

# CHEMICAL PLANT TECHNOLOGY

NSQF LEVEL- 6



**SECTOR - CHEMICALS AND PETROCHEMICALS**

**COMPETENCY BASED CURRICULUM**  
**CRAFT INSTRUCTOR TRAINING SCHEME (CITS)**



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

# CHEMICAL PLANT TECHNOLOGY

(Applicable for “Attendant Operator (Chemical Plant) and  
Maintenance Mechanic (chemical Plant)” trade)

(Engineering Trade)

SECTOR – CHEMICALS AND PETROCHEMICALS

(Designed in 2020)

Version 1.0

CRAFT INSTRUCTOR TRAINING SCHEME (CITS)

NSQF LEVEL - 6

Developed By

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## 1. COURSE OVERVIEW

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

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

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

## 2. TRAINING SYSTEM

### 2.1 GENERAL

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

### 2.2 COURSE STRUCTURE

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

S No.	Course Element	Notional Training Hours
1.	<b>Trade Technology</b>	
	Professional Skill (Trade Practical)	640
	Professional Knowledge (Trade Theory)	240
2.	<b>Engineering Technology</b>	
	Workshop Calculation & Science	80
	Engineering Drawing	120
3.	<b>Training Methodology</b>	
	TM Practical	320
	TM Theory	200
	<b>Total</b>	<b>1600</b>

### 2.3 PROGRESSION PATHWAYS

- Can join as an Instructor in a Vocation Training Institute / technical Institute.
- Can join as a supervisor in Industries.

### 2.4 ASSESSMENT & CERTIFICATION

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

a) The **Continuous Assessment (Internal)** during the period of training will be done by **Formative Assessment Method** to test competency of instructor with respect to assessment criteria set against each learning outcomes. The training institute has to maintain an individual trainee portfolio in line with assessment guidelines. The marks of internal assessment will be as per the formative assessment template provided on [www.bharatskills.gov.in](http://www.bharatskills.gov.in).

b) The **Final Assessment** will be in the form of **Summative Assessment Method**. The All India Trade Test for awarding National Craft Instructor Certificate will be conducted by DGT at the end of the year as per the guidelines of DGT. The learning outcome and assessment criteria will be the basis for setting question papers for final assessment. The external examiner during final examination will also check the individual trainee's profile as detailed in assessment guideline before giving marks for practical examination.

### 2.4.1 PASS CRITERIA

**Allotment of Marks among the subjects for Examination:**

Sl. No.	Subject		Marks	Internal Assessment	Full Marks	Pass Marks	
						Exam	Internal Assessment
1.	Trade Technology	Trade Theory	100	40	140	40	24
2.		Trade Practical	200	60	260	120	36
3.	Engineering Technology	Workshop Cal. & Sc.	50	25	75	20	15
4.		Engineering Drawing	50	25	75	20	15
5.	Training Methodology	TM Practical	200	30	230	120	18
6.		TM Theory	100	20	120	40	12
<b>Total Marks</b>			<b>700</b>	<b>200</b>	<b>900</b>	<b>360</b>	<b>120</b>

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

### 2.4.2 ASSESSMENT GUIDELINE

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

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

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

Assessment will be evidence based comprising of the following:

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

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

Performance Level	Evidence
(a) Weightage in the range of 60%-75% to be allotted during assessment	
For performance in this grade, the candidate should be well versed with instructional design, implement learning programme and assess learners which demonstrates attainment of an <b>acceptable standard</b> of crafts instructorship with <b>occasional guidance</b> and engage students by demonstrating good attributes of a trainer.	<ul style="list-style-type: none"> <li>• Demonstration of <b>fairly good</b> skill to establish a rapport with audience, presentation in orderly manner and establish as an expert in the field.</li> <li>• Average engagement of students for learning and achievement of goals while undertaking the training on specific topic.</li> <li>• A fairly good level of competency in expressing each concept in terms the student can relate, draw analogy and summarize the entire lesson.</li> <li>• Occasional support in imparting effective training.</li> </ul>
(b) Weightage in the range of 75%-90% to be allotted during assessment	
For performance in this grade, the candidate should be well versed with instructional design, implement learning programme and assess learners which demonstrates attainment of a <b>reasonable standard</b> of crafts instructorship with <b>little guidance</b> and engage students by demonstrating good attributes of a trainer.	<ul style="list-style-type: none"> <li>• Demonstration of <b>good</b> skill to establish a rapport with audience, presentation in orderly manner and establish as an expert in the field.</li> <li>• Above average engagement of students for learning and achievement of goals while undertaking the training on specific topic.</li> <li>• A <b>good</b> level of competency in expressing each concept in terms the student can relate, draw analogy and summarize the entire lesson.</li> <li>• Little support in imparting effective training.</li> </ul>

## (c) Weightage in the range of more than 90% to be allotted during assessment

For performance in this grade, the candidate should be well versed with instructional design, implement learning programme and assess learners which demonstrates attainment of a **high standard** of crafts instructorship with **minimal or no support** and engage students by demonstrating good attributes of a trainer.

- Demonstration of **high** skill level to establish a rapport with audience, presentation in orderly manner and establish as an expert in the field.
- Good engagement of students for learning and achievement of goals while undertaking the training on specific topic.
- A **high** level of competency in expressing each concept in terms the student can relate, draw analogy and summarize the entire lesson.
- Minimal or no support in imparting effective training.



### 3. GENERAL INFORMATION

Name of the Trade	<b>CHEMICAL PLANT TECHNOLOGY - CITS</b>
Trade Code	DGT/4044
NCO – 2015	2356.0100, 7233.1100, 3111.0100, 3111.0300, 3133.0100, 7233.0301, 8131.3700, 3134.0300, 8131.3600, 3134.0100, 8131.0100, 8131.3501, 3133.0400, 3133.0500, 8131.2100, 8131.7700, 3139.0100, 8131.0400, 8131.2300, 8131.2700, 8131.1400, 8131.8500
NSQF Level	Level-6
Duration of Craft Instructor Training	One Year
Unit Strength (No. Of Student)	25
Entry Qualification	Diploma/Degree in Chemical Engineering from AICTE recognized Board / University.  OR NTC/ NAC in the Attendant Operator (Chemical Plant) or Maintenance Mechanic (Chemical plant) trade.
Minimum Age	18 years as on first day of academic session.
Space Norms	180 Sq. m
Power Norms	13 KW
<b>Instructors Qualification for</b>	
<b>1. CHEMICAL PLANT TECHNOLOGY - CITS Trade</b>	B.Voc/Degree in Chemical Engineering from AICTE / UGC recognized University with two years' experience in relevant field.  OR 03 years Diploma in Chemical Engineering from AICTE/ recognized Board/ University or relevant Advanced Diploma (Vocational) from DGT with five years' experience in relevant field.  OR NTC/ NAC passed in the Attendant Operator (Chemical Plant) or Maintenance Mechanic (Chemical plant) trade with seven years' experience in relevant field.  AND <b>Essential Qualification:</b> National Craft Instructor Certificate (NCIC) in <b>CHEMICAL PLANT TECHNOLOGY</b> Trade in any of the variants under DGT.
<b>2. Workshop Calculation &amp; Science</b>	B.Voc./Degree in any relevant Engineering from AICTE/ UGC recognized Engineering College/ university with two years' experience in relevant field.  OR 03 years Diploma in any relevant Engineering from AICTE /recognized board of Technical education or relevant Advanced Diploma

	<p>(Vocational) from DGT with five years' experience in relevant field. OR NTC/ NAC in any Engineering trade with seven years' experience in relevant field. <b>Essential Qualification:</b> National Craft Instructor Certificate (NCIC) in relevant trade. OR NCIC in RoDA or any of its variants under DGT</p>					
<b>3. Engineering Drawing</b>	<p>B.Voc./Degree in relevant Engineering from AICTE/ UGC recognized Engineering College/ university with two years experience in relevant field. OR 03 years Diploma in relevant Engineering from AICTE /recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with five years experience in relevant field. OR NTC/ NAC in any one of the 'Mechanical group (Gr-I) trades categorized under Engg. Drawing'/ D'man Mechanical / D'man Civil' with seven years experience.  Essential Qualification: National Craft Instructor Certificate (NCIC) in relevant trade. OR NCIC in RoDA / D'man (Mech /civil) or any of its variants under DGT</p>					
<b>4. Training Methodology</b>	<p>B.Voc./Degree in any discipline from AICTE/ UGC recognized College/ university with two years' experience in training/ teaching field. OR Diploma in any discipline from recognized board / University with five years' experience in training/teaching field. OR NTC/ NAC passed in any trade with seven years' experience in training/ teaching field.  <b>Essential Qualification:</b> National Craft Instructor Certificate (NCIC) in any of the variants under DGT / B.Ed /ToT from NITTTR or equivalent.</p>					
<b>5. Minimum Age for Instructor</b>	21 years					
<b>Distribution of training on Hourly basis: (Indicative only)</b>						
<b>Total Hrs /week</b>	<b>Trade Practical</b>	<b>Trade Theory</b>	<b>Workshop Cal. &amp; Sc.</b>	<b>Engg. Drawing</b>	<b>TM Practical</b>	<b>TM Theory</b>
40 Hours	16 Hours	6 Hours	2 Hours	3 Hours	8 Hours	5 Hours

## 4. JOB ROLE

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### Brief description of job roles:

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

**Mechanic Maintenance (Chemical Plant);** Repairs and overhauls chemical plant, machinery and equipment periodically and on break downs to maintain them in efficient operating condition. Studies methods of processing of raw material to finished products. Examines plant and equipment to locate faults and removes minor defects on spot. Reports major defects and break downs to Chemical Engineer and dismantles defective unit as directed with necessary precaution, using hand tools, adopter, twists etc, as necessary. Replaces or repairs defective parts and components by revealing, filling, drilling, grinding, scraping, soldering, brazing, etc. as required and reassembles unit according to specifications with prescribed precautions particularly for explosive, gas acid and other chemical plants, ensuring correct alignment clearance, valve operations, adjustments, flow of material operational functions and other necessary details. Tests assembled unit for proper performance, make assembled if examined by appropriate authority before handing over to production. Checks, adjusts and lubricates equipment periodically or gets it done and performs other tasks to maintain plan in proper working order. May maintain records of parts examined, repairs done, replacements made and plant performance. May erect and install equipment under guidance of chemical engineer.

**Laboratory Assistant, Physical;** assists and carries out routine duties in physical laboratory as directed by physicist in conducting experiments. Sets up required apparatus and instruments in position as directed for conducting experiments. Makes necessary electrical connection to equipment and instruments as required. Records routine and other observations as indicated by instruments and makes necessary calculations as directed. Removes apparatus when not in use, cleans and maintains them in good condition. May do minor repairs to equipment and apparatus. May store and maintain account of instruments, equipment, apparatus etc., if required.

**Laboratory Assistant, Chemical;** arranges and sets various chemicals, instruments and apparatus such as salts, acids, balances, heaters as desired by Chemists for conducting experiments in chemical laboratory. Sets up required apparatus and equipment as directed by Chemist. Performs routine tasks, such as preparations of standard solutions and common reagents, weighing and measuring of salts and chemicals, filtration, precipitation etc. and conducts simple tests as directed by Chemist. Cleans and maintains balances. Changes,

Keeps apparatus and maintains laboratory clean and tidy. Keeps required chemicals readily available and replenishes stock from stores. May clean special apparatus, if required.

**Process Man, Chemical;** process chemical ingredients by mixing in specific proportions, heating, distilling, cooling, filtering, blending, percolating, refining, pulverizing, etc. for causing chemical reactions for research or production. Obtains scheme of processing from Chemist; sets apparatus and equipment; collects chemicals in required quantities; regulates feed of gaseous, liquid or solid materials into equipment. Checks progress of process by looking through peep holes, observing temperature readings, pressure gauges and other instruments and making simple chemical tests; regulates material feed, and heating and cooling devices and makes other adjustments necessary to ensure that processes are correctly carried out. Strains, filters and distills chemical substances to obtain required product in purified form. Implements safety measures in regards to operation of plant/machinery and in handling and processing materials such as acids, oils and maintains machinery. May be designated, according to type of material processed or plant in charge of, such as Distilling Still Attendant, Filter Pressman, etc.

**Bearing Maintenance;** identify the problems in the equipment, rectify the root causes for leakages, replaces the bearings, lubricates the bearings, ensures fitness of all types of bearings in the plant and carry out routine maintenance.

**Reactor Convertor Operator;** (Chemical Process, except Petroleum) operates or tends number of pieces of equipment, other than those used for treating petroleum, which perform sequence of complex operations in chemical reaction process. Regulates feed of gaseous, liquid or solid material into equipment. Checks progress of process by looking through peep holes, observing temperature readings, pressure gauges and other instruments and making simple chemical tests. Regulates material feed and heating or cooling devices and makes other adjustments as necessary to ensure that processes are correctly carried out.

**Pump Man (Petroleum Refining);** controls pumps and manifold systems to circulate crude semi compressed and finished petroleum products, water and chemical solutions through processing and storage departments of refinery according to schedules or instructions and plans movement of product through lines of processing and storage unit, utilizing knowledge of interconnections and capacities of pipelines, valve manifolds, pumps and tanks. Synchronizes activities with other pump houses to assure continuous flow of products and minimum contamination between products. Starts battery of pumps, observes pressure and flow meter and turns valve to regulate pumping speeds according to schedules. Turns hand wheels to open line valves to direct flow of product. Signals by telephone to operate pumps in designed units to open and closed pipeline and tank valves and to gauge, sample and determine temperature of tank contents. Records operating data, such as products and quantities pumped, stocks used, gauging results and operating time. May blend oil and gasoline. May repair pumps, lines and auxiliary equipment.

**Evaporator Operator; Pan Operator; Vacuum Pan Operator** charges and operates evaporating tank, vacuum-pan or similar device to concentrate solutions by driving off excess water contents. Pumps weak (liquid) solution into evaporator tank or pan; operates vacuum pump to obtain vacuum in pan, if required; regulates flow of steam into heater coils of evaporator; periodically tests concentrations of solution by use of instruments or by making simple chemical tests; makes necessary adjustments to temperature and pressure to obtain required solution; pumps concentrated solution from evaporator for auxiliary heating. Implements safety measures in regard to operation of plant/machinery and in handling and processing materials, oils and maintains machinery. May tend auxiliary equipment such as settling tanks, preheating tanks, condensers and cooling equipment. May treat solutions, such as those of glue, glycerin, glucose and caustic soda and be designated accordingly.

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

**Crusher Operator, Chemical;** operates power driven crushing machine to break solid lumps of chemicals or other materials into smaller size for further processing. Collects material to be crushed; fills hopper of machine by hand or by operating mechanical feed; fixes screen to machine to retain pieces which are too large. Operates controls to start, stop and regulate speed of machine; breaks oversize or jammed lumps with a hammer; discharges crushed material into outlet container-cleans crusher and work area. May weigh the material before and after crushing to know loss in crushing. May be designated according to type of process adopted/industry attached to.

**Autoclave Operator Sterilization Attendant;** charges, operates and unloads an autoclave (high-pressure vessel) for processing chemicals, oils, or sterilizing bottles, ampoules, etc. Charges or loads vessel with predetermined quantities of chemicals or objects; checks valves

for operation; raises temperature of autoclave by increasing steam pressure. Observes pressure and temperature gauges, thermometers, timings and other instruments and makes necessary adjustments to ensure that process or sterilization is carried out correctly. Unloads product on completion of process and prepares vessel for next batch. Implements safety measures in regard to operation of plant/machinery and in handling and processing materials, and maintains machinery. May keep records. May be designated according to product processed or sterilized.

**Batch Still Operator, Chemical;** operates one or more stills in which batches of liquid chemicals, other than petroleum, are treated to separate them into their chemical constituent such as alcohol beverages, perfume or drugs or to refine those constituents. Manipulates feed valves to fill tank with liquid to desired levels; adjusts valves to control pressure in tank and rate of heating; regulates valves to control amount of condensed vapors returned to tank to enrich vapors driven from it; draws, from containers receiving condensed vapors, product samples for testing either on their own or in laboratory; determines by purity of samples, container to which product should be routed. Maintains record of raw materials drawn, quantity consumed to indicate production capacity of plant; enters in log book condition of plant and abnormalities noticed in distillation during shift for report to Chemist. May make adjustments to still auxiliaries such as condensers and pumps. May operate ordinary type of wood-fire distillation plant. May be designated according to type of chemicals used and industry attached to e.g. Ammonia still operator; alcohol still operator; benzene still operator.

**Continuous Still Operator, Chemical;** Distillation Operator tends one or more stills in which continuous feed of liquid chemical, other than petroleum is heated to separate into chemical constituents by regulating temperature, pressure, cooling valves etc. Adjusts feed valves to allow liquid to enter still at prescribed rate; adjusts controls to maintain temperature at various levels of still and to maintain prescribed pressure in still; regulates valves to control amount of condensed vapor returned to still to enrich vapors driven from it; draws, from containers receiving condensed vapors, product samples for testing either themselves or in the laboratory; determines by purity of samples to which container product should be routed; returns impure samples to main stock; maintains record of temperature, pressure and feed indicator readings. May make adjustments to still auxiliaries such as heat exchangers, absorbers, strippers, boilers and compressors. May specialize in type of chemical treated and be designated accordingly.

**Ammonia Operator/Ammonia Plant Operator;** Ammonia Operator controls converter and auxiliary equipment that combine hydrogen and nitrogen to produce anhydrous ammonia: Lights burner and starts pumps, compressors, scrubbers, and absorption units. Moves controls on panel board to regulate temperatures of solutions and opens valves to admit heated and purified air and hydrogen into combustion chamber of burner, where nitrogen driven from air combines with hydrogen to form ammonia. Reads instruments, such as thermometers, pressure gauges, and potentiometers. Makes control adjustments according to operating instructions and charts. Pumps fresh solutions into scrubbing and absorption

towers when readings indicate excessive alkalinity. Records operational data in logbook. May compute percentage of hydrogen and ammonia in burner gases, using standard test procedure.

**Acid Plant Operator;** maintains and operates acid plant for manufacturing sulphuric, hydrochloric, nitric or other acids by treating raw materials (Sulphur, salts, etc.) with acid or steam. Collects required amount of raw materials for preparation of desired acid. Sets up and checks equipment, valves, gauges and other instruments; charges vessel with predetermined amount of chemicals, or regulates feed of materials into equipment; controls temperature in vessel by adjusting steam pressure; checks progress of process by looking through peep holes, observing temperature readings, pressure gauges and other instruments and making simple chemical tests; regulates material feed and heating or cooling devices, as necessary; removes acid when process is completed. May keep records. May be designated according to product or process, e.g. SULPHURIC ACID PLANT OPERATOR; HYDROCHLORIC ACID PLANT OPERATOR; FERTILISER MAKER; PHOSPHORUS MAKER.

**Digester Operator, Paper Pulp;** Rag Boiler Operator, Paper Pulp operates boiler (cooker) to convert raw materials into paper pulp. Supervises charging of cooker with ingredients such as wood chips, rags, straw and waste paper shreds. Directs adding of chemicals and admission of steam to raise temperature and pressure. Observes gauges and makes adjustments to maintain desired operating conditions. Tests samples by titration or color tests to determine stage of cooking. When the process completes, drains liquid from digester and instructs others in removal of cooked pulp. May be designated according to materials processed or chemicals used.

**Mixing Machine Man Attendant (Chemical);** feeds and tends machine to mix and blend different solid or liquid ingredients in required proportions. Weighs ingredients according to formulae or specifications and feeds prescribed quantities of ingredients into machine container by hand or by operating valves, pumps or mechanical loaders; starts machine agitators to mix materials thoroughly; adds further ingredients, if required; runs machine until mixing process is completed; removes mixture from machine container; cleans machine and work area and prepares machine for fresh run. Observes and reports abnormalities in blending and mixing.

**Filter Press Operator;** operates filter press machine to filter impurities or other insoluble materials from slurries, chemical solutions or mother liquids. Opens filter press and covers filter plates with canvas, paper or other filtering media; closes press and ensures that its joints make a liquid tight seal; adds diatomaceous earth, saw dust, other settling compound to solution to precipitate impurities; pumps when specified pressure is reached. Removes filtered impurities from screen with compressed air, water or steam, and dislodges solid materials caught between frames. Occasionally replaces damaged filter media and adjusts and makes minor repairs to equipment.

**Hydro Extractor Operator;** Centrifuge Operator operates centrifuge machine that separates solids from liquids, or liquids of different specific gravity. Fills drum of machine with liquid material. Starts machine and adjusts drum speed to obtain efficient separation of substances; empties containers when separation is completed. May fix and clean filtering media in machine, operate heating attachment on machine and test samples for moisture content. May be designated according to type of materials separated.

**Drying Chamber Attendant (Drugs)/Chamber Operators;** dries tables and powder in drying chamber. Spreads out powder and tables evenly in trays and loads trays on racks and shelves in drying chamber. Closes chamber and applies heat for fixed period of time; checks at frequent intervals to ensure that products are properly dried. Keeps drying chamber clean.

**Extraction Attendant, Chemical;** Extraction Operator; Extractor Battery Attendant; Kettle Operator; Percolation Attendant; Acidification Operator boils necessary ingredients in kettles, vats, pans, and regulates temperature, pressure etc. as directed by Process man, Chemical, to effect desired chemical reaction. Collects different ingredients in required proportions and feeds them into pan separately or together, according to specification, adding required amount of fluids and other liquids, mixing them by stirrer. Switches on plant, injecting steam to boil and mix ingredients; observes temperature, pressure gauges, timings and other instruments, making adjustments, where necessary, to ensure process is complete. Collects samples for observation and test; drains stuff for storage; cleans pan and work place. Implements safety measures in regard to operation of plant/machinery and in handling and processing materials, oils and maintains machinery. May tend open or wood fire pan. May be designated according to type of pan or industry associated with.

May be designated, according to type of material processed or plant in charge of type of chemicals used and industry attached to, process involved or plant operated as such as Distilling Still Attendant, Filter Pressman, Ammonia Still Operator; Alcohol Still Operator, Benzene Still Operator. May specialize in a particular type of still, kind of oil processed, and be designated according to Absorption Plant Operator; Purification Operator; Stillman; Cracking Unit; Stillman etc.

**Reference NCO-2015:**

- (i) 2356.0100-Manual Training Teacher/ Craft Instructor
- (ii) 7233.1100 – Mechanic Maintenance (Chemical Plant)
- (iii) 3111.0100 – Laboratory Assistant, Physical
- (iv) 3111.0300 – Laboratory Assistant, Chemical
- (v) 3133.0100 – Process Man, Chemical
- (vi) 7233.0301 – Bearing Maintenance
- (vii) 8131.3700– Reactor Converter Operator
- (viii) 3134.0300 – Pump Man (Petroleum Refining)
- (ix) 8131.3600 – Evaporator Operator Evaporator
- (x) 3134.0100 – Continuous Still Operator, Petroleum



- (xi) 8131.0100 – Crusher Operator, Chemical
- (xii) 8131.3501 – Autoclave Operator
- (xiii) 3133.0400 – Batch Still Operator, Chemical
- (xiv) 3133.0500 – Continuous Still Operator, Chemical
- (xv) 8131.2100 – Ammonia Operator/Ammonia Plant Operator
- (xvi) 8131.7700 – Acid Plant Operator
- (xvii) 3139.0100 – Digester Operator, Paper Pulp
- (xviii) 8131.0400 – Mixing Machine Man Attendant (Chemical)
- (xix) 8131.2300 – Filter Press Operator
- (xx) 8131.2700 – Hydro Extractor Operator
- (xxi) 8131.1400 – Drying Chamber Attendant (Drugs)/Chamber Operators
- (xxii) 8131.8500 – Extraction Attendant, Chemical

## 5. LEARNING OUTCOME

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*Learning outcomes are a reflection of total competencies of a trainee and assessment will be carried out as per the assessment criteria.*

### 5.1 TRADE TECHNOLOGY

1. Demonstrate related safety and general awareness in chemical industry. [*viz. application of fire extinguishers, use of PPE'S with general and chemical hazards, interpretation of data from MSDS, detect dust percentage in Air, etc.*].
2. Demonstrate procedures to make job / component as per specification, assembling them and checking of dimensional/ functional accuracy following safety precautions. [Fitting operation – marking, punching, Hack-sawing, Filing, Drilling, countersinking, counter boring, reaming, Taping, fitting, polishing, assembling, etc. Accuracy:  $\pm 0.05\text{mm}$ ].
3. Transfer skill of welding – by Setting Gas and Electric Arc welding plant, joining metal components observing safety precautions. [*Different Operations – select and operate fire extinguisher, straight line beads, single V-butt joint* ].
4. Demonstrate experiments in Physics laboratory to determine physical constants, verify laws, etc.
5. Demonstrate experiments in Chemistry laboratory to determine concentration of solutions,  $\text{P}^{\text{H}}$ , melting point, boiling point, flash point of oil, viscosity of oil, selection of oil for particular application at certain temperature, Reynold's Number to predict flow pattern in a conduit, compare properties of metals & alloys, prepare chemicals, etc.
6. Exhibit production of component on conventional lathe machine observing standard operation practice. [Different operations: - plain turning, facing, step turning, through & step drilling, knurling, threading, etc].
7. Execute pipe joints & fittings with pipes, apply lagging materials in accordance with job condition - hot/cold and test for leakages. [*Range of skills – Cutting, Threading, gasket cutting, lagging of pipeline, Joining and use of locking devices*]
8. Demonstrate installation /connection of instrument/devices to measure pressure, temperature, flow rate and level, pressure drop due to friction, effect of pipe roughness on friction, frictional loss in fittings and valves, coefficient of discharge, density and record readings. [*Different instrument/devices – Bourdon tube pressure gauge, capsule type gauge, mercury in glass thermometer, bimetal thermometer, RTD, thermocouple, orifice meter, venture meter, Rotameter, sight glass level indicator, air purge level indicator, capacitance type level indicator, hydrometer, control valve*]
9. Demonstrate different types of maintenance (viz. Online, Predictive, Preventive and breakdown) and Trouble shoot, dismantle, repair & assemble / Align different mechanical components for power transmission & check their functionality.

(*Different Mechanical Components viz. Belt, Pulleys, shaft, motor, coupling, Gearbox, bearings, Hydraulic jack*).

10. Demonstrate overhauling of different types of valve.
11. Trouble shoot, dismantle, Overhaul / repair & reassemble different machine, pumps & components for transportation of liquid, check their functionality and plot the graphs for characteristic curve of different types of pump. [*Different Machines & Components – Pumps - centrifugal, gear pump, metering pump, screw pump, multistage compressor, vacuum pump, mechanical seals*]
12. Demonstrate machinery handling, installation, operations, maintenance, troubleshooting of various types of conveyors as per standard procedure, it's planning & implementation.
13. Demonstrate function of pressure vessel, various pipe fittings, valves, parameters, trouble shoot, dismantle, repair / overhauling & reassemble different machine & components for transportation of Gases, Air dryers & Air filters and check their functionality.
14. Trouble shoot, dismantle, clean scale formation & reassemble Electrode & Oil fired boiler and Air handling unit and check their functionality.
15. Demonstrate operation of different Heat exchange equipment, Evaporators & calculate heat transfer rate, trouble shoot, dismantle, clean & reassemble different types of Heat exchangers, Evaporators and check functionality. [*Heat exchange equipment's-Double Pipe Heat exchanger, Shell & tube Heat exchanger, plate heat exchanger*] [*Evaporation equipment's-Vertical tube evaporator, multiple effect evaporator*]
16. Demonstrate operation of different types of distillation column, filtration unit, Dryer used for loading wet material in tray dryer, cyclone separator, packed distillation column, sieve tray column, different types of extraction unit and troubleshoot, dismantle, clean and reassemble components and check for proper functionality.
17. Operate an absorption column & determine flooding velocity, explain gas absorption, packed tower, types of packing. Demonstrate operation of crystallization equipment.
18. Exhibit different modules of DC'S and PLC's, their function, Wire and connect I/OS field devices to the I/O Modules.
19. Demonstrate operation of different types of mixing equipment like ribbon blender, different size reduction machines (Hammer mill, Ball mill), Screening Equipment & troubleshoot, dismantle, clean and maintenance of different mechanical components.
20. Explain selection of appropriate Dryer and demonstrate operation of Tray dryer and carry out its cleaning, maintenance, trouble shooting for proper functionality.
21. . Explain operation of cooling tower, perform humidification & dehumidification operations, find out relative humidity by measuring dry bulb & wet bulb temperatures.
22. Explain sedimentation operation and differentiate between settling, sedimentation and decantation operations.

23. Manufacture different chemical products
24. Explain function of various types of Chemical reactor and their accessories.

## 6. COURSE CONTENT

SYLLABUS FOR CHEMICAL PLANT TECHNOLOGY – CITS TRADE			
TRADE TECHNOLOGY			
Duration	Reference Learning Outcome	Professional Skills (Trade Practical)	Professional Knowledge (Trade Theory)
Practical 16 Hrs.  Theory 06 Hrs	Demonstrate related safety and general awareness in chemical industry. [viz. application of fire extinguishers, use of PPE'S with general and chemical hazards, interpretation of data from MSDS, detect dust percentage in Air etc.].	<ul style="list-style-type: none"> <li>• Demonstrate correct use of appropriate PPE.</li> <li>• Demonstrate First aid methods against different types of injury.</li> <li>• Explain Safety sign/slogan for Danger. Illustrate Safety signs and symbols used in chemical industry.</li> <li>• Demonstrate use of fire fighting equipment's.</li> <li>• Demonstration about Fire, gas detector &amp; smock alarm system.</li> <li>• Disposal of workshop waste material like cotton waste, chips.</li> <li>• Housekeeping &amp; workshop cleaning.</li> <li>• Prepare PPT on pollution control and 5's concept.</li> <li>• Demonstrate General house-keeping, good shop floor practices and waste disposal following Environmental guidelines</li> <li>• Prepare MSDS of common chemicals used in chemical industries.</li> <li>• Determine the dust percentage in Air.</li> </ul>	<b>SAFETY :</b> <ul style="list-style-type: none"> <li>• PPEs and safety equipment used in chemical industries.</li> <li>• Safety slogan.</li> <li>• First aid in workshop &amp; chemical industry.</li> <li>• Different terms such as Hazard, risk, LEL, VEL, TWA, STEL</li> <li>• Material safety data sheet (MSDS).</li> <li>• Standard operating procedures. ( SOP )</li> <li>• Colour code of different pipe lines, hot work permit, height permit.</li> <li>• 5s, concept and their application.</li> <li>• Environmental pollution - Types of pollution-noise, water, air, their resources and control, permissible limits.</li> <li>• Fires - types, prevention and control, Fire triangle, Classification of fire, Firefighting equipment – Fire extinguisher, fire bucket, fire blanket, Hydrant system, Fire-alarm, smoke, fume.</li> </ul>
Practical 32 Hrs.	Demonstrate procedures to make job /	<ul style="list-style-type: none"> <li>• Demonstrate marking of</li> </ul>	<b>FITTING:</b> <ul style="list-style-type: none"> <li>• Safety precautions to be followed in fitting workshop.</li> </ul>

<p>Theory 12 Hrs</p>	<p>component as per specification, assembling them and checking of dimensional/ functional accuracy following safety precautions. [Fitting operation – marking, punching, Hack-sawing, Filing, Drilling, countersinking, counter boring, reaming, Taping, dieing, fitting, polishing, assembling, etc. Accuracy: <math>\pm 0.05\text{mm}</math>].</p>	<p>components as per the detailed drawing (marking, punching).</p> <ul style="list-style-type: none"> <li>• Demonstrate production of components through different operation (viz. Hack-sawing, Filing, Drilling, countersinking, counter boring, reaming, Taping, dieing, making key way, fitting, scrapping, Lapping),</li> <li>• Demonstrate inspection of dimensional accuracy (using Vernier caliper, Micrometer, Dial Indicator, Gauges, Protractors, etc.) &amp; finish desired parts viz. 'A' &amp; 'B, etc'.</li> <li>• Assemble parts as per the assembly drawing and check for functionality.</li> <li>• Check level of the machine with spirit level, Dial test indicator</li> <li>• Perform positive locking with castle nut &amp; split-pin.</li> <li>• Repair key ways and demonstrate application of scrapper.</li> </ul>	<ul style="list-style-type: none"> <li>• Construction and use of different Hand tools - files, chisels, hacksaw &amp; hammer etc.</li> <li>• Free-hand sketches of Hand tools, Screw drivers, Pliers, Spanner, Tweezer,</li> <li>• Marking tools - Surface Plate, scriber, punches, scribing block / surface gauge (universal &amp; fixed type), Angle plate, combination set, etc.</li> </ul> <p>Job holding devices:</p> <ul style="list-style-type: none"> <li>• Construction and uses of different job holding devices such as vice, V' Block with clamp etc.</li> <li>• Types of Vice – Bench vice, leg vice, pipe vice, pin vice etc.</li> <li>• Linear Measuring Instruments - Construction, working principle, calculation and uses. steel rule, calliper (Inside, Outside, Odd leg), Try square, Vernier Calliper, Micrometre and their Least count Vernier Depth gauge, Height gauge, Bevel protector, Slip gauges and sine bars.</li> <li>• Free-hand sketches of Vernier Caliper, Micrometer, Depth Gauge, Dial Test Indicator, Bevel protractor</li> <li>• Drilling, Countersinking, counter boring. Reaming and tapping.</li> <li>• Nomenclature and uses of Drill, Reamer etc.</li> <li>• Threading and nomenclature and uses of different types of threads – metric, BSW, BSF, and BSP etc.</li> <li>• Calculation of tap drill size.</li> </ul>
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<p>Practical 32 Hrs.</p> <p>Theory 12 Hrs</p>	<p>Transfer skill of welding – by Setting Gas and Electric Arc welding plant, joining metal components observing safety precautions. <i>[Different Operations – select and operate fire extinguisher, straight line beads, single V-butt joint ].</i></p>	<ul style="list-style-type: none"> <li>• Demonstrate Safety precautions to be observed in welding workshop – Gas and Arc using appropriate PPE's</li> <li>• Demonstrate Setting of oxy-acetylene plant.</li> <li>• Exhibit oxy-acetylene flames (Neutral, oxidizing, carburizing).</li> <li>• Perform marking on job as per drawing.</li> <li>• Weld components according to drawing and specifications without &amp; with filler rod.</li> <li>• Illustrate function of electrode coating &amp; welding transformer.</li> <li>• Set- up an arc welding machine.</li> <li>• Demonstrate Preparation, clamping &amp; grounding of job to be welded by arc as per given specification.</li> <li>• Weld components by arc</li> </ul>	<ul style="list-style-type: none"> <li>• Safety &amp; General precautions observed during welding in chemical plant, application of PPE's, toxic fumes, light intensity, ventilation and housekeeping. Environmental hazard, waste management, types of fire and fire extinguishers.</li> <li>• Types of welding terms and their definition.</li> <li>• Types of transformer single phase, three phase, step up, step down transformer.</li> <li>• Heat, temperature and Expansion of solids.</li> <li>• Effects of arc length, Types of welding joints, welding positions, welding symbols.</li> <li>• Selection criteria, Storage and baking of electrode, Welding defects, Types of cracks, causes and their remedies.</li> </ul>

		welding according to drawing and specifications.	<ul style="list-style-type: none"> <li>ISI symbols of Generator, Voltmeter, Ammeter, Wattmeter, Resistor, Inductor Capacitor, Transformer, AC &amp; DC motors etc.</li> </ul>
Practical 32 Hrs.  Theory 12 Hrs	Demonstrate experiments in Physics laboratory to determine physical constants, verify laws, etc.	<p><b><u>Simple pendulum -</u></b></p> <ul style="list-style-type: none"> <li>Measure diameter of bob, length of Pendulum, Record time for 20 oscillations and Tabulate all readings.</li> <li>Calculate acceleration due to gravity(g) and Plot the graph of L &amp; T<sup>2</sup>.</li> </ul> <p><b><u>Law of parallelogram of forces -</u></b></p> <ul style="list-style-type: none"> <li>Find resultant force by Law of parallelogram and drawing diagonal and Calculate resultant by formula.</li> </ul> <p><b><u>Inclined plane</u></b></p> <ul style="list-style-type: none"> <li>Find weights for upward and downward motion of roller for different inclination of plane (30°, 40°, 50°, 60°) and Plot graph.</li> </ul> <p><b><u>Screw Jack -</u></b></p> <ul style="list-style-type: none"> <li>Calculate Mechanical Advantage, velocity ratio by putting load on screw jack.</li> </ul> <p><b><u>Young's Modulus -</u></b></p> <ul style="list-style-type: none"> <li>Calculate Young's Modulus for wire.</li> </ul> <p><b><u>Ohm's law -</u></b></p> <ul style="list-style-type: none"> <li>Calculate and prove the ohm's law by connecting two resistances in series and parallel</li> </ul> <p><b><u>Faraday's first law -</u></b></p> <ul style="list-style-type: none"> <li>Calculate electrochemical equivalent of copper and Find out electrolytic property of</li> </ul>	<ul style="list-style-type: none"> <li>Representation of forces, resultant and use of scaler and vector quantities.</li> <li>Laws of oscillations, parallelogram.</li> </ul> <p><b>Friction -</b></p> <ul style="list-style-type: none"> <li>units and type of friction.</li> <li>Advantages and disadvantages of friction.</li> <li>simple machine viz. – wheel and axle, Screw jack, Lever etc.– mechanical advantage, velocity ratio, efficiency etc.</li> <li>Elasticity, stress, strain, elastic limit, – Young's modulus of elasticity.</li> <li>Electricity - Unit of current &amp; voltage</li> <li>Ohm's law, Kirchhoff's law.</li> <li>Electrolysis - Faraday's laws of electrolysis.</li> <li>Electroplating - electrolytic and non-electrolytic solutions.</li> <li>Modes of heat transfer – conduction, convection and radiation.</li> <li>Temperature, Thermal conductivity &amp; expansion of solid, liquid. Mechanical equivalent of heat ('J' by electric method)</li> <li>Coefficient of linear and cubical expansion.</li> </ul>



		<p>copper sulphate solution.</p> <p><b><u>Mechanical Equivalent of Heat -</u></b></p> <ul style="list-style-type: none"> <li>Calculate Mechanical equivalent of heat 'J'.</li> </ul> <p><b><u>Coefficient of expansion of solid -</u></b></p> <ul style="list-style-type: none"> <li>Calculate coefficient of expansion of solid rod.</li> </ul> <p><b><u>Coefficient of expansion of liquid -</u></b></p> <ul style="list-style-type: none"> <li>Calculate coefficient of expansion of liquid.</li> </ul> <p><b><u>Thermal conductivity of metal rod -</u></b></p> <ul style="list-style-type: none"> <li>Calculate thermal conductivity of a metal rod.</li> </ul>	
<p>Practical 32 Hrs.</p> <p>Theory 12 Hrs</p>	<p>Demonstrate experiments in Chemistry laboratory to determine concentration of solutions, <math>P^H</math>, melting point, boiling point, flash point of oil, viscosity of oil, selection of oil for particular application at certain temperature, Reynold's Number to predict flow pattern in a conduit, compare properties of metals &amp; alloys, prepare chemicals, etc.</p>	<p><b><u>Titration- HCl- NaOH -</u></b></p> <ul style="list-style-type: none"> <li>Titrate standard solution of HCl against NaOH and Find Normality &amp; strength of NaOH.</li> </ul> <p><b><u>Titration – HCl- <math>Na_2CO_3</math> -</u></b></p> <ul style="list-style-type: none"> <li>Titrate standard solution of HCl against <math>Na_2CO_3</math> and Find Normality &amp; strength of HCl.</li> </ul> <p><b><u>Properties of mixture and compound</u></b></p> <ul style="list-style-type: none"> <li>Compare properties of iron sulphide with mixture of iron and sulphur.</li> </ul> <p><b><u>Laboratory preparation Soap -</u></b></p> <ul style="list-style-type: none"> <li>Prepare soap with caustic soda, vegetable oil, etc.</li> </ul> <p><b><u>Determination of pH -</u></b></p> <ul style="list-style-type: none"> <li>Determine pH of given solutions (acidic, basic, neutral) and Calibrate PH meter</li> </ul> <p><b><u>Boiling point determination -</u></b></p> <ul style="list-style-type: none"> <li>Determine boiling point of a</li> </ul>	<p><b>Chemistry -</b></p> <ul style="list-style-type: none"> <li>Element, atom and molecule.</li> <li>Acids, bases and salts-their properties and uses.</li> <li>Compound, mixture, Physical change, chemical change, Molecular weight, equivalent weight, atomic weight, Normality, molarity and molality.</li> </ul> <p>Atomic structure</p> <ul style="list-style-type: none"> <li>Electrons, protons, neutrons.</li> <li>Electronic theory of valence.</li> <li>Classification of elements,</li> <li>Modern periodic law, periodic table, Groups, periods, periodic properties</li> </ul> <p>Allotropy</p> <ul style="list-style-type: none"> <li>Allotropy of hydrogen, carbon, phosphorus and sulphur. Allotropic forms of Sulphur – monoclinic, amorphous and rhombic Sulphur.</li> </ul> <p>Water -</p> <ul style="list-style-type: none"> <li>Sources, hard and soft water, causes and removal of hardness,</li> </ul>

		<p>given liquid</p> <p><b><u>Melting point determination -</u></b></p> <ul style="list-style-type: none"> <li>• Determine melting point of a given substance.</li> <li>• Determine flash point for given oil sample</li> <li>• Determine viscosity of given oil by digital viscometer</li> <li>• Calculate Reynold's number and determine the nature of flow rate of fluid/flow pattern of liquid</li> </ul>	<ul style="list-style-type: none"> <li>• water for industrial purposes.</li> <li>• Corrosion- causes, effects and prevention.</li> <li>• Working procedure of Effluent treatment plant (ETP)</li> </ul> <p>Organic chemistry</p> <ul style="list-style-type: none"> <li>• pH, pH scale, measurement of pH</li> <li>• Purification processes, organic reactions- substitution, addition, Elimination, rearrangement reactions, examples.</li> <li>• Boiling point and melting point of organic compounds.</li> <li>• Flash point, fire point auto ignition temp.</li> <li>• fluid, ideal fluid, real fluid, compressible fluid, incompressible fluid.</li> </ul> <p>Properties of fluid-viscosity.</p> <ul style="list-style-type: none"> <li>• Manometer, Reynold's Number, Equation of continuity, Bernoulli's theorem.</li> <li>• ETP: introduction, different stages used in ETP plant, different parameters in ETP.</li> </ul>
<p>Practical 32 Hrs.</p> <p>Theory 12 Hrs</p>	<p>Exhibit production of component on conventional lathe machine observing standard operation practice. [Different operations: - plain turning, facing, step turning, through &amp; step drilling, knurling, threading, etc].</p>	<ul style="list-style-type: none"> <li>• Grind cutting tools for different lathe operations with correct angles.</li> <li>• Produce component as per drawing performing lathe operations (Viz. Facing, Plain turning, step turning, Drilling, Taper turning, knurling, threading, etc.).</li> </ul>	<ul style="list-style-type: none"> <li>• Overview of chemical plant designing</li> <li>• Lubrications and maintenance of lathe, lubrications points.</li> <li>• Lathe cutting tools- different types, shapes and different angles. Materials of cutting tools.</li> <li>• Lathe accessories – types and their uses</li> <li>• Drills – Parts, Types, specification, angles of drill</li> <li>• Threads – Types, nomenclature, uses.</li> </ul>

<p>Practical 16 Hrs.</p> <p>Theory 06 Hrs</p>	<p>Execute pipe joints, &amp; fittings with pipes, apply lagging materials in accordance with job condition - hot/cold and test for leakages. <i>[Range of skills – Cutting, Threading, gasket cutting, lagging of pipeline, Joining and use of locking devices]</i></p>	<ul style="list-style-type: none"> <li>• Construct pipeline with different joints using gaskets as per drawing and check for leakage.</li> <li>• Install and assemble the pipe line Closed at one end with appropriate pipe fitting.</li> <li>• Prepare blind flange on pipeline</li> <li>• Demonstrate Lagging, Cladding and fitting of Gasket on pipelines.</li> </ul>	<ul style="list-style-type: none"> <li>• Pipes – Types, materials, specification.</li> <li>• pipe joints such as screwed joint, flanged joints etc.</li> <li>• Standard pipe threads, BSP.</li> <li>• Types of pipe fittings - Tee, bend, elbow, etc. Specification, material and applications.</li> <li>• Corrosion and Thermal insulation – lagging materials, Types &amp; uses, materials, application of lead, rubber, FRP and glass lining.</li> <li>• Gasket and gland packing's - materials, types, uses</li> <li>• Locking devices - locknut castle nut, saw nut, locking pin, spring lock water.</li> </ul>
<p>Practical 32 Hrs.</p> <p>Theory 12 Hrs</p>	<p>Demonstrate installation /connection of instrument/devices to measure pressure, temperature, flow rate and level, pressure drop due to friction, effect of pipe roughness on friction, frictional loss in fittings and valves, coefficient of discharge, density and record readings. <i>[Different instrument/devices – Bourdon tube pressure gauge, capsule type gauge, mercury in glass thermometer,</i></p>	<ul style="list-style-type: none"> <li>• Connect the bourdon type pressure gauge, capsule type pressure gauge and note down at least five readings.</li> <li>• Measure temperature using mercury in glass thermometer, bimetal thermometer, RTD (PT 100) thermometer and take five readings of temperature &amp; record.</li> <li>• Connect the orifice flow meter with the water pipe line, then 'U' tube manometer with orifice flow meter, take different readings by controlling the flow and tabulate/ calibrate the readings in a table and convert it to lit/min.</li> <li>• Connect the venture flow meter, Rota meter in the water line in vertical position and tabulate / calibrate the readings &amp; compare.</li> </ul>	<ul style="list-style-type: none"> <li>• Pressure: Definition, unit's conversion of units.</li> <li>• Classification of pressure measuring instruments - Bourdon type, capsule type helical type, bellows type diaphragm type pressure gauges.</li> <li>• Temperature: Definition, units, conversation of units. Classification of temperature measuring instruments: Mercury in glass thermometer, bimetallic thermometer, RTD thermometer &amp; Thermocouple.</li> <li>• Flow Measurement- Classification of flow measuring instruments - Construction, workings &amp; uses of orifice meter, venturi meter, disc type, turbine type flow meters.</li> <li>• Level Measurement – Classification of level measuring</li> </ul>

	<p><i>bimetal thermometer, RTD, thermocouple, orifice meter, venture meter, Rotameter, sight glass level indicator, air purge level indicator, capacitance type level indicator, hydrometer, control valve]</i></p>	<ul style="list-style-type: none"> <li>Graphical representation of flow rate &amp; differential pressure (<math>\Delta H</math>).</li> <li>Describe the working principle of v-notch during experiment &amp; also calculate the flowrate through it.</li> <li>Measure volume of container and calculate quantity of liquid in container with float type level indicator.</li> <li>Measure Back pressure and quantity of liquid in the container with Air purge level indicator and capacitance type level indicator.</li> <li>Explain working principle and operation of Hydrometer and Flow control valve.</li> <li>Demonstrate working principle and operation of pilot tube</li> <li>Trouble shooting and maintenance of above said instruments.</li> </ul>	<p>instruments – simple float type level indicator, sight glass level indicator, air purge level indicator, Capacitance type level indicator.</p> <ul style="list-style-type: none"> <li>Construction and working principle of Hydrometer and Flow control valve.</li> </ul> <p>Notch &amp; weir: introduction, different types of notch &amp; weir. Drawing of pressure control process line. Drawing of Pressure, Level, Flow and Temperature control system.</p>
<p>Practical 32 Hrs.</p> <p>Theory 12 Hrs</p>	<p><i>Demonstrate different types of maintenance (viz. Online, Predictive, Preventive and breakdown) and Trouble shoot, dismantle, repair &amp; assemble / Align different mechanical components for power transmission &amp; check their functionality. (Different Mechanical Components viz.</i></p>	<ul style="list-style-type: none"> <li>Explain and differentiate between different types of maintenance.</li> <li>Demonstrate use of PPE's</li> <li>Prepare check list and Maintenance record of equipment.</li> <li>Explain selection of proper lubrication system and demonstrate lubrication.</li> <li>Demonstrate removal of bearing, cleaning, lubrication and mounting on shaft observing standard procedure.</li> <li>Demonstrate dismantling of gear box, removing its parts, cleaning, check for any damages &amp; replace if necessary and</li> </ul>	<ul style="list-style-type: none"> <li>Maintenance – definition, Types, advantages and disadvantages, making of check list.</li> <li>Lubricant – Definition, Quality of good lubricant, Selection of lubricant, methods of lubrication.</li> <li>Types, construction &amp; uses of bearings such as ball, roller, bush etc. their care &amp; maintenance.</li> <li>Types of gears - Spur gear, Helical gear, Bevel gear, Worm gear - Their uses &amp; care.</li> <li>Drawing of different types locking devices such as Double nut, Castle nut, Pin, keys, etc.</li> </ul>

	<p><i>Belt, Pulleys. shaft, motor, coupling, Gearbox, bearings, Hydraulic jack).</i></p>	<p>assemble all parts as per standard procedure.</p> <ul style="list-style-type: none"> <li>• Demonstrate alignment of motor, coupling and pump as per standard procedure.</li> <li>• Demonstrate removal of the pulley from shaft, cleaning hub, keyways, shaft and mounting of pulley on shaft as per standard procedure.</li> <li>• Demonstrate operation, working, use and Construction details of Hydraulic Jack and Hydraulic Trainer, Inspect, note down defects, dismantle, trouble shooting, cleaning and Overhauling, Check oil level and grade, reassembling and Check for proper functioning.</li> </ul>	<ul style="list-style-type: none"> <li>• Power transmission -</li> </ul> <p><b>Couplings</b> - Types of couplings– muff coupling, flange coupling and their application. Draw different types of couplings such as Muff coupling, Half lap coupling, Flange coupling, etc.</p> <p><b>Pulleys and Belts</b> - Size &amp; specification, Belt material, Selection of belt, Load &amp; belt tension, Advantages &amp; disadvantages of belts.</p> <ul style="list-style-type: none"> <li>• <b>Lifting devices</b> : Working of– chain block, screw jack, hydraulic jack.</li> <li>• Material handling devices Working of - hand trolley, fork lift etc.</li> </ul> <p><b>Alignment of pump</b> - Causes and effects of misalignment, Methods of testing misalignments, Alignment by two dial gauge, Advance laser alignment techniques.</p> <p><b>HYDRAULICS:-</b> Basic principal, Inherent physical properties of liquids, comparison of molecular structure of solids, liquids &amp; gases,</p> <ul style="list-style-type: none"> <li>• Basic terms &amp; definition in hydraulics i.e. Force, Pressure, Work, Viscosity, Pascal's law]</li> </ul>
<p>Practical 48 Hrs.  Theory 18 Hrs</p>	<p>Demonstrate overhauling of different types of valve.</p>	<ul style="list-style-type: none"> <li>• Demonstrate dismantling of - (i) Gate valve, (ii) Globe valve - check controlling elements for damages, clean, Lubricate, replace gland packing, reassemble valve sequentially and check for leakage.</li> <li>• Demonstrate dismantling of needle valve, remove lock nut, bonnet and inspect threads on</li> </ul>	<ul style="list-style-type: none"> <li>• Valves: types and applications, Principle, Construction, Operating and working of Gate valve, Globe valve, Needle valve, Ball valve, Plug valve, NRV, PSV, Diaphragm valve, Butterfly valve, Control valve - maintenances and troubleshooting.</li> </ul>

		<p>the stem at terminal ends and vice-versa, clean, reassemble and check for proper Functioning.</p> <ul style="list-style-type: none"> <li>• Demonstrate dismantling of ball valve - remove its hand wheel, gland nut, bonnet, stem, check parts for any damage, seepage, clean, reassemble sequentially and check for proper Functioning.</li> <li>• Demonstrate dismantling of plug valve - remove its stem, controlling device, check parts for any damage, clean, reassemble sequentially and check for proper Functioning.</li> <li>• Demonstrate dismantling of NR valve - check parts for any damage, clean, reassemble sequentially and check for proper Functioning.</li> <li>• Explain construction details, operating &amp; working of diaphragm valve, remove hand wheel bonnet etc, inspect diaphragm for any damage, reassemble sequentially and check for proper functioning.</li> <li>• Explain construction details, operating &amp; working of Butterfly valve, remove gland flange, inspect ropes for its tightness, reassemble sequentially and check disc movement and locking arrangement for proper functioning.</li> <li>• Explain control valve, Dismantle and check for damage / replacement, reassemble sequentially and check for proper functioning.</li> </ul>	<ul style="list-style-type: none"> <li>• Selection of appropriate type of valve for given service.</li> <li>• Free-hand sketches and symbolic representation of different types of valves, Gate valve, Globe valve, Butterfly valve, Ball valve, Diaphragm valve, Control valve, Non-return valve and Needle valve.</li> </ul>
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<p>Practical 32 Hrs.</p>	<p>Trouble shoot, dismantle, Overhaul / repair &amp; reassemble</p>	<ul style="list-style-type: none"> <li>• Check centrifugal pump, note down defects, dismantle the pump, check all the parts clean all parts, replace gasket / oilpaper / parts if damage &amp; assemble and check for proper functioning.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Mechanical seal</b> – Types, Material, application of mechanical seals, Oil seals.</li> </ul>
<p>Theory 12 Hrs</p>	<p>different machine, pumps &amp; components for transportation of liquid, check their functionality and plot the graphs for characteristic curve of different types of pump. [Different Machines &amp; Components – Pumps - centrifugal, gear pump, metering pump, screw pump, multistage compressor, vacuum pump, mechanical seals]</p>	<ul style="list-style-type: none"> <li>• Inspect reciprocating pump, note down defects, dismantle the pump, check and replace any worn out parts, lubricate, assemble and Check for proper functioning.</li> <li>• Inspect Gear pump, note down defects, dismantle the pump, check all the parts, coat all seals and replace any worn out parts, lubricate, assemble and Check for proper alignment and functioning.</li> <li>• Inspect Lobe pump, note down defects, dismantle the pump, inspect all the parts, replace any worn out parts, lubricate, assemble and Check for proper functioning.</li> <li>• Setup apparatus and set valve at a certain position, switch on the specified pump, attain steady state, inspect and note down the head developed, collect discharge for certain time interval, calculate volumetric flow rate, conduct procedure for different valve positions &amp; calculate flow rates, Co-relate head developed and capacity of the pump, interpret graph of head vs. capacity.</li> <li>• Explain working, application and maintenance of different types of screw pump and metering</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Pumping Device for Liquid Centrifugal Pump</b> – Classification, Construction, working &amp; use of centrifugal pump, Head vs. capacity relation, Starting &amp; Shutting down procedure, Types (volute/ diffuser ring type), Types of impeller, advantages &amp; disadvantages, trouble shooting in centrifugal pump.</li> <li>• <b>Positive Displacement Pump - Reciprocating Pump</b> – Classification, working principal, Construction details, Operating &amp; uses, Starting &amp; shutting down procedure, maintenance and trouble shooting.</li> <li>• <b>Rotary Pump</b> - Working principal, Construction details, Operating &amp; uses of Rotary pump, Types (Gear pump, Screw pump, Lobe pump), advantages &amp; disadvantages, Starting &amp; shutting down procedure, Maintenance and Trouble shooting.</li> <li>• Construction, working &amp; use of different types of Screw pump &amp; metering pump.</li> <li>• Construction, working &amp; uses of fans, blowers &amp; compressor.</li> <li>• <b>Vacuum Pump</b> - Definition, it's utilisation in chemical industries, working principal, construction details, operating &amp; working, and maintenance.</li> </ul>

		<p>pump.</p> <ul style="list-style-type: none"> <li>• Explain working, application and preventive maintenance of multistage compressor.</li> <li>• Inspect vacuum pump, note down defects, dismantle the pump, clean, inspect all the parts, replace any worn out parts, lubricate, assemble and Check for proper functioning.</li> </ul>	<p>Types - Water and steam jet ejector, Water / Oil Ring vacuum pump, Procedure for vacuum line up and vacuum break up.</p> <ul style="list-style-type: none"> <li>• <b>Characteristic curves of pumps</b>-the plot of actual head, total power consumption, and efficiency vs. volumetric flow rate. Flow of incompressible fluids in pipes.</li> </ul>
<p>Practical 32 Hrs.</p> <p>Theory 12 Hrs</p>	<p>Demonstrate machinery handling, installation, operations, maintenance, troubleshooting of various types of conveyors as per standard procedure, it's planning &amp; implementation.</p>	<ul style="list-style-type: none"> <li>• Demonstrate machinery handling, installation - Prepare foundation plan, Layout, template of foundation, fixing of foundation bolts, moving and setting machine onto foundation bolt, levelling and installation of machine as per standard procedure.</li> <li>• Explain Construction details and working of various types of conveyors like belt conveyor, screw conveyer and bucket elevators – starting, Supply of material, Measure speed / time taken for travel from one end to other, discharge of material at another end.</li> <li>• Inspect Belt Conveyor, note down defects, dismantle, trouble shooting, cleaning and Overhauling of driver &amp; driven roller, Checking integrity of belt and Empty running.</li> </ul>	<ul style="list-style-type: none"> <li>• Machinery installation – Receiving, Foundation, Levelling, Installation, Grouting, Trail</li> </ul> <p><b>Conveyor -</b></p> <ul style="list-style-type: none"> <li>• Types of conveyor – Belt conveyor, Bucket conveyor, Screw conveyor, Pneumatic conveyor.</li> <li>• Selection of conveyor. <ul style="list-style-type: none"> <li>• Working principal, construction details, operating &amp; working, its maintenance &amp; Trouble shooting.</li> <li>• Free-hand sketches of Belt conveyer, Screw conveyer, Bucket elevator.</li> </ul> </li> </ul>
<p>Practical 32 Hrs.</p> <p>Theory 12 Hrs</p>	<p>Demonstrate function of pressure vessel, various pipe fittings, valves, parameters, trouble shoot,</p>	<ul style="list-style-type: none"> <li>• Explain volume calculation of different storage tank, Measure level, maintain temperature &amp; pressure.</li> <li>• Inspect pressure vessel, examine system components including structural attachment and</li> </ul>	<p><b>Different types of storage vessels:</b></p> <ul style="list-style-type: none"> <li>• Storage of non-volatile, volatile liquids, storage of gases. Fixed or cone roof tanks, Floating roof tanks, cone roof with floating pan,</li> </ul>



	<p>dismantle, repair / overhauling &amp; reassemble different machine &amp; components for transportation of Gases, Air dryers &amp; Air filters and check their functionality</p>	<p>vessel connections, identify leakage or inadequate insulation, corrosion and wear around nozzles, Carryout repair / rectification, test pressure and maintain log book.</p> <ul style="list-style-type: none"> <li>• Inspect Reciprocating Compressor, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassembling and Empty running.</li> <li>• Inspect Centrifugal Compressor, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassembling and Empty running.</li> <li>• Inspect Screw Compressor and Lobe Compressor, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassembling and Empty running.</li> <li>• Inspect Fan and blower, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassembling and Empty running.</li> <li>• Inspect Air filter and Air dryer, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassembling and Empty running.</li> <li>• Inspect cooling tower, note down defects, dismantle, trouble shooting, Remove Scale formation, cleaning and Overhauling, reassembling and running.</li> </ul>	<p>Care and maintenance.</p> <ul style="list-style-type: none"> <li>• Introduction of pressure vessel, design pressure, design temperature, ASME &amp; BPVC, Material of construction, pressure vessel testing, types, maintenance &amp; care.</li> </ul> <p><b>Utility : Pumping Device for Gas</b></p> <ul style="list-style-type: none"> <li>• Compressed air - it's utilization in chemical industries.</li> <li>• Type of compressor – Reciprocating, Centrifugal, screw and Lobe Compressor - Working Principal, application, construction, operation &amp; maintenance.</li> <li>• Fan and Blower - Working principal, uses, construction details, operation and it's maintenance.</li> <li>• Air treatment -Introduction, RH, Dew point, water trap, Air filters-dry filter, wet filter, coarse filter, micro filter, pressure regulator.</li> <li>• <b>Air Dryers</b> - classification, components of a typical compresses air system.</li> <li>• <b>COOLING TOWER:</b> Water (Cooling, chill, hot, D I), Construction, types &amp; uses of cooling tower, maintenance &amp; trouble shooting, Scale formation, preventive maintenance. De foaming agent.</li> </ul>
<p>Practical</p>	<p>Trouble shoot, dismantle, clean</p>	<ul style="list-style-type: none"> <li>• Explain operation, working and construction details of Electrical</li> </ul>	<p><b>STEAM GENERATION -</b></p> <ul style="list-style-type: none"> <li>• Steam &amp; its types.</li> </ul>

<p>32 Hrs. Theory 12 Hrs</p>	<p>scale formation &amp; reassemble Electrode &amp; Oil fired boiler and Air handling unit and check their functionality.</p>	<p>Boiler.</p> <ul style="list-style-type: none"> <li>• Inspect Electrical Boiler, note down defects, dismantle, trouble shooting, Remove Scale formation, cleaning and Overhauling, reassembling and Check steam trap for proper functioning.</li> <li>• Explain operation, working and construction details of Oil-fired Boiler</li> <li>• Inspect Oil fired Boiler, note down defects, dismantle, trouble shooting, Remove Scale formation, cleaning and Overhauling, reassembling and Check for proper functioning.</li> <li>• Explain Refrigeration system, Refrigerant, vapor absorption and vapor compression, Air Handling Unit system.</li> <li>• Demonstrate Handling of Refrigerants, Inspect Refrigeration unit, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassembling and Check for proper functioning.</li> <li>• Inspect Air Handling Unit system, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassemble and Check for proper functioning.</li> </ul>	<ul style="list-style-type: none"> <li>• Types of boiler –</li> <li>• Electrode Boiler - Mountings &amp; accessories, Types of draught, Working Principal, application, construction, operation, maintenance &amp; trouble shooting, Scale formation, Types of Electrode, Types of steam trap, Panel control system</li> <li>• Oil fired Boiler - Working Principal, application, construction, operation, maintenance &amp; trouble shooting, Types of fuel, Scale formation, Ignition system, Panel control system.             <ul style="list-style-type: none"> <li>• REFRIGERATION: Types of refrigerant and its properties, Handling of refrigerant.</li> </ul> </li> </ul>
<p>Practical 32 Hrs. Theory 12 Hrs</p>	<p>Demonstrate operation of different Heat exchange equipment, Evaporators &amp; calculate heat transfer rate,</p>	<ul style="list-style-type: none"> <li>• Demonstrate Preparation, apparatus setting, starting cold and hot stream in Heat Exchanger, noting inlet &amp; outlet temperatures of both streams, noting mass flow rate of both streams, Calculation &amp; Result.</li> <li>• Explain working, use and</li> </ul>	<p><b>Boilers:</b> Types of boilers, construction &amp; working, Boiler inspection.  <b>Fuel:</b> introduction, types of fuel  <b>Steam:</b> Definitions, types of steam.  <b>Steam Trap:</b> Types, Construction and uses.</p> <ul style="list-style-type: none"> <li>• Free-hand sketches of</li> </ul>

	<p>trouble shoot, dismantle, clean &amp; reassemble different types of Heat exchangers, Evaporators and check functionality.  <i>[Heat exchange equipment's-Double Pipe Heat exchanger, Shell &amp; tube Heat exchanger, plate heat exchanger]</i>  <i>[Evaporation equipment's-Vertical tube evaporator, multiple effect evaporator]</i></p>	<p>Construction details of different types of Heat Exchanger, Inspect, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassembling and Check for proper functioning.</p> <ul style="list-style-type: none"> <li>• Demonstrate Preparation, apparatus setting, loading of evaporator, heating solution, noting temperatures, pressure, flow parameters, discharging and measuring concentrated solution, Calculation &amp; Result.</li> <li>• Explain working, use and Construction details of different types of Evaporator, Inspect, note down defects, dismantle, trouble shooting, cleaning scale formation and Overhauling, reassembling and Check for proper functioning.</li> </ul>	<p>steam jet ejector, stream trap.</p> <p><b>Heat Transfer:</b> Mechanism of Heat Transfer in solid, liquid and gases and their application in industries thermal conductivity, Fourier's law, Newton's law of cooling, Stefan boltzman law. Heat transfer equipment, its classification, Heat exchangers, coolers, condenser and chillers. Double pipe heat exchanger, co-current, counter current, cross current flow pattern. LMTD, Shell and tube heat exchanger-its types, applications in industries, Plate type heat exchanger, Advantages and disadvantage.</p> <p><b>Evaporation:</b> Definition, types of evaporators, Capacity, steam economy of evaporators, Multiple effect evaporation, methods of feeding in multiple effect evaporation.</p>
<p>Practical 32 Hrs.  Theory 12 Hrs</p>	<p>Demonstrate operation of different types of distillation column, filtration unit, Dryer used for loading wet material in tray dryer, cyclone separator, packed distillation column, sieve tray column, different types of extraction unit and troubleshoot, dismantle, clean and reassemble components and check for proper</p>	<ul style="list-style-type: none"> <li>• Explain working, use and Construction details of different types of Distillation column, Inspect, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassembling and Check for proper functioning.</li> <li>• Explain Preparation and apparatus setup, loading of sample solution, Maintaining the temperature, Collecting the sample solution, Reflux the sample to improve purity of product, Calculation &amp; prepare Result.</li> <li>• Explain working, use and Construction details of different</li> </ul>	<p><b>DISTILLATION:</b> Concept of distillation, boiling point diagrams, vapour-liquid equilibrium, relative volatility, constant boiling mixtures - minimum &amp; maximum azeotropes, Method &amp; types of distillation, Flash differential, rectification and azeotropic, extractive, vacuum, steam distillation. Reflux ratio: minimum, total, optimum, importance of reflux ratio. Types of Distillation column (packed &amp; plate) - Construction details, operation, maintenance, &amp; trouble shooting. Types of pickings and plate, Channeling. Diagram of distillation column</p>

	<p>functionality.</p>	<p>types of Filtration equipment, Inspect, note down defects, dismantle, trouble shooting, cleaning scale formation and Overhauling, reassembling and Check for proper functioning.</p> <ul style="list-style-type: none"> <li>• Explain Preparation and apparatus setup in cyclone separator, Measurement of air flow, Weight of dust particles in particular time, Calculation &amp; prepare Result in ppm.</li> <li>• Explain Preparation and apparatus setup in different types of extraction unit, analyse feed &amp; solvent, Stirring, Settling, Separation of raffinate &amp; extract phase, test &amp; prepare Result.</li> </ul>	<p>with all accessories.</p> <p><b>FILTRATION:</b> Definition, Filtration media &amp; Filter aid. Filtration equipment (plate &amp; filter, rotary vacuum filter, centrifuge, Buckner filter, nautch filter, sparkler filter, Leaf filter)</p> <p>Working principal, construction details, operation, maintenance, &amp; Trouble shooting.</p> <p><b>Pollution:</b> Sources, types &amp; effect of water pollution, air pollution. Pollution control equipment such as bag filter, electrostatic precipitators, Water scrubber, cyclone separator.</p> <p><b>Solvent Extraction:</b> definition, choice of solvent, distribution coefficient. Equipment used for extraction, Packed and perforated plate towers, application of extractions</p> <p><b>Leaching:</b> Application and different types of equipment used for leaching oil extraction from oil seeds.</p>
<p>Practical 16 Hrs.</p> <p>Theory 06 Hrs</p>	<p>Operate an absorption column &amp; determine flooding velocity, explain gas absorption, packed tower, types of packing. Demonstrate operation of crystallization equipment.</p>	<ul style="list-style-type: none"> <li>• Demonstrate absorption - preparation and apparatus setup, analyse gas mixture &amp; solvent, contacting of gas &amp; liquid phase, maintain flow rates &amp; pressure, analyse gas phase &amp; liquid phase, prepare Result.</li> <li>• Demonstrate flooding velocity - Preparation and apparatus setup, Set liquid flow rate, maintain gas flow rate at different velocities, note down manometer reading, prepare Graphical representation of flow rate &amp; differential</li> </ul>	<p><b>Absorption:</b> Introduction, equipment's used for absorption –columns, factors affecting rate of absorption, tower packing.</p> <p><b>Flooding</b> and flooding velocity.</p> <p><b>Crystallization:</b> Introduction, concepts of solubility &amp; effect of temperature on solubility, crystallization, methods of super-saturation, Different types of crystallizers &amp; their application in industries.</p>

		<p>pressure (<math>\Delta H</math>).</p> <ul style="list-style-type: none"> <li>Demonstrate crystallization - Preparation and apparatus setup, prepare saturated/super saturated solution using solid solute like NaCl, Formation of crystals, Cooling &amp; Stirring, Separation of crystal &amp; mother liquor, Crystal drying</li> </ul>	
<p>Practical 16 Hrs.</p> <p>Theory 06 Hrs</p>	<p>Exhibit different modules of DC'S and PLC's, their function, Wire and connect I/OS field devices to the I/O Modules.</p>	<ul style="list-style-type: none"> <li>Explain different function of DCS system, different modules of DCS and different process instruments in process plant, connect the I/O Module of DCS to field signals, Install DCS Programming software and establish communication with PC and DCS.</li> <li>Explain modules in a rack and mount in the specified slot, connect the digital I/OS field devices to the I/O Module of PLC.</li> </ul>	<ul style="list-style-type: none"> <li>Structure of DCS system. Importance of DCS, Use of DCS in chemical industries.</li> <li>characteristics of programmable controllers, limitation of PLCs, method of developing PLC programming.</li> </ul>
<p>Practical 16 Hrs.</p> <p>Theory 06 Hrs</p>	<p>Demonstrate operation of different types of mixing equipment like ribbon blender, different size reduction machines (Hammer mill, Ball mill), Screening Equipment &amp; troubleshoot, dismantle, clean and maintenance of different mechanical components.</p>	<ul style="list-style-type: none"> <li>Demonstrate working, use and Construction details of Jaw crusher, Hammer mill &amp; Ball mill, crushing operation, Collection of crushed material, Inspect, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassembling and Check for proper functioning.</li> <li>Explain working, use and Construction details of Vibratory sieve shaker, Loading, Operating, Collection &amp; weighing of sample, Inspect, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassembling and Check for proper functioning.</li> <li>Demonstrate working, use and</li> </ul>	<p><b>Size Reduction:</b> Definition, Advantages, Crushing &amp; Grinding, Classification, different Equipment's (Blake jaw crusher, Hammer mill, Ball mill, Multi mill, Rod mill) - Working principal, construction details, operating &amp; working, their maintenance &amp; Trouble shooting.</p> <ul style="list-style-type: none"> <li><b>SCREENING:</b> Definition, different Screening equipment (Sieve shaker, vibratory sifter, ultrasonic vibratory sifter) - Working principal, construction details, Types of sieves, Mesh number, efficiency of sieve operating &amp; working, their maintenance &amp;</li> </ul>

		Construction details of Agitator, Homogeneous mixing of substances, unloading of mixer, Washing & cleaning, Inspect, note down defects, dismantle, trouble shooting, cleaning and Overhauling, reassembling and Check for proper functioning.	Trouble shooting. <b>MIXER &amp; AGITATORS</b> : Definition, Types of mixer and agitators - mixers for mixing solid-solid, solid-liquid., their application and construction, Vortex, Baffled.  Free-hand sketches of Crushers, Ball mill, Hammer mill and Centrifuges.
Practical 16 Hrs.  Theory 06 Hrs	Explain selection of appropriate Dryer and demonstrate operation of Tray dryer and carry out its cleaning, maintenance, trouble shooting for proper functionality.	<ul style="list-style-type: none"> <li>Explain working, use and Construction details of Tray dryer, material loading, start drying, Collection &amp; weighing of sample, Inspect, note down defects, dismantle, trouble shooting, cleaning scale formation and Overhauling, reassembling and Check for proper functioning.</li> </ul>	<b>DRYING:</b> Definition, different Drying equipment (tray dryer, Rotary dryer, Spray dryer, FBD, RCVD) – their working principal, construction details, operating & working, factors affecting rate of drying, Loading & unloading material. Re-drying, maintenance & Trouble shooting.
Practical 16 Hrs.  Theory 06 Hrs	Explain operation of cooling tower, perform humidification & dehumidification operations, find out relative humidity by measuring dry bulb & wet bulb temperatures	<ul style="list-style-type: none"> <li>Explain operation of cooling tower, note reading of wet bulb and dry bulb, compare readings and prepare result. Note down temperature of inlet water and cooled water outlet temperature at specific intervals, compare <i>readings and</i> prepare result.</li> </ul>	<b>Humidification &amp; Dehumidification:</b> Theory of Humidification and different terms related to Humidification. <b>Cooling Tower:</b> Types of cooling tower, their Construction and working. <b>PETROLEUM &amp; PETROCHEMICAL:</b> Introduction, origin of petroleum, composition, classification of petroleum, ADU, VDU, 36 Products of petroleum, Introduction of petrochemical, feedstock used in it.
Practical 16 Hrs.  Theory 06 Hrs	Explain sedimentation operation and differentiate between settling, sedimentation and decantation operations.	<ul style="list-style-type: none"> <li>Explain preparation and apparatus setup, coagulant addition, Stirring, Settling, separation &amp; prepare Result.</li> </ul>	<b>Sedimentation &amp; Decantation:</b> Type of thickeners and sedimentation operation equipment.
Practical 32 Hrs.	Manufacture different chemical	<ul style="list-style-type: none"> <li><b>Manufacture Sulphuric Acid by Contact Process:</b> Properties, Raw materials, chemical</li> </ul>	<b>Unit Process:</b> Difference between Unit operations & Unit Processes.

<p>Theory 12 Hrs</p>	<p>products</p>	<p>reactions.</p> <ul style="list-style-type: none"> <li>• <b>Manufacture Soda Ash:</b> Raw materials, chemical reactions.</li> <li>• <b>Manufacture Caustic soda</b> - raw materials, chemical reactions.</li> <li>• <b>Manufacture Ammonia:</b> Raw materials, chemical reactions.</li> <li>• <b>Manufacture of cement by wet process:</b> Raw materials, chemical reactions,</li> <li>• <b>Manufacture Urea:</b> Raw materials, chemical reactions,</li> <li>• <b>Manufacture VEGETABLE OIL:</b> Raw materials, chemical reactions,</li> <li>• <b>MANUFACTURE OF SUGAR:</b> Raw materials, chemical reactions,</li> <li>• <b>Manufacture of pulp &amp; paper:</b> raw materials, chemical reactions</li> </ul>	<p>Important chemical processes. Terms related to Unit Processes- Raw material, Instruments, finished product, by-product, conversion, yield, batch process, continuous process. Free-hand sketches of process instrument, such as Temperature indicator, Level indicator, LIC, TIC, PI, PIC, FI, FIC. Types of reactions. Flow sheet- Types of flow sheet, Process block diagram (PBD), process flow diagram (PFD), PID. Importance of different symbols of unit operations and its use. <b>Manufacturing process of Sulphuric Acid by Contact Process, Soda Ash, Caustic soda, Ammonia, Sugar, Urea, Cement, vegetable oil, Pulp &amp; Paper:</b> their Properties, Raw materials, chemical reactions, process description, flow sheet. And Uses.</p>
<p>Practical 16 Hrs.  Theory 06 Hrs</p>	<p>Explain function of various types of Chemical reactor and their accessories.</p>	<ul style="list-style-type: none"> <li>• Explain function and use of various types of Chemical reactor, their fittings and accessories.</li> </ul>	<p><b>Chemical Reactor:</b> Types of reactor, Parts of reactor.</p>

**Note:** More emphasis to be given on video/real-life pictures during theoretical classes. Some real-life pictures/videos on the skills/ topics taught may be shown to the trainees to give a feel of Industry and their future assignment.

<b>SYLLABUS FOR CORE SKILLS</b>
1. Workshop Calculation & Science (Common for all Engineering CITS trades) (80 Hrs)
2. Engineering Drawing (Group I) (120 Hrs)
3. Training Methodology (Common for all CITS trades) (320 Hrs + 200 Hrs)

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



## 7. ASSESSMENT CRITERIA

LEARNING OUTCOME	ASSESSMENT CRITERIA
<b>TRADE TECHNOLOGY</b>	
1. Demonstrate related safety and general awareness in chemical industry. <i>[viz. application of fire extinguishers, use of PPE'S with general and chemical hazards, interpretation of data from MSDS, detect dust percentage in Air, etc.]</i>	1.1 Demonstrate use of appropriate PPE
	1.2 Demonstrate First aid methods on different types of injury.
	1.3 Demonstrate fire fighting
	1.4 Illustrate Safety signs and symbols, Fire, gas detector & smock alarm system.
	1.5 Demonstrate disposal of workshop wastes, 5's concept and Housekeeping.
	1.6 Demonstrate determination of dust percentage in Air.
2. Demonstrate procedures to make job / component as per specification, assembling them and checking of dimensional/ functional accuracy following safety precautions. <i>[Fitting operation – marking, punching, Hack-sawing, Filing, Drilling, countersinking, counter boring, reaming, Taping, fitting, polishing, assembling, etc. Accuracy: ± 0.05mm].</i>	2.1 Demonstrate production of components as per given drawing
	2.2 Demonstrate inspection of dimensional accuracy of produced components and record keeping
	2.3 Demonstrate assembly of parts as per drawing and check for functionality
	2.4 Demonstrate levelling of machine
3. Transfer skill of welding – by Setting Gas and Electric Arc welding plant, joining metal components observing safety precautions. <i>[Different Operations – select and operate fire extinguisher, straight line beads, single V-butt joint ]</i> .	3.1 Demonstrate welding of components by gas welding as per drawing
	3.2 Demonstrate welding of components by arc welding as per drawing
4. Demonstrate experiments in Physics laboratory to determine physical constants, verify laws, etc.	4.1 Demonstrate experiment on simple pendulum to calculate acceleration due to gravity(g) and Plotting graph of L & T <sup>2</sup> .
	4.2 Demonstrate finding resultant force by Law of parallelogram and calculation of resultant.
	4.3 Demonstrate determination of weights for upward and downward motion of roller for different inclination of plane

	4.4 Demonstrate calculation of Mechanical Advantage, velocity ratio by putting load on screw jack.
	4.5 Demonstrate calculation of Young's Modulus for wire.
	4.6 Demonstrate experiment to prove ohm's law
	4.7 Demonstrate calculation of electrochemical equivalent of copper and finding electrolytic property of copper sulphate solution.
	4.8 Demonstrate calculation of Mechanical equivalent of heat 'J'.
	4.9 Demonstrate calculation of coefficient of expansion of solid, liquid and thermal conductivity of a metal rod
5. Demonstrate experiments in Chemistry laboratory to determine concentration of solutions, P <sup>H</sup> , melting point, boiling point, flash point of oil, viscosity of oil, selection of oil for particular application at certain temperature, Reynold's Number to predict flow pattern in a conduit, compare properties of metals & alloys, prepare chemicals, etc.	5.1 Demonstrate titration of solution of acid and base and find normality & strength of acid / base.
	5.2 Demonstrate comparison of properties of mixture and compound
	5.3 Demonstrate preparation of soap
	5.4 Determine pH of given solutions (acidic, basic, neutral) and Calibrate PH meter
	5.5 Demonstrate determination of boiling point of a liquid and melting point of a substance
	5.6 Demonstrate determination of flash point and viscosity for given oil sample
	5.7 Explain calculation of Reynold's number and determine the nature of flow rate /flow pattern of liquid
6. Exhibit production of component on conventional lathe machine observing standard operation practice. [Different operations: - plain turning, facing, step turning, through & step drilling, knurling, threading, etc].	6.1 Demonstrate grinding of cutting tools for different lathe operations and checking of different angles.
	6.2 Demonstrate lubrication and maintenance of machine for trouble free performance.
	6.3 Demonstrate manufacturing of component as per drawing performing lathe operations (Viz. Facing, Plain turning, step turning, Drilling, Taper turning, knurling, threading, etc.).
	6.4 Demonstrate checking / inspection of manufactured component for its dimensional accuracy
7. Execute pipe joints & fittings with pipes, apply lagging materials in accordance with job condition - hot/cold and test for leakages. <i>[Range of skills – Cutting, Threading, gasket cutting, lagging of pipeline, Joining and use of locking devices]</i>	7.1 Demonstrate construction of pipeline using different joints as per drawing with different conditions. (viz. closed at one end, blind flange, etc)
	7.2 Demonstrate Lagging, Cladding and fitting of Gasket on pipelines.
	7.3 Demonstrate checking of pipelines for leakage.
8. Demonstrate installation /connection of	8.1 Demonstrate installation and measuring pressure with different types of pressure measuring instruments (viz.

instrument/devices to measure pressure, temperature, flow rate and level, pressure drop due to friction, effect of pipe roughness on friction, frictional loss in fittings and valves, coefficient of discharge, density and record readings. <i>[Different instrument/devices – Bourdon tube pressure gauge, capsule type gauge, mercury in glass thermometer, bimetal thermometer, RTD, thermocouple, orifice meter, venture meter, Rotameter, sight glass level indicator, air purge level indicator, capacitance type level indicator, hydrometer, control valve]</i>		Bourdon type and capsule type) and recording of readings.
	8.2	Demonstrate installation and measuring temperature with different types of temperature measuring instruments (viz. mercury in glass thermometer, bimetal thermometer, RTD thermometer) and recording of readings.
	8.3	Demonstrate connection and measuring flow rate and coefficient of discharge with different types of flow measuring instruments (viz. orifice meter, venturi meter, Rota meter) and recording of readings.
	8.4	Explain Graphical representation of flow rate & differential pressure ( $\Delta H$ ).
	8.5	Demonstrate installation and calculation of Back pressure and quantity of liquid in the container with different types of level measuring instruments (viz. float type, Air purge and capacitance type level indicator) and recording of readings.
	8.6	Explain working principle and operation of Hydrometer, Flow control valve and pilot tube.
	8.7	Demonstrate trouble shooting and maintenance of different types of pressure measuring, temperature measuring, flow measuring and level measuring instruments.
9. Demonstrate different types of maintenance (viz. Online, Predictive, Preventive and breakdown) and Trouble shoot, dismantle, repair & assemble / Align different mechanical components for power transmission & check their functionality. <i>(Different Mechanical Components viz. Belt, Pulleys. shaft, motor, coupling, Gearbox, bearings, Hydraulic jack).</i>	9.1	Explain different types of maintenance (viz. Online, Predictive, Preventive and breakdown), check list and Maintenance record of equipment.
	9.2	Demonstrate removal of bearing, cleaning, lubrication, mounting on shaft and checking of proper functionality.
	9.3	Demonstrate dismantling of gear box, removing of parts, cleaning, lubrication, assembling and checking of proper functionality.
	9.4	Demonstrate aligning of motor, coupling, pump and checking of proper functionality.
	9.5	Demonstrate removal of pulley from shaft, cleaning hub, keyways, shaft, mounting of pulley on shaft and checking of proper functionality.
	9.6	Demonstrate operation, working, use and Construction details of Hydraulic Jack and Hydraulic Trainer.
	9.7	Demonstrate dismantling of Hydraulic Jack, trouble shooting, cleaning and Overhauling, Check oil level and grade, reassembling and check for proper functioning.
10. Demonstrate overhauling of different types of valve.	10.1	Explain Construction, Operating and working of different valve (viz. Gate valve, Globe valve, Needle valve, diaphragm valve, Ball valve, Plug valve, NR valve, Stop Cock valve, Butterfly valve, etc.)
	10.2	Demonstrate dismantling, servicing and assembling of

	different valve (viz. Gate valve, Globe valve, Needle valve, diaphragm valve, Ball valve, Plug valve, NR valve, Stop Cock valve, Butterfly valve, etc.) and checking for proper functioning.
11. Trouble shoot, dismantle, Overhaul / repair & reassemble different machine, pumps & components for transportation of liquid, check their functionality and plot the graphs for characteristic curve of different types of pump. [Different Machines & Components – Pumps - centrifugal, gear pump, metering pump, screw pump, multistage compressor, vacuum pump, mechanical seals]	<p>11.1 Demonstrate inspection of different pumps (viz. centrifugal pump, reciprocating pump, Gear pump, Lobe pump, vacuum pump, etc.) noting down defects, dismantling, servicing, replacing worn out / damaged parts, assembling of different pumps and checking for proper functioning.</p> <p>11.2 Explain calculation of flow rates at different valve positions, Co-relation of head developed and capacity of the pump, interpretation of graph of head vs. capacity.</p> <p>11.3 Explain working, application and maintenance of different types of screw pump and metering pump.</p> <p>11.4 Explain working, application and preventive maintenance of multistage compressor.</p>
12. Demonstrate machinery handling, installation, operations, maintenance, troubleshooting of various types of conveyors as per standard procedure, it's planning & implementation.	<p>12.1 Demonstrate machinery handling and its installation as per standard procedure – ( viz. preparation of foundation plan, Layout, template of foundation, fixing of foundation bolts, moving and setting machine onto foundation bolt, levelling and installation of machine).</p> <p>12.2 Explain Constructional details and working of various types of conveyors like belt conveyor, screw conveyer and bucket elevators</p> <p>12.3 Demonstrate inspection of Belt Conveyor, noting down defects, dismantling, trouble shooting, servicing, Overhauling, assembling of different parts and checking for proper functioning.</p>
13. Demonstrate function of pressure vessel, various pipe fittings, valves, parameters, trouble shoot, dismantle, repair / overhauling & reassemble different machine & components for transportation of Gases, Air dryers & Air filters and check their functionality.	<p>13.1 Demonstrate Inspection of pressure vessel and its structural attachment and connections, noting down leakage, inadequate insulation, corrosion and wear, repairing / rectification, testing of pressure and maintaining log book.</p> <p>13.2 Demonstrate inspection of different Compressor (viz. Reciprocating Compressor, Centrifugal Compressor, Screw Compressor, etc.) noting down defects, dismantling, trouble shooting, servicing and overhauling, assembling of different parts and checking for proper functioning.</p> <p>13.3 Demonstrate inspection of Fan and blower, noting down defects, dismantling, trouble shooting, servicing and</p>

	overhauling, assembling of different parts and checking for proper functioning.
	13.4 Demonstrate inspection of Air filter and Air dryer, noting down defects, dismantling, trouble shooting, servicing and overhauling, assembling of different parts and checking for proper functioning.
	13.5 Demonstrate inspection of cooling tower, noting down defects, dismantling, cleaning scale formation, trouble shooting, servicing and overhauling, assembling of different parts and checking for proper functioning.
14. Trouble shoot, dismantle, clean scale formation & reassemble Electrode & Oil fired boiler and Air handling unit and check their functionality.	14.1 Explain operation, working and construction details of different boilers (viz. Electrical Boiler, Oil-fired Boiler, etc.) .
	14.2 Demonstrate inspection of different boilers (viz. Electrical Boiler, Oil-fired Boiler, etc.), noting down defects, dismantling, cleaning scale formation, trouble shooting, servicing and overhauling, assembling of different parts and checking for proper functioning.
	14.3 Explain Refrigeration system, Refrigerant, vapor absorption and vapor compression and Air Handling Unit system.
	14.4 Demonstrate Handling of Refrigerants, Inspection of Refrigeration unit, noting down defects, dismantling, trouble shooting, cleaning and overhauling, reassembling and checking for proper functioning.
	14.5 Demonstrate inspection of Air Handling Unit, noting down defects, dismantling, trouble shooting, cleaning and overhauling, reassembling and checking for proper functioning.
15. Demonstrate operation of different Heat exchange equipment, Evaporators & calculate heat transfer rate, trouble shoot, dismantle, clean & reassemble different types of Heat exchangers, Evaporators and check functionality. [ <i>Heat exchange equipment's-Double Pipe Heat exchanger, Shell &amp; tube Heat exchanger, plate heat exchanger</i> ] [ <i>Evaporation equipment's-Vertical tube evaporator, multiple effect evaporator</i> ]	15.1 Explain working, use and Construction details of different types of Heat Exchanger (viz. <i>Double Pipe Heat exchanger, Shell &amp; tube Heat exchanger, plate heat exchanger</i> ).
	15.2 Demonstrate noting of inlet & outlet temperatures of cold and hot stream in Heat Exchanger, noting mass flow rate and calculation of heat transfer rate.
	15.3 Demonstrate inspection of different types of Heat Exchanger (viz. Double Pipe Heat exchanger, Shell & tube Heat exchanger, plate heat exchanger) noting down defects, dismantling, trouble shooting, cleaning and overhauling, reassembling and checking for proper functioning.
	15.4 Explain working, use and Construction details of different types of Evaporator ( <i>Vertical tube evaporator, multiple effect evaporator</i> )

	15.5 Demonstrate inspection of different types of Evaporator (Vertical tube evaporator, multiple effect evaporator) noting down defects, dismantling, trouble shooting, cleaning and overhauling, reassembling and checking for proper functioning.
16. Demonstrate operation of different types of distillation column, filtration unit, Dryer used for loading wet material in tray dryer, cyclone separator, packed distillation column, sieve tray column, different types of extraction unit and troubleshoot, dismantle, clean and reassemble components and check for proper functionality.	16.1 Explain working, use and Construction details of different types of Distillation column
	16.2 Demonstrate inspection of different types of Distillation column, noting down defects, dismantling, trouble shooting, cleaning and overhauling, reassembling and checking for proper functioning.
	16.3 Explain working, use and Construction details of different types of Filtration equipment
	16.4 Demonstrate inspection of different types of Filtration equipment, noting down defects, dismantling, trouble shooting, cleaning scale formation and overhauling, reassembling and checking for proper functioning.
	16.5 Explain measurement of air flow, weight of dust particles, Calculation of ppm in cyclone separator.
	16.6 Explain analysis of feed & solvent, Stirring, Settling, Separation, extraction and test in different types of extraction unit.
17. Operate an absorption column & determine flooding velocity, explain gas absorption, packed tower, types of packing. Demonstrate operation of crystallization equipment.	17.1 Demonstrate absorption – analysis of gas mixture & solvent, maintaining flow rates & pressure, preparation of Result.
	17.2 Demonstrate flooding velocity – Setting of liquid flow rate, gas flow rate, noting manometer reading, preparation of Graphical representation of flow rate & differential pressure ( $\Delta H$ ).
	17.3 Demonstrate crystallization – preparation of saturated solution, Formation of crystals, Separation of crystal & mother liquor, Crystal drying
18. Exhibit different modules of DC'S and PLC's, their function, Wire and connect I/OS field devices to the I/O Modules.	18.1 Explain functions and modules of DCS system, different process instruments, connection of I/O Module and Installation of DCS Programming software and establishing communication with PC and DCS.
	18.2 Demonstrate connection of digital I/OS to the I/O Module of PLC.
19. Demonstrate operation of different types of mixing equipment like ribbon blender, different size	19.1 Demonstrate working, use and Construction details of different size reduction machines (viz. Hammer mill & Ball mill), crushing operation and collection of crushed material.

reduction machines (Hammer mill, Ball mill), Screening Equipment & troubleshoot, dismantle, clean and maintenance of different mechanical components.	19.2	Explain working, use and Construction details of Vibratory sieve shaker, Loading, Operating, Collection & weighing of sample.
	19.3	Demonstrate working, use and Construction details of Agitator, Homogeneous mixing of substances, unloading of mixer, Washing & cleaning.
	19.4	Demonstrate inspection of different types of size reduction machines (viz. Hammer mill & Ball mill), Vibratory sieve shaker and Agitator, noting down defects, dismantling, trouble shooting, cleaning and overhauling, reassembling and checking for proper functioning.
20. Explain selection of appropriate Dryer and demonstrate operation of Tray dryer and carry out its cleaning, maintenance, trouble shooting for proper functionality.	20.1	Explain working, use and construction details of Tray dryer, material loading, drying, Collection & weighing of sample.
	20.2	Demonstrate inspection of Tray dryer, noting down defects, dismantling, trouble shooting, cleaning scale formation and overhauling, reassembling and checking for proper functioning.
21. Explain operation of cooling tower, perform humidification & dehumidification operations, find out relative humidity by measuring dry bulb & wet bulb temperatures.	21.1	Explain operation of cooling tower
	21.2	Demonstrate humidification & dehumidification operations, find out relative humidity by measuring dry bulb & wet bulb temperatures
22. Explain sedimentation operation and differentiate between settling, sedimentation and decantation operations.	22.1	Demonstrate settling, sedimentation and decantation operations.
23. Manufacture different chemical products	23.1	Demonstrate Manufacturing of Sulphuric Acid by Contact Process
	23.2	Demonstrate Manufacturing process of Soda Ash
	23.3	Demonstrate Manufacturing process of Caustic soda
	23.4	Demonstrate Manufacturing process of Ammonia
	23.5	Demonstrate Manufacturing of Nitric acid by ammonia oxidation process
	23.6	Demonstrate Manufacturing process of Urea
	23.7	Demonstrate Manufacturing process of Ethyl Alcohol
24. Explain function of various types of Chemical reactor and their accessories.	24.1	Explain function and use of various types of Chemical reactor, their fittings and accessories.

## 8. INFRASTRUCTURE

LIST OF TOOLS AND EQUIPMENT			
Chemical Plant Technology - CITS			
S No.	Name of the Tools & Equipment	Specification	Quantity
<b>A: TRAINEES TOOL KIT</b>			
1.	Safety shoes	Regular size	25 Nos.
2.	Safety hand gloves Rubber	Regular size	25 Nos.
3.	Safety hand gloves PVC	Regular size	25 Nos.
4.	Ear plug		25 Nos.
5.	Helmet		25 Nos.
6.	Dust Mask/Nose Mask		5 Nos.
7.	Steel Rule	300 mm, Graduated both in Metric and English Unit	7 Nos.
8.	Try Square	150 mm	7 Nos.
9.	Caliper - Inside Spring	150 mm	7 Nos.
10.	Caliper - Outside Spring	150 mm	7 Nos.
11.	Jenny Caliper/Odd Leg Caliper/Morphy Caliper	150 mm	7 Nos.
<b>B. GENERAL SHOP OUTFIT</b>			
12.	First Aid Box		1 No.
13.	Divider Spring Type	150 mm	6 Nos.
14.	Punch Centre	Diameter - 10 mm and Length - 100 mm	6 Nos.
15.	Punch Prick	100 mm	6 Nos.
16.	Letter and Number Punch	5mm	1 No.
17.	Scriber- Straight	150 mm	6 Nos.
18.	Hand Hacksaw Frame - Fixed	300 mm	6 Nos.
19.	File - Flat - Bastard	250 mm	6 Nos.
20.	File - Flat - Second Cut	250 mm	6 Nos.
21.	File - Flat - Smooth	250 mm	6 Nos.
22.	File - Half Round - Second Cut	250 mm	6 Nos.
23.	File - Round - Smooth	250 mm	6 Nos.
24.	File - Triangular - Smooth	150 mm	6 Nos.
25.	File - Square - Second Cut	200 mm	6 Nos.



26.	Hammer - Ball Pain	250 grams	6 Nos.
27.	Hammer - Ball Pain	500 grams	6 Nos.
28.	Screw Driver	9 X 300 mm	4 Nos.
29.	Drill Twist Set - Straight Shank	3 mm to 13 mm by 0.5 mm	1 No.
30.	Drill Twist Set - Straight Shank	9.8 mm	1 No.
31.	Hand Reamer Parallel	10 mm	2 Nos.
32.	Tap set	12 mm	2 Nos.
33.	Gauge Screw Pitch	Metric -0.25 to 6 mm	1 No.
34.	Wire Gauge - Metric		1 No.
35.	Allen Key Set - Hexagonal	1 - 12 mm, set of 12 Keys	1 No.
36.	Combination Set	300 mm	2 Nos.
37.	V Block	75 x 75 x 50 mm with Clamp (Hardened & Ground)	1 Pair.
38.	Bench Vice	125 mm	6 Nos.
39.	Anvil	50 Kg - with stand	1 No.
40.	Scraper	Flat- 250 mm	6 Nos.
41.	Scraper	Half Round - 250 mm	6 Nos.
42.	Scraper	triangular 250 mm	6 Nos.
43.	Oil stone		1 No.
44.	Surface Plate - Granite	600 x 600 mm with Stand and Cover	1 No.
45.	Angle Plate		1 No.
46.	Surface Gauge (Universal/Fixed Type)		1 No.
47.	Snips(Straight & Bend Type)	250 mm	1 no. each
48.	Specific Gravity bottle		2 Nos.
49.	Joules Calorimeter		1 No.
50.	Bunsen Burners		10 Nos.
51.	Tripods Stand		10 Nos.
52.	Asbestos wire gauge		10 Nos.
53.	Gauge Wire without asbestos		10 Nos.
54.	Burettes	25ml	10 Nos.
55.	Pipettes	10ml	10 Nos.
56.	H.D.P. Distill water bottle		10 Nos.
57.	Clamp holders		12 Nos.
58.	Stands with clamps for burette		12 Nos.
59.	Triangles clay		10 Nos.
60.	Measuring cylinder	25 ml Glass(borosilicate)	10 Nos.

61.	Measuring cylinder	50 ml Glass (borosilicate)	10 Nos.
62.	Measuring cylinder	100 ml Glass (borosilicate)	10 Nos.
63.	Volumetric flask	100 ml(borosilicate)	10 Nos.
64.	Volumetric flask	500 ml(borosilicate)	10 Nos.
65.	Volumetric flask	1000 ml(borosilicate)	10 Nos.
66.	Funnels Dia	4cms(borosilicate)	10 Nos.
67.	Beaker	250ml corining(borosilicate)	10 Nos.
68.	Beaker	400ml (borosilicate)	10 Nos.
69.	Bottles for solutions	1000 ml(borosilicate)	6 Nos.
70.	Bottles for solutions	2000 ml(borosilicate)	6 Nos.
71.	Bottles for solutions	500 ml(borosilicate)	6 Nos.
72.	Conical flask	150 ml(borosilicate)	20 Nos.
73.	Conical flask	250 ml(borosilicate)	20 Nos.
74.	China dish	50 ml (borosilicate)	12 Nos.
75.	Watch Glass	3" dia(borosilicate)	10 Nos.
76.	Tong - Flat	300 mm	10 Nos.
77.	Spatula	8"	10 Nos.
78.	Distilled water still	10 lit.	1 No.
79.	Glass test tubes	15 ml	50 Nos.
80.	Round Bottom Distillation flask with side neck	500ml	6 Nos.
81.	Condenser for distillation lebig	30 cm long	6 Nos.
82.	Rubber cork	2.5 cm, 3cm size	10 Nos.
83.	Rubber Tubing (ID- 5mm)	MOC: Borosilicate glass	10 Nos.
84.	Rubber Bulbs for pipettes		6 Nos.
85.	Arc Welding Table -	Metal - 900 X 600 X 750 mm with Positioner	1 No.
86.	Safety google (white)		6 Nos.
87.	Double ended Open spanners set	6x7,8x9,10x11,12x13,14x15,16x17,18x19,20x22, 21x23,24x27,25x28,30x32 mm.	1 Set.
88.	Double ended Ring spanners set	6x7,8x9,10x11,12x13,14x15,16x17,18x19,20x22, 21x23,24x27,25x28,30x32 mm.	1 Set.
89.	Circlip Plier	8"(internal)	1 No.
90.	Circlip Plier	8"(External)	1 No.
91.	Oil Can	½ pt	1 No.
92.	Spanner - Adjustable	200 mm	1 No.
93.	Socket Spanner With Ratchet Handle	6 mm to 30 mm	1 Set
94.	Torque Wrench	6 mm to 30 mm	1 Set

95.	Pipe Wrench	450 mm	1 No.
96.	Hole Punch	6 mm to 30 mm	1 Set
97.	Spirit Level	300 mm	1 No.
98.	Hydraulic Bearing puller		1 No.
99.	Grease Gun		1 No.
100.	Gate Valve 50 mm Cut section	Size 50mm, Body material -S.S, connection form- Flanged, Pneumatic Actuator, Direct Acting, Normally Open,operation method - manual	1 No.
101.	Globe valve 50 mm Cut section	Made up S.S. of 50mm Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection. operation method -manual	1 No.
102.	Safety Valve (Spring Type) 50 mm Cut section	Made up cast steel/forged steel of 50mm Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 No.
103.	Needle valve 50 mm Cut section	25 mm Cut section made up S.S. of 300 series (forged body).Seal material- Nitrile. Pattern Straight, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 No.
104.	Butter fly valve 50 mm Cut section	Made up S.S. of 50 mm Size, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 No.
105.	Non-return valve(swing check type, Lift check & Ball check type) 50 mm Cut section	Made up S.S. of 50 mm Size, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 each
106.	Pneumatically operated diaphragm valve. Cut section connection.	Made up S.S. of 50 mm Size, Pneumatic Actuator, Direct Acting, Normally Open, With flange	1 No.
107.	Ball valve 50 mm Cut section	Made up S.S. of 50 mm Size, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection. Seat and seal-Teflon, Port-full port	1 No.
108.	Solenoid valve	Made up S.S. of 50 mm Size, Direct Acting, With flange connection. Direct lift diaphragm, Seal material NBR, Coil power 40W.Electric connection DIN Operating voltage 230V/ 50Hz, Normally closed.	1 No.
109.	Diaphragm valve 50 mm Cut section	Made up S.S. of 50 mm Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, With flange connection. Diaphragm specialized polyimide, Normally closed,	1 No.
110.	Control valve. 25mm Cut section	Size 25mm Type-Globe Straight Body, body material SS with pneumatic actuator, Normally open. Direct Acting, With flange connection.	1 No.
111.	Cut section of Internal gear		1 No.

	pump		
112.	Cut section of External gear pump		1 No.
113.	Chisel - Cold - Cross Cut	9 mm X 150 mm	4 Nos.
114.	Chisel - Cold - Flat	20 mm X 150 mm	4 Nos.
115.	Double Ended Spanner set	Metric 6 X 7 to 30 X 32	1 set
116.	Pipe wrench	14"	1 set
117.	Die & Die stock complete (BSP)	½" & 1"	1 set each
118.	Pipe vice	50 mm / 2"	1 set
119.	Work bench (Wooden Top)	6' X 3' X 3'	1 No.
120.	Combination Plier	6"	2 Nos.
121.	Tap set	M 8, M10, M12	2 Nos.
122.	Solid die	10 / 12 mm with die stock	2 Nos.
123.	Gauge Screw Pitch - Metric	0.25 to 6 mm	1 No.
124.	Wire Gauge - Metric		1 No.
125.	Allen Key Set	Hexagonal - 1 - 12 mm, set of 12 Keys	1 No.
126.	Different types of pipe fittings		1 No.
127.	Locking devices Lock nut, Castle nut		1 No.
128.	Thermometers:		
	(1) 0 to 110° C		6 Nos.
	(2) 0 to 250° C		6 Nos.
	(3) 0 to 360 ° C		6 Nos.
<b>C. LAB EQUIPMENT &amp; GLASSWARE</b>			
129.	Rheostat		
	(a) Rheostat 25 ohms		2 Nos.
	(b) Rheostat 100 ohms		2 Nos.
130.	Resistance box 0 to 500 ohms		2 Nos.
131.	Resistance coils (2 ohms, 5 ohms, 10 ohms, 100 ohms)		2 Nos.
132.	Ammeter		
	0 to 1000 mA. (DC)		2 Nos.
	0 to 10 Amp. (AC, DC)		2 Nos.
133.	Voltmeter		2 Nos.
	0 to 1 volt (DC)		2 Nos.
	0 to 5 volt (DC)		2 Nos.
	0 to 10 volt (DC)		2 Nos.
134.	Battery eliminator	Input: 240 volts	2 Nos.

		Output: 4.5 -6 volts	
135.	Specific Gravity bottle 25 cc		2 Nos.
136.	Multi meter (digital)		2 Nos.
137.	Milli voltmeter 1) 0 - 5mv 2) 0-500mv		2 Nos.
138.	Hydrometer		1 No.
139.	Inclined plane with pulley, pan, weights etc.		1 No.
140.	Simple machines - Screw Jack with Accessories.		1 No.
141.	Calorimeter for determining Joule's mechanical Equivalent of heat by electric method.		1 No.
142.	Capsule type pressure gauge.	Range: 0- 1kg/cm <sup>2</sup>	1 No.
143.	Thermocouple	J, K, E, R, T, S types	1 No.
144.	Digital Viscometer	LED display/LCD • Measurement range in mpa.s/cp with 4 spindles, • 6/12/30/60 rotor speed (rpm), • Provided with RS 232 C interface.	1 No.
145.	Steam generator (copper) Cap. 1000ml Lab equipment & glassware		2 Nos.
146.	Burette clamp		12 Nos.
147.	Bunsen Burners		8 Nos.
148.	Tripods Stand		8 Nos.
149.	Asbestos wire gauge		8 Nos.
150.	Gauge Wire without asbestos	MOC: Borosilicate	8 Nos.
151.	Burettes 25ml boro flow	MOC: Borosilicate	8 Nos.
152.	Pipettes 10ml	MOC: Borosilicate	8 Nos.
153.	Measuring Pipette 5 ml	MOC: Borosilicate	8 Nos.
154.	Pipette Rubber Bulb		8 Nos.
155.	H.D.P. Distil water bottle		8 Nos.
156.	Clamp holders		12 Nos.
157.	Stands with clamps for burette		12 Nos.
158.	Triangles clay		8 Nos.
159.	Measuring cylinder 250 ml Glass	MOC: Borosilicate	8 Nos.
160.	Measuring cylinder 500 ml Glass/ Plastic	MOC: Borosilicate/Plastic	8 Nos.
161.	Measuring cylinder 1000 ml	MOC: Borosilicate/Plastic	8 Nos.

	Glass/ Plastic		
162.	Volumetric flask 100 ml	MOC: Borosilicate	8 Nos.
163.	Volumetric flask 500 ml	MOC: Borosilicate	8 Nos.
164.	Volumetric flask 1000 ml	MOC: Borosilicate	8 Nos.
165.	Funnels Dia 7.5cms	MOC: Borosilicate	8 Nos.
166.	Beaker 250ml corning	MOC: Borosilicate	8 Nos.
167.	Beaker 500 ml corning	MOC: Borosilicate	8 Nos.
168.	Bottles for solutions 1000 ml	MOC: Borosilicate	6 Nos.
169.	Bottles for solutions 2000 ml	MOC: Borosilicate	6 Nos.
170.	Bottles for solutions 500 ml	MOC: Borosilicate	6 Nos.
171.	Conical flask –500 ml	MOC: Borosilicate	25 Nos.
172.	Conical flask - 250 ml	MOC: Borosilicate	25 Nos.
173.	Evaporating dish - 50 ml	MOC: Borosilicate	12 Nos.
174.	Watch Glass - 3" dia.	MOC: Borosilicate	8 Nos.
175.	Tongs for laboratory - Flat - 200 mm	300 mm	8 Nos.
176.	Distilled water still 10 lit.	S.S. made, low water level cutoff	1 No.
177.	Glass test tubes - 15 ml	MOC: Borosilicate	50 Nos.
178.	Round bottom Distillation flask with side neck	500ml	6 Nos.
179.	Condenser for distillation lebig	30 cm long	6 Nos.
180.	Rubber cork of (2.5 cm, 3 cm) size various size		10 Nos.
181.	Rubber Tubing (ID-5mm)	8/10 ml	10 Nos.
182.	Rubber Bulbs for pipettes		6 Nos.
183.	Fire alarm system with air tight chamber		1 No.
184.	Gas detector with air tight chamber		1 No.
185.	Bourdon tube (C-type) pressure gauge		1 No.
186.	R.T.D. thermometer PT100		1 No.
187.	Flash point apparatus	This apparatus is made as per IP 34, ASTM D-93 and IS 1448 (Part I) 1270 (P.21) and IS 1209-1953 method B. Ready to use.	1 No.
188.	Bimetallic thermometer		1 No.
189.	Instrument for determining 'g' (Simple Pendulum)		1 No.
190.	Mechanical board for testing triangle and parallelogram of force including all accessories.		2 Nos.

191.	Searle's apparatus for young's Modulus		2 Nos.
192.	Apparatus for measurement of co-efficient of expansion (thermal) of solid (plunger's apparatus)	It will consist of a half-meter long chromium plated rod, Steam prepared in copper steam boiler of 2-liter capacity, 2 Thermometers, 1 hot plate of 1kw. Ready to use.	2 Nos.
193.	Apparatus for measurement of thermal conductivity of good and bad conductors	Made up of S.S. with heater assembly of 1000 watt, 300 mm (D) test specimen, 8 J type sensors, Dimmer state, Voltmeter and Ampere meter.	1 No.
194.	Digital Stop Watch 1/10 Second		1 No.
195.	pH Meter Digital	Microprocessor base, Auto calibration facility with electrode, Auto & Manual temperature compensation. Ready for use.	1 No.
196.	Redwood viscometer		1 No.
197.	Digital Balance 200 gm	Accuracy: $\pm 1$ mg	1 No.
198.	Digital Balance 10 kg	Accuracy: $\pm 1$ gm	1 No.
199.	Test tube stand for 12 tubes metallic		1 No.
200.	Test tube Holder		12 Nos.
201.	Fire Extinguisher (CO <sub>2</sub> )		1 No.
202.	Fire extinguishers (Dry chemical powder)	Capacity: 4 kgs.	1 No.
203.	Sand Bucket	10 – 12 liters	2 Nos.
204.	Fire bucket	10 – 12 liters	2 Nos.
<b>D. UNIT OPERATION MACHINERY &amp; EQUIPMENT</b>			
205.	Hammer mill	Made up of M.S. diameter 8", S.S. 6 hammer, electric motor 2 HP, V pulleys& belt system, starter, energy meter, Filter bag, Feed Hooper, suitable size metallic screen. Capacity 15 -20 kg/hr.	1 No.
206.	Ball mill	Made up of S.S. of 450 mm (L) 300 mm (D), 50 S.S. balls, Dual starter, energy meter, RPM indicator, proximate sensor, variable speed.	1 No.
207.	Sieve shaker and sieves	Sieve shaker machine with sieves Made up of Brass with different sieves, with viberator/rotap and timer.	1 No.
208.	Pressure vessel with all accessories	Made up of M.S. with glass line jacketed vessel capacity with agitation facility, Electrical Baby boiler, pressure transmitter, PLC module, HMI module, control valve, I/P converter, Pressure vessel, air regulator, pressure gauge, air compressor, current meter, safety valve, pressure relief valve.	1 No.

209.	Cut model of different types of pumps	Centrifugal pump, Reciprocating pump, screw pump, Vane pump, gear pump.	1 No. each
210.	Various type of valve	like Safety valve, Gate valve, globe valve, check valve, diaphragm valve. Ball valve, needle valve, butterfly valve (Flanged and Thread End) 2"/4" dia	1 Each
211.	Venturimeter, orifice meter, rota meter test rig	Made up of S.S. sump tank, S.S. measuring tank, S.S. pump, venturimeter, orifice meter of 10 mm (D) of orifice with flange, rotameter of 3 - 30 LMP, manometer with pressure tapings as required with suitable piping. Mounted on Suitable Frame Structure.	1 No.
212.	Capacitance Level indicator	Made up of S.S. sump tank, Acrylic measuring tank, S.S. pump, Level transmitter – Range : 0 – 500 mm WC Accuracy: +/- 3 % With HART version 6. Output: 4-20 mA DC Probe: fully insulated rod probe with pre-amplifier with necessary piping arrangement, mounted on suitable frame structure.	1 No.
213.	Sight glass level indicator	Made up of S.S. tank with sight glass, scale, drain valve.	1 No.
214.	Air purge Level Indicator	Made up of S.S. tank, Casing of Aluminum with Front Transparent Cover, glass tube, S.S. purge pipe.	1 No.
215.	Sedimentation Equipment	Sedimentation Tank Material: Acrylic Size: 1000 X 400 X 200 mm Rotameter 2 nos., Sump Tank of PVC, Feed pump: Compatible capacity for slurry, Circulation with suitable piping, mounted on suitable frame structure.	1 No.
216.	Metering Pump	Capacity 2 LPH, HP/RPM: 0.5/1440	1 Each
217.	Common Effluent Treatment Plant laboratory size	Includes operations like different treatments like Preliminary, Primary, Secondary, Tertiary, Flocculent feed flow rate control by Rotameter, Aeration tank, Feed pump, All pumps start/stopped from control panel with lamp indication.	1 No.
218.	Petroleum Plant Simulator	Study following operations of petroleum in simulator 1. Atmospheric Distillation Unit (ADU) 2. Vacuum Distillation Unit (VDU) 3. Fluid Catalytic Cracking Unit (FCCU) 4. Catalytic Reforming Unit 5. Hydrocracking Unit (HCU) 6. Sulphur Recovery Unit (SRU) 7. Diesel hydrotreater unit (DHDT) 8. Kerosene hydrotreater unit (KHT)	1 No.



		9. Gas Oil Separation Plant (GOSP) 10. LPG Unit and LNG Plant	
219.	Multistage Reciprocating compressor fitted with intercooler & after cooler	Fitted with intercooler & after cooler with 3 HP electric motor, pressure gauge 2 Nos. energy meter, Pressure relief valve, pressure switch, Air damping tank, orifice, manometer.	1 No.
220.	Pitot Tube Setup	Made up of copper/ S.S. of compatibles size, Fitted with Vernier scale. Test Section: Material M.S, compatible to 2" Diameter pipe. Water Circulation: 0.5. Pump. Flow Measurement: Using Measuring Tank with Piezometer, Capacity, S.S. Sump Tank, Stop Watch. With suitable piping arrangement, mounted on suitable frame structure.	1 No.
221.	Boiling Point and Melting Point Apparatus	Microprocessor temp. range: Ambient to 300°C, Digital type, Memory: up to 100 samples	1 No.

**E. GENERAL MACHINERY & EQUIPMENT**

**MACHINERY:**

222.	Drilling Machine - Bench Type	13 mm Motorized with Standard Accessories	1 No.
223.	Power Saw Machine	Stroke length 160 mm No of speed stroke 3 Range of speed stroke 80-100-125 Blade size 525 x 45 x 2.25 Power of motor 1.5 kw	1 No.
224.	Pedestal Grinder	Double Ended - 200 mm	1 No.
225.	Welding Transformer -	300 A, OCV 60 - 100 V, 60% Duty Cycle with Standard Accessories	1 No.
226.	Lathe Machine -	All Geared, Center Height 150 mm, Between Centers 1200 mm, 4 Jaw Chuck, Taper Turning Attachment and all Standard Accessories	1 No.
227.	Pilot plan for flow measurement through, Orifice meter, rotameter, venturi meter	Made up of S.S sump tank, S.S. measuring tank, ½ " centrifugal pump, rotamter, orifice, venturi, U tube manometer with suitable piping.	1 No.
228.	Centrifugal pump Back pullout type with motor and base plate		1 No.
229.	Multistage centrifugal pump	With Balance drum or disk without motor with Type - Two stage centrifugal pump, Capacity of Up to 20 LPM, total Head of Up to 60 Meters, Pump Speed of 2800 RPM.	1 No.
230.	Diaphragm Pump (Air Operated)	made up of polypropylene with C-1500N diaphragm pump series with heavy duty head with bullet cartridge valves, Maximum working pressure: 8.6 Bar, Maximum fluid temperature: 54°C, Maximum ambient temperature: -10 to	1 No.

		50° C, Maximum viscosity: 1000 CP, Maximum suction lift: 10 Ft, Output adjustment range: 5-100% stroke length, Duty cycle: continuous, Size: 6"	
231.	Metering Pump	Made up of S.S. Plunger (MM) 5, Size (MM) 8 x 8, capacity (LPH): 2HP/RPM : 0.5/1440	1 No.
232.	Lazer alignment kit for pump & motor shaft (wireless 3 axis system)	With Wireless Integrated Bluetooth standard on all systems, Simple Step-by-Step Laser Alignment Procedure, Industry's Highest Laser Measurement Accuracy, "Live-Track" Dynamic Graphics, either 3-Axis, Fastest Auto-Sweep Laser Measurement, Full Colour 8" or 10" Touch Tablet, Long Life LiPO Batteries for up to 15H+ operation Rugged Design, water resistant and dustproof to IP67, Distance/Range: 3m/6m, Extensive Software Features and Options.	1 No.
233.	Hydraulic jack		1 No.
234.	Hydraulic Trainer	With Equipment trays - 2nos., Pressure gauge – 2 nos., Hydraulic Motor -1 no., 4/2-way hand lever valve - 3no.s, 4/3-way hand lever valve with relieving mid-position - 3nos., 4/3-way hand lever valve with closed mid-position - 3nos., 4/3-way hand lever valve with recirculating mid-position - 3nos., Pressure sequence valve, pressure relief valve – 3nos., 3-way pressure reducing valve – 2nos., 2-way flow control valve – 2nos., One-way flow control valve - 4nos., Non-return valves – 4nos., Shut-off valve- 4nos., Diaphragm accumulator with shut-off block – 1no., Weight upto 10 kg- 1no., 2/2 way plunger / stem actuated – 2nos., Standard hoses with quick connectors, Flow dividing valve – 1no., 5-way distributor with pressure gauge - 1no.s, mounted on suitable frame structure.	1 No.
235.	Pressure Vessel with Control and Maintenance of Plant like Transmitters, Valves, Pumps and All Parameters Simulation Software and all accessories	Made up of M.S. with pressure transmitter, PLC module, HMI module, control valve, I/P converter, Pressure vessel, air regulator, pressure gauge, air compressor, current meter, safety valve, pressure relief valve, mounted on suitable frame structure.	1 No.
236.	Multistage compressor fitted with inter-cooler and after coolers (Cut model)	Made up of Transparent acrylic casing, with M.S. air compressor, 2 H.P. motor.	1 No.
237.	Screw Compressor	Rotary screw type compressor with 4 HP motor.	1 No.
238.	Lobe Compressor		1 No.
239.	Centrifugal blower		1 No.

240.	Final control element (control valves) Pneumatically & Electrically Unit Operation.	Globe Valve: (Pneumatically Operated) Body Type: 2 way Size: 1" Operating Pressure: 3-15 psi (0.2-1kg/cm <sup>2</sup> ) Diaphragm Control valve: (Pneumatically Operated) Type: Pneumatic Size: 1/2" Input: 3-15 psig, Action: Air to close Ball Type (Electrically Operated) Body Type: 2 Way Size: 1"	1 No.
241.	Reactor trainer with all controlling accessories	With all Controlling Accessories.	1 No.
242.	DCS Kit	True distributed control system having dedicated redundant function controller, power supply, communication modules and integrated software modules, algorithms for complex process control. consist of small pilot plant with different control action using basic parameters like level, temperature, flow, pressure, ratio, feed forward, cascade, with 4-20 mA input single pan circular chart recorder.	1 No.
243.	PLC Kit	With 8 DI/DO, 8 AI/AO with necessary hardware & software to understand PLC functioning.	1 No.
244.	Centrifugal pump.	Centrifugal pump coupled with 2 HP electrical motor. With suitable piping arrangement.	1 No.
245.	Gear pump	Gear Pump coupled with 2 HP electric motor. With necessary piping.	1 No.
246.	Screw pump	with 1 HP electric motor.	1 No.
247.	Bearing removing and fitting kit		1 No.
248.	Gear box	Ratio: 1:10 To study the power transmission.	1 No.
249.	Reynold's equipment	With S.S. sump tank with bell mouth discharge, Glass tube of 1 meter of 1" diameter with Flow control valve, measuring cylinder, stop watch, mounted on suitable frame structure.	1 No.
250.	Centrifugal pump test rig	With S.S. sump tank, S.S. measuring tank, Variable speed DC drive, RPM regulator, RPM indicator, Pressure gauge, vacuum gauge, energy meter and suitable piping, mounted on Suitable Frame Structure.	1 No.
251.	Gear pump test rig	With S.S. sump tank, S.S. measuring tank, Variable speed DC drive, RPM regulator, RPM indicator, Pressure gauge, vacuum gauge, energy meter. With piping arrangement mounted on Suitable Frame Structure.	1 No.

252.	Reciprocating pump test rig	With S.S. sump tank, S.S. measuring tank, Variable speed DC drive, RPM regulator, RPM indicator, Pressure gauge, vacuum gauge, energy meter and suitable piping, mounted on Suitable Frame Structure.	1 No.
253.	Apparatus for determine Frictional losses in straight pipe, pipe fitting	With S.S. sump tank, S.S. measuring tank, S.S. pump, Manometer & suitable piping & fittings with pressure tappings.	1 No.
254.	Double pipe Heat exchanger	Made up of S.S. 1000 mm (L) 75 mm (D) heat exchanger with S.S. hot water tank with heater, S.S. cold water tank, 2 rotameters, 2 S.S. pumps, Multi zone temperature indicator, PID and suitable piping. Mounted on Suitable Frame Structure.	1 No.
255.	Electrical Baby Boiler	Made up of S.S. with electrical heater with thermostatic switch, Temperature indicator, thermally insulated, pressure relief valve, safety valve, pressure gauge, low level alarm, level gauge, drain valve, inlet valve.	1 No.
256.	Forced draft cooling	Tower made up of Acrylic of minimum 1 meter height, S.S.hot water tank with heater, S.S. pump, rotameter, manometer, blower, PID, multi zone temperature indicator, packings, PID with suitable piping, mounted on suitable frame structure.	1 No.
257.	Shell and tube heat	Exchanger made up of S.S. 300 mm long, 75 mm (D), S.S. hot water tank with heater, S.S. cold water tank, S.S. pump, rotameters 2 nos. PID, temp. indicator, temperature sensors 4 nos. with necessary piping, mounted on suitable frame structure.	1 Each
258.	Plate heat exchanger,	Made up of Acrylic of minimum 1-meter height, S.S. hot water tank with heater, S.S. pump, rotameter, manometer, blower, PID, multi zone temperature indicator, packings, PID with suitable piping, mounted on suitable frame structure.	1 Each
259.	Vertical tube evaporator	Made up of S.S. single effect evaporator of 900 mm (H) 100 mm (D), with steam generator, S.S. feed tank, collecting tank 2 Nos., 2 nos. pumps, rotameters 2 nos., vacuum pump, shell & tube type condenser, PID, temp. indicator with suitable piping, mounted on suitable frame structure.	1 No.
260.	Packed distillation Column	Made up of S.S. of 1000 mm (H) 75 mm (D) with sight glasses, feed tank, cold water tank, steam generator, 4 rotameters, multi temperature indicator, Shell & Tube type heat exchanger, 2 S.S. pumps, reflux pump, distillate pump, Reflux	1 No.

		drum, solenoid valve, product collection tank with necessary piping, mounted on suitable frame structure.	
261.	Plate and frame filter Press	Made up of Cast iron structure with plate and frame made up of P.P. of 300 mm x 300 mm size, S.S. slurry tank, S.S. pump, S.S. water tank, 2 cake trays, stirrer with suitable piping, mounted on suitable frame structure.	1 No.
262.	Bottom-driven centrifuge	Made up of S.S. 450 mm Diameter x 225 mm H, basket shell: 450 mm (D), Height of basket shell: 225 mm, Basket capacity, Filter area of basket: 0.32 Sq. Mtrs. Basket speed: 1350 RPM, Drive motor: 1 H.P. 1440 RPM, 50 Hz with dual starter, Filter cloth, bottom discharge 1" valve. Ready to use.	1 No.
263.	Tray drier	Made up of S.S. from inside, with heaters, variable speed DC motor, Multi zone temperature indicator, weighing scale, PID. Ready to use instrument.	1 No.
264.	Vibrating screen	Made up of M.S. of 18" width, 24" length, with 3 nos. of vibrating screens, motor, feed Hooper, filter cloth. Ready to use instrument.	1 No.
265.	Belt conveyor	Made up of nylon of 8" width, 60" length, FHP motor with gear box, bins 2 nos.	1 No.
266.	Vernier Caliper	0 - 200 mm with least count 0.02mm	1 No.
267.	Vernier Height Gauge	0 - 300 mm with least count = 0.02 mm	1 No.
268.	Vernier Bevel Protractor	300 mm Blade with Acute Angle Attachment	1 No.
269.	Vernier Depth Gauge	300 mm (L.C. 0.02mm)	1 No.
270.	Universal Dial Test Indicator -	Plunger Type - Range 0 - 10 mm, Graduation 0.01 mm & 0.001mm Reading 0 - 10 with Revolution Counter complete with Clamping Devices and Magnetic Stand	2 Nos.
271.	Micrometer - Outside	0 - 25 mm	1 No.
272.	Micrometer - Outside	25 - 50 mm	1 No.
273.	Micrometer- Outside	0 - 1"	1 No.
274.	Micrometer- Inside	50 mm - 200 mm	1 No.
275.	Sine Bar with Slip Gauge Box		1 Set (41 Pcs.)
276.	Acetylene Cylinder		1 No.
277.	Oxygen Cylinders		1 No.
278.	Electric Spark Lighter		6 Nos.
279.	Oxygen Gas Pressure Regulator Double Stage		1 No.
280.	Acetylene Gas Pressure Regulator Double Stage		1 No.

281.	Rubber Hose - Acetylene,	Diameter = 8 mm, Length = 10 meters	1 No.
282.	Rubber Hose - Oxygen,	Diameter = 8 mm, Length = 10 meters	1 No.
283.	Rubber Hose Clips - 1/2 inch		6 Nos.
284.	Tong - Flat - 300 mm		4 Nos.
285.	cylinder Key		4 Nos.
286.	Gas welding torch with nozzle set with Input voltage 415 ( $\pm$ 10%), Frequency – 50/60, Current range – 30/300, Efficiency - >85		1 No.
287.	Instrument for determining 'g' (Simple Pendulum)		1 No.
288.	Mechanical board for testing triangle and parallelogram of forces including all accessories		1 No.
289.	Inclined plane with pulley, pan, Hanger weights etc.		1 No.
290.	Simple machines - Screw Jack		1 No.
291.	Searle's Apparatus for young's Modulus		2 Nos.
292.	Calorimeter for determining Joule's mechanical Equivalent of heat and specific heat		1 No.
293.	Apparatus for measurement of co-efficient of expansion (thermal) of solid (pullinger's apparatus) with hot plate with heater, thermometer 2 nos. Ready to use instrument.		2 Nos.
294.	Apparatus for measurement of thermal conductivity of good and bad conductors made up of Diameter 300 mm M.S. 20 mm, Asbestos 15 mm, Wooden Slab 10 mm, J type sensors 8 nos.		1 No.
295.	Milli voltmeter	1) 0 - 5mv, 2) 0- 500mv	2 Nos.
296.	Digital Stop Watch 1/10 Second		1 No.
297.	Steam generator (copper)	Cap. 500ml	2 Nos.
298.	Arc Welding Cables	Multi Cored Copper - 400 A, 50 Meter	1 No.
299.	Tip Cleaner Set		17 Nos.
300.	Welding goggle		6 Nos.
301.	Auto Darkening Welding Helmet		2 Nos.

302.	Gauge Feeler / Thickness	0.05 mm to 1 mm by 0.05 and	1 No.
303.	Pliers – combination	8"/20 cm	4 Nos.
304.	Phillips head screw driver set	1-4 sizes	1 No.
305.	Lapping Plate	300 x 300mm	1 No.
306.	Stud Extractor	Set of 8	1 No.
307.	Single row deep groove Ball Bearing	no.6309	1 No.
308.	Cylindrical Roller Bearing	NU307	1 No.
309.	Taper Roller Bearing	30208	1 No.
310.	Needle Roller Bearing	RNA 4908	1 No.
311.	Spherical Roller Bearing	22211 EKC3	1 No.
312.	3 leg Bearing puller	6"	1 No.
313.	Bearing fitting kit	including standard sleeve, mallet, Bearing induction heater	1 No.
314.	Bearing Testing Kit		1 No.
315.	Gear Box Reduction Type(Cut Section)	Made up of M.S Internal Part Transparent acrylic casing, 8" (D), Input- 1400 RPM, Output 140 RPM, Reduction Ratio - 10:1, Rated Torque - 630 Nm, Rated power - 5.0 KW at 1400 Rpm, Radial load - 7460 N, Thermal rating - 7.5 KW, Cut Section - 25 % of the casing, mounted on suitable frame structure.	1 No.
316.	Gear Box Planetary Bevel Gear Type(Cut Section)	Made up of Cast iron Casing, transparent Acrylic Casing, Size - 6", Input - 1400 Rpm, Output - 140 Rpm, Reduction Ratio - 10:1, Rated Torque - 630 Nm, Rated Power - 5.0 Kw At 1400 Rpm, Radial Load - 7460 N, Thermal Rating - 7.5 Kw, Cut Section of 25 % Of The Casing, mounted on suitable frame structure.	1 No.
317.	Cut section of Centrifugal pump of back pullout type		1 No.
318.	Mechanical seal (multiple spring)		1 No.
319.	Mechanical seal (Bellows seal)		1 No.
320.	Mechanical seal (single spring)		1 No.
321.	Pressure sensor with transmitter and display unit		1 No.
322.	Temperature sensor with transmitter and display unit		1 No.
323.	Level sensor with transmitter and display unit		1 No.
324.	Flow Meter		1 No.

**F. FURNITURE**

1.	Steel cupboard with 8 pigeon lockers		03 nos.
2.	Chair with arm		02 nos.
3.	Table for trainer		01 no.
4.	Steel cupboard	180 x 90 x 45cm	02 nos.
5.	Steel cupboard	120 x 60 x 45cm	02 nos.
6.	White board with magnetic duster	6'x4'	01 no.
7.	Metal rack	182 x 182 x 45cm	01 no.

**G. LIST OF TOOLS & EQUIPMENTS for Engg. Drawing**

8.	Drawing table for A1 sheet		25 nos.
9.	Stools (Revolving type) Adjustable height		25 nos.
10.	T.O's Table	6ft X 4ft	1 no
11.	T.O's chair revolving		1 no.
12.	D.L.P Projector	2000 lumen or higher	
13.	White board	6FT. x 4FT.	
14.	Computer 3GHz or latest with 1GB Or higher RAM with compatible motherboard	DVD combo drive with latest x version, hard disk with 160 GB or above, 19" TFT Monitor, 1 GB AGP card, 10/100 Ethernet card, Internal modem, UPS with 800 VA / Latest Version	12 nos.
15.	Software:	MS-Office XP or latest version of operating software Auto-CAD with power pack or latest version	12 nos.
16.	Laser Jet printer	Latest model – Print, Copy and Scan 1200x1200dpi, 16MB	1 no.
17.	Computer table		12 nos.
18.	Printer table		1 No
19.	Almirah Steel	6 feet height or higher	1 no.

**F. ACCESSORIES FOR TRAINING METHODOLOGY / AUDIO VISUAL ROOM (Common for all Trades)**

20.	Class Room Chairs	armless / Dual desk may also be allowed	25 /13nos.
21.	Class Room Tables	3ft X 2ft / Dual desk may also be allowed	25 /13nos.
22.	Chair for Trainer (armed) movable		01 no.
23.	Table for Trainer	4 ft X 2 ft with Drawer and cupboard	01 no.
24.	LCD / LED Projector		01 no.
25.	Multimedia Computer System with all accessories with UPS	0.5 KVA	01 set
26.	White Board	6ft X 4 ft.	01 no.
27.	LCD Projector Screen		01 no.
28.	Digital Video Camera (hard Disk) with Tripod stand		01 no.
29.	Air Conditioner for computer room	1.5Ton	As



			required
30.	Wall charts, Transparencies and DVDs	related to the trade	As required
<b>Note:</b> <i>1. All the tools and equipment are to be procured as per BIS specification.</i> <i>2. Internet facility is desired to be provided in the class room.</i>			

## ANNEXURE - I

The DGT sincerely acknowledges contributions of the Industries, State Directorates, Trade Experts, Domain Experts and all others who contributed in designing the curriculum. Special acknowledgement is extended by DGT to the following expert members who had contributed immensely in this curriculum.

<b>List of Expert members contributed/ participated for finalizing the course curriculum of Chemical Plant Technology (CITS) trade</b>			
<b>S No.</b>	<b>Name &amp; Designation Sh/Mr/Ms</b>	<b>Organization</b>	<b>Remarks</b>
1.	B.V.S. Seshachari, Director	CSTARI, Kolkata	Chairman
2.	C.S. Murthy, Jt.Dir. of Trg.	CSTARI, Kolkata	Member
3.	Soumit Pal, Asstt. Engineer (Chem)	Durgapur Chemicals Limited	Member
4.	Pradip Kumar Sarkar, Instructor (MMCP)	V.P.ITI, Haldia	Member
5.	Suparna Samanta, Instuctor (AOCP)	V.P.ITI, Haldia	Member
6.	Rupa Sarkar, Instructor (MMCP)	Hooghly ITI, Sahagaunge	Member
7.	Sushmita Mukherjee, Instructor (AOCP)	Hooghly ITI, Sahagaunge	Member
8.	G.N. Eswarappa, Jt.Dir. of Trg.	CSTARI, Kolkata	Member
9.	R.N. Manna, Trg. Officer.	CSTARI, Kolkata	Member