Calculation of tap drill size.	Same as week No 6	Algebra: Basics, simple equations, simultaneous equations, quadratic equation & shop problems.
8.	Practice of angular filing checking with bevel protector.	Calculation of drilling speed, feed, drilling time etc. Concept of interchangeability system (limit, fits & tolerances).	Geometrical construction on lines, angles and triangles.	Logarithms : Introduction, definition, characteristic & mantissa, how to refer log tables and anti log tables, rules while using logarithms, examples

9	Turning Introduction, types of work done in the section. Lathe -its parts and functions Check it for proper running, cleaning and oiling of various parts. Holding job in four jaw chuck & turning. Grinding rough turning tool.	Shop safety, safety precaution as applied to Section. Lathe-its construction, cleaning and oiling. Lathe chucks – types, construction and uses. Common lathe cutting tools types, shapes and different angles.	Geometrical construction of lines, angles & triangles.	Velocity and Speed: rest and motion, vector quantity ,scalar quantity ,speed, velocity , difference between speed & velocity ,acceleration , equations and laws of motion, , Rotational motion
10	Setting tools in tool post. Facing operation, making the job to specified length and centre drilling. Grinding of lathe tools. Plain turning by holding job in the chuck. Turning specified diameter etc.	Lathe, Accessories, such as centre mandrel, Catch plate and lathe dog, face plate, lathe steady etc. Construction and use.	Geometrical construction of regular polygons.	Metals and Non-metals : Properties of metals , types of metals , difference between ferrous and non ferrous metals , classification of iron : pig iron , cast iron, wrought iron ,Steel: types of steel, difference between cast iron and steel, types of alloy steel, Difference between metal & non-metal
11	Step turnings, Chamfering, Grooving, Grinding of finishing tool.	Common lathe cutting tools roughing and Finishing tool, knife tool, recessing tool etc. Lathe tool material	Conventional representation of common materials.	Heat Treatment :purpose of heat treatment , methods of heat treatment : annealing , normalizing , hardening, tempering, case hardening
12	Drilling on lathe. Drilling through and drilling blind hole. Setting boring tool in tool post. Boring plain, taper, step.	Drills-construction types. Uses of drill Sleeves. Boring tool types Setting of Boring tool.	Isometric drawing of simple blocks	Density and Specific Gravity Mass ,weight , density , relative density , Archimedes's principle , simple experimental determination

13.	Taper turning by swivelling compound rest. Taper turning by method offsetting tail stock. knurling practice	Tapers and its purpose, standard tapers, Different methods of taper turning. Taper calculation, Knurling tool-types, and uses, Advantages and disadvantage of offset Method.	Isometric views of simple solid and hollow Object	Surface Tension and Viscosity : Definition and units Different methods of determination
14.	Thread cutting	Thread purpose and forms. Types of thread & terminology. Calculation of change wheel. Calculation of pitch depth& core diameter, pitches diameter etc.	Same as week No.13	Friction and Lubrication Definition, co-efficient of friction, limiting friction, laws of limiting friction angle of friction, simple problem related to friction, types of lubricant, Advantages and disadvantage of friction
15.	Thread cutting	Same as Week No.14	Orthographic views of simple objects by 1 st angle projection	Force : Newton's law of motion, unit of force , to find out resultant force , representation of force , parallel forces ,couple
16.	Practice on making small parts of instruments, e.g. Nozzle.	Introduction to Precision Watch-maker's Lathe, Different accessories of Watchmaker Lathe, Its care & maintenance	Same as week No.15	Law of parallelogram of forces ,condition of equilibrium ,kinds of equilibrium ,,some examples of equilibrium in daily life, triangle law of forces ,converse of triangle of forces , Lami's theorem, jib crane.
17.	Physics Lab To study parallelogram of forces with the help of mechanical board. Determination of acceleration due to gravity by simple	Moment and Levers : moments, units, arm of couple and moment of couple , types of Levers Simple machines Simple machines , efforts and load , mechanical	Orthographic views of simple objects by 1 st angle projection	Work, Power and Energy. Potential and Kinetic Energy

	<p>pendulum</p> <p>Determination of coefficient of static friction using inclined plane.</p> <p>Determination of mechanical advantage velocity ratio and % efficiency of Simple machine</p> <p>Determination of Young's Modulus by Seattle's apparatus</p>	<p>advantage, velocity ratio , efficiency of machines , their relationship, examples</p>		
18	<p>Determination of coefficient of expansion of solid</p> <p>Determination of coefficient of Thermal conductivity of metal rod</p>	<p>Elasticity,: Introduction , stress and strain , modulus of elasticity, different types of stresses, Hooke's law , Young's modulus , Yield point , ultimate, stress-strain graph , modulus of Rigidity. , poison ratio, bulk modulus, factor of safety, examples</p>	Same as week No.17	<p>Elasticity,: Problems on stress and strain , modulus of elasticity, different types of stresses, Hooke's law , Young's modulus , Yield point , ultimate, stress-strain graph , modulus of Rigidity. , poison ratio, bulk modulus, factor of safety, examples</p>
19.	<p>To study Ohm's law and Kirchoff's law about current and voltage.</p> <p>To study electric cell using series and parallel connections.</p> <p>Determination of specific resistance using wheat stone's Bridge.</p>	<p>Heat and Temperature</p> <p>Heat and temperature and their units , Boiling point, Melting point, temperature scales , specific heat , thermal capacity interchanges of heat , latent heat of fusion , latent heat of vapour , transmission of heat, thermal expansion of solids, liquids and gases , co-efficient of linear expansion , indicated thermal efficiency , brake thermal efficiency , examples</p>	Orthographic views of simple objects by 3 rd angle projection	<p>Heat and Temperature</p> <p>Heat and temperature and their units , Boiling point, Melting point, temperature scales , specific heat , thermal capacity interchanges of heat, latent heat of fusion , latent heat of vapour , transmission of heat, thermal expansion of solids, liquids and gases , co-efficient of linear expansion , indicated thermal efficiency , brake thermal efficiency , examples</p>

20	<p>Verification of faraday's First law of electrolysis.</p> <p>Determination of mechanical equivalent of heat using electrical method</p>	<p>Electricity :current, voltage Use of fuses and switches , conductors and insulators , simple electrical Circuits , Ohm's law , electrical insulating Materials, Kirchoff's law, examples, Parallel and series circuit connections. Wheatson's bridge potentiometer. Electrolysis, conservation of electrical energy into heat energy, Joule's law. mechanical equivalent of heat</p>	Same as week No.19	<p>Electricity Simple electrical Circuits , simple calculations, Ohm's law ,simple calculation , electrical insulating Materials, Kirchoff's law, examples, Parallel and series circuit connections. Wheatson's bridge potentiometer. Electrolysis, conservation of electrical energy into heat energy, Joule's law. mechanical equivalent of heat</p>
21 to 23	<p>Welding (Gas) Introduction- Importance of trade, types of work done. Demonstrate about general safety, personal safety, & precautions - observed during gas welding. Procedure of fire prevention and fire control in gas welding workshop. Safety equipment's and their uses. Lighting and adjustments of flame. Fusion runs with and without filler rod.</p>	<p>Introduction to general safety, personal safety, & precautions observed in the gas welding workshop. Fire prevention and fire control in gas welding workshop. Importance of welding in the maintenance of chemical plant and equipment's. Description and uses of tools and equipment's used. Welding terms and their definitions</p>	<p>Drawing of different types of thread forms, rivet heads, keys, and coupling.</p>	<p>Mensuration: Introduction , Rectangle, Square, Parallelogram, Trapezium , Rhombus, Triangles , Radius of larger holes that can be inscribed in a given triangle , Pentagon , Hexagon, Circle , Sector , segment of a Circle , Ellipse, length of Belts ,Area of irregular Surface .</p>
24	<p>Practice of edge joint with or without filler rod.</p>	<p>Welding methods and types of welding, welding terms and definitions. Common used gases in welding - Oxygen, Hydrogen, Acetylene, CO₂ gas etc.. Colour coding of gas cylinders for identification. Chemistry and types of flame.</p>	<p>Drawing of different types of riveted joints such as lap and butt joints</p>	<p>Same as week No.23</p>
25	Project Work / Industrial Visit (Optional)			
26	Examination			

**Syllabus for the Trade of
 “INSTRUMENT MECHANIC (CHEMICAL PLANT)” under C .T.S.
 (Semester Code No. IMC-02)**

SEMESTER – II

Week No.	Trade Practical	Trade Theory	Engineering Drawing	Workshop Calculation & Science
01	Practice on outside corner joints, fillet weld inside corner joint.	Introduction to oxy-acetylene welding and its equipments such as regulators, blow pipes etc. Assembly, care and maintenance of gas welding equipments	Drawing of different types of locking devices such as double nut, castle nut, pin etc	Same as week No.24
02	Practice on Pipe butt joint & Pipe T-joint.	Oxygen cylinder, Acetylene cylinder, Description methods of charging and care. Faults in gas welding. Definition of faults, their effects, causes, correction	Same as week No 01	Same as week No.24
03	Practice of hard surface stiling. Brazing of similar metals. Straight cutting by gas.	Hard facing-necessity, types, ethods application. Destructive test, stiling-necessity, type flame adjustment-methods and applications. Methods employed to control distortion and stress relieving.	Construction of Isometric scales and drawings. Isometric Projection of simple solids etc.	Finding out volumes of solids: cube, rectangular solid, cylinder, hallow cylinder, sphere, hallow sphere, hemisphere, cone, frustum of cone, prism.
04	P.V.C. Welding, all types joints on sheets 3mm, 4 mm, 6 mm. P.V.C. Welding pipe, Flange, elbow and Tee etc. Practice of different PVC/HDPE welding process.	Definition of P.V.C./ HDPE, its type properties and uses. Different methods of plastic welding.	Same as week No 03	Same as week No.03

05	Welding (Arc) Straight line beads on M.S. Plate. Open corner joint M.S. Plate Outside and inside joints. Single 'V' Butt joint.	Description and use of tools and equipment used in Arc welding. Types of electric welding Principle of arc welding types of welding and their advantages. Welding machine care and maintenance. Electrodes, types, method of coating, flux, characteristic I.S.I. specification	Orthographic views of objects by 1 st angle projection	Same as week No. 03
06	Advanced welding (TIG & MIG) with all types of joints	Theory of Advanced Welding (TIG & MIG)	Same as week No 05	Same as week No. 03
07	Instrumentation Calibration of (i) Bourden tube pressure gauges (ii) Manometers	Units of pressure, measurement of pressure by different methods	Orthographic views of objects by 3 rd angle projection.	Same as week No. 03
08	Calibration of (i) Diaphragm type pressure gauge. (ii) Vacuum gauge (iii) Compound gauge	Same as WeekNo.03	Same as week No 07	Trigonometry- Trigonometrically ratios, use of Trigonometrically tables , area of triangle by trigonometry, problem based on trigonometric table (sine, cosine, tangent tables)
09	Calibration of Alcohol in glass thermometer Calibration of mercury in glass thermometer	Temperature scale, different methods of temperature measurement.	Sectional view of simple objects such as brackets, bearings etc.	Same as week No.08
10	Calibration of gas filled thermometer. Calibration of bimetallic thermometer	Same as Week No.09	Same as week No 07	Same as week No.08

11	Testing of a Resistance thermometer Testing of Thermocouple	Same as Week No.07	Revision and more exercises on orthographic views of machine parts such as bearing brackets etc.	Finding height and distance by trigonometry, application of trigonometry to shop problems Problems on measurement of liquid quantity by change in height of liquid
12	Study of quantity meters, Orifice meter, Rotameter	Flow Measurement	Same as week No 11	Pressure : Types of pressure, Atmospheric pressure, Vacuum pressure, gauge pressure & absolute pressure and its units, pressure measuring devices
13	Experiments on a level measurement. Experiment on hydrometer Calibration of PH meter	Different Methods of Level Measurement	Free-hand sketches of Hand Tools, Screw drivers, Plier, Spanner, Tweezer. Free-hand sketches of Vernier Caliper, micrometer, Depth Gauge, Dial Test Indicator, Bevel protractor	Balancing of chemical equation.
14	Study of diaphragm control valve, Calibration of control valve Study of recorders transmitters and controllers	Final control elements, Recorders, Transmitters, Controllers	Same as week No.13	The mole & pH calculation. Material balance without chemical reaction.
15	Chemistry: Separation of mixture of liquids by distillation. To study the properties of FeS mixture and FeS compound.	Introduction to Chemistry, Introduction to radio-activity Atomic structure Classification of elements Electronic theory of valency Law of mass action Electrolysis and Catalysis	ISI symbols of Generator, Voltmeter, Ammeter, Watt-meter. of Resister, Inductor, Capacitor, Transformer, AC & DC motors.etc. Drawing of pressure control process line.	Avogadro's Hypothesis (conversion of mass into volume of chemicals)

16	Preparation of following – a) soap b) Nitrobenzene c) Aniline d) Copper sulphate & e) Ferrous ammonium sulphate	Metallurgy-General Principle and processes Metallurgy of Copper, aluminum Zinc, Iron & Steel.	Drawing different types of pipeline diagram, pipe fitting symbols.	Atomic, Molecular & Equivalent Weight
17	To study the allotropic forms of sulphur To study action of pure salt water on metals and alloys.	Introduction to organic chemistry,	Free hand sketching of pipe joints and fittings.	Percentage composition, Empirical formula & Molecular formula
18	To study the corrosion of metals. To study action of acids and bases on metal alloys.	Organic reaction, IUPAC nomenclature and functional groups	- -do-	-do-
19 to 21	Analysis and Treatment of Effluent Water Volumetric analysis. Qualitative analysis (Inorganic) (Simple without interfering radicals)	Introduction to aromatic compounds	Free hand sketches of - Electrolytic Analyser - P ^H meter - Redwood Viscometer - Microscope	Percentage Purity.
22 to 24	Determination of Flash point. Determination of pH (by Lovibond)	-do-	Free hand sketches of Block Diagram of - Photo colorimeter - Flame Photometer Spectrophotometer	- -do-
25	Project work / Industrial visit (Optional)			
26	Examination			

Syllabus for the Trade of
“INSTRUMENT MECHANIC (CHEMICAL PLANT)” under C .T.S.
(Semester Code No. IMC-03)

SEMESTER – III

Week No.	Trade Practical	Trade Theory	Engineering Drawing	Workshop calculation & Science
01	Introduction to the training. Familiarization with the institute. Layout of shop equipment & machineries. Syllabus, system of training, Examination, Types of work done by the trainees. Familiarization with the institutional Rules, discipline, cleaning & forming those habits. Study on cells connected in series, parallel as well as in combination. Determination of current and voltage.	Organization of the Institute, Departments various trades & functions. Types of work, responsibility to be undertaken, incentives and future planning of profession. Safety precautions to be observed in the trade both during ‘theoretical Periods’ and ‘Practical hours/workshop hours’	Revision of orthographic view of objects 1 st and 3 rd angle projection	Introduction of unit processes in chemical industries .Importance and use of symbols , colour coding , block diagram , flow sheeting & specification sheet in chemical process industries
02	Study on cells connected in series, parallel as well as in combination. Determination of current and voltage Verification of Faraday's first law of Electrolysis. Precautions to be observed in performing experiments	Basic Electricity: Electricity by chemical method type of primary cell, Storage Battery, Lead acid cell, Alkaline cell, Lithium cell etc. Faraday's Law of Electrolysis: Explanation, Objective, Procedure.	Same as week No 01	Process classification, raw materials, chemical reactions, manufacturing process description, flow sheet and uses of Sulphuric acid
03	Familiar with Digital & Analog Multimeter. Connections of Simple circuits	Connections of Simple circuits using Ammeter, Voltmeter, Wattmeter with electrical	Same as week No 01	Process classification, raw materials, chemical reactions,

	using Ammeter, Voltmeter, Wattmeter with electrical components in series, parallel and combinations. Photo electric cell principle & working.	components in series, parallel and combinations. Photo electric cell principle & working		manufacturing process description, flow sheet and uses of Soda ash
04	Verification of Ohm's Law, Kirchhoffs law, precaution to be observed while experimenting the laws, Construction of circuits with choke, transformer, relay. capacitor etc.	Introduction to Ohm,s law and Kirchoff's law. Resistance: Type of resistors, their materials, colour code and uses. Combination of resistance series and parallel Inductance: Self, Mutual Induction-Inductors, Transformers, Relays, Capacitance: Type of capacitors	Same as week No 01	Process classification, raw materials, chemical reactions, manufacturing process description, flow sheet and uses of Caustic Soda and Chlorine
05	AC & DC supplies, Units of Electricity. Measuring of current, voltage in the circuit construct, making of electric bell, Alarm, power circuits	Principle of Motor: AC and DC Motors, type and uses in chemical plants.	Drawing sketches of different types of valves, such as gate valve, globe valve, ball valve, Plug Valve, check valve etc.	Process classification, raw materials, chemical reactions, manufacturing process description, flow sheet and uses of Nitric acid
06	Use of electrical meters in measuring and their care and maintenance Use of electrical test equipments. e.g. for measuring the current, voltage etc. Wattmeter, Meger, Energy	Moving Coil & Moving Iron Instruments: Ammeter, voltmeter, extension of range. Ohm meter, Wattmeter, Meger construction, range, sensitivity, accuracy, damping etc.	Same as week No 05	Process classification, raw materials, chemical reactions, manufacturing process description, flow sheet and uses of ammonia

07	Study the characteristics of Semiconductor. conductor, & Insulator. Making of DC power supply, smooth and regulated output	Introduction to Semiconductor Devices: semiconductor materials- Intrinsic & Extrinsic, P type & N-type materials, charge carriers	Drawing sketches of different types of valves, such as Needle valve, Plug Valve, check valve, diaphragm valve etc.	Process classification, raw materials, chemical reactions, manufacturing process description, flow sheet and uses of urea
08	Practice on making Different circuits and transistorized amplifiers by soldering on Vero board	Bipolar Transistors: PNP, NPN, types- amplifier circuits, classification, Biasing, coupling, FET, UJT, MOSFET	Same as week No 07	Process classification, raw materials, chemical reactions, manufacturing process description, flow sheet and uses of Soap and Glycerine
09	Experiments on Logic Gates : AND, NAND, OR, NOR, XNOR using Digital IC- Trainer, Preparation of truth table.	Introduction to digital electronics: Binary and Hexadecimal number Systems: Logic gates, Circuits, Truth Tables. BCD coding systems.	Drawing sketches of different types of pumps such as centrifugal, reciprocating and rotary pump ,etc	Process classification, raw materials, chemical reactions, manufacturing process description, flow sheet and uses of Portland cement
10	Experiments on IC 555/IC 556, IC 741 with IC-Trainer Study of Digital ICs on digital trainer Kit, conversion of Analog to Digital, Digital to Analog	Introduction to Integrated Circuits: Timer IC, OPAMP etc. their functions, ICs used in various Instruments. Introduction to Microprocessor: Introduction to Computer. Arithmetic Logic unit, Memory, CPU, ROM, RAM, EPROM, etc	Same as week No 09	Process classification, raw materials, chemical reactions, manufacturing process description, flow sheet and uses of sugar

11	Soldering Practice. Using OP-Amp circuits of Astable, Monstable, Bistable multivibrators, Study by Oscilloscope Working in PCBs on different circuits, mounting of components, Precautions to be observed while soldering sensitive components on PCBs	Operational Amplifiers and their use in Instrumentation, Principle, operation & function of CRO. Application of ICs in various instruments, Recorders and controllers	Same as week No 09	Process classification, raw materials, chemical reactions, manufacturing process description, flow sheet and uses and ethyl alcohol
12	Dismantling and assembling of pressure Gauge, Testing of Pressure indicators with Standard Calibrator/Dead weight Tester, Precaution to be observed while testing	Study of different types of sensors & signal systems. Pressure Measuring Instruments: Definition of pressure, Barometric Pressure, Gauge Pressure, Differential Pressure, Absolute Pressure, their units. Different type of Pressure measuring Instruments, Manometers, Barometers	Drawing of Different types of symbols used in chemical industry	Petroleum & petroleum refining crude oil & its origin and classification, distillation of crude
13	Dismantle the pressure gauge and study the construction, adjustments for correct functioning.	Construction and principle of operation for various pressure gauges. Importance of calibration in Metrology.	Same as week No 12	unit process involved in petroleum refining, properties of uses of petroleum products
14	Calibration of compound pressure gauges/ Vacuum gauges. Calibration of Absolute pressure Gauge. Calibration of Aneroid Barometer	Compound pressure gauges/Vacuum gauges: Its construction uses Principle of operation, construction of Absolute Pressure Gauge Aneroid Barometer	Same as week No 12	Water: Mineral matter, Hardness, Causes of Scale formation & their Removal. Water Treatment & Types of Water used in Industry
15	Calibration of 1. Filled System Temp. Indicator	Measurement of Temperature: Liquid Expansion Type-Mercury in glass	Free hand sketches of different types of Shell and	Boiler feed water treatment and sewage waste water treatment

	2. Bimetallic Thermometer	thermometer, steel thermometers, Alcohol in glass thermometer. Solid Expansion Type- Bimetallic thermometers. Vapour Pressure thermometers.	tube Heat Exchanges / Evaporators. / Distillation Column.	
16	Calibration of Alcohol Thermometer, Maintenance & reconditioning of Thermocouple, Testing of Thermocouple and Resistance Thermometer, thermistor Characteristic.	Thermocouple & RTD Thermistor, their ranges, construction, principle of operation, compensating leads,	Same as week No.15	Global Warming & climate changes and their effects on human life , agriculture ,plants and animals
17	T.C.pyrometer. Calibration of Temperature measuring instruments using electronic temperature calibrator	Recorders , pyrometers etc. introduction of electronic temperature calibrator	Free hand sketching of spur, helical and bevel gears.	Effluents and Environmental Issues (Air & Water, noise, radiation Pollution).Solid, liquid and gaseous pollutants Sources of air , water, noise, radiation pollutions & their effects
18	Calibration of Temperature switch Calibration of Thermostat	Calibration of temp. instrument	Same as week No.17	Effluent Treatment (Water & Air Pollution). Effluent: Types, Sources of effluent, effluent Analysis & Treatment
19	Potentionmetric Recorder. Single point & Multiple Point Recorder	Potentionmetric Recorder	Layout diagram, connection of DP cell (electronic)	Equipments used to control water and air pollution in chemical industries

20	Optical Pyrometer Radiation Pyrometer	Pyrometry. Molecular activity and lectromagnetic radiation, defining pyrometry, effects of emittance,	Process diagram PI controllers,	Corrosion : different types of Corrosion ,
21 to 22	--do--	--do--	diagrams of PID process	Method of Prevention
23 to 24	Digital Temperature Indicator	effects of temperature, radiated energy, pyrometers and wave lengths, using of optical and radiation pyrometer	-do-	-do-
25	Project work / Industrial visit (Optional)			
26	Examination			

**Syllabus for the Trade of
“INSTRUMENT MECHANIC (CHEMICAL PLANT)” under C .T.S.**

FOURTH SEMESTER

(Semester Code No. IMC-04)

Week No.	Trade Practical	Trade Theory	Engineering Drawing
01	<p>Level Study construction of Hook type, Sight glass and Float type level measuring instruments of close and open tank.</p> <p>Static pressure level measuring instruments, Bubbler system for close and open tank. differential pressure measurement</p> <p>Diaphragm & Air Trap</p>	<p>Units, Liquid Level Measurement. Direct & Indirect level easurement , The principle of operation, use and construction of Hook type, Sight glass type,. Air purge system.</p>	<p>Revision of orthographic view of objects 1st and 3rd angle projection</p>
02	<p>Differential pressure type level checking calibration of Electronic Level Indicators., Ultrasonic, Calibration of Capacitance type Level Indicator & transmitter</p>	<p>Electronic Level Measuring Instrument: Variable capacitance, Ultrasonic and Magnetic type level indicators & Switches , Radar Type Level Measurement, Level measurement by Load cell.</p>	<p>Same as week No 01</p>
03	<p>Flow</p> <p>Study of orifice plates, Flow nozzles, Pitot tubes, Venturi heads, their shape and connections etc.</p>	<p>Measurement of Fluid Flow: Units, Primary elements used for rate of flow measurement – like orifice meter & venture meter, Rota meter- its type.. Quantity Flow Measurement.</p>	<p>Same as week No 01</p>
04	<p>Study of piston type, Rotating vane meter, Nutating discmeter. Rota meter.</p>	<p>Volumetric type, Gas flow meter, magnetic flow meter, ultrasonic flow meter. Turbine Flow Meter, Mass Flow Meter, Reynolds number.</p>	<p>Same as week No 01</p>
05	<p>Study construction of DP Transmitter pneumatic type, Calibration of DP Cell (Pneumatic) its range changing, Zero adjustment etc. Calibration of Pressure Transmitter,</p>	<p>Telemetry: Types of Pressure transmitters, principle of construction of different Pneumatic & Electronic Transmitters. Safety practices for DP transmitter mounting & Maintenance.</p>	<p>Free Hand Sketch of Process Flow Sheet of Manufacturing of Sulphuric Acid</p>
06	<p>Reconditioning and Calibration of I to P and P to I converters Reconditioning of Press. Safety Valve.</p>	<p>Converters: Principle, Construction, operation of I to P, and P to I Converters, Study of Press. Safety valve. Electronic Manometer.</p>	<p>Free Hand Sketches of Process Flow Sheets of Manufacturing of Ammonia</p>

07	Calibration Of Flow Meter/Transmitter, Rotameter transmitter, Calibration of Temperature transmitter.	Types Of Temperature Transmitter, Types Of Flow Transmitter, Level Transmitter ,Types Of Temp, Flow & Level Indicator.2-wire ,3-Wire& 4-wire Transmitter	Free Hand Sketches of Process Flow Sheets of Manufacturing of Urea
08	Calibration of mechanical recorders, adjustment of time travels, changing of charts, ink, minor rectification/repairing. Find out errors and adjustment	Theory of Integrating system in recording processes variables, Multi-pens recorder and cam arrangements	Free Hand Sketches of Process Flow Sheets of Manufacturing of Sugar
09	Reconditioning of Strip Chart & Circular chart recorders Providing different type of recorders trainees to check calibrate individually	Electrical & Electronic Recorders-principle of operations, recording system, chart motor, ink, pen, moving element etc. Punching and Dot systems, Errors and Adjustment	Free Hand Sketches of Process Flow Sheets of Manufacturing of Ethyl Alcohol
10	Calibration of Smart transmitter and its adjustment. Calibration Of HART Devices.	Smart devices, HART transmitters , Its advantages & applications. HART protocol. HART communicators and PC based HART device configuration. Steps in calibration of HART devices.	Free Hand Sketches of Process Flow Sheets of Manufacturing of Caustic Soda and Chlorine
11	Study the construction, Identification of components of ON-OFF type controller, Testing and Calibration of ON-OFF type control system with any one parameter.(Temp, Flow, Level & Press)	Controller's:(Analog & Digital) Open loop, Closed loop, Feedback control system, Modes of control system, ON-OFF control system, its operation, function, advantages & disadvantages.	Free Hand Sketches of Process Flow Sheets of Manufacturing of Soda Ash
12	Check calibration of proportional Controller, reconditioning, adjustment, setting of proportional Band. Setting of Reset Action & proportional Band, Check calibration of controller.	Proportional Controller: Principle of construction, operation, Proportional Band-Setting, adjustment. Proportional with Rest action, effect of reset, rate of proportional action	Free Hand Sketches of Process Flow Sheets of petroleum refining process
13	Observe the step response, frequency response, lead and Lag on PID controller using Simulator. Repair/Reconditioning of Electronic controllers, Testing and calibration of PID controllers.	Control Lag, Step and Frequency response, Derivative action of PID controller. Principle of Electronic controller, study of circuit diagram, components, method of calibration	Free hand flow Sheet of Manufacturing of Soap and Glycerine

14	Dismantling, reconditioning, checking and resetting of diaphragm control valves, calibration of diaphragm control valve. Leak test, replacement of valve parts like diaphragm, sealing rings, plugs etc. Lapping of valve seats, plug leakage test, calibration of valves. Erection of valve positioner.	Final control element valve, Globe valve, diaphragm valve its function, parts, setting range, calibration etc. Pneumatic control valves, Role Of pneumatic valve positioner solenoid valve.	Free Hand Sketches of Process Flow Sheets of Manufacturing of Portland Cement
15 & 16	Understanding the function of PLC and concept Basic small programs on PLC – logic gates preparation Small programs on timers and counters. Industrial visit for understanding SCADA and DCS operating controlling system.	Introduction to programmable controllers. History of programmable controllers, general characteristics of programmable controllers, some limitation of PLCs, method of developing PLC programming, Types of PLC Input/output devices. Definition of input/output devices, I/O interface, input modules, output modules, input devices encoders	Instrumentation Diagram of a Distillation Column, Instrumentation Diagram of an Evaporator & Tray Drier
17 & 18	Study of SCADA. Industrial visit for understanding SCADA and DCS operating controlling system.	Basic SCADA & DCS	Drawing of pressure, Level, flow and temperature control system.
19	Calibration & Maintenance Of following Instruments:- 1). PH-Meter 2). Conductivity Meter 3) Flame Photo Mete	Study of Analytical Instruments:- Ph-Meter, Conductivity Meter, Flame Photo Meter.	Same as week No. 18 Free-hand sketch of Analytical Balances
20	Calibration & Maintenance Of following Instruments:- 4) Weighing Balance 5) Flash Point apparatus	Study of Analytical Instruments:- , Weighing Balance, Flash Point apparatus, Viscosity Meter.	Same as week No. 18 Free-hand sketch of Analytical Balances
21 to 22	Calibration & Maintenance Of following Instruments:- 1) Calorimeter, 2) Spectrometer, 3) Photo calorimeter,	Study of Analytical Instruments:- 1). Calorimeter, 2). Spectrometer, 3). Photo calorimeter,	Free-hand sketch of laboratory glass apparatus

23 to 24	Calibration & Maintenance Of following Instruments:- 4) Flame photometer 5) Refractometer, 6) Polarimeter,	Study of Analytical Instruments:- 4) Flame photometer 5) Refract meter, 6) Polarimeter,	-do-
25	Revision		
26	Examination		

**LIST OF TOOLS & EQUIPMENT FOR
“INSTRUMENT MECHANIC” (CHEMICAL PLANT)
BATCH OF 16 TRAINEES**

A. TRAINEES TOOL KIT

Sl. No.	Name of the item	Quantity
1	Steel Rule 15 cm both side Graduated in Metric & English.	17 nos.
2	Center punch 100 mm	17 nos.
3	File flat Bastard 300 mm	17 nos.
4	File flat 2 nd cut 250 mm	17 nos.
5	File flat bastard 350 mm	17 nos.
6.	File flat smooth 200 mm	17 nos.

B. General Machinery Shop Outfit (As Per The Table)

1.*	Surface plate 600 x 600 x 80 mm	1no.
2.*	Scribing block universal 300mm	2
3.*	Marking table 910mm x910mmx(1220mm high)	1nos.
4.*	Vee –blocks pair with clamps 150mm	2 nos.
5.*	Combination set 30mm	2 nos.
6.	Vice 100mm	20 nos.
7.*	Drill twist (straight shank) 6 mm to 16 mm by 1mm	3 set
8.	H.S.S. hand reamers 5 to 8 mm by 1 mm	1 set
9.*	Workbench 240 cm x 120 cm x 75 cm with 150 mm vice (Each bench fitted with 4 vices)	4 nos.
10.*	Almirah	1 no.
11.	Tool boxes of drawers fitted in the working bench	20 nos.
12.*	Punch letter set of 5 mm	1 no.
13.*	Punch number setoff 5 mm	1no.
14.	Taps and dies complete set in box – M6	1set
15.*	File flat 300mm bastard	2 nos.
16.	File flat 250mm 2 nd cut	2 nos.
17.*	File flat 250mm smooth	2 nos.
18.*	File three square 150mm 2 nd cut	2 nos.
19.*	File flat 150mm smooth	2 nos.
20	Chisel cold flat 15mm	4 nos.
21	Chisel cross cut 6 mm	4 nos.
22	Micrometer outside 0-25mm	4 nos.
23	Micrometer inside 50mm to 200mm	2 nos.
24	Vernier 24alipers 300mm	2 nos.
25	Radius Gauge 0-25mm	1no.
26.	Center gauge 55° and 60 °	1 each
27.	Knurling Tool	2 nos.
28.	Centre drill Ø3 mm	2 nos.
29.	Set of sockets (Morse Taper) (0-1, 1-2, 2-3)	1 each
30.	4 jaw chuck (Independent)	2 nos.
31.	3 jaw self centering chuck (125 mm)	2 nos.
32.	Set of tools for lathe	2 nos.
33.	Lathe dog 15mm to 40mm	2 nos.
34.	Drill chuck 0 to 15mm with Morse Taper shank	1 no.

35.	Grease pressure gun (Hand operated)	1 no.
36.	Welding helmet	4 nos.
37.	Welding goggles	4 nos.
38.	Welding Table (Metal top)1220mmx 120mm x 600mm with positioned	4 nos.
39.	Welding gloves	4 pairs
40.	Tachometer	1no.
41.	Tap extractor 3 mm to 12 mm x 1.5 mm	1 set
42.	Screw extractors sizes 1mm to 3mm	1 set
43.	Tools bit holder as Armstrong straight	4 nos.
44.	Engraving machine model ,complete with accessories and two sets of master numbers and alphabets	1 no.
45.	Temperature calibration bath(dry)	1 no.
46.	Instrument testing bench with cupboards	4 nos.
47.	Piler combination 120mm	4 nos.
48.	Piler long nose 100mm	4 nos.
49.	Piler side cutting insulated 150mm	4 nos.
50.	Nipper side cutting 100mm	4 nos.
51.	Tweezers fine point 120mm	4 nos.
52.	Vice for drilling machine 100mm	1 no.

C. PHYSICS LABORATORY

Sl. No.	Name and description of the item	Quantity
1	Physical balance (with weight box)	3 sets
2	Chemical balance (with weight box)	3 sets
3	Viscometer :	
	(a) Oswald viscometer	3 pieces
	(b) Redwood viscometer	3 pieces
	(c) Stop watch (1/10 th Secn)	6 pieces
	(d) Thermostatic bath	2 pieces
4	Talagnometer	6 pieces
5	Travelling microscope	2 nos.
6	Specific gravity bottle	6 nos.
7	Pyknometer	6 nos.
8	Mechanical board for testing triangle and parallelogram of forces including all accessories	6 sets
9	Spirit level	3 sets
10	Inclined plane with pulley, pan, weight etc.	2 sets
11	Simple machines (Wheel and axle), screw jack inclined plane with roller or trolley, pulleys or pulley blocks for first, second and third system of pulleys).	1 set
12	Different types of levers	1 set

13	Instrument for determining 'g' (simple pendulum).	2 sets
14	Barometer	1 no.
15	Altimeter	1 no.
16	Searle's apparatus for young's, modules, modules	2 sets
17	Nicholson's Hydrometer with glass jag	2 sets
18	Wet and dry bulb thermometer	2 sets
19	Apparatus for measurement specific heat of solid and liquid (Renault's Apparatus).	2 sets.
20	Apparatus for measurement of coefficient of expansion (thermal) of solid and liquid.	2 sets.
21	Apparatus for measurement of thermal conductivity of good and bad conductor	2 sets
22	Calorimeter for determining mechanical equivalent of heat and specific heat.	4 sets.
23	Thermometers :	
	(i) 0 to 110C	6 nos.
	(ii) 0 to 210 C	6 nos.
	(iii) 0 to 300 C	6 nos.
24	Polarimeter with monochromatic light	2 sets
25	Abbe refractometer	2 sets
26	Pulfrich refractometer	2 sets
27	Equipment to study Kirchhoff's law and Electrochemical equivalent	1 set
28	Potentiometer	2 sets
29	Whetstone's bridge	2 sets
30	Resistances Centre zero galvanometer	4 nos.
31	Resistance box : (a) Resistance box 0 to 100 ohms (b) Resistance box 0 to 500 ohms.	2 nos. 2 nos.
32	Rheostat : a) Rheostat 25 Ohms b) Rheostat 100 Ohms c) Rheostat 500 Ohms	2 nos. 2 nos. 2 nos.
33	Ammeter : a) 0 to 1 Amp (DC) b) 0 to 5 Amp (DC) c) 0 to 10 Amp (AC, DC) d) 0 to 30 Amp (AC, DC)	2 sets 2 sets 2 sets 2 sets.
34	Volt meter : a) 0 to 1 volt (DC) b) 0 to 5 volt (DC) c) 0 to 25 volt (DC) d) 0 to 50 volt (DC) e) 0 to 100 volt (DC) f) 0 to 250 volt (DC)	2 sets 2 sets 2 sets 2 sets 2 sets 2 sets
35	millivoltmeter : a) 0 to 5 mV b) 0 to 50 mV Digital millivoltmeter: a) 0 to 200mV	2 no. 2 no. 2 no.
36	Resistance coils (5 Ohms, 10 Ohms, 50 Ohms,100 Ohms)	2 sets

37	PH meter	1 set
38	Charger for battery (lead acid accumulator)	1 set
39	12 volt hand operated Dynamo lachlanche denial cell, Weston cell, acidic cell, accumulator, alkali cell with enable resistances	2 sets.
40	Multimeter Analog & Digital	2 each
41	Battery eliminator	2 nos.

Note : (1) All electrical equipment should be provided with extra 20 meter wire, switcher, terminals for Connection.

(2) All electrical equipment in connection with heat must be provided with necessary thermometer

*** Common to Chemical Trade group including AOCp/MMCP/IMCP/LACP**

**LIST OF TOOLS & EQUIPMENT FOR
"INSTRUMENT MECHANIC" (CHEMICAL PLANT)
A BATCH OF 16 TRAINEES**

A. Trainees Tool Kit

Sl. No.	Name and description of the item	Quantity
1.	Bourdon Tube Pressure Gauges Different Ranges	2 each
2.	Compound Gauge	2 No.
3.	Diaphragm Type Pressure Gauge	2 No.
4.	Dead Weight Tester with Assoceries	1 nos.
5.	Comparator with Assoceries & STD Pressure Gauges	1 no.
6.	Thermocouple Type K, J,I,T	2 each
7.	Digital Millivoltmeter	2 nos.
8.	Mercury in Glass Thermometer	4 no.
9.	Alcohol in Glass Thermometer	2 No.
10.	Filled System Temperature Indicator	2 nos.
11.	Bimetallic Thermometer	2 nos.
12.	Resistance Thermometer (Pt-100)	6 nos.
13.	Heating plate (electric) 1000 watt	4 no.
14.	Thermostatic bath	2 pieces
15.	T.C. Pyrometer	2 N0.
16.	Digital Multimeter	4 No.
17.	Pressure regulating Valve	2 No.
18.	Quantity meters, Orifice meter ,Rotameter	1 each
19.	Circular chart Recorder	2 No.
20.	PH meter	1 No.
21.	Diaphragm control valve, Air to open	1 No.
22.	Diaphragm control valve, Air to Close	1 No.
23.	Capacitance Type Level Transmitter	1 No.
24.	Pressure Transmitter	1 No.
25.	On off Controller	1 No.

B. General machinery shop outfit (as per the table)

Sl. No	Name and description of the item	Quantity
1.	Analytical balances of different makes (with rider, optical reading, one pan analytical balance)	2 nos.
2.	Digital balance	5 nos.
3.	Balance (tech.) to 1 kg.	1 no.
4.	Electric drying ovens (200°C)	2 nos.
5.	Water baths(6 places)(electrically heated)	4 nos.
6.	Sand bath (to be fabricated)	1 no.
7.	Stirrers with motors, 230V, AC, capacity 5 – 7 liters	8 nos.
8.	Magnetic stirrers (with heating plate) 2 liters capacity	2 nos.
9.	Mortar , 100mm, porcelain with pestle	6 nos.
10.	Heating plates (electric) 1000 watt	1 no.

11.	Desiccators 150 mm. dia.	20 nos.
12.	Desiccators vacuum	2 nos.
13.	Spoons plastic	24 nos.
14.	Apparatus for determination of flash point	1 no.
15.	Bunsen's burners	30 nos.
16.	Steam generator (copper) for steam distillation	10 nos.
17.	Hot water funnel	10 nos.
18.	Glass tubes & rods of different diameter	100 kg.
19.	Rubber tubes for water, gas & vacuum, stopper, rubber each glass, plastic & cork of different sizes	20 m
20.	Tongs (forceps) nickel for crucibles & weights	24 nos.
21.	Tongs long for crucibles (muffle furnace)	6 nos.
22.	Spatulas nickel	20 nos.
23.	Test tube stand for 10 – 12 test tubes	24 nos.
24.	Tripods	40 nos.
25.	Asbestos wire gauge	30 nos.
26.	Wire gauge (without asbestos)	30 nos.
27.	Cork rings	24 nos.
28.	Test tube holders	24 nos.
29.	Clamp holders	48 nos.
30.	Clamps	48 nos.
31.	Rings with clamps for filtering & heating	48 nos.
32.	Stands	48 nos.
33.	Stands with clamps for burettes	24 nos.
34.	Pipe clay Triangles	48 nos.
35.	Goggles	26 nos.
36.	Apparatus for distilling for demineralising water	1 no.
37.	Crucible nickel 30 mm. dia, height 40 mm., rabless brushes, liquid soap, acid cleaning mixture for glassware, glass wool, etc.	6 nos.
38.	Erlenmeyer flasks 250 ml.	48 nos.
39.	Burettes 25 ml.	24 nos.
40.	Pipettes 10 ml.	48 nos.
41.	Pipettes 25 ml.	48 nos.
42.	Pipettes measuring 0 to 5 ml.	6 nos.
43.	Pipettes measuring 0 to 10 ml.	10 nos.
44.	Pipettes measuring 0 to 1 ml.	6 nos.
45.	Pipettes micro 0 to 0.2 ml.	6 nos.
46.	Pipettes 1ml. (graduated)	12 nos.
47.	Flasks for distilled water 500 ml.	30 nos.
48.	Measuring cylinders 25 ml.	10 nos.
49.	Measuring cylinders 50 ml.	24 nos.
50.	Measuring cylinders 100 ml.	24 nos.
51.	Measuring cylinders 250 ml.	24 nos.
52.	Measuring cylinders 500 ml.	12 nos.
53.	Measuring cylinders 1000 ml.	16 nos.
54.	Volumetric flask 100 ml.	24 nos.
55.	Volumetric flask 250 ml.	24 nos.
56.	Volumetric flask 500 ml.	24 nos.
57.	Volumetric flask 1000 ml.	12 nos.
58.	Weighing bottles polyethylene or glass 50 ml.	24 nos.

59.	Weighing bottles polyethylene or glass 100 ml.	12 nos.
60.	Funnels with regular & long stem 7 cm. dia.	24 nos.
61.	Funnels 4 cm. dia.	24 nos.
62.	Funnels 9 cm. dia.	24 nos.
63.	Funnels separatory 100 ml.	12 nos.
64.	Funnels separatory 250 ml.	12 nos.
65.	Funnels for filter crucibles & Gooch crucibles with rubber rings	24 nos.
66.	Beakers 100 ml. Corning	48 nos.
67.	Beakers 250 ml. Corning	48 nos.
68.	Beakers 400 ml. Corning	48 nos.
69.	Beakers 600 ml. Corning	24 nos.
70.	Beakers 1000 ml.	12 nos.
71.	Watch glasses 5 cm.dia.	24 nos.
72.	Watch glasses 7.5 cm.dia.	48 nos.
73.	Watch glasses 10 cm.dia.	48 nos.
74.	Dishes evaporating 5 cm. dia. porcelain, glass	12 nos.
75.	Dishes evaporating 7.5 cm. dia.	24 nos.
76.	Dishes evaporating 10 cm. dia. flat bottom	24 nos.
77.	Thermometers 0 to 110°C	24 nos.
78.	Thermometers 0 to 250°C	12 nos.
79.	Boiling flasks with round bottom 100ml.	24 nos.
80.	Boiling flasks with round bottom 250ml.	24 nos.
81.	Boiling flasks with round bottom 500ml. for each distilling flasks 50 ml., 100 ml., 250 ml.	12 nos.
82.	Boiling flasks with round bottom 500ml. for each distilling flasks 50 ml, 100 ml, 250 ml – Writz and others	24 nos.
83.	Filtering flasks 250 ml.	24 nos.
84.	Filtering flasks 500 ml.	24 nos.
85.	Condensers liebig 30 mm. long	24 nos.
86.	Condensers liebig 50 cm. long	12 nos.
87.	Condenser bulb type 30 cm. long	6 nos.
88.	Condenser spiral type 20 cm. long	6 nos.
89.	Ventiles for volumetric analysis (KCI 03, etc.)	24 nos.
90.	CO2 determination apparatus (Schrotter)	6 nos.
91.	Gas generator (Kipp) 500 ml.	5 nos.
92.	Gas washing bottles (Dreshsler)	24 nos.
93.	Drying tubes with one bulb	12 nos.
94.	Crucibles porcelain 5 cm, dia, height 4 cm indigenous	60 nos.
95.	Test tube (160 mm x 15 mm.)	500 nos.
96.	Test tube (10 mm.)	400 nos.
97.	Water pumps for vacuum	6 nos.
98.	Gas sampling tubes	12 nos.
99.	Paiers nessler tubes	24 nos.
100.	Tubes for centrifuge	500 nos.
101.	Tubes for Gerber centrifuge	44 nos.
102.	Bottles with droppers for indicator solutions & semi-micro qualitative analysis 30 ml.	72 nos.
103.	Bottles with droppers for indicator solutions & semi-micro qualitative analysis 50 ml.	72 nos.
104.	Bottles for solids 50 ml.	72 nos.

105.	Bottles for solids 100 ml.	36 nos.
106.	Bottles for solutions 100 ml.	100 nos.
107.	Bottles for solutions 250 ml.	36 nos.
108.	Bottles for solutions 1000 ml.	12 nos.
109.	Bottles for solutions 2000 ml.	12 nos.
110.	Bottles for solutions 3000 ml.	6 nos.
111.	Bottles for solutions 5000 ml.	3 nos.
112.	One pan analytical balances (Metler type) – if available indigenously 0.1 mg. sensibility	5 nos.
113.	Flash point apparatus	1no.
114.	Lovibond comparator	1no

**LIST OF TOOLS & EQUIPMENT FOR
INSTRUMENT MECHANIC (CHEMICAL PLANT)
BATCH OF 16 TRAINEES**

A. Workshop Furniture

Sl. No.	Name of the Item	Quantity
1	Chalk Board green(glass)	01
2	Desk with sun mica top	01
3	Chair with Full Table, for training	20
4	White Board	01
5	Voltage Stabilizer Servo-control 5KV A	01
6	Semiconductor Test set	02
7	Air Compressor with Air Drier	01
8	Vacuum Cleaner	01
9	Vacuum Pump	01

B. General machinery shop outfit (as per the table)

Sl. No	Item	Quantity
1	Engraving Machine model, complete with accessories and two sets of master numbers & alphabets	01
2	Electric Furnace, Twin Chamber	01
3	Instrument Work Bench with cupboards	06
4	Steel Cupboards 6' x 3' x 1.5'	06
5	Tool Kit Boxes for trainees (steel lockers)	20
6	Function generator with counter 10 Mhz Or above	01
7	Dual trace CRO 30 Mhz Or above	01
8	PLC & SCADA Training Kit	01
9	DCS Training Kit	01
10	Temperature calibration Bath	01
11	Moving coil Voltmeters (various ranges)	04 each
12	Moving coil Ammeters (various ranges) 4	04 each
13	Moving Milliammeters (various ranges)	04 each
14	Moving Millivoltmeters (various ranges)	04 each
15	Galvanometer, centre-zero indicating	04 No.
16	Moving iron AC- Voltmeters, various ranges	04 each
17	Moving Iron AC-Ammeters, various ranges	04 each
18	Voltmeter Dynamometer type AC & DC	02 each
19	Ammeter-Dynamometer induction type, AC & DC	02 each
20	Wattmeter dynamometer type	02 No.
21	Power factor meter	02 No.
22	Hot wire instruments	02 No.
23	Clamp on AC-Ammeter	02 No.
24	Ohmmeters multi-ranges	02 each
25	Insulation testers (Megger), 500 volts	02 No.
26	Watt-hour meter	04No.
27	Frequency meter, Vibrating reed type	02 No.
28	Ampere-hour meter	02 No.
29	Calibrator for Ammeters, Voltmeters, Ohmmeters	01 No.
30	Calibrator for Wattcmeters, Energy meters	01No.
31	Calibrator for Wattcmeters, Energy meters	01 No.
32	L.C.R.Bridge for Resistance, Capacitance, Inductance	02 No.

33	Digital Source & Measure for Resistance, Current and Voltage	02 No.
34	Regulated power supply with variable DC source	04 No.
35	Servo operated AC- Voltage Stabilizer, to KV A	02 No.
36	Hair Hygrometer	02 No.
37	Wet & Dry bulb Thermometer Type Hygrometer	02 No.
38	Sling Pyrometer	02 No.
39	Manometer, U-tube	02 No.
40	Manometer, Inclined tube	02 No.
41	Manometer, well type	02 No.
42	Barometer Mercury	01 No.
43	Barometer Aneroid capsule	01 No.
44	Air pressure regulator	02 No.
45	Pressure Indicator Bourdon type, various ranges	16 No.
46	Pressure Gauge Capsule type, various ranges	06 No.
47	Pressure Gauge Diaphragm type, various ranges	06 No.
48	Dead Weight Tester, with accessories	01 No.
49	Comparator & STD Pressure Gauges	01 No.
50	Pressure Switch	02 No.
51	Pressure Safety Valve	02 No.
52	Pressure transmitter (pneumatic & electronic)	02 No.
53	I to P Convertor	02 No.
54	P to I Convertor	02 No.
55	Quantity Flow meter, simple tank type	02 No.
56	Reciprocating piston type flow meter	04 No.
57	Flow meter impeller type	04 No.
58	Bellows type Gas flow meter	02 No.
59	Magnetic flow meter	02 No.
60	Orifice type differential flow meter	02 No.
61	Ventury tube differential flow meter	02 No.
62	Nozzle type differential flow meter	02 No.
63	Pitot tube differential flow meter	02 No.
64	Rotameter	02 No.
65	Rotating Vane Flow Meter	02 No.
66	D.P. Transmitter For flow Measurement	02 No.
67	Rotameter Transmitter	02 No.
68	Flow Switch	02 No.
69	Sight Glass Level Indicator	02 No.
70	Hook type Level Indicator	02 No.
71	Float type Level Indicator	02 No.
72	Static pressure and air purge Level Indicator	01 No.
73	Show piece Ultra-sonic Level Indicator	01 No.
74	Variable Capacitance type Level Indicator	02 No.
75	Level Switch (Magnetic)	02 No.
76	D.P. Transmitter For flow Measurement	02 No.
78	Show Piece for Radar type Level Indicator	01 No.
79	Mercury-in-Glass Thermometers (various ranges)	06 No.
80	Alcohol or other liquid in glass Thermometers	02 No.
81	Mercury in Steel Thermometers, Remote Indicating	02 No.
82	Vapor pressure Thermometers	02 No.
83	Bi-Metal thermometers, (various ranges)	04 No.

84	RTD Resistance-bulb Wheatstone Bridge Thermometers	02 No.
85	Thermo-couple Pyrometers (with different thermocouple	06 No.
86	Thermo-couple with milli-volt-potentiometer pyrometer	02 No.
87	Optical Pyrometer	01 No.
88	Tungsten strip filament lamp for calibration of optical pyrometer	01 No.
89	Radiation Pyrometer	01 No.
90	Temperature switch	02 No.
91	Thermostats	03 No.
92	Thermostats	06 No.
93	RTD & TC Simulator	06 No.
94	Speedometer (four different popular make)	04 each
95	Tachometer Centrifugal	02 No.
96	Tachometer Drag-cup type	02 No.
97	Tachometer Electrical, Synchronous	02 No.
98	Stroboscope	01 No.
99	RPM- Tester/Techo. Tester	01 No.
100	Circular Charts Recorder (Potentiometer type)	02 No.
101	Strip Charts Recorder (Potentiometer type)	02 No.
102	Secondary devices for measurement of Temperature, pressure level and flow for above recorders	02 each
103	2-Position controller (ON-OFF type)	02 No.
104	Proportional Controller	02 No.
105	Proportional with RESET type Electronic Controller	02 No.
106	PID Controller	02 No.
107	I to P & P to I Convertor	02 each
108	Pressure and Flow Control loop (With PID Controller)	01 each
109	Temperature and Level Control loop (With PID Controller)	01 each
110	Computers (Latest Configuration)with License of Operating Software, Antivirus and Printer, UPS	06 No.
111	Table Lamps 230 Volts,	06 No.
112	IC- Tester Linear with accessories	02 No.
113	IC- Tester Digital with accessories	02 No.
114	Hydrometer	02 No.
115	Soldering Gun	04 No.
116	De-Soldering Gun	04 No.
117	Thermo-Couple welders	01 No.
118	Universal Calibrator	01 No.
119	Sensitive Balance with weight and cover	02 No.
120	Voltage Stabilizer 10 KVA and UPS (1KVA)	01 No.
121	Educational CD/DVDs or Software on Instrumentation	02 Sets
122	Tool Kit Boxes for trainees, steel lockers	16 No.
123	LCD Multimedia Projector & O.H.P. Projector	01each
124	Fire Extinguisher, Soda-Acid, CTC	01 No.
125	First Aid Box	01 No.
126	Steel Cupboards 6' x 4' x 1.5'	06 No.

Misc. Items (substantial quantities):

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