



GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
DIRECTORATE GENERAL OF TRAINING

COMPETENCY BASED CURRICULUM

ATTENDANT OPERATOR (CHEMICAL PLANT)

**(Duration: Two Years)
(Revised in July 2022)**

**CRAFTSMEN TRAINING SCHEME (CTS)
NSQF LEVEL- 4**



SECTOR –CHEMICAL& PETROCHEMICALS



Directorate General of Training

ATTENDANT OPERATOR (CHEMICAL PLANT)

(Engineering Trade)

(Revised in July 2022)

Version: 2.0

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL- 4

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

CENTRAL STAFF TRAINING AND RESEARCH INSTITUTE

EN-81, Sector-V, Salt Lake City,

Kolkata – 700 091

www.cstaricalcutta.gov.in

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1. COURSE INFORMATION

During the two-year duration a candidate is trained on subjects Professional Skill, Professional Knowledge and Employability Skills related to job role. In addition to this a candidate is entrusted to make/do project work and Extra Curricular Activities to build up confidence. The practical skills are imparted in simple to complex manner & simultaneously theory subject is taught in the same fashion to apply cognitive knowledge while executing task. The practical part starts with allied trade training viz basic fitting, followed by gas welding and laboratory experiments in basic physics and chemistry. Practical skills related to unit operations comprising of Fluid flow, Heat transfer, and Mass transfer Mechanical operations are covered in period of two years. The broad components covered under Professional Skill subject are as below:

FIRST YEAR: The practical part starts with allied trades viz., basic fitting. In the basic fitting the skills imparted are Hack-sawing, marking, punching, Chiseling, Filing, Drilling, countersinking, counter boring, reaming, Taping and observation of all safety aspects is mandatory. Basic physics and chemistry practical covers conducting experiments in laboratory to determine physical constants, verification of laws, to determine concentration of solutions, P^H , melting point, boiling point, compare properties of metals & alloys, prepare chemicals. The safety aspect covers components like PPE, Fire extinguisher, First Aid.

The trainees will be performing different operations or experiments related to safety and general awareness in chemical industry. Identification, installation /connection of instrument/devices to measure pressure, temperature, flow and level, density are covered. Skills to execute pipe joints, fittings valves on pipes, dismantling, overhauling, cleaning & assembling valves, different machines & components used for fluid transportation such as centrifugal pump, gear pump, metering pump, screw pump, multistage compressor are achieved. Dismantling, repairing and assembling of different damaged mechanical components used for power transmission such as Gearbox, bearings are also covered.

SECOND YEAR: In this year the trainee covers unit operations i.e., fluid flow, heat transfer and mass transfer operations. Skills to operate different machines/equipment such as Shell and tube Heat exchangers, evaporators, Distillation columns are gained in this section. Study of manufacturing processes and pressure vessels, petroleum refining is covered in this section.

Mass transfer operations such as Solvent extraction, Leaching, Absorption, Crystallization, and Drying are taught. Mechanical operations such as Size reduction, mixing conveying, and filtration are also covered. Study of chemical reactor, plant utilities- steam, cooling tower, chilled water, instrument air are covered in this section. Pollution in chemical industry and manufacturing processes are also taught.

Professional Knowledge subject is simultaneously taught in the same fashion to apply cognitive knowledge while executing task. It includes theory related to basic fitting, gas welding, basic physics & chemistry, safety in chemical plant, process control instruments measuring flow, temperature, pressure, pH, concentration etc. Unit operations- fluid flow, heat transfer, mass transfer, and mechanical operations are covered in professional knowledge. Different unit processes – sulfuric acid, soda ash, urea etc., study of plant utilities, chemical reactor is also the part of this section.

Total three projects need to be completed by the candidates in a group. In addition to above components the core skills components viz., Workshop calculation & science, Engineering drawing, employability skills are also covered. These core skills are essential skills which are necessary to perform the job in any given situation.

2. TRAINING SYSTEM

2.1 GENERAL

The Directorate General of Training (DGT) under Ministry of Skill Development & Entrepreneurship offers a range of vocational training courses catering to the need of different sectors of Labour market. The vocational training programmes are running under aegis of Directorate General of Training (DGT). Craftsman Training Scheme (CTS) and Apprenticeship Training Scheme (ATS) are two pioneer programmes under DGT for propagating vocational training.

The Attendant Operator (Chemical Plant) trade under CTS is one of the popular courses delivered nationwide through network of ITIs. The course is of two years duration. It mainly consists of Domain area and Core area. The Domain area (Trade Theory & Practical) impart professional skills and knowledge, while Core area (Employability Skills) impart requisite core skill & knowledge and life skills. After passing out of the training programme, the trainee is awarded National Trade Certificate (NTC) by DGT which is recognized worldwide.

Trainee broadly needs to demonstrate that they are able to:

- Read & interpret technical parameters/documentation, plan and organize work processes, identify necessary materials and tools;
- Perform tasks with due consideration to safety rules, accident prevention regulations and environmental protection stipulations;
- Apply professional knowledge, core skills & employability skills while performing the job, and repair & maintenance work.
- Document the technical parameters in tabulation sheet related to the task undertaken.

2.2 PROGRESSION PATHWAYS:

- Can join industry as Technician and will progress further as Senior Technician, Supervisor and can rise up to the level of Manager.
- Can become Entrepreneur in the related field.
- Can take admission in the diploma course in notified branches of Engineering by lateral entry.
- Can join Apprenticeship programs in different types of industries leading to a National Apprenticeship certificate (NAC).
- Can join Crafts Instructor Training Scheme (CITS) in the trade for becoming an instructor in ITIs.
- Can join Advanced Diploma (Vocational) courses under DGT as applicable.

2.3 COURSE STRUCTURE:

Table below depicts the distribution of training hours across various course elements during a period of two years: -

S No.	Course Element	Notional Training Hours	
		1 st Year	2 nd Year
1	Professional Skill (Trade Practical)	840	840
2	Professional Knowledge (Trade Theory)	240	300
3	Employability Skills	120	60
	Total	1200	1200

Every year 150 hours of mandatory OJT (On the Job Training) of industry opportunity not available the group project is mandatory.

4	On the Job Training (OJT)/ Group Project	150	150
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Trainees of one-year or two-year trade can also opt for optional courses of up to 240 hours in each year for 10th/ 12th class certificate along with ITI certification, or, add on short term courses.

2.4 ASSESSMENT & CERTIFICATION

The trainee will be tested for his skill, knowledge and attitude during the period of course through formative assessment and at the end of the training programme through summative assessment as notified by the DGT from time to time.

a) The **Continuous Assessment** (Internal) during the period of training will be done by **Formative Assessment Method** by testing for assessment criteria listed against learning outcomes. The training institute has to maintain an individual trainee portfolio as detailed in assessment guideline. The marks of internal assessment will be as per the formative assessment template provided on www.bharatskills.gov.in

b) The final assessment will be in the form of summative assessment. The All-India Trade Test for awarding NTC will be conducted by Controller of examinations, DGT as per the guidelines. The pattern and marking structure is being notified by DGT from time to time. **The learning outcome and assessment criteria will be the basis for setting question papers for final assessment. The 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 REGULATION

For the purposes of determining the overall result, weightage of 100% is applied for six months and one year duration courses and 50% weightage is applied to each examination for two years courses. The minimum pass percent for Trade Practical and Formative assessment is 60% & for all other subjects is 33%..

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. Due consideration should 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 some of the following:

- Job carried out in labs/workshop
- Record book/ daily diary
- Answer sheet of assessment
- Viva-voce
- Progress chart
- Attendance and punctuality
- Assignment
- Project work
- Computer based multiple choice question examination
- Practical Examination

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

Performance Level	Evidence
(a) Marks in the range of 60%-75% to be allotted during assessment	
For performance in this grade, the candidate	• Demonstration of good skill in the use of



<p>should produce work which demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and practices</p>	<p>hand tools, machine tools and workshop equipment.</p> <ul style="list-style-type: none">• 60-70% accuracy achieved while undertaking different work with those demanded by the component/job.• A fairly good level of neatness and consistency in the finish.• Occasional support in completing the project/job.
<p>(b) Marks in the range of 75%-90% to be allotted during assessment</p>	
<p>For this grade, a candidate should produce work which demonstrates attainment of a reasonable standard of craftsmanship, with little guidance, and regard for safety procedures and practices</p>	<ul style="list-style-type: none">• Good skill levels in the use of hand tools, machine tools and workshop equipment.• 70-80% accuracy achieved while undertaking different work with those demanded by the component/job.• A good level of neatness and consistency in the finish.• Little support in completing the project/job.
<p>(c) Marks in the range of more than 90% to be allotted during assessment</p>	
<p>For performance in this grade, the candidate, with minimal or no support in organization and execution and with due regard for safety procedures and practices, has produced work which demonstrates attainment of a high standard of craftsmanship.</p>	<ul style="list-style-type: none">• High skill levels in the use of hand tools, machine tools and workshop equipment.• Above 80% accuracy achieved while undertaking different work with those demanded by the component/job.• A high level of neatness and consistency in the finish.• Minimal or no support in completing the project.

3. JOB ROLE

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 distils 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

Attendant Operator (Chemical Plant)

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 coordinate process variables, such as flows, temperatures, pressures, vacuum, time, catalyst, and chemicals, by automatic regulation and remote control of processing units, such as heaters

Attendant Operator (Chemical Plant)

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

Attendant Operator (Chemical Plant)

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.

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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,

Attendant Operator (Chemical Plant)

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) 3111.0100 – Laboratory Assistant, Physical
- (ii) 3111.0300 – Laboratory Assistant, Chemical
- (iii) 3133.0100 – Process Man, Chemical
- (iv) 7233.0301 – Bearing Maintenance
- (v) 8131.3700 – Reactor Converter Operator
- (vi) 3134.0300 – Pump Man (Petroleum Refining)
- (vii) 8131.3600 – Evaporator Operator
- (viii) 3134.0100 – Continuous Still Operator, Petroleum
- (ix) 8131.0100 – Crusher Operator, Chemical
- (x) 8131.3501 – Autoclave Operator
- (xi) 3133.0400 – Batch Still Operator, Chemical
- (xii) 3133.0500 – Continuous Still Operator, Chemical
- (xiii) 8131.2100 – Ammonia Operator/Ammonia Plant Operator
- (xiv) 8131.7700 – Acid Plant Operator
- (xv) 3139.0100 – Digester Operator, Paper Pulp
- (xvi) 8131.0400 – Mixing Machine Man Attendant (Chemical)
- (xvii) 8131.2300 – Filter Press Operator
- (xviii) 8131.2700 – Hydro Extractor Operator
- (xix) 8131.1400 – Drying Chamber Attendant (Drugs)/Chamber Operators
- (xx) 8131.8500 – Extraction Attendant, Chemical

4. GENERAL INFORMATION

Name of the Trade	ATTENDANT OPERATOR (CHEMICAL PLANT)
Trade Code	DGT/1046
NCO - 2015	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
NOS Covered	(NOS:RSC/N9403),(NOS:RSC/N9404),(NOS:RSC/N9405), (NOS:RSC/9406),(NOS:RSC/9407),(NOS:RSC/N9408), (NOS:RSC/N9409),(NOS:RSC/N9409), (NOS:RSC/N9410),(NOS:RSC/N9411),(NOS:RSC/N9412), (NOS:RSC/N9413),(NOS:RSC/9414),(NOS:RSC/N9415), (NOS:RSC/N9416),(NOS:RSC/N9417),(NOS:RSC/N9418), (NOS:RSC/N9419),(NOS:RSC/N9420),(NOS:RSC/N94021) (NOS:RSC/N9422),(NOS:RSC/N9423),(NOS:RSC/N9424) (NOS:RSC/N9425),(NOS:RSC/N9426),,(NOS:RSC/N9427), (NOS:RSC/N9428), (NOS:RSC/NCAFX)
NSQF Level	Level- 4
Duration of Craftsmen Training	Two Years (2400 hours + 300 hours OJT/Group Project)
Entry Qualification	Passed 10th class examination with Science and Mathematics or with vocational subject in same sector or its equivalent.
Minimum Age	14 years as on first day of academic session.
Eligibility for PwD	LD, CP, LC, DW, AA, DEAF, HH, AUTISM, ID, SLD, MI
Unit Strength (No. Of Students)	24(There is no separate provision of supernumerary seats)
Space Norms	170 Sq. m
Power Norms	13 KW
Instructors Qualification for:	
1. Attendant Operator (Chemical Plant) Trade	B.Voc/Degree in Chemical Technology/ Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience



	<p>in the relevant field.</p> <p style="text-align: center;">OR</p> <p>03 years Diploma in Chemical Technology/ Engineering from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field.</p> <p style="text-align: center;">OR</p> <p>NTC/NAC passed in the trade of "Attendant Operator (Chemical Plant)" with three years' experience in the relevant field.</p> <p>Essential Qualification: Relevant National Craft Instructor Certificate (NCIC) in any of the variants under DGT.</p> <p>NOTE: -Out of two Instructors required for the unit of 2(1+1), one must have Degree/Diploma and other must have NTC/NAC qualifications. However, both of them must possess NCIC in any of its variants.</p>
2. Employability Skill	<p>MBA/ BBA / Any Graduate/ Diploma in any discipline with Two years' experience with short term ToT Course in Employability Skills. (Must have studied English/ Communication Skills and Basic Computer at 12th / Diploma level and above)</p> <p style="text-align: center;">OR</p> <p>Existing Social Studies Instructors in ITIs with short term ToT Course in Employability Skills.</p>
3. Minimum Age for Instructor	21 Years
List of Tools and Equipment	As per Annexure – I

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

5.1 LEARNING OUTCOME

FIRST YEAR:

1. Plan and organize the work to make job as per specification applying different types of basic fitting operations and Check for dimensional accuracy following safety precautions. [Basic fitting operations – marking, Hack-sawing, punching, Chiselling, Filing, Drilling, countersinking, counter boring, reaming, Taping etc. Accuracy: $\pm 0.25\text{mm}$] (NOS:RSC/N9403)
2. Make a step fit of components for assembling as per required tolerance. (NOS:RSC/9404)
3. Select and ascertain measuring instrument and measure dimension of components and record data. (NOS:RSC/N9405)
4. Set up apparatus, instrument and conduct experiments in Physics laboratory to determine physical quantity/constants and verify laws. (NOS:RSC/N9406)
5. Set up apparatus, instrument and conduct experiments in Chemistry laboratory to determine concentration of solutions, P^H , melting point, boiling point, compare properties of metals & alloys, prepare chemicals. (NOS:RSC/N9407)
6. Plan, identify and perform different operations/experiments related to safety and general awareness in chemical industry. [*Different Operations – select and operate fire extinguisher, identify chemical hazards, read & obtain relevant data from MSDS, determine flash point of oil*] *Identify the dust percentage in Air.* (NOS:RSC/N5007)
7. Identify and install/connect instrument/devices to measure pressure, temperature, flow and level, 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*]. (NOS:RSC/N9408)
8. Apply a range of skills to execute pipe joints, dismantle & assemble valves & fittings with pipes and test for leakages. [*Range of skills – Cutting, Threading, gasket cutting, lagging of pipeline, Joining and use of locking devices*]. (NOS:RSC/N9409)
9. Plan, dismantle, clean and assemble different machines & components used for fluid transportation & check functionality. [*Different Machines & Components – Pumps-centrifugal, gear pump, metering pump, screw pump, multistage compressor*]. (NOS:RSC/N5001)

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10. Read and apply engineering drawing for different application in the field of work.
11. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.

SECOND YEAR:

12. Plan, identify & perform experiments to determine viscosity of oil & select oil for particular application at certain temperature, Reynold's Number to predict flow pattern in a conduit. (NOS:RSC/NCAFX)
13. Draw the operating characteristics of different types of pumps to find the optimum conditions for operating the pump and its selection. (NOS:RSC/N9410)
14. Determine experimentally the pressure drop due to friction for a fluid flowing through a pipe, verify the effect of pipe roughness on friction, and express the frictional loss in fittings and valves through the Equivalent length of fittings. (NOS:RSC/N9411)
15. Plan, identify & operate different Heat exchange equipments & calculate heat transfer rate. [*Heat exchange equipment's-Double Pipe Heat exchanger, Shell & tube Heat exchanger, plate heat exchanger*]. (NOS:RSC/N9412)
16. Plan, identify & operate different Evaporators to obtain economy & heat transfer rate. [*Evaporation equipment's-Vertical tube evaporator, multiple effect evaporators*]. (NOS:RSC/N9413)
17. Plan, identify & operate cyclone separator to remove particulates from an air, gas, or liquid. (NOS:RSC/5001,5007)
18. Plan, identify & operate packed distillation column, sieve tray column, identify effect of different packings, demonstrate the effect of height of packing, & effect of reflux ratio. (NOS:RSC/N9414)
19. Identify, types the functionalities of pressure vessels; list various types of pressures, state various terminologies related to pressure vessels. (NOS:RSC/N9415)
20. Identify, operate & state different types of extraction unit & select most appropriate extractor. (NOS:RSC/N9416)
21. Operate an absorption column & carry out experiment to determine flooding velocity. Explain about gas absorption, packed tower and different types of packings. (NOS:RSC/N9417)
22. Identify types of crystallization equipments and know their basic operations. (NOS:RSC/N9418)
23. Identify, operate & state different types of filtration units. Study the parts and functions of plate and frame filter press & select appropriate unit. (NOS:RSC/N9419)
24. Identify the different modules of DCS, function, Wire and connect I/O field devices to the I/O Modules. (NOS:RSC/N9420)
25. Identify modules of PLC, its function, Wire and connect the digital I/O field devices to the I/O Module of PLC. (NOS:RSC/N9421)

Attendant Operator (Chemical Plant)

26. Identify to operate different types of mixing equipment like ribbon blender. (NOS:RSC/N9422)
27. Identify, operate different types of drying equipments & determine rate of drying. Demonstrate the effect of operating parameters on drying of solids. Identify the time of drying for the constant rate period & falling rate period. Select appropriate dryer for the given feed. (NOS:RSC/N9423)
28. Identify, demonstrate, operate different size reduction machines. Find out critical speed of the Ball mill. (NOS:RSC/N9424)
29. Operate Screening Equipment Determine screen effectiveness of a sieve. (NOS:RSC/N9425)
30. Set up, operate humidification & dehumidification operations. Measure dry bulb & wet bulb temperatures and find out relative humidity. Demonstrate & Operate cooling tower. (NOS:RSC/N9426)
31. Identify & demonstrate the various types of conveyors like belt conveyor, screw conveyor and bucket elevators and list their components and uses. (NOS:RSC/N9427)
32. Conduct sedimentation operation and draw sedimentation curve. Differentiate between settling, sedimentation and decantation operations. (NOS:RSC/N9428)
33. Identify the function of Chemical reactor; list various types of chemical reactors, state various accessories of Chemical reactors. (NOS:RSC/NCAFX)
34. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.

6. ASSESSMENT CRITERIA

LEARNING OUTCOMES	ASSESSMENT CRITERIA
FIRST YEAR	
<p>1. Plan and organize the work to make job as per specification applying different types of basic fitting operations and Check for dimensional accuracy following safety precautions. [Basic fitting operation – marking, Hack-sawing, punching, Chiselling, Filing, Drilling, countersinking, counter boring, reaming, Taping etc. Accuracy: $\pm 0.25\text{mm}$]. (NOS:RSC/N9403)</p>	<p>Plan & Identify tools, instruments and equipment for marking and make this available for use in a timely manner.</p> <p>Select raw material and visually inspect for defects.</p> <p>Mark as per specification applying desired mathematical calculation and observing standard procedure.</p> <p>Measure all dimensions in accordance with standard specifications and tolerances.</p> <p>Identify Hand Tools for different fitting operations and make these available for use in a timely manner.</p> <p>Prepare the job for Hacksawing, chiselling, filing, drilling, tapping, grinding.</p> <p>Perform basic fitting operations viz., Hacksawing, filing, drilling, tapping and grinding to close tolerance as per specification to make the job.</p> <p>Observe safety procedure during above operation as per standard norms and company guidelines.</p> <p>Check for dimensional accuracy as per standard procedure.</p> <p>Avoid waste, ascertain unused materials and components for disposal, store these in an environmentally appropriate manner and prepare for disposal.</p>
<p>2. Make a step fit of components for assembling as per required tolerance. [Step fit, required tolerance: $\pm 0.04\text{ mm}$]. (NOS:RSC/N9404)</p>	<p>Recognize general concept of Limits, Fits and tolerance necessary for fitting applications and functional application of these parameters.</p> <p>Ascertain and select tools and materials for the job and make this available for use in a timely manner.</p> <p>Set up workplace/ assembly location with due consideration to operational stipulation</p> <p>Plan work in compliance with standard safety norms and collecting desired information.</p> <p>Demonstrate possible solutions and agree tasks within the team.</p> <p>Make components according to the specification for step fit</p>



	using a range of practical skills and ensuring interchange ability of different parts.
	Assemble components applying a range of skills to ensure proper fit.
	Check functionality of components.
3. Select and ascertain measuring instrument and measure dimension of components and record data. (NOS:RSC/N9405)	Select the appropriate measuring Instrument.
	Calculate least count & zero error.
	Calculate thickness of given object and record the data.
	Calculate least count & zero error.
	Calculate thickness of given object and record the data.
4. Set up apparatus, instrument and conduct experiments in Physics laboratory to determine physical quantity/constants and verify laws. (NOS:RSC/N9406)	Identify apparatus/instrument for conducting experiment.
	Set up the apparatus/instrument for experiment.
	Weigh apparatus/chemicals accurately and if necessary prepare solution.
	Measure diameter/length/distance using proper meter.
	Make necessary electrical connections (circuit diagram). Draw required experimental diagram.
	Plan and perform laboratory experiment following proper procedure.
	Observe safety procedure during experiments as per standard norms.
	Record observations/ readings in tabular form and carry out calculations using correct formulae.
	Plot graph from the data recorded, if necessary
Report conclusion /result with proper unit.	
5. Set up apparatus, instrument and conduct experiments in Chemistry laboratory to determine concentration of solutions, P ^H , melting point, boiling point, compare properties of metals & alloys, prepare chemicals. (NOS:RSC/N9407)	Identify method, apparatus/instrument for conducting experiment.
	Know and follow proper procedures and regulations for safe handling and use of chemicals
	Arrange & set various chemicals, set up apparatus/ instrument for conducting experiment.
	Weigh apparatus/chemicals accurately and prepare standard solutions, common reagents.
	Plan and perform laboratory experiments demonstrating safe and proper use of standard chemistry glassware and



	equipment.
	Conduct simple tests to analyse and determine strength and purity.
	Observe safety procedure during experiments as per standard norms.
	Record observations/ readings in tabular form and carry out calculations using correct formulae.
	Report conclusion /result with proper unit.
6. Plan, identify and perform different operations /experiments related to safety and general awareness in chemical industry. <i>[Different Operations – select and operate fire extinguisher, identify chemical hazards, read & obtain relevant data from MSDS, determine flash point of oil] Identify the dust percentage in Air. (NOS:RSC/N5007)</i>	Identify different types of fire extinguishers and select appropriate one for given class of fire.
	Operate Extinguisher to extinguish fire following safety precautions.
	Identify and select apparatus for conducting experiment.
	Set up apparatus for conducting experiment.
	Identify different chemical hazards.
	Plan and perform laboratory experiment following proper procedure.
	Read and obtain relevant data from Material Safety Data sheet for particular chemical.
	Record observations/ readings.
	Report conclusion /result with proper unit.
7. Identify and install/connect instrument/devices to measure pressure, temperature, flow and level, 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,</i>	Ascertain and select tools and materials for the job and make this available for use in a timely manner.
	Identify instrument/device, components/parts of instrument, collect desired information.
	Connect/install the instrument to pipeline/manifold/storage tank.
	Check functionality of instrument/device.
	Ascertain basic working principle of instrument.
	Observe safety/ precaution during operation.
	Record observations/readings.
	Report conclusion /result with proper unit.



<p><i>capacitance type level indicator, hydrometer, control valve].</i> (NOS:RSC/N9408)</p>	
<p>8. Apply a range of skills to execute pipe joints, dismantle & assemble valves & fittings with pipes and test for leakages. <i>[Range of skills – Cutting, Threading, gasket cutting, lagging of pipeline, Joining and use of locking devices].</i> (NOS:RSC/N9409)</p>	<p>Ascertain and select tools and materials for the job and make this available for use in a timely manner.</p> <p>Plan to cut & thread GI pipe, dismantle and assemble valves and pipe fittings.</p> <p>Plan to cut gasket with appropriate size, apply lagging material to a pipeline, use appropriate locking device.</p> <p>Perform cutting & threading of GI pipe.</p> <p>Dismantle valves and fittings in pipes applying range of skills and check for defect as per standard procedure.</p> <p>Demonstrate possible solutions in case of defect and agree tasks within the team for repair or replacement.</p> <p>Assemble valves and various pipe fittings using range of skills and observing standard procedure.</p> <p>Cut gasket to fit with the flange of valve.</p> <p>Test for leakage and appropriate functioning of valves.</p> <p>Perform to cover pipeline with lagging material.</p> <p>Use appropriate locking device.</p> <p>Avoid waste, ascertain unused materials and components for disposal, store these in an environmentally appropriate manner and prepare for disposal.</p>
<p>9. Plan, dismantle, clean and assemble different machines & components used for fluid transportation & check functionality. <i>[Different Machines & Components – Pumps-centrifugal, gear pump, metering pump, screw pump, multistage compressor].</i> (NOS:RSC/N5001)</p>	<p>Select and ascertain tools for the job and make this available for use in a timely manner.</p> <p>Plan to dismantle, repair and assemble mechanical components used for pump/compressor as per drawing and collecting necessary information.</p> <p>Perform dismantling, checking for any defects and replacing of different components with accuracy applying range of skills and standard operating procedure.</p> <p>Comply with safety rules when performing the above operations.</p> <p>Assemble different components.</p> <p>Check for functionality of part/components.</p>



10. Read and apply engineering drawing for different application in the field of work.	Read & interpret the information on drawings and apply in executing practical work.
	Read & analyze the specification to ascertain the material requirement, tools and assembly/maintenance parameters.
	Encounter drawings with missing/unspecified key information and make own calculations to fill in missing dimension/parameters to carry out the work.
11. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	Solve different mathematical problems
	Explain concept of basic science related to the field of study
SECOND YEAR	
12. Plan, identify & perform experiments to determine viscosity of oil & select oil for particular application at certain temperature, Reynold's Number to predict flow pattern in a conduit. (NOS:RSC/NCAFX)	Identify apparatus/instrument for conducting experiment.
	Setup the apparatus for conducting experiment
	Select and weigh raw material/chemicals accurately for the experiment and if necessary prepare solutions.
	Perform the experiment as per standard norms.
	Record observations/ readings in tabular form and carry out calculations using correct formulae.
	Report conclusion /result with proper unit.
13. Draw the operating characteristics of different types of pumps to find the optimum conditions for operating the pump and its selection. (NOS:RSC/N9410)	Identify different types of pumps & collect desired information.
	Setup the particular pump test rig for conducting experiment.
	Check the valves of set up, if required prime the pump to ensure that the pump is not air locked.
	Operate the pump.
	Adjust flow rate using valve.
	Note pressure & flow readings
	Report conclusion, result with proper unit.
Plot the graphical relation between head & capacity.	



<p>14. Determine experimentally the pressure drop due to friction for a fluid flowing through a pipe, verify the effect of pipe roughness on friction, and express the frictional loss in fittings and valves through the Equivalent length of fittings. (NOS:RSC/N9411)</p>	Identify experimental setup to study friction losses through straight pipe, different fittings and valves & collect desired information.
	Check for valve positions & manometer connections.
	Start regulate flow of water through the setup.
	Record observations/ readings of flow rates and manometer readings
	Repeat the experiment for five or more different flow rates & tabulate the data.
	Carry out calculations using correct formulae.
	Report conclusion, result with proper unit.
<p>15. Plan, identify & operate different Heat exchange equipments & calculate heat transfer rate. [<i>Heat exchange equipment's- Double pipe Heat exchanger, Shell & tube Heat exchanger, plate heat exchanger</i>]. (NOS:RSC/N9412)</p>	Identify experimental setup to operate Heat exchange equipment & collect desired information.
	Note the dimensions of heat exchanger-the inside diameter of shell, length of tubes, inner and outer diameter of tubes and number of tubes.
	Setup the particular heat exchanger for conducting experiment. Check for valve positions & manometer connections.
	Set the hot and cold water flow rates & at steady state, record flow rates, inlet, outlet temperatures of hot and cold water.
	Repeat the experiment for five or more different flow rates & tabulate the data.
	Carry out calculations using correct formulae.
	Conduct hydraulic test for shell & tube heat exchanger. Report conclusion, result with proper unit.
<p>16. Plan, identify & operate different Evaporators to obtain economy & heat transfer rate. [<i>Evaporation equipment's-Vertical tube evaporator, multiple effect evaporator</i>]. (NOS:RSC/N9413)</p>	Identify experimental setup to operate Evaporator & collect desired information.
	Setup the particular Evaporator for conducting experiment. Check for valve positions.
	Start-up mini boiler by observing safety precautions.
	Prepare feed solution of predetermined concentration & pour it in the feed tank.
	Load the evaporator with feed solution and steam at definite pressure.
	Run the evaporator till the feed tank is empty & record temperatures, pressures, steam condensate, feed outlet, feed



	vapour condensate.
	Calculate Economy and rate of heat transfer.
	Report conclusion, result with proper unit.
17. Plan, identify & operate cyclone separator to remove particulates from an air, gas, or liquid. (NOS:RSC/5001,5007)	Identify different types of air-solid separation equipment & collect desired information.
	Setup the experimental assembly.
	Weigh & fix filter bag to the bottom outlet of the cyclone.
	Feed the dust laden air/gas at high speed & collect particles at the bottom of the cyclone separator.
	Carry out calculations using correct formulae.
	Report conclusion, result with proper unit.
18. Plan, identify & operate packed distillation column, sieve tray column, identify effect of different pickings, demonstrate the effect of height of packing, & effect of reflux ratio. (NOS:RSC/N9414)	Identify different types of distillation column & collect desired information.
	Setup the particular distillation unit for conducting experiment.
	Demonstrate main components of distillation column & column internals.
	Prepare solution of desired composition.
	Start feed pump, cooling water & heater.
	Measure and record different flow rates, temperatures, pressures at steady states. Find reflux ratio.
	Collect the distillate, residue, find densities & compositions and tabulate.
	Repeat the experiment with different reflux ratios.
	Report conclusion, result with proper unit.
19. Identify, types the functionalities of pressure vessels; list various types of pressures, state various terminologies related to pressure vessels. (NOS:RSC/N9415)	State and describe different functionalities of pressure tanks.
	List types of pressure vessels as per ASME.
	State various terms related to pressure vessels-ASME, API, design pressure, design temperature, operating conditions and hydrostatic test, corrosion allowance, material of construction etc.
	State applications of storage vessels.
20. Identify, operate & state different types of extraction unit & select most	Identify different types of mass transfer equipments
	Setup experimental assembly
	Prepare feed stream (solute mixture)



appropriate extractor. (NOS:RSC/N9416)	Selection of proper solvent
	Operate the equipment with due precaution & safety
	Collection of overhead & bottom product
	Measure & check the concentration of product
	Report conclusion, result with proper unit
21. Operate an absorption column & carry out experiment to determine flooding velocity. Explain about gas absorption, packed tower and different types of packings. (NOS:RSC/N9417)	Setup experimental assembly
	Arrange for gas & liquid streams
	Operate the equipment with due precaution & safety
	Note down pressure & flow rate readings.
	Calculate gas velocity
	Report conclusion, result with proper unit.
22. Identify types of crystallization equipments and know their basic operations. (NOS:RSC/N9418)	Identify different types of crystallization equipments
	Preparation of saturated/super saturated solution using solid solute like NaCl
	Formation of crystals, cooling & stirring.
	Separation of crystal & mother liquor.
	Crystal drying.
	Report conclusion, result with proper unit
23. Identify, operate & state different types of filtration units. Study the parts and functions of plate and frame filter press & select appropriate unit. (NOS:RSC/N9419)	Identify different types of mechanical separation equipments
	Setup experimental assembly
	Prepare feed stream
	Operate the equipment with due precaution & safety
	Collection & measurement of filter cake, filtrate/ end product
	Report conclusion, result with proper unit
24. Identify the different modules of DCS, function, Wire and connect I/OS field devices to the I/O Modules. (NOS:RSC/N9420)	Identify the different modules of DCS
	Identify different process instruments in process plant.
	Install DCS programming software and establish communication with PC and DCS.
	Observed safety precautions
	Used proper manual and documentation



25. Identify modules of PLC, its function, Wire and connect the digital I/OS field devices to the I/O Module of PLC. (NOS:RSC/N9421)	Identify each module in a rack
	Identify specified slot.
	Wire and connect the digital I/OS field devices to the I/O Module of PLC.
	Observed safety precautions
	Used proper manual and documentation
26. Identify to operate different types of mixing equipment like ribbon blender. (NOS:RSC/N9422)	Select the appropriate mixing equipment.
	Setup the apparatus.
	Prepare Homogeneous mixing of substances.
	Unload the mixer.
	Washing & cleaning.
27. Identify, operate different types of drying equipments & determine rate of drying. Demonstrate the effect of operating parameters on drying of solids. Identify the time of drying for the constant rate period & falling rate period. Select appropriate dryer for the given feed. (NOS:RSC/N9423)	Identify different types of drying equipments
	Setup experimental assembly
	Prepare wet material (filter cake)
	Operate the equipment with due precaution & safety
	Note down the temperature, time interval & weight of the sample
	Calculate the weight loss of given material
	Report conclusion, result with proper unit
28. Identify, demonstrate, operate different size reduction machines. Find out critical speed of the Ball mill. (NOS:RSC/N9424)	Identify different types of size reduction equipments
	Setup experimental assembly
	Weighing sample
	Operate the equipment with due precaution & safety
	Collection & measurement of crushed material
	Select the sieves of proper size
	Collection & measurement of oversize material at every sieve
	Report conclusion, result with proper unit
29. Operate Screening Equipment. Determine screen effectiveness of a	Select appropriate screening equipments.
	Setup the apparatus.
	Loading of sieve shaker.



sieve. (NOS:RSC/N9425)	Operating sieve shaker.
	Unloading sieve shaker.
	Collection & weighing of sample in each sieve.
	Prepare Observation table.
	Follow the proper safety precaution.
30. Set up, operate humidification & dehumidification operations. Measure dry bulb & wet bulb temperatures and find out relative humidity. Demonstrate & Operate cooling tower. (NOS:RSC/N9426)	Identify different types of humidification & dehumidification equipments
	Setup experimental assembly
	Prepare for air & water streams
	Operate the equipment with due precaution & safety
	Note down the inlet & outlet temperatures of both streams
	Note down the humidity of air (sling psychrometer /hygrometer reading)
	Report conclusion, result with proper unit
31. Identify & demonstrate the various types of conveyors and list their components and uses. (NOS:RSC/N9427)	Identify different types conveyors
	Preparation and apparatus setup
	Supply of raw material
	Operate the equipment with due precaution & safety
	Note down the amount of material handle & time taken
	Report conclusion, result with proper unit
32. Conduct sedimentation operation and draw sedimentation curve. Differentiate between settling, sedimentation and decantation operations. (NOS:RSC/N9428)	Identify different types of settling equipments
	Selection of proper coagulants
	Operate the equipment with due precaution & safety
	Separation of light & heavy layer
	Report conclusion, result with proper unit
33. Identify the function of Chemical reactor; list various types of chemical reactors, state various accessories of Chemical reactors. (NOS:RSC/NCAFX)	State and describe different functionalities of Chemical reactors.
	List types of Chemical reactors.
	State various accessories of chemical reactor.
	Demonstrate different accessories of chemical reactors.



34. Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.	Solve different mathematical problems
	Explain concept of basic science related to the field of study

SYLLABUS FOR ATTENDANT OPERATOR (CHEMICAL PLANT) TRADE			
FIRST YEAR			
Duration	Reference Learning Outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
Professional Skill 79Hrs.; Professional Knowledge 17Hrs.	Plan and organize the work to make job as per specification applying different types of basic fitting operations and Check for dimensional accuracy. <i>[Basic fitting operation – marking, Hack-sawing, punching, Chiselling, Filing, Drilling, countersinking, counterboring, reaming, Taping etc. Accuracy: ± 0.25mm]</i> (NOS:RSC/N9403)	<ol style="list-style-type: none"> 1. Importance of trade training, List of tools & Machinery used in the trade. (01 hr.) 2. Safety attitude development of the trainee by explaining importance of safety. (03 hrs.) 3. Identify and demonstrate the correct use of appropriate PPE.(04 hrs.) 4. First aid methods and basic training. (03 hrs.) 5. Safety sign/slogan for Danger. (02 hrs.) 6. Safe use of tools and equipments used in the trade. (03 hrs.) 	<p>All necessary guidance to be provided to the new comers to become familiar with the working of Industrial Training Institute system including stores procedures.</p> <p>Introduction about ITI Rules and Regulation.</p> <p>Importance of trade training.</p> <p>SAFETY:</p> <p>Introduction & Importance of safety, general precautions about safety. PPEs used in chemical industries. Safety slogan. First aid in workshop & industry. (03hrs)</p>
		<ol style="list-style-type: none"> 7. Practice and understand precautions to be followed while working in fitting workshop. (06 hrs.) 8. Hold the job in a bench vice horizontally for filing.(05 hrs.) 9. Select flat files of various grades and length according to <ol style="list-style-type: none"> a) Size of the job b) Quantity of metal to be removed. c) Material of the 	<p>BASIC FITTING:</p> <p>Safety precautions to be followed in fitting workshop. Introduction to different hand tools such as files, chisels, hacksaw & hammer etc., their uses. Description, construction and uses of different marking tools such as steel rule, caliper, punches, v-block, scribing block etc. (09hrs)</p>



		<p>job.(03 hrs.)</p> <p>10. File flat surface. (20hrs.)</p> <p>11. Check the flatness & squareness of the filed surface with the blade of try square.(04hrs.)</p>	
		<p>12. File two adjacent sides flat and square.(08hrs.)</p> <p>13. Apply marking medium on the surface to be marked. (01 hr)</p> <p>14. Marking dimensions as per drawing. (01 hr)</p> <p>15. File all the other sides to size.(07 hrs.)</p> <p>16. Check flatness & squareness using try square.(01 hrs.)</p> <p>17. Check dimensions using outside calliper.(01 hrs.)</p> <p>18. Check dimensions with a steel rule. (01 hrs.)</p> <p>19. Mark parallel lines using a jenny calliper & scribe. (02 hrs.)</p> <p>20. Mark curves & circles by jenny calliper & divider. (01 hrs.)</p> <p>21. Punch the centre of circle with centre punch and ball peen hammer. (02 hrs.)</p>	<p>JOB HOLDING DEVICES: Description, construction and uses of different job holding devices. Such as vice, V' Block. (05 hrs)</p>
<p>Professional Skill 43 Hrs.;</p> <p>Professional Knowledge 08 Hrs.</p>	<p>Make a step fit of components for assembling as per required tolerance. [Step fit, required tolerance: ± 0.04 mm]. (NOS:RSC/N9404)</p>	<p>22. Check the raw material size as per drawing. (01 hr.)</p> <p>23. File two adjacent sides at right angles to each other. (15 hrs.)</p> <p>24. File two reference surfaces flat & square. (12 hrs.)</p> <p>25. Mark & punch the job as per drawing (Both 'A' & 'B'). (03</p>	<p>Description, construction, calculation and uses of different Linear Measuring Instruments – Vernier Depth gauge, Height gauge, Bevel protector. (08 hrs.)</p>



		<p>hrs.)</p> <p>26. Separate the part 'A' & 'B' by sawing or drilling. (05 hrs.)</p> <p>27. File & finish part 'A' & 'B'. (05 hrs.)</p> <p>28. Check dimensions and then assemble two parts. (02hrs.)</p>	
<p>Professional Skill 20 Hrs.;</p> <p>Professional Knowledge 07 Hrs.</p>	<p>Select and ascertain measuring instrument and measure dimension of components and record data. (NOS:RSC/N9405)</p>	<p><u>Vernier caliper</u></p> <p>29. Calculate least count & zero error. (04hrs.)</p> <p>30. Calculate thickness of given object. (06hrs.)</p> <p><u>Outside Micrometer</u></p> <p>31. Calculate least count & zero error. (04hrs.)</p> <p>32. Calculate thickness of given object. (06hrs.)</p>	<p>Introduction to Physics, Units, dimensions and physical quantities.</p> <p>Vernier caliper – parts of a Vernier caliper, principle and uses of a Vernier caliper. Least count and measurement with Vernier caliper.</p> <p>Outside micrometer – parts of an outside micrometer, working principle, least count and measurement with outside micrometer. (07hrs.)</p>
<p>Professional Skill 125 Hrs.;</p> <p>Professional Knowledge 30 Hrs</p>	<p>Set up apparatus, instrument and conduct experiments in Physics laboratory to determine physical quantity/constants and verify laws. (NOS:RSC/N9406)</p>	<p><u>Simple pendulum</u></p> <p>33. Measure diameter of bob with the help of Vernier calliper.(02 hrs.)</p> <p>34. Find the length of Pendulum.(01 hr.)</p> <p>35. Record time for 20 oscillations. (04 hrs.)</p> <p>36. Tabulate all readings.(02 hrs.)</p> <p>37. Calculate acceleration due to gravity (g). (02 hrs.)</p> <p>38. Plot the graph of L & T². (01 hr.)</p> <p><u>Law of parallelogram of forces</u></p> <p>39. Attach two pulleys to the mechanical board fixed to the wall as shown in figure. (02 hrs.)</p> <p>40. Fix drawing sheet to the</p>	<p>Velocity, its unit, average velocity, speed, average speed, acceleration, Acceleration due to gravity, Newton's laws of motion.</p> <p>Force, unit of force, Effect of force. Representation of forces resultant. triangle and parallelogram laws of forces(06 hrs.)</p>



		<p>board with pins. (02 hrs.)</p> <p>41. Apply two forces to the pulley by hanging a mass of 100 & 200 grams. (03 hrs.)</p> <p>42. Find resultant force by completing parallelogram and drawing diagonal. (02 hrs.)</p> <p>43. Calculate resultant by formula. (01 hr.)</p>	
		<p><u>Inclined plane</u></p> <p>44. Weigh separately the roller/wooden block and the pan with balance. (01 hr.)</p> <p>45. Generate angle of inclination of inclined plane (30°, 40°, 50°, 60°). (04 hrs.)</p> <p>46. Find weights for upward and downward motion of roller for different inclination of plane. (07 hrs.)</p> <p>47. Plot graph (should be straight line). (01 hr.)</p> <p><u>Screw Jack</u></p> <p>48. Find pitch of screw jack. (03 hrs.)</p> <p>49. Put load on the jack and start applying efforts gradually. (05 hrs.)</p> <p>50. Record the observations as the load just moves. (03 hrs.)</p> <p>51. Calculate Mechanical Advantage, velocity. (03 hrs.)</p>	<p>Friction-definition, unit, types of friction, laws of friction, advantages and disadvantages of friction.</p> <p>Inclined plane.</p> <p>Simple machines- types of simple machines-pulley, inclined plane, lever, wheel and axle, screw jack.</p> <p>Mechanical advantage, velocity ratio, efficiency of machine (07 hrs)</p>
		<p><u>Ohm's law</u></p> <p>52. Arrange the apparatus as per the circuit diagram. (03hrs.)</p> <p>53. Adjust the rheostat to get small deflection in ammeter</p>	<p>Current electricity, Ohm's law, Kirchhoff's law.</p> <p>Resistances in series and parallel.</p> <p>Electrolysis, Faradays laws of electrolysis.</p>



		<p>and voltmeter. (01 hr.)</p> <p>54. Record the readings of ammeter and voltmeter. Take at least six sets of readings.(04hrs.)</p> <p>55. Connect two resistances in series & record readings. (03hrs.)</p> <p>56. Connect two resistances in parallel & record readings. (03hrs.)</p> <p><u>Faraday's first law</u></p> <p>57. Prepare copper sulphate solution. (03hrs.)</p> <p>58. Weigh copper electrodes & record their masses. (03hrs.)</p> <p>59. Connect the electrodes to a cell and ammeter as shown in fig.(01 hr.)</p> <p>60. Pass a steady current for definite time & record.(04hrs.)</p> <p>61. Calculate electrochemical equivalent of copper.(03 hrs.)</p> <p><u>Mechanical Equivalent of Heat</u></p> <p>62. Weigh empty calorimeter cup and record its mass.Pour about 200 ml of water into calorimeter & record mass of the calorimeter cup with water. (05hrs.)</p> <p>63. Submerge the heating coil with stirrer into the water and thermometer. (04hrs.)</p> <p>64. Connect the circuit as shown in figure. (04hrs.)</p> <p>65. Start the stop- clock and</p>	<p>Energy and power, forms of energy- potential, kinetic, heat, light. Mechanical equivalent of heat ('J' by electric method) (10 hrs.)</p>
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		<p>start the current flowing in the heating coil. (04hrs.)</p> <p>66. Switch off power supply and stop timer when water temperature is 10-12 °C above the initial temperature. (04hrs.)</p> <p>67. Record final temperature of water; calculate the quantity of heat produced and electrical energy. Calculate Mechanical equivalent of heat 'J'. (03 hrs.)</p>	
		<p><u>Coefficient of expansion of solid</u></p> <p>68. Insert the rod in the Pullinger's apparatus and adjust the spherometer screw until the spherometer screw touches the rod. Read the length of rod using the spherometer scale. (02 hrs.)</p> <p>69. Fill the steam generator two-thirds full of water and turn it on. Place thermometer in the opening provided. (01 hr.)</p> <p>70. Allow the steam to flow through the jacket of apparatus until a steady temperature is reached. (02 hrs.)</p> <p>71. Record the final temperature and spherometer reading. Find coefficient of expansion of rod. (02 hrs.)</p> <p><u>Coefficient of expansion of liquid</u></p>	<p>Modes of heat transfer – conduction, convection and radiation.</p> <p>Determination of thermal conductivity.</p> <p>Temperature & expansion of solid, liquid.</p> <p>Coefficient of linear and cubical expansion.(07 hrs.)</p>



		<p>72. Weigh empty specific gravity bottle, fill it with water and weigh it again. (02 hrs.)</p> <p>73. Record the initial temperature of water. Heat the liquid and container (specific gravity bottle) & observe the increase in level of liquid. (02hrs.)</p> <p>74. Calculate coefficient of expansion of liquid. (02 hrs.)</p> <p><u>Thermal conductivity of metal rod</u></p> <p>75. Measure the diameter of copper rod using Vernier calliper. Measure the distance (d) between two thermometers. (02 hrs.)</p> <p>76. Place the rod in Searle's apparatus. Place thermometers in the holes provided. (01 hr.)</p> <p>77. Pass the steam through the steam chamber and water through a copper tube surrounded to the other end of the bar. (04 hrs.)</p> <p>78. Record the water flow rate, steady temperatures and time for collecting water. (02 hrs.)</p> <p>79. Calculate the thermal conductivity. (02 hrs.)</p>	
Professional Skill 121Hrs.; Professional Knowledge	Set up apparatus, instrument and conduct experiments in Chemistry laboratory to determine	<p><u>Simple distillation</u></p> <p>80. Take about 100 ml salty water in distillation flask and arrange expt. Setup as shown in fig. (06hrs.)</p>	Introduction to Chemistry, branches of chemistry. Importance of chemistry. Safety precautions to be taken in Chemistry Laboratory.



23 Hrs.	concentration of solutions, P^H , melting point, boiling point, compare properties of metals & alloys, prepare chemicals. (NOS:RSC/N9407)	<p>81. Heat the water till it vaporizes. (04hrs.)</p> <p>82. Collect purified water. (03hrs.)</p> <p>83. Record observations and result. (02hrs.)</p> <p><u>Titration- HCl- NaOH</u></p> <p>84. Prepare standard solution of Hydrochloric acid. (06hrs.)</p> <p>85. Titrate standard solution of HCl against NaOH using Phenolphthalein indicator. (04hrs.)</p> <p>86. Repeat titration three times to obtain mean burette reading and record observations. (03hrs.)</p> <p>87. Find Normality & strength of NaOH. (02hrs.)</p> <p><u>Titration – HCl- Na_2CO_3</u></p> <p>88. Prepare standard solution of Sodium Carbonate. (07hrs.)</p> <p>89. Titrate standard solution of HCl against Na_2CO_3 using methyl orange indicator. (04hrs.)</p> <p>90. Repeat titration three times to obtain mean burette reading and record observations. (03hrs.)</p> <p>91. Find Normality & strength of HCl. (02hrs.)</p>	<p>Different equipment and apparatus used in Chemistry Laboratory.</p> <p>Acids, bases and salts-their properties and uses.</p> <p>Element, atom and molecule.</p> <p>Compound, mixture, Physical change, chemical change, Molecular weight, equivalent weight, atomic weight, Normality, molarity and molality.</p> <p>Volumetric analysis- titrimetric analysis- determination of the amount of substance in solution.</p> <p>Detection of end point.</p> <p>Types of Titrimetric analysis. (08 hrs.)</p>
		<p><u>Properties of mixture and compound</u></p> <p>92. Prepare mixture of iron and sulphur. (02 hrs.)</p> <p>93. Prepare compound iron</p>	<p>ATOMIC STRUCTURE:</p> <p>Electrons, protons, neutrons.</p> <p>Electronic theory of valency.</p> <p>Classification of elements,</p> <p>Modern periodic law, table,</p>



		<p>94. sulphide by heating the mixture. (04 hrs.)</p> <p>94. Perform tests mentioned and record observations. (04 hrs.)</p> <p>95. Compare properties of iron sulphide with mixture of iron and sulphur. (04 hrs.)</p>	<p>Groups, periods, periodic properties</p> <p>Allotropy of hydrogen, carbon, phosphorus and sulphur.</p> <p>Allotropic forms of sulphur – monoclinic, amorphous and rhombic sulphur. (04 hrs)</p>
		<p><u>Action of pure and salt water on metals</u></p> <p>96. Take pure and salt water separately in two beakers. Take six iron nails and shine them to expose their surfaces. (03 hrs.)</p> <p>97. Place three of them into the beaker containing pure water and place another three nails into salt water for several hours. (03 hrs.)</p> <p>98. Record the observations. (03 hrs.)</p> <p><u>Action of acid and base on metals</u></p> <p>99. Take Hydrochloric acid and sodium Hydroxide separately. (02 hrs.)</p> <p>100. Perform tests mentioned and record observations. (04 hrs.)</p> <p><u>Laboratory preparation Soap</u></p> <p>101. Weigh chemicals accurately- caustic soda, vegetable oil. (02 hrs.)</p> <p>102. Add caustic to water in a beaker and stir it to dissolve. Cool the solution. (02 hrs.)</p> <p>103. Gradually add vegetable oil</p>	<p>WATER:</p> <p>Sources, hard and soft water, causes and removal of hardness, water for industrial purposes.</p> <p>Corrosion- causes, effects and prevention.</p> <p>Catalyst definition types of catalysts, characteristics of catalysts and use of catalyst.</p> <p>Introduction to Effluent treatment plant (ETP) (06 hrs.)</p>



		<p>to the solution with stirring. (03 hrs.)</p> <p>104. Cool the solution till solid form of soap is obtained. Record observations. (03 hrs.)</p> <p><u>Laboratory preparation copper sulphate</u></p> <p>105. Take dilute sulphuric acid in a beaker, add few grams of cupric oxide and stir well. (03 hrs.)</p> <p>106. Let the solid be added in excess. Wait till the effervescence is over. (03 hrs.)</p> <p>107. Filter the solution; evaporate the filtrate slowly and carefully. Blue coloured copper sulphate crystals are obtained. (02 hrs.)</p>	
		<p><u>Determination of pH</u></p> <p>108. Prepare solutions (acidic, basic, neutral). (03 hrs.)</p> <p>109. Calibrate PH meter with buffer solutions. (03 hrs.)</p> <p>110. Dip electrode in each solution and record pH of given solution. (03 hrs.)</p> <p><u>Boiling point determination</u></p> <p>111. Fill a capillary tube to about half its capacity with given liquid whose boiling point is to be determined, seal one end of a capillary tube. (02 hrs.)</p> <p>112. Introduce the tube into boiling point apparatus in</p>	<p>Definition of pH, pH scale, measurement of pH.</p> <p>ORGANIC CHEMISTRY: Introduction, purification processes, organic reactions- substitution, addition, Elimination, rearrangement reactions, examples. Nomenclature-Basic rules for Common name & IUPAC name system for alkanes, alkenes & alkynes, their examples. Boiling point and melting point of organic compounds (05 hrs)</p>

		<p>inverted fashion near the bulb of thermometer. (02 hrs.)</p> <p>113. Heat the apparatus and note down the boiling point when bubble enlarges and moves in upward direction. (06 hrs.)</p> <p><u>Melting point determination</u></p> <p>114. Seal one end of a capillary tube by heating. Fill a capillary tube about 4 mm length and attach it to the lower end of the thermometer with thread. (02 hrs.)</p> <p>115. Suspend the thermometer in the Thieles tube containing paraffin liquid. (02 hrs.)</p> <p>116. Heat the Apparatus uniformly from its side arm carefully and record temperature as the substance melts. (05 hrs.)</p>	
<p>Professional Skill 33 Hrs.;</p> <p>Professional Knowledge 08 Hrs</p>	<p>Plan, identify and perform different operations/experiments related to safety and general awareness in chemical industry.</p> <p><i>[Different Operations – select and operate fire extinguisher, identify chemical hazards, obtain relevant data from MSDS, determine flash point of oil],</i></p> <p><i>Identify the dust</i></p>	<p>117. Select the appropriate type of fire extinguisher for a given class of fire. (03 hrs.)</p> <p>118. Identify different fire extinguishers. (03hrs.)</p> <p>119. Use fire extinguisher to extinguish fire. (04 hrs.)</p> <p>120. Demonstrate about fire alarm system. (03 hrs.)</p> <p>121. Demonstrate about the gas detector. (04 hrs.)</p> <p>122. Identify hazardous chemical (Spilling of acids). (03 hrs.)</p> <p>123. Obtain the relevant details</p>	<ul style="list-style-type: none"> • Definition of fire, chemistry of fire, fire triangle classification of fire, • Causes of fire in chemical industries. • Different types of fire Extinguishers • Accident - causes and effects of accident • Prevention of accidents. (04 hrs.) • Different terms such as Hazard, risk, LEL, VEL, TWA,



	percentage in Air. (NOS:RSC/5008)	form Material safety data sheet (MSDS) for chemicals. (05 hrs.) 124. To determine the dust percentage in Air for pollution purpose. (05 hrs.) 125. Determine flash point for given oil sample. (03 hrs.)	STEL <ul style="list-style-type: none"> Flash point, fire point auto ignition temp. Material safety data sheet. Housekeeping – importance of housekeeping in chemical industries. Pollution and its controls Concept of 5S (04 hrs.)
Professional Skill 155 Hrs.;	Identify and, install/connect instrument/devices to measure pressure, temperature, flow and level, 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> (NOS:RSC/N9408)	126. Study the parts of bourdon tube pressure gauge. (06 hrs.) 127. Connect the bourdon tube pressure gauge. (05hrs.) 128. Note down at least five readings (04 hrs.) 129. Study the parts of Capsule type gauge. (04 hrs.) 130. Connect the Capsule type pressure gauge. (05 hrs.) 131. Note down at least five readings. (04 hrs.)	<ul style="list-style-type: none"> Pressure: Definition, unit's conversion of units. Classification of pressure measuring instruments Bourdon type, capsule type helical type, bellows type diaphragm type pressure gauges. (04 hrs.)
Professional Knowledge 25 Hrs		132. Measure temperature using mercury in glass thermometer. (05 hrs.) 133. Note down at least five readings. (06 hrs.) 134. Measure temperature using bimetal thermometer. (07 hrs.) 135. Note down at least five readings. (05 hrs.) 136. Study the R.T.D. Thermometer. (07 hrs.) 137. Measure temperature using RTD (PT 100) thermometer. (04 hrs.) 138. Take five readings of	<ul style="list-style-type: none"> Temperature: Definition, units, conversation of units. Classification of temperature measuring Instruments: Mercury in glass thermometer, bimetallic thermometer, RTD thermometer & Thermocouple. (05 hrs.) Flow Measurement. - Classification of flow measuring instruments. Construction, workings & uses of orifice meter,



		<p>temperature & record. (08 hrs.)</p> <p>139. Study the construction of thermocouple. (05 hrs.)</p> <p>140. Study the working of thermocouple instruments. (04 hrs.)</p> <p>141. Observe the deflection of milli-voltmeter record. (08 hrs.)</p>	<p>venturimeter, Rotameter, Pilot tube & it's all troubleshooting. (07 hrs.)</p>
		<p>142. Fit sight-glass level indicator to the tank. (03 hrs.)</p> <p>143. Fill the tank with water. (04 hrs.)</p> <p>144. Control the water flow to the tank and take readings at regular intervals. (04 hrs.)</p> <p>145. Convert the level into liters by the capacity of the tank. (03 hrs.)</p> <p>146. Connect the Air purge level indicator to the tank filled with water. (04 hrs.)</p> <p>147. Slightly open the air flow control valve and observe the bubble in the bubbler. (04 hrs.)</p> <p>148. Record back pressure & level in the tank. (03 hrs.)</p> <p>149. Study the parts of capacitance type level indicator. (04 hrs.)</p> <p>150. Study the functions of capacitance type level indicator. (03 hrs.)</p> <p>151. Connect the instrument and take few readings. (04</p>	<ul style="list-style-type: none">• Level Measurement –• Classification of level measuring instruments – simple float type level indicator, sight glass level indicator, air purge level indicator, Capacitance type level indicator. (04 hrs.)



		hrs.)	
		152. Study the principle of Hydrometer. (08 hrs.) 153. Study the function of Hydrometer. (07 hrs.) 154. Study the parts of control valve. (09 hrs.) 155. Study the operation of control valve. (08 hrs.)	<ul style="list-style-type: none"> • Definition and measurement of specific gravity. • Working principle of Hydrometer. • Construction of final control element (control valve) (05 hrs.)
Professional Skill 167Hrs; Professional Knowledge 29Hrs.	Apply a range of skills to execute pipe joints, dismantle & assemble valves & fittings with pipes and test for leakages. <i>[Range of skills – Cutting, Threading, gasket cutting, lagging of pipeline, cleaning and joining, use of locking devices].</i> (NOS:RSC/N9409)	156. Hold G.I pipe in pipe vice tightly. (02 hrs.) 157. Mark the required length in G I Pipe. (02 hrs.) 158. Cut the GI pipe squarely. (04 hrs.) 159. Chamfer the edge of pipe slightly. (03 hrs.) 160. Select a die of suitable size & fit the die in the diestock. (01 hr.) 161. Hold the pipe in a vice & place the leading side of the die on the chamfer of pipe. (02 hrs.) 162. Apply pressure on the diestock evenly and turn in clockwise direction & cut slowly and reverse the die for a short distance in order to break the chips. (04 hrs.) 163. Increase the depth of the cut gradually. (03 hrs.) 164. Check the threading using the appropriate sized coupling. (01 hr.)	<ul style="list-style-type: none"> • Standard pipe threads, nominal diameter, wall thickness, schedule number, die & diestock, tubing. (06 hrs.)
		165. Carefully note down how many pieces of the pipe sections and length of each section are required. (05	<ul style="list-style-type: none"> • Different types of pipe joints – flanged and threaded. Straight connections, bedsores, elbows, tees,



		<p>hrs.)</p> <p>166. Cut the required length of the pipes as per drawing. (06 hrs.)</p> <p>167. Threading of pipe. (05 hrs.)</p> <p>168. Joining the fitting accessories as per drawing. (06 hrs.)</p>	<p>screwed fittings, coupling, flanges, bush & caller, plug, stop cock, binding material. Tools for fitting.(05 hrs.)</p>
		<p>169. Inspect the pipe line. (03 hrs.)</p> <p>170. Select the appropriate lagging material. (02 hrs.)</p> <p>171. Lagging of pipeline. (04 hrs.)</p> <p>172. Cladding of pipeline. (02 hrs.)</p> <p>173. Select Gasket material. (01 hr.)</p> <p>174. Mark as per flange. (02 hrs.)</p> <p>175. Cutting of Gasket. (03hrs.)</p> <p>176. Punching by hollow punch. (03 hrs.)</p> <p>177. Fitting of Gasket. (03 hrs.)</p>	<ul style="list-style-type: none"> • Thermal insulation – Lagging of utilities in chemical industries. • Types & uses of lagging materials. Properties of lagging materials. • Gasket-materials for particular application cork sheet, oil proof paper, PTFE rubber & graphite. (03 hrs.)
		<p>178. Select appropriate locking device for given service. (02 hrs.)</p> <p>179. Perform the correct positioning of locking devices (03 hrs.)</p> <p>180. Proper tightening. (02 hrs.)</p> <p>181. Nut locking by pin or spring washer. (02 hrs.)</p> <p>182. Dismantle the gate valve using proper hand tools. (04 hrs.)</p> <p>183. Check the parts of gate valve for any damage. (03 hrs.)</p> <p>184. Cleaning, lubrication &</p>	<ul style="list-style-type: none"> • Locking devices- use of correct material and locking devices – locknut castle nut, saw nut, locking pin, spring lock water. • Construction, working & use of gate valve. (06 hrs)



		<p>replacing stand packing (04 hrs.)</p> <p>185. Assemble all the parts, in sequence. (05 hrs.)</p>	
		<p>186. Dismantle the globe valve using proper hand tools. (04 hrs.)</p> <p>187. Check the parts of globe valve for any damage. (02 hrs.)</p> <p>188. Cleaning, lubrication & replacing stand packing.(03 hrs.)</p> <p>189. Assemble all the parts in sequence. (05 hrs.)</p> <p>190. Remove the top cap using suitable spanner. (03 hrs.)</p> <p>191. Check the disc & hinge pin. (03 hrs.)</p> <p>192. Clean it with kerosene. (03 hrs.)</p> <p>193. Assemble it & check for proper functioning by hand. (02 hrs.)</p>	<ul style="list-style-type: none">• Construction, working & use of Globe valve & check valve.(03 hrs.)
		<p>194. Take the needle valve & check the threads on end connection. (02 hrs.)</p> <p>195. Remove the lock nut, metal seal bonnet to body & stem. (02 hrs.)</p> <p>196. Clean all parts with kerosene oil. (02 hrs.)</p> <p>197. Assemble all the parts in sequence & check it for proper functioning. (02 hrs.)</p> <p>198. Take the diaphragm valve & remove hand wheel, bonnet using proper</p>	<ul style="list-style-type: none">• Construction, working & use of needle valve, diaphragm & ball valve.(03 hrs.)



		<p>spanner. (02 hrs.)</p> <p>199. Take our and check the diaphragm. (02 hrs.)</p> <p>200. Assemble it in the same sequence. (02 hrs.)</p> <p>201. Take a ball valve & remove its hand wheel, gland nut, Bonnet, stuffing box, packing. (02 hrs.)</p> <p>202. Remove shaft spindle / stem. (02 hrs.)</p> <p>203. Observe the parts for damage. (02 hrs.)</p> <p>204. Clean the parts with kerosene oil. (02 hrs.)</p> <p>205. Assemble the parts in sequence. (03 hrs.)</p>	
		<p>206. Take the stop clock valve & remove the handle, gland nut & nut check the gland robe. (05hrs.)</p> <p>207. Remove the bonnet with spindle from the body k clean all parts. (04 hrs.)</p> <p>208. Assemble it and check for proper functioning. (04 hrs.)</p> <p>209. Take the butterfly valve & remove the gland flange by using suitable spanner. (04 hrs.)</p> <p>210. Check the ropes and rotate the handle to see the tightness of rope. (03 hrs.)</p> <p>211. Refix the gland flange. (03 hrs.)</p> <p>212. Check the movement the disc. (02 hrs.)</p>	<ul style="list-style-type: none"> • Construction, working & use of stop cock & butterfly valve • Maintenance of valve • Selection of appropriate type of valve for given service (03 hrs.)
Professional	Plan, dismantle, clean	213. Check the centrifugal pump	<ul style="list-style-type: none"> • PUMP Classification of



<p>Skill 97 Hrs.;</p> <p>Professional Knowledge 15 Hrs.</p>	<p>and assemble different machines & components used for fluid transportation & check functionality. <i>[Different Machines & Components – Pumps- centrifugal, gear pump, metering pump, screw pump, multistage compressor]</i>. (NOS:RSC/5001)</p>	<p>physically & note down the defects. (02 hrs.)</p> <p>214. Remove the end cover using proper site spanner. (03 hrs.)</p> <p>215. Remove the impeller and flange using Box spanner & what puller. (04 hrs.)</p> <p>216. Check the shaft for any damages and ply of shaft. (03 hrs.)</p> <p>217. Remove the gland cover and check the gland packing. (04 hrs.)</p> <p>218. Check the bearings for any ply. (03 hrs.)</p> <p>219. Clean all parts with kerosene. (03 hrs.)</p> <p>220. Assemble all the parts in the same sequence. (02 hrs.)</p> <p>221. Replace the gasket if damaged & fix the end cover. (02 hrs.)</p>	<p>pumps</p> <ul style="list-style-type: none"> • Construction, working & use of centrifugal pump • Starting & Shutting down procedure for centrifugal pump • Trouble shooting in centrifugal pump (05 hrs.)
		<p>222. Check the Gear pump physically & note down the defects. (02 hrs.)</p> <p>223. Mark the relative positions of the gear mesh & the body. (02 hrs.)</p> <p>224. Remove cover assembly, wear plate, seal ring on the cover assembly. (04 hrs.)</p> <p>225. Remove the idler shaft drive shaft, load ring, preload ring & seal ring. (02hrs.)</p> <p>226. Carefully inspect all parts & clean them. Dispose of any</p>	<ul style="list-style-type: none"> • Construction, working & use of Gear pump • Trouble shooting in Gear pump (02 hrs.)



		<p>damaged seals (02 hrs.)</p> <p>227. Remove shaft seal in body assembly. (02 hrs.)</p> <p>228. Coat all seals with seal grease. (02 hrs.)</p> <p>229. Assemble all parts in sequence. (04 hrs.)</p> <p>230. Check for an alignment of drive shaft & Idler shaft. (02 hrs.)</p> <p>231. Inspect gear teeth for alignment & lubricate the complete set. (02 hrs.)</p>	
		<p>232. Study the screw pump - its parts. (04 hrs.)</p> <p>233. Types of screw pump. (03 hrs.)</p> <p>234. Working & application of screw pump. (03hrs.)</p> <p>235. Maintenance of screw pump. (03 hrs.)</p> <p>236. Study of metering pump - its parts. (03 hrs.)</p> <p>237. Working & application of metering pump. (04 hrs.)</p> <p>238. Maintenance of metering pump. (04 hrs.)</p>	<ul style="list-style-type: none"> • Construction, working & use of Screw pump & metering pump. (04 hrs)
		<p>239. Study of multistage compressor - its parts. (05 hrs.)</p> <p>240. Working principle of compressor. (06 hrs.)</p> <p>241. Application of multistage compressor. (06 hrs.)</p> <p>242. Preventive maintenance of multistage compressor. (06 hrs.)</p>	<ul style="list-style-type: none"> • Construction, working & uses of fans, blowers & compressor. (04 hrs)
Professional Knowledge	Read and apply engineering drawing for	<u>ENGINEERING DRAWING: (40 Hrs.)</u>	<u>WORKSHOP CALCULATION & SCIENCE: (38 Hrs)</u>



<p>ED- 40 Hrs. WCS- 38 Hrs.</p>	<p>different application in the field of work.</p> <p>Demonstrate basic mathematical concept and principles to perform practical operations. Understand and explain basic science in the field of study.</p>	<p>Introduction to Engineering Drawing and Drawing Instruments – (2 hrs.)</p> <p>Conventions</p> <p>Sizes and layout of drawing sheets</p> <p>Title Block, its position and content</p> <p>Drawing Instrument</p> <p>Free hand drawing of – (6 hrs.)</p> <p>Geometrical figures and blocks with dimension</p> <p>Transferring measurement from the given object to the free hand sketches.</p> <p>Free hand drawing of hand tools.</p> <p>Drawing of Geometrical figures: (4 hrs.)</p> <p>Angle, Triangle, Circle, Rectangle, Square, Parallelogram.</p> <p>Lettering & Numbering – Single Stroke</p> <p>Dimensioning Practice (2 hrs.)</p> <p>Types of arrowhead</p> <p>Symbolic representation – (4 hrs.)</p> <p>Different symbols used in the related trades</p> <p>Reading of chemical plant Circuit Diagram (14 hrs.)</p> <p>Reading of Chemical plant Layout drawing (8 hrs.)</p>	<p>Unit, Fractions (4 hrs.)</p> <p>Classification of unit system</p> <p>Fundamental and Derived units</p> <p>F.P.S, C.G.S, M.K.S and SI units</p> <p>Measurement units and conversion</p> <p>Factors, HCF, LCM and problems</p> <p>Fractions - Addition, subtraction, multiplication & division</p> <p>Decimal fractions - Addition, subtraction, multiplication & division</p> <p>Solving problems by using calculator</p> <p>Square root, Ratio and Proportions, Percentage (6 hrs.)</p> <p>Square and square root</p> <p>Simple problems using calculator</p> <p>Applications of Pythagoras theorem and related problems</p> <p>Ratio and proportion</p> <p>Ratio and proportion - Direct and indirect proportions</p> <p>Percentage</p> <p>Percentage - Changing percentage to decimal and fraction</p> <p>Material Science(4 hrs.)</p> <p>Types metals, types of ferrous and non-ferrous metals</p> <p>Physical and mechanical properties of metals</p> <p>Mass, Weight, Volume and Density (4 hrs.)</p> <p>Mass, volume, density, weight and specific gravity</p> <p>Related problems for mass, volume, density, weight and specific gravity</p> <p>Speed and Velocity, Work, Power and Energy (8 hrs.)</p> <p>Speed and velocity - Rest,</p>
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			<p>motion, speed, velocity, difference between speed and velocity, acceleration and retardation</p> <p>Speed and velocity - Related problems on speed & velocity</p> <p>Work, power, energy, HP, IHP, BHP and efficiency</p> <p>Heat & Temperature and Pressure (6 hrs.)</p> <p>Concept of heat and temperature, effects of heat, difference between heat and temperature, boiling point & melting point of different metals and non-metals</p> <p>Scales of temperature, Celsius, Fahrenheit, kelvin and conversion between scales of temperature</p> <p>Heat & Temperature - Temperature measuring instruments, types of thermometer, pyrometer and transmission of heat - Conduction, convection and radiation</p> <p>Concept of pressure - Units of pressure, atmospheric pressure, absolute pressure, gauge pressure and gauges used for measuring pressure</p> <p>Basic Electricity (4 hrs.)</p> <p>Introduction and uses of electricity, molecule, atom, how electricity is produced, electric current AC, DC their comparison, voltage, resistance and their units</p> <p>Conductor, insulator, types of connections - series and parallel</p> <p>Ohm's law, relation between V.I.R & related problems</p> <p>Electrical power, energy and their units, calculation with</p>
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			assignments Magnetic induction, self and mutual inductance and EMF generation Electrical power, HP, energy and units of electrical energy Trigonometry (2 hrs.) Measurement of angles Trigonometrical ratios
Project work / Industrial visit Broad area: a) Fire hydrant system b) Fire alarm system c) Gas detection system d) Making of pipe fitting model e) Prepare MSDS for particular chemical f) Set up assembly of pipes and valves & test for leakage/functionality.			

SYLLABUS FOR ATTENDANT OPERATOR(CHEMICAL PLANT) TRADE			
SECOND YEAR			
Duration	Reference Learning Outcome	Professional Skills (Trade Practical) With Indicative Hours	Professional Knowledge (Trade Theory)
Professional Skill 48Hrs.; Professional Knowledge 18 Hrs.	Plan, identify & perform experiments to determine viscosity of oil & select oil for particular application at certain temperature, Reynold's Number to predict flow pattern in a conduit. (NOS:RSC/NCAFX)	243. Clean the oil cup and dry it, Mount the bath on the stand & fill it with water. (03 hrs.) 244. Heat the viscometer bath to the desired temperature. Rest the ball valve in the depression in the jet. (04 hrs.) 245. Pour the oil sample into oil cup through a filter. Stir the sample till it attains test temperature. Place the clean, dry standard 50 ml flask below the jet. (04 hrs.) 246. Lift the ball and simultaneously start the stop watch, collect the oil in 50 ml flask & note the time taken in seconds for collection 50 ml of oil. (04 hrs.) 247. Increase the temperature and repeat the procedure and note down the redwood seconds for different temperatures. (03 hrs.) 248. To determine the viscosity of given oil by digital viscometer. (10 hrs.)	Role of attendant operator in chemical plant. Introduction to Unit Operations and Unit processes, their meanings. Features of unit Operations. (03 hrs.) Flow of Fluid: Definition of fluid, ideal fluid, real fluid, compressible fluid, incompressible fluid. Properties of fluid-viscosity, mass density, (06 hrs.)
		249. Prepare coloured solution	Manometer, Reynold's Number,



		<p>of permanganate & fill it in the pot provided.(03 hrs.)</p> <p>250. Allow the water to flow at the lowest possible flow rate. (03 hrs.)</p> <p>251. Introduce the coloured solution through capillary and adjust the flow so that its velocity is same as that of water. (04 hrs.)</p> <p>252. Note the colour filament appears as a continuous thread without intermingling with water. Determine the flow rate of water. (04 hrs.)</p> <p>253. Repeat the experiment gradually increasing flow rate of water. Observe the flow rate at which the continuous thread just breaks up and colour gets diffused uniformly throughout the tube. (03hrs.)</p> <p>254. Calculate Reynold's number and determine the nature of flow of fluid/flow pattern of liquid.(03 hrs.)</p>	<p>Equation of continuity, Bernoulli's theorem. (04 hrs.)</p> <p>Plant Utility: Steam, cooling water, chilled water, brine, instrument air, Nitrogen, vacuum, introduction of boiler, cooling tower, chilling plant, compressor, ejector. (05 hrs.)</p>
<p>Professional Skill 67 Hrs.;</p> <p>Professional Knowledge 25Hrs.</p>	<p>Draw the operating characteristics of different types of pumps to find the optimum conditions for operating the pump and its selection. (NOS:RSC/N9410)</p>	<p>255. Preparation and apparatus setup. (03 hrs.)</p> <p>256. To adjust discharge pressure with the help of discharge valve.(05hrs.)</p> <p>257. Note down the reading of Suction & Discharge pressure.(06hrs.)</p> <p>258. Note down the flow rate of liquid at particular pressure</p>	<p>Characteristic curves of pumps- the plot of actual head, total power consumption, and efficiency vs. volumetric flow rate. Flow of incompressible fluids in pipes (06 hrs.)</p> <p>Unit Process: Importance of different symbols of unit operations and its use. Difference between Unit</p>



		<p>head.(06hrs.)</p> <p>259. Graphical representation of flow rate & Discharge head (HT).(04 hrs.)</p>	<p>operations & Unit Processes.</p> <p>Important chemical processes.</p> <p>Terms related to Unit Processes- Raw material, finished product, by-product, conversion, yield, batch process, continuous process. (03 hrs.)</p>
		<p>260. Preparation and apparatus setup.(05 hrs.)</p> <p>261. To adjust discharge pressure with the help of discharge valve.(05 hrs.)</p> <p>262. Note down the reading of Suction & Discharge pressure.(06hrs.)</p> <p>263. Note down the flow rate of liquid at particular pressure head.(03hrs.)</p> <p>264. Graphical representation of flow rate & Discharge head (HT).(03hrs.)</p>	<p>Characteristic curves of pumps- the plot of actual head, total power consumption, and efficiency vs. volumetric flow rate. (06 hrs.)</p> <p>Unit Process:</p> <p>Flow sheet- Types of flow sheet, Process block diagram (PBD), process flow diagram (PFD), PID. (02 hrs.)</p>
		<p>265. Preparation and apparatus setup.(05 hrs.)</p> <p>266. To adjust discharge pressure with the help of discharge valve.(05 hrs.)</p> <p>267. Note down the reading of Suction & Discharge pressure.(04hrs.)</p> <p>268. Note down the flow rate of liquid at particular pressure head.(03 hrs.)</p> <p>269. Graphical representation of flow rate & Discharge head (HT).(04 hrs.)</p>	<p>Characteristic curves of pumps- the plot of actual head, total power consumption, and efficiency vs. volumetric flow rate. (06 hrs.)</p> <p>Manufacturing process of Sulphuric Acid by Contact Process:</p> <p>process description, flow sheet, Uses of Sulphuric acid(02 hrs.)</p>
Professional Skill 43 Hrs.;	Determine experimentally the pressure drop due to friction for a fluid	<p>270. Preparation and apparatus setup.(03 hrs.)</p> <p>271. To maintain flow at different velocities by</p>	<p>Skin friction, pressure drop due to friction in a pipe for laminar and turbulent flow</p> <p>Friction loss from sudden</p>



<p>Knowledge 17 Hrs.</p>	<p>flowing through a pipe, verify the effect of pipe roughness on friction, and express the frictional loss in fittings and valves through the Equivalent length of fittings. (NOS:RSC/N9411)</p>	<p>operating flow control valve.(06hrs.) 272. Note down the rotameter reading.(04 hrs.) 273. Note down manometer reading.(04 hrs.) 274. Calculation &Result.(04 hrs.) 275. Preparation and apparatus setup.(03 hrs.) 276. To maintain flow at different velocities by operating flow control valve.(06hrs.) 277. Note down the rotameter reading.(04 hrs.) 278. Note down manometer reading.(05hrs.) 279. Calculation &Result.(04hrs.)</p>	<p>enlargement, sudden contraction, friction losses in pipe fittings and valves. Equivalent length of a fitting (08 hrs.) Manufacturing process of Soda Ash: Raw materials, chemical reactionsprocess description, flow sheet, uses. (09 hrs.)</p>
<p>Professional Skill 77 Hrs.; Professional Knowledge 25 Hrs.</p>	<p>Plan, identify & operate different Heat exchange equipments& calculate heat transfer rate.[<i>Heat exchange equipment's-Double Pipe Heat exchanger, Shell & tube Heat exchanger, plate heat exchanger</i>] (NOS:RSC/N9412)</p>	<p>280. Preparation and apparatus setup.(07hrs.) 281. To set the operating pressure of boiler. (07 hrs.) 282. Study of water feed pump.(07hrs.) 283. Preparation and apparatus setup.(03hrs.) 284. Start cold stream in H.E.(03 hrs.) 285. Start hot stream in H.E.(04 hrs.) 286. Note down the inlet & outlet temperatures of both streams. (04 hrs.) 287. Note down the mass flow rate of both streams. (03 hrs.) 288. Calculation &Result.(03</p>	<p>Steam: Definitions, types of steam. Boilers: Types of boilers, construction & working Steam Trap: Types, Construction and uses. Boiler inspection (06 hrs.) Heat Transfer: Mechanism of Heat Transfer in solid, liquid and gases and their application in industries thermal conductivity, Fourier's law, and resistances in series, plane and round surfaces. (04 hrs.) Manufacturing process of Caustic soda - raw materials, chemical reactions,process description, flow sheet, uses (04 hrs.)</p>



		hrs.)	
		289. Preparation and apparatus setup.(03 hrs.) 290. Start cold stream in H.E.(03 hrs.) 291. Start hot stream in H.E.(03 hrs.) 292. Note down the inlet & outlet temperatures of both streams. (03 hrs.) 293. Note down the mass flow rate of both streams. (03 hrs.) 294. Calculation &Result.(03 hrs.)	Heat transfer equipment, its classification, Heat exchangers, coolers, condenser and chillers. Double pipe heat exchanger, co-current, counter current flow pattern. (05 hrs.)
		295. Preparation and apparatus setup. (03 hrs.) 296. Start cold stream in H.E.(03 hrs.) 297. Start hot stream in H.E.(03 hrs.) 298. Note down the inlet & outlet temperatures of both streams. (03 hrs.) 299. Note down the mass flow rate of both streams. (03 hrs.) 300. Calculation&Result.(03 hrs.)	Shell and tube heat exchanger- its types, applications in industries, Plate type heat exchanger(06 hrs.)
Professional Skill 47 Hrs.; Professional Knowledge 16 Hrs.	Plan, identify & operate different Evaporators to obtain economy & heat transfer rate. <i>[Evaporation equipment's-Vertical tube evaporator, multiple effect evaporator].</i> (NOS:RSC/N9413)	301. Preparation and apparatus setup.(03hrs.) 302. Loading of evaporator. (03hrs.) 303. Heating the solution. (03hrs.) 304. Maintaining the temperature, pressure & steam flow during operation. (03hrs.) 305. Note down the	Evaporation: Definition, classification of evaporators, Capacity, steam economy of evaporators(05hrs.) Manufacturing process of Ammonia: Process description, flow sheet, uses, raw materials, chemical reactions(05 hrs.)



		<p>temperature, pressure & flow parameters. (03hrs.)</p> <p>306. Discharge the evaporator & measuring concentrated solution. (03hrs.)</p> <p>307. Calculation & Result. (04 hrs.)</p>	
		<p>308. Preparation and apparatus setup. (04hrs.)</p> <p>309. Loading of evaporator. (04hrs.)</p> <p>310. Heating the solution. (03hrs.)</p> <p>311. Maintaining the temperature, pressure & steam flow during operation. (03hrs.)</p> <p>312. Note down the temperature, pressure & flow parameters. (03 hrs.)</p> <p>313. Discharge the evaporator & measuring concentrated solution. (03hrs.)</p> <p>314. Calculation & Result. (05hrs.)</p>	<p>Multiple effect evaporation, methods of feeding in multiple effect evaporation. (06hrs.)</p>
<p>Professional Skill 23 Hrs.;</p> <p>Professional Knowledge 09 Hrs.</p>	<p>Plan, identify & operate cyclone separator to remove particulates from an air, gas, or liquid. (NOS:RSC/5001,5007)</p>	<p>315. Preparation and apparatus setup. (06 hrs.)</p> <p>316. Measurement of air flow. (06 hrs.)</p> <p>317. Weight of dust particles in particular time. (05 hrs.)</p> <p>318. Calculation & Result in ppm. (06 hrs.)</p>	<p>Pollution:</p> <p>Sources, types & effect of water pollution, air pollution.</p> <p>Pollution control equipment such as bag filter, electrostatic precipitators, Water scrubber, cyclone separator. (09hrs.)</p>
<p>Professional Skill 28 Hrs.;</p> <p>Professional Knowledge 17 Hrs.</p>	<p>Plan, identify & operate packed distillation column, sieve tray column, identify effect of different packings, demonstrate the effect</p>	<p>319. Preparation and apparatus setup. (05 hrs.)</p> <p>320. Loading of sample solution. (05 hrs.)</p> <p>321. Maintaining the temperature. (04 hrs.)</p> <p>322. Collecting the sample</p>	<p>Distillation:</p> <p>Concept of distillation, boiling point diagrams, vapour-liquid equilibrium, relative volatility, constant boiling mixtures- minimum & maximum azeotropes (09 hrs.)</p>



	of height of packing, & effect of reflux ratio. (NOS:RSC/N9414)	<p>solution. (05 hrs.)</p> <p>323. Reflux the sample to improve purity of product. (04 hrs.)</p> <p>324. Calculation & Result. (05 hrs.)</p>	Flash differential, rectification and azeotropic, extractive, vacuum, steam distillation. Reflux ratio: minimum, total, optimum, importance of reflux ratio. Types of distillation column. Column internals. Types of trays/plates. (08 hrs.)
Professional Skill 23 Hrs.; Professional Knowledge 10 Hrs.	Identify, types the functionalities of pressure vessels; list various types of pressures, state various terminologies related to pressure vessels. (NOS:RSC/N9415)	<p>325. Calculation of volume of different storage tank. (06hrs.)</p> <p>326. Measurement of level. (05hrs.)</p> <p>327. Material of construction of storage tank. (05hrs.)</p> <p>328. To maintain temperature & pressure. (07hrs.)</p>	<p>Different types of storage vessels:</p> <p>Storage of non-volatile, volatile liquids, storage of gases. Fixed or cone roof tanks, Floating roof tanks, cone roof with floating pan (05 hrs.)</p> <p>Manufacturing process of Nitric acid by ammonia oxidation process:</p> <p>Raw materials, chemical reactions, process description, flow sheet, uses (05 hrs.)</p>
Professional Skill 49 Hrs.; Professional Knowledge 16 Hrs.	Identify, operate & state different types of extraction unit & select most appropriate extractor. (NOS:RSC/N9416)	<p>329. Preparation and apparatus setup. (03 hrs.)</p> <p>330. Analysis of feed & solvent. (04hrs.)</p> <p>331. Stirring. (03hrs.)</p> <p>332. Settling. (03 hrs.)</p> <p>333. Separation of raffinate & extract phase. (04hrs.)</p> <p>334. Testing. (04hrs.)</p> <p>335. Result. (03 hrs.)</p> <p>336. Preparation and apparatus setup. (04 hrs.)</p> <p>337. Analysis of feed & solvent. (05hrs.)</p> <p>338. Maintaining heavy phase. (05hrs.)</p> <p>339. Dispersion of light phase.</p>	<p>Solvent Extraction:</p> <p>Introduction, definition, choice of solvent, distribution coefficient. Equipments used for extraction, Packed and perforated plate towers, application of extractions (08 hrs.)</p> <p>Leaching:</p> <p>Application and different types of equipment uses for leaching oil extraction from oil seeds. (08hrs.)</p>



		(04hrs.) 340. Analysis of light phase & heavy phase. (04hrs.) 341. Result.(03hrs.)	
Professional Skill 47 Hrs.; Professional Knowledge 17 Hrs.	Operate an absorption column & carry out experiment to determine flooding velocity. Explain about gas absorption, packed tower and different types of packings. (NOS:RSC/N9417)	342. Preparation and apparatus setup. (04 hrs.) 343. Analysis of gas mixture & solvent. (05 hrs.) 344. Contacting of gas & liquid phase. (04 hrs.) 345. Maintaining flow rates & pressure. (04 hrs.) 346. Analysis of gas phase & liquid phase. (04hrs.) 347. Result.(03 hrs.)	Absorption: Introduction, equipment's used for absorption –columns, factors affecting rate of absorption, tower packing. (04 hrs.) Manufacturing Process of Sugar: Raw materials, chemical reactions, process description, flow sheet, uses.(05 hrs.)
		348. Preparation and apparatus setup. (04 hrs.) 349. Set liquid flow rate. (05hrs.) 350. To maintain gas flow rate at different velocities by operating flow control valve. (05hrs.) 351. Note down manometer reading. (04 hrs.) 352. Graphical representation of flow rate & differential pressure (ΔH). (05hrs.)	Flooding and flooding velocity. (08 hrs.)
Professional Skill 28 Hrs.; Professional Knowledge 09 Hrs.	Identify types of crystallization equipments and know their basic operations. (NOS:RSC/N9418)	353. Preparation and apparatus setup. (05hrs.) 354. To prepare saturated/super saturated solution using solid solute like NaCl. (5hrs.) 355. Formation of crystals, Cooling & Stirring. (6 hrs.) 356. Separation of crystal & mother liquor. (6 hrs.) 357. Crystal drying.(6 hrs.)	Crystallization: Introduction, concepts of solubility & effect of temperature on solubility, crystallization, methods of super-saturation, Different types of crystallizers & their application in industries.(09hrs.)
Professional	Identify, operate & state different types of	358. Preparation and apparatus setup. (01 hr.)	Filtration: Principles of filtration, types of



<p>Skill 87 Hrs.;</p> <p>Professional Knowledge 25Hrs.</p>	<p>filtration units. Study the parts and functions of plate and frame filter press & select appropriate unit. (NOS:RSC/N9419)</p>	<p>359. Assembling filter press properly. (02 hrs.)</p> <p>360. Operating filter press. (04 hrs.)</p> <p>361. Collection of Filtrate. (03 hrs.)</p> <p>362. Removal of cake. (03 hrs.)</p> <p>363. Cleaning & reassemble of filter press. (03 hrs.)</p> <p>364. Preparation and apparatus setup. (02 hrs.)</p> <p>365. Loading of slurry tub. (01 hr.)</p> <p>366. Application of vacuum & compressed air. (03hrs.)</p> <p>367. Operating filter unit. (04 hrs.)</p> <p>368. Collection of Filtrate. (02 hrs.)</p> <p>369. Removal of cake. (02 hrs.)</p> <p>370. Preparation and apparatus setup. (01 hr)</p> <p>371. Assembling filter press properly. (01 hr)</p> <p>372. Operating filter press. (04 hrs.)</p> <p>373. Collection of Filtrate (03 hrs.)</p> <p>374. Removal of cake. (03 hrs.)</p> <p>375. Cleaning & reassemble of filter press. (01 hr)</p> <p>376. Preparation and apparatus setup. (01 hr)</p> <p>377. Application of vacuum. (03 hrs.)</p> <p>378. Operating filter unit. (04 hrs.)</p> <p>379. Collection of Filtrate. (03 hrs.)</p>	<p>filtrations such as atmospheric, pressure, vacuum and their specific applications.</p> <p>Construction & working of plate and frame Filter Press.</p> <p>Factors affecting filtration. Filter media. Construction & working of Rotary drum vacuum filter. (08 hrs.)</p> <p>Construction & working of Sparkler filter (02 hrs.)</p> <p>Manufacturing Process of Urea: Raw materials, chemical reactions, process description, flow sheet, uses. (04 hrs.)</p> <p>Construction & working of Leaf filter (03 hrs.)</p>
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		<p>382. Preparation of slurry and apparatus setup. (01 hr) 383. Application of vacuum. (03 hrs.) 384. Operating filter unit. (04 hrs.) 385. Collection of Filtrate (03 hrs.) 386. Removal of cake. (01 hr) 387. Washing & cleaning of filter unit. (02hrs.) 388. Preparation of slurry and apparatus setup. (01 hr) 389. Application of vacuum (03 hrs.) 390. Operating centrifuge. (04 hrs.) 391. Collection of Filtrate (03hrs.) 392. Removal of cake. (01 hr) 393. Washing & cleaning. (02 hrs.)</p>	<p>Construction & working of Nutch filter (02 hrs.) Centrifugation: Types of Centrifuges. Construction & working of Bottom driven centrifuge.(06 hrs.)</p>
<p>Professional Skill 25 Hrs.; Professional Knowledge 08 Hrs.</p>	<p>Identify the different modules of DCS, function, Wire and connect I/OS field devices to the I/O Modules. (NOS:RSC/N9420)</p>	<p>394. Familiar with different faculties and function of DCS system. (05hrs.) 395. Identify the different modules of DCS and different process instruments in process plant. (10hrs.) 396. Wire and connect the I/O Module of DCS to field signals. (05 hrs.) 397. Install DCS Programming software and establish communication with PC and</p>	<p>Fundamentals of DCS. History of DCS development. Structure of DCS system. Importance of DCS, Use of DCS in chemical industries.(08hrs.)</p>



		DCS. (05hrs.)	
Professional Skill 24 Hrs.; Professional Knowledge 08 Hrs.	Identify modules of PLC, its function, Wire and connect the digital I/Os field devices to the I/O Module of PLC . (NOS:RSC/N9421)	398. Identify each module in a rack and mount in the specified slot. (14hrs.) 399. Wire and connect the digital I/Os field devices to the I/O Module of PLC. (10hrs.)	Introduction to programmable controllers. History of programmable controllers, general characteristics of programmable controllers, some limitation of PLCs, method of developing PLC programming. (08hrs.)
Professional Skill 25 Hrs.; Professional Knowledge 08 Hrs.	Identify to operate different types of mixing equipment like ribbon blender. (NOS:RSC/N9422)	400. Preparation and apparatus setup. (06hrs.) 401. Homogeneous mixing of substances. (09hrs.) 402. Unloading of mixer. (07 hrs.) 403. Washing & cleaning. (03hrs.)	Mixing: Introduction, classification of mixing equipment's and its applications, mixers for mixing solid-solid, solid-liquid, solid-gas. (08hrs.)
Professional Skill 27 Hrs.; Professional Knowledge 07 Hrs.	Identify, operate different types of drying equipments & determine rate of drying. Demonstrate the effect of operating parameters on drying of solids. Identify the time of drying for the constant rate period & falling rate period. Select appropriate dryer for the given feed. (NOS:RSC/N9423)	404. Preparation and apparatus setup. (01 hr) 405. Weighing sample for different trays. (01 hr) 406. Drying operation at constant temperature. (04 hrs.) 407. Weighing sample at regular interval of time. (03hrs.) 408. Calculation & Result. (03hrs.) 409. Washing & cleaning. (01 hr.) 410. Preparation and apparatus setup. (03hrs.) 411. Drying operation at constant temperature. (04 hrs.) 412. Weighing product after drying operation. (03hrs.) 413. Calculation & Result. (02 hrs.)	Drying: Definition, factors affecting rate of drying, Different types of dryers, their construction, working & uses. (07 hrs.)



		414. Washing & cleaning. (02 hrs.)	
Professional Skill 48 Hrs.; Professional Knowledge 10 Hrs.	Identify, demonstrate, operate different size reduction machines. Find out critical speed of the Ball mill. (NOS:RSC/N9424)	415. Preparation and apparatus setup. (03 hrs.) 416. Weighing sample. (03 hrs.) 417. Crushing operation. (03hrs.) 418. Collection of crushed material. (03 hrs.) 419. Equipment cleaning.(03hrs.) 420. Preparation and apparatus setup. (03hrs.) 421. Weighing sample. (03 hrs.) 422. Hammer mill operation. (03hrs.) 423. Collection of crushed material. (03hrs.) 424. Equipment cleaning. (06 hrs.) 425. Preparation and apparatus setup. (03hrs.) 426. Weighing sample. (03 hrs.) 427. Ball mill operation. (03hrs.) 428. Collection of grinding material. (03hrs.) 429. Equipment cleaning (03hrs.)	Size Reduction: Introduction. Classification of crushing & grinding equipment. Construction, working and applications of jaw / roller Crushers. (02 hrs.) Construction, working and applications of Hammer mill. (02 hrs.) Manufacturing Process of Ethyl Alcohol: Raw materials, chemical reactions, process description, flow sheet, uses. (04 hrs.) Construction, working and applications of Ball mill. (02 hrs.)
Professional Skill 23 Hrs.; Professional Knowledge 07 Hrs.	Operate Screening Equipment.Determines creen effectiveness of a sieve. (NOS:RSC/N9425)	430. Preparation and apparatus (04hrs.) 431. Loading of sieve shaker. (04hrs.) 432. Operating sieve shaker.(04hrs.) 433. Unloading sieve shaker. (04hrs.) 434. Collection & weighing of sample in each sieve.(04hrs.) 435. Observation table.(03 hrs.)	Screening: Screens, standard screens (Tyler’s standard screen) and its principle. mesh number, Classification of Screening equipment’s such as trammels, vibrating Screens & their industrial applications.(07hrs.)
Professional	Set up, operate humidification &	436. Preparation and apparatus setup.(04 hrs.)	Humidification & Dehumidification:



<p>Skill 43 Hrs.;</p> <p>Professional Knowledge 09 Hrs.</p>	<p>dehumidification operations. Measure dry bulb & wet bulb temperatures and find out relative humidity. Demonstrate & Operate cooling tower.</p> <p>(NOS:RSC/N9426)</p>	<p>437. Note the reading of wet bulb. (05 hrs.)</p> <p>438. Note the reading of dry bulb. (04 hrs.)</p> <p>439. Compare readings.(05hrs.)</p> <p>440. Result. (04 hrs.)</p> <p>441. Preparation and apparatus setup.(05hrs.)</p> <p>442. Note down temperature of inlet water.(05hrs.)</p> <p>443. Maintain air flow rate.(04hrs.)</p> <p>444. Take cooled water outlet temperature at specific intervals.(04hrs.)</p> <p>445. Result.(03hrs.)</p>	<p>Theory of Humidification and different terms related to Humidification.(03 hrs.)</p> <p>Cooling Tower: Types of cooling tower, their Construction, working. (03 hrs.)</p> <p>Manufacturing Process of Pulp & Paper: Raw materials, chemical reactions, process description, flow sheet, and uses. (03 hrs.)</p>
<p>Professional Skill 35 Hrs.;</p> <p>Professional Knowledge 09 Hrs.</p>	<p>Identify & demonstrate the various types of conveyors like belt conveyor, screw conveyor and bucket elevators and list their components and uses.</p> <p>(NOS:RSC/N9427)</p>	<p>446. Preparation and apparatus setup. (01hr.)</p> <p>447. Start the conveyor.(01hr.)</p> <p>448. Supplyof raw material. (04hrs.)</p> <p>449. Measurement of speed/time taken for travel from one end to other. (04hrs.)</p> <p>450. Discharge of material at other end and result. (04hrs.)</p> <p>451. Preparation and apparatus setup. (01hr.)</p> <p>452. Start the conveyor.(01hr.)</p> <p>453. Supply of raw material.(03 hrs.)</p> <p>454. Measurement of speed/time taken for travel from one end to other. (03 hrs.)</p> <p>455. Discharge of material at other end and result. (03</p>	<p>Conveying: Introduction and different types of conveyors.(09hrs.)</p>



		<p>hrs.)</p> <p>456. Preparation and apparatus setup. (01hr.)</p> <p>457. Start the Elevator. (01hr.)</p> <p>458. Supply of raw material. (03 hrs.)</p> <p>459. Measurement of speed/time taken for travel from one end to other. (03 hrs.)</p> <p>460. Discharge of material at other end and result. (02hrs.)</p>	
<p>Professional Skill 23 Hrs.;</p> <p>Professional Knowledge 12Hrs.</p>	<p>Conduct sedimentation operation and draw sedimentation curve. Differentiate between settling, sedimentation and decantation operations. (NOS:RSC/9428)</p> <p>Identify the function of Chemical reactor; list various types of chemical reactors, state various accessories of Chemical reactors. (NOS:RSC/NCAFX)</p>	<p>461. Preparation and apparatus setup. (03hrs.)</p> <p>462. Add coagulant. (03hrs.)</p> <p>463. Stirring for specific period. (03hrs.)</p> <p>464. Settling & separation. (02 hrs.)</p> <p>465. Result. (02 hrs.)</p> <p>466. Material of construction. (02 hrs.)</p> <p>467. Use of reactor. (03hrs.)</p> <p>468. Fittings & accessories on the reactor. (03 hrs.)</p> <p>469. Stirrer used.(02hrs.)</p>	<p>Sedimentation & Decantation:</p> <p>Various type of thickeners and sedimentation operation equipment.</p> <p>Chemical Reactor:</p> <p>Types of reactor, Parts of reactor. (12hrs.)</p>
<p>Professional Knowledge WCS- 18 Hrs.</p>	<p>Demonstrate basic mathematical concept and principles to perform practical operations.</p> <p>Understand and explain basic science in the field of study.</p>		<p><u>WORKSHOP CALCULATION & SCIENCE: (18 Hrs)</u></p> <p>Friction (2 hrs.)</p> <p>Friction - Advantages and disadvantages, Laws of friction, co-efficient of friction, angle of friction, simple problems related to friction</p> <p>Friction - Lubrication</p> <p>Friction - Co- efficient of friction, application and effects of</p>



			<p>friction in workshop practice Algebra (6 hrs.) Algebra - Addition, subtraction, multiplication & division Algebra - Theory of indices, algebraic formula, related problems Estimation and Costing (10 hrs.) Estimation and costing - Simple estimation of the requirement of material etc., as applicable to the trade Estimation and costing - Problems on estimation and costing</p>
<p>Implant training / Project work (work in a team)</p> <p>Broad area:</p> <ul style="list-style-type: none">a) Crystallization of sugar/salt from saturated/supersaturated solution.b) Extraction of oil seeds.c) To create a water filtration system from common material. (sand filter)d) Slide show presentation of size reduction equipments.e) Purification of mud water with the help of sedimentation & coagulation operation.			

SYLLABUS FOR CORE SKILLS

1. Employability Skills (Common for all CTS trades) (120 Hrs. + 60 Hrs.)

Learning outcomes, assessment criteria, syllabus and Tool List of Core Skills subjects which is common for a group of trades, provided separately in www.bharatskills.gov.in

LIST OF TOOLS AND EQUIPMENT			
ATTENDANT OPERATOR (CHEMICAL PLANT) (For batch of 24 candidates)			
S No.	Name of the Tool & Equipment	Specification	Quantity (Nos.)
A: TRAINEES TOOL KIT			
1.	Safety shoes	Regular size	25(24+1) Nos.
2.	Safety Goggles		25(24+1)Nos.
3.	Safety hand gloves (PVC gloves)	Regular size	25(24+1) Nos.
4.	Ear plug		25(24+1) Nos.
5.	Dust mask/nose mask		25(24+1) Nos.
6.	Helmet		6 Nos.
7.	Steel Rule	300 mm, Graduated both in Metric and English Unit	8 Nos.
B. GENERAL SHOP OUTFIT			
8.	Try Square	150 mm	2 Nos.
9.	Calliper - Inside Spring	150 mm	2 Nos.
10.	Calliper - Outside Spring	150 mm	2 Nos.
11.	Divider Spring Type	150 mm	2 Nos.
12.	Punch Centre	100 mm	2 Nos.
13.	Punch Prick	100 mm	2 Nos.
14.	Letter and Number Punch	5mm	1 No.
15.	Scriber- Straight	150 mm	2 Nos.
16.	Hacksaw Frame	Fixed type - 300 mm	2 Nos.
17.	File - Flat - Bastard	250 mm	2 Nos.
18.	File - Flat - Second Cut	250 mm	2 Nos.
19.	File - Flat - Smooth	250 mm	2 Nos.
20.	File - Half Round Second Cut	250 mm	2 Nos.
21.	File - Round - Smooth	250 mm	2 Nos.
22.	File - Triangular - Smooth	150 mm	2 Nos.
23.	File - Square - Second Cut	200 mm	2 Nos.
24.	Chisel - Cold - Flat	20 mm X 150 mm	2 Nos.



25.	Hammer - Ball Pein	500 grams	2 Nos.
26.	Screw Driver	9 X 300 mm	2 Nos.
27.	Double Ended Spanner set	Metric 6*7 to 30*32	1 set
28.	Pipe wrench	14"	1 set
29.	Die & Die stock complete (BSP)	½" & 1"	1 set each
30.	Pipe vice	50 mm / 2"	1 set
31.	Work bench (Wooden Top)	6'X3'X3'	1 No.
32.	Combination Plier	6"	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.	Vernier Calliper	0 - 200 mm with least count 0.02mm	1 No.
37.	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.
38.	Locking devices Lock nut, Castle nut		1 No.
39.	Fire extinguishers	Operate and test clinical equipment/ instruments used in hospital.	1 No.
40.	Thermometers:		
	(1) 0 to 110° C		6 Nos.
41.	Micrometre - Outside	0 - 25 mm	1 No.
42.	V Block	75 x 75 x 50 mm with Clamp (Hardened & Ground)	1 No.
43.	Bench Vice	125 mm	8 Nos.
44.	Anvil	50 Kg - with stand	1 No.
45.	Surface Plate	Granite - 450 x 450mm with Stand and Cover	1 No.
C. LAB EQUIPMENT & GLASSWARE			
46.	Rheostat		
	(a) Rheostat 100 ohms		2 Nos.
47.	Resistance box 0 to 500 ohms		2 Nos.
48.	Resistance coils (2 ohms, 5 ohms, 10 ohms, 100 ohms)		2 Nos.
49.	Ammeter	0 to 10 Amp. (AC, DC)	2 Nos.



50.	Voltmeter		2 Nos.
	0 to 10 volt (DC)		2 Nos.
51.	Battery eliminator	Input: 240 volts Output: 4.5 -6 volts	2 Nos.
52.	Specific Gravity bottle 25 cc		2 Nos.
53.	Multi meter (digital)		2 Nos.
54.	Hydrometer		1 No.
55.	Inclined plane with pulley, pan, weights etc.		1 No.
56.	Simple machines - Screw Jack with Accessories.		1 No.
57.	Calorimeter for determining Joule's mechanical Equivalent of heat by electric method.		1 No.
58.	Capsule type pressure gauge.	Range: 0- 1kg/cm ²	1 No.
59.	Thermocouple	J, K, E, R, T, S types	1 No.
60.	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.
61.	Steam generator (copper) Cap. 1000ml Lab equipment & glassware		2 Nos.
62.	Burette clamp		6 Nos.
63.	Bunsen Burners		6 Nos.
64.	Tripods Stand		6 Nos.
65.	Asbestos wire gauge		6 Nos.
66.	Gauge Wire without asbestos	MOC: Borosilicate	6 Nos.
67.	Burettes 25ml boroflow	MOC: Borosilicate	6 Nos.
68.	Pipettes 10ml	MOC: Borosilicate	6 Nos.
69.	Pipette Rubber Bulb		6 Nos.
70.	H.D.P. Distil water bottle		4 Nos.
71.	Clamp holders		6 Nos.
72.	Stands with clamps for burette		6 Nos.
73.	Triangles clay		6 Nos.



74.	Measuring cylinder 250 ml Glass	MOC: Borosilicate	4 Nos.
75.	Measuring cylinder 500 ml Glass/ Plastic	MOC: Borosilicate/Plastic	4 Nos.
76.	Measuring cylinder 1000 ml Glass/ Plastic	MOC: Borosilicate/Plastic	4 Nos.
77.	Volumetric flask 100 ml	MOC: Borosilicate	4 Nos.
78.	Volumetric flask 500 ml	MOC: Borosilicate	4 Nos.
79.	Volumetric flask 1000 ml	MOC: Borosilicate	4 Nos.
80.	Funnels Dia 7.5cms	MOC: Borosilicate	4 Nos.
81.	Beaker 250ml corning	MOC: Borosilicate	4 Nos.
82.	Beaker 500 ml corning	MOC: Borosilicate	4 Nos.
83.	Bottles for solutions 1000 ml	MOC: Borosilicate	3 Nos.
84.	Bottles for solutions 2000 ml	MOC: Borosilicate	3 Nos.
85.	Bottles for solutions 500 ml	MOC: Borosilicate	3 Nos.
86.	Conical flask –500 ml	MOC: Borosilicate	6 Nos.
87.	Conical flask - 250 ml	MOC: Borosilicate	6 Nos.
88.	Evaporating dish - 50 ml	MOC: Borosilicate	6 Nos.
89.	Watch Glass - 3" dia.	MOC: Borosilicate	6 Nos.
90.	Tongs for laboratory - Flat - 200 mm	300 mm	6 Nos.
91.	Spatula - 8"	8"	6 Nos.
92.	Distilled water still 10 lit.	S.S. made, low water level cutoff	1 No.
93.	Glass test tubes - 15 ml	MOC: Borosilicate	20 Nos.
94.	Round bottom Distillation flask with side neck	500ml	3 Nos.
95.	Condenser for distillation lebig	30 cm long	3 Nos.
96.	Rubber cork of (2.5 cm, 3 cm) size various size		3 Nos.
97.	Rubber Tubing (ID-5mm)	8/10 ml	10 Nos.
98.	Fire alarm system with air tight chamber		1 No.
99.	Gas detector with air tight chamber		1 No.
100.	Bourdon tube (C-type) pressure gauge		1 No.
101.	R.T.D. thermometer PT100		1 No.



102.	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.
103.	Bimetallic thermometer		1 No.
104.	Instrument for determining 'g' (Simple Pendulum)		1 No.
105.	Mechanical board for testing triangle and parallelogram of force including all accessories.		2 Nos.
106.	Searle's apparatus for young's Modulus		2 Nos.
107.	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.
108.	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.
109.	Digital Stop Watch 1/10 Second		1 No.
110.	pH Meter Digital	Microprocessor base, Auto calibration facility with electrode, Auto & Manual temperature compensation. Ready for use.	1 No.
111.	Redwood viscometer		1 No.
112.	Digital Balance 200 gm	Accuracy: ± 1 mg	1 No.
113.	Digital Balance 10 kg	Accuracy: ± 1 gm	1 No.
114.	Test tube stand for 12 tubes metallic		1 No.
115.	Test tube Holder		6 Nos.
116.	Fire extinguishers (Dry chemical powder)	Capacity: 4 kgs.	1 No.
117.	Sand Bucket	10 – 12 liters	1 No.

D. UNIT OPERATION MACHINERY & EQUIPMENT

118.	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.
119.	Ball mill	Made up of S.S. of 450 mm (L) 300 mm (D), 50 S.S. balls, Dual starter, energy meter, RPM indicator,	1 No.

		proximate sensor, variable speed.	
120.	Sieve shaker and sieves	Sieve shaker machine with sieves Made up of Brass with different sieves, with vibrator/rotap and timer.	1 No.
121.	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.
122.	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
123.	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.
124.	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.
125.	Sight glass level indicator	Made up of S.S. tank with sight glass, scale, drain valve.	1 No.
126.	Sedimentation Equipment	Sedimentation Tank Material: Acrylic Size: 1000 *400*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.
127.	Metering Pump	Capacity 2 LPH, HP/RPM: 0.5/1440	1Each
128.	Multistage Reciprocating compressor fitted with	Fitted with intercooler & after cooler with 3 HP electric motor, pressure gauge 2 Nos. energy	1 No.

	intercooler & after cooler	meter, Pressure relief valve, pressure switch, Air damping tank, orifice, manometer.	
129.	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.
130.	Boiling Point and Melting Point Apparatus	Microprocessor temp. range: Ambient to 300°C, Digital type, Memory: up to 100 samples	1 No.
E. GENERAL MACHENERY & EQUIPMENTS			
MACHENERY:			
131.	Reactor trainer with all controlling accessories	With all Controlling Accessories.	1 No.
132.	PLC Kit	With 8 DI/DO, 8 AI/AO with necessary hardware & software to understand PLC functioning.	1 No.
133.	Screw pump	with 1 HP electric motor.	1 No.
134.	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.
135.	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.
136.	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.
137.	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.
138.	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.
139.	Shell and Tube heat exchanger	Made up of S.S. 500 mm (L) 75 mm (D) heat	1 No.

		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 arrangement.	
140.	Plate type heat exchanger	Made up of minimum 7 S.S. plates with S.S. hot water tank with heater, S.S. cold water tank, 2 rotameters, 2 S.S. pump, Multi zone temperature indicator, PID and necessary piping mounted on Suitable Frame Structure.	1 No.
141.	Mixer-settler type extractor	Made up of S.S. extraction column of 700 mm (H) 100 mm (D), S.S. feed tank, S.S. solvent tank, S.S. pump, 2 rotameters and suitable piping.	1 No.
142.	Packed tower of glass for flooding velocity experiment	Made up of glass 1200 mm (H) 50 mm (D) with Rasching Rings, S.S. feed tank, S.S. pump, 2 rotameters, Air compressor and suitable piping.	1 No.
143.	Batch type tank crystallizer	Made up of S.S. Jacketed tank with S.S. feed tank with heater, S.S. pump, Rotameter, multi zone temperature indicator, PID and suitable piping. Mounted on Suitable Frame Structure.	1 No.
144.	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 and suitable piping. Mounted on Suitable Frame Structure.	1 No.
145.	Rotary drum vacuum filter	made up of S.S. of 500 mm (L) 400 mm (D), with S.S. cake trays 5 Nos., S.S. slurry tank, S.S. washing tank, Vacuum pump, compressor, Moisture trap, 2 dual starters.	1 No.
146.	Sparkler filter	Made up of S.S. 8" ϕ having 0.2 m ² filtering area, pump, filter cloth. With necessary piping arrangement.	1 No.
147.	Leaf filter	Made up of S.S. different filter leaves, vibrator, with gasket	1 No.
148.	Nutch filter	Made up of S.S. with vacuum pump, S.S. vacuum receiver tank, slurry tank, filter cloth, pressure gauge. With suitable piping.	1 No.
149.	Tray dryer	Tray Dryer: Made up of S.S. from inside, with heaters, variable speed DC motor, multi zone temperature indicator, weighing scale, PID.	1 No.
150.	Rotary drum drier	Made up of S.S., with heater, variable speed blower, Temperature indicator, PID, collection tray.	1 No.
151.	Blake jaw crusher	Made up of having minimum size 4"X6" with electric motor, starter, energy meter capacity:	1 No.



		approx. 150 kg/hr.	
152.	Humidification control equipment with dry and wet bulb Temperature	With heating and cooling arrangement to increase and decrease humidity.	1 No.
153.	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.	1 No.
Equipment:			
154.	Rising and falling film evaporator	Made up of S.S. with hot water tank, cold water tank, steam generator, 2 S.S. pump, 2 rotameters, Multi zone temperature indicator, Shell & Tube type heat exchanger and suitable piping mounted on Suitable Frame Structure.	1 No.
155.	Triple effect evaporator	Made up of S.S. with feed tank, cold water tank, steam generator, 3 rotameters, Multi zone temperature indicator, Shell & Tube type heat exchanger, 5 product vessels, PID and suitable piping, mounted on Suitable Frame Structure.	1 No.
156.	Packed distillation tower.	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 zone temperature indicator, Shell & Tube type heat exchanger, 2 S.S. pumps, reflux pump, PID, distillate pump, Reflux drum, solenoid valve, product collection tank with essential automation and suitable piping, mounted on Suitable Frame Structure.	1 No.
157.	Spray extraction column	Made up of glass. 750 mm (H) 75 mm (D), S.S. feed tank, S.S. solvent tank, 2 S.S. pump, 2 rotameters, 2 sample collection tanks with suitable piping. Mounted on Suitable Frame Structure.	1 No.
158.	Absorption and Stripping Equipment	Made up of different glass columns, with S.S. feed tank, 3 pumps, 3 rotameters, nitrogen cylinder, dissolved oxygen meter. With piping arrangement mounted on Suitable Frame Structure.	1 No.
159.	Bottom driven centrifuge	Made up of S.S. drum Filter collection tank of S.S., Brake system, limit switch, with suitable motor and polypropylene filter bags. Capacity of 15 kg.	1 No.
NOTE:			
<ol style="list-style-type: none"> 1. Internet facility is desired to be provided in the class room. 2. Projector (Digital type) 			

ABBREVIATIONS

CTS	Craftsmen Training Scheme
ATS	Apprenticeship Training Scheme
CITS	Craft Instructor Training Scheme
DGT	Directorate General of Training
MSDE	Ministry of Skill Development and Entrepreneurship
NTC	National Trade Certificate
NAC	National Apprenticeship Certificate
NCIC	National Craft Instructor Certificate
LD	Locomotor Disability
CP	Cerebral Palsy
MD	Multiple Disabilities
LV	Low Vision
HH	Hard of Hearing
ID	Intellectual Disabilities
LC	Leprosy Cured
SLD	Specific Learning Disabilities
DW	Dwarfism
MI	Mental Illness
AA	Acid Attack
PwD	Person with disabilities

