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

COMPETENCY BASED CURRICULUM

MAINTENANCE MECHANIC

(CHEMICAL PLANT)

(Duration: Two Years)

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL- 5

SECTOR – CHEMICALS AND PETROCHEMICALS

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Directorate General of Training

MAINTENANCE MECHANIC
(CHEMICAL PLANT)

(Engineering Trade)

(Revised in 2019)

Version: 1.2

CRAFTSMEN TRAINING SCHEME (CTS)

NSQF LEVEL- 5

Developed By

Ministry of Skill Development and Entrepreneurship

Directorate General of Training

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1. COURSE INFORMATION

During the two-year duration of Maintenance Mechanic (Chemical Plant) trade, a candidate is trained on Professional Skill, Professional Knowledge, Engineering Drawing, Workshop Calculation & Science and Employability Skill related to job role. In addition to this, a candidate is entrusted to undertake project work and extracurricular activities to build up confidence. The broad components covered under Professional Skill subject are as below:-

FIRST YEAR: In this year, the trainee learns about safety and environment, use of fire extinguishers, artificial respiratory resuscitation to begin with. He gets the idea of trade tools & its standardization, familiarize with basics of electricity, test the cable and measure the electrical parameter. Skilling practice on different types of filling adjoining sides/surfaces maintains the right angle between the sides. Making the job on the step fitting (male & female).Practice of enlargement of drill holes, countersinking, Counter boring, tapping and dieing of BSW and metric threads of various sizes.

The trainees will be able to construct and test of safety precautions observed in workshop also able to know pipe butt joint-D & pipe T-Joint-D, Welding all types joints on sheet, 3mm, 4mm, 6mm etc. Trainees should be able co-efficient of expansion of solid and liquid. Construct and test of corrosion of metals, volumetric analysis, quantities of analysis.

SECOND YEAR: In this year, the trainee will be able evaluated of safety equipment and their uses and awareness of first aid, firefighting equipment's and hydrant system. Filling for smoothness of machined surface and cutting, threading, bending and fitting of pipes as per drawing. Dismantling, overhauling and assembling of different type of pump such as positive displacement pumps (reciprocation pumps & gear pump, plunger pump).Oil seals, checking and replacing of oil seals, removing bearing using bearing pullers. Importance of preventive and routine maintenance, log cards, records of maintenance schedules etc.

The trainees will be able to prepare shaping of rectangular block to size and checking by steel rule, calliper and try square, marking out for slotting, cutting slots and grooves. The trainees will be able slot cutting according to dimensions with cylindrical cutters and side & face cutters. Practice of different PVC welding process. Making head vs. capacity curve for centrifugal and gear pumps. Practice on hammer mill, ball mill and Blake jaw crusher, multi-stage compressor. Trainees should be test on hydraulic circuit on hydraulic jack & its Maintenance .Operating& maintenance of belt, bucket, screw & pneumatic conveyor. They will plan and carry out the selection of a project, assemble the project and evaluate its performance of the jobs.

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 economy/ Labour market. The vocational training programmes are delivered under the aegis of Directorate General of Training (DGT). Craftsman Training Scheme (CTS) with variants and Apprenticeship Training Scheme (ATS) are two pioneer schemes of DGT for strengthening vocational training.

The Maintenance mechanic (Chemical Plant) trade under CTS is one of the popular courses delivered nationwide through a 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) imparts professional skills and knowledge, while Core area (Workshop Calculation & science, Engineering Drawing and Employability Skills) imparts requisite core skill, knowledge and life skills. After passing out the training program, 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.
- Check the job with circuit diagrams/components as per drawing for functioning, diagnose and rectify faults in the components/module.
- 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	
		1st Year	2nd Year
1	Professional Skill (Trade Practical)	1000	1000
2	Professional Knowledge (Trade Theory)	280	360
3	Workshop Calculation & Science	80	80
4	Engineering Drawing	80	80
5	Employability Skills	160	80
	Total	**1600**	**1600**

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 have to maintain 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 basis for setting question papers for final assessment. The examiner during final examination will also check** 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%. There will be no Grace marks.

2.4.2 ASSESSMENT GUIDELINE

Appropriate arrangements should be made to ensure that there will be no artificial barriers to assessment. The nature of special needs should be taken into account while undertaking the assessment. 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 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

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 while assessing:

Performance Level	Evidence
(a) Weightage in the range of 60%-75% to be allotted during assessment	
For performance in this grade, the candidate should produce work which demonstrates attainment of an acceptable standard of craftsmanship with occasional guidance, and due regard for safety procedures and	• Demonstration of good skill in the use of hand tools, machine tools and workshop equipment. • 60-70% accuracy achieved while undertaking different work with those

practices	demanded by the component/job. • A fairly good level of neatness and consistency in the finish. • Occasional support in completing the project/job.
(b) Weightage in the range of 75%-90% to be allotted during assessment	
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	• 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.
(c) Weightage in the range of more than 90% to be allotted during assessment	
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.	• 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

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

Reference NCO-2015

(i) 7233.1100 – Mechanic Maintenance (Chemical Plant)

4. GENERAL INFORMATION

Name of the Trade	**MAINTENANCE MECHANIC (CHEMICAL PLANT)**
Trade Code	DGT/1055
NCO - 2015	7233.1100
NSQF Level	Level-5
Duration of Craftsmen Training	Two Years (3200 Hours)
Entry Qualification	Passed 10th class examination with Science and Mathematics or its equivalent.
Minimum Age	14 years as on first day of academic session.
Eligibility for PwD	LD, LC, DW, AA, LV, DEAF, AUTISM
Unit Strength (No. Of Students)	20 (There is no separate provision of supernumerary seats)
Space Norms	96 Sq. m
Power Norms	13 KW
Instructors Qualification for:	
(i) Maintenance Mechanic (Chemical Plant) Trade	B.Voc/Degree in Chemical Technology/ Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. **OR** 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. **OR** NTC/NAC passed in the Trade of "Maintenance Mechanic (Chemical Plant)" With three years' experience in the relevant field. **Essential Qualification:** Relevant National Craft Instructor Certificate (NCIC) in any of the variants under DGT. ***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.***
(ii) Workshop Calculation	B.Voc/Degree in Engineering from AICTE/UGC recognized

& Science	Engineering College/ university with one-year experience in the relevant field. **OR** 03 years Diploma in Engineering from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. **OR** NTC/ NAC in any one of the engineering trades with three years' experience. **Essential Qualification:** National Craft Instructor Certificate (NCIC) in relevant trade. **OR** NCIC in RoDA or any of its variants under DGT.
(iii) Engineering Drawing	B.Voc/Degree in Engineering from AICTE/UGC recognized Engineering College/ university with one-year experience in the relevant field. **OR** 03 years Diploma in Engineering from AICTE/ recognized board of technical education or relevant Advanced Diploma (Vocational) from DGT with two years' experience in the relevant field. **OR** NTC/ NAC in any one of the Mechanical group (Gr-I) trades categorized under Engg. Drawing'/ D'man Mechanical / D'man Civil' with three years experience. **Essential Qualification:** National Craft Instructor Certificate (NCIC) in relevant trade. **OR** NCIC in RoDA / D'man (Mech /civil) or any of its variants under DGT.
(iv) Employability Skill	MBA/ BBA / Any Graduate/ Diploma in any discipline with Two years' experience with short term ToT Course in Employability Skills from DGT institutes. (Must have studied English/ Communication Skills and Basic Computer at 12th / Diploma level and above) **OR**

	Existing Social Studies Instructors in ITIs with short term ToT Course in Employability Skills from DGT institutes.
(v) Minimum Age for Instructor	21 Years
List of Tools and Equipment	As per Annexure – I

Distribution of training on hourly basis: (Indicative only)

Year	Total Hrs /week	Trade Practical	Trade Theory	Workshop Cal. & Sc.	Engg. Drawing	Employability Skills
1st	40 Hours	25 Hours	7 Hours	2 Hours	2 Hours	4 Hours
2nd	40 Hours	25 Hours	9 Hours	2 Hours	2 Hours	2 Hours

5. LEARNING OUTCOME

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 OUTCOMES (TRADE SPECIFIC)

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 operation – marking, Hack-sawing, punching, Chiselling, Filing, Drilling, countersinking, counter boring, reaming, Taping etc. Accuracy: ± 0.25mm]*
2. Test various steps fit of components for assembling as per required tolerance. *[Step fit, required tolerance: ±0.04 mm]*
3. Set the Oxy-acetylene gas welding plant, set Oxy-acetylene flames & join metal components by edge joint observing safety precautions.
4. Select and ascertain measuring instrument and measure dimension of components and record data.
5. Set up apparatus, instrument and conduct experiments in Physics laboratory to determine physical quantity/constants and verify laws.
6. 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.
7. Plan, identify and perform different operations related to safety and Arc welding *[Different Operations – select and operate fire extinguisher, straight line beads, single V-butt joint].*
8. Set different shaped jobs on different chuck and demonstrate conventional lathe machine operation observing standard operation practice. *[Different operations: - plain turning, facing, step turning, through & step drilling].*
9. Plan, identify & perform different operation – Experiments related to safety & general awareness in chemical industries. (Diff. operations – Select & operate proper fire extinguisher as per demand, identify chemicals hazards, PPE'S, read & obtain relevant data).
10. Identify different types of tools in fitting workshop, Types of fasteners on locking devices, arranged & perform different operations in shop.(Operations – making key ways, scraping & lapping of surfaces.)
11. Identify and select lagging materials and apply same in accordance with job condition-hot/cold.

12. Apply range of skills to execute pipe joints, pipe fittings for assembling the line and test for leakages.
13. Identify, describe, install different types of flow meter, and carry out flow measurements & record readings. (Flow meter – Rota meter, Venturi- meter, Orifice meter)
14. Identify, select dial gauge, it's construction, parts, graduations, care & use for checking flatness of job.
15. Identify and install / connect instruments / devices to measure pressure, temperature, flow & level, record readings. (Instruments / Devices - bourden tube, capsule type gauge, mercury in glass, bimetallic thermometer, RTD, Orifice, venturimeter, Rotameter, sight glass type, Air purge type & capacitance type level indicator.

SECOND YEAR:

16. Carryout testing of different types of maintenance- Online, Predictive, Preventive and breakdown and frequent record keeping.
17. Plan, dismantle, trouble shoot, clean & reassemble different mechanical components for power transmission & check their functionality.
18. Identify leakage and replace or repair relevant gasket or gland packing.
19. Identify different types of valve, their specific application. Carry out overhauling procedure for different types of valve.
20. Plan, dismantle, trouble shoot, clean & reassemble different machine, pumps& components for transportation of liquid and check their functionality.
21. Verify and plot the graphs for characteristic curve of different types of pump such as centrifugal pump and gear pump.
22. Overhaul and troubleshooting of vacuum pump and checking for proper functioning.
23. Identify and Check functionality of Power Transmission Device, Belt, and Pulleys.
24. Plan and perform method of Alignment of pulley, shaft, motor, coupling by thread, straight edge and laser system.
25. Identify major function of mechanical seals, select and install the same on a pump shaft, discuss care and it's maintenance.
26. Identify Machinery handling and their installation as per standard procedure, it's planning & implementation.
27. Identify major parts and function of pressure vessel, various pipe fittings, valves, parameters, its care and safety precaution.
28. Plan, dismantle, trouble shoot, clean & reassemble different machine & components for transportation of Gases and check their functionality.
29. Plan, dismantle, trouble shoot, clean & reassemble Air dryers & Air filters.
30. Plan, dismantle, trouble shoot, clean scale formation & reassemble Electrode & Oil fired boiler and identify various operating parts.

31. Identify different types of refrigerant & it's uses in chemical industries and dismantle Air handling unit for cleaning and troubleshooting with due care and safety.
32. Plan, dismantle, trouble shoot, clean, overhaul & reassemble Hydraulic jack and check oil level for their functionality.
33. Identify, Plan, dismantle, trouble shoot, clean & reassemble different types of Heat exchangers and check functionality.
34. Plan, dismantle, troubleshoot, clean and reassemble components in different types of distillation column.
35. Identify different types of filtration unit and carry out its maintenance and trouble shooting.
36. Identify different types of Dryer used for loading wet material in tray dryer and carryout its maintenance, trouble shooting for checking proper functionality.
37. Identify term size reduction and operate size reduction machine (Hammer mill, Ball mill). Carry out size analysis with proper screening equipment's & their maintenance.
38. Identify different types of term mixing & agitation. Dismantle, troubleshoot, clean and maintenance of different mechanical components.
39. Identify Specification of different types of conveyor belts, construction details, materials used and carry out its operations, maintenance, troubleshooting.

6. ASSESSMENT CRITERIA

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

	Make components according to the specification for step fit using a range of practical skills and ensuring interchangeability of different parts.
	Assemble components applying a range of skills to ensure proper fit.
	Check functionality of components.
3. Set the Oxy-acetylene gas welding plant, set Oxy-acetylene flames & join metal components by edge joint observing safety precautions.	Identify different components/parts of Gas welding (oxy-acetylene)plant, collect desired information and set each components/parts as per standard procedure
	Observe safety/ precaution during operation.
	Plan and select the nozzle size, working pressure, type of flame, filler rod as per requirement.
	Prepare, set and tack the pieces as per drawing.
	Set up the tacked joint in specific position.
	Deposit the weld following proper welding technique and safety aspect.
	Carry out visual inspection to ascertain quality weld joint.
4. Select and ascertain measuring instrument and measure dimension of components and record data.	Calculate thickness of given object.
	Calculate least count& zero error.
	Calculate thickness of given object.
	Calculate least count& zero error.
	Record the data.
5. Set up apparatus, instrument and conduct experiments in Physics laboratory to determine physical quantity/constants and verify laws.	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 form the data recorded, if necessary
	Report conclusion /result with proper unit.
6. 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.	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.
7. Plan, identify and perform different operations related to safety and Arc welding [Different Operations – select and operate fire extinguisher, straight line beads, single V-butt joint].	Follow and maintain procedure to achieve safe working environment for occupational health hazard and safety regulation in arc-welding workshop.
	Identify different components / parts of arc-welding (SMAW) plant, collect necessary information and set the plant in accordance to standard procedure.
	Plan and select metal material / thickness to weld.
	Select proper size electrode / material.
	Perform necessary edge preparation for the job to be performed as per drawing/dimensions.
	After completion of electrical connections / voltage, strike an arc, and conduct welding as per drawing specifications.
	Slag removal operation.
	Carry out visual inspection to ascertain welding run quality.
8. Set different shaped jobs	Follow and maintenance the procedures to achieve safe

	on different chuck and demonstrate conventional lathe machine operation observing standard operation practice. *[Different operations: - plain turning, facing, step turning , through & step drilling].*	working environment with occupational health and safety hazards in machine workshop.
		Identification if lathe its parts mounting accessories.
		Overlook the assembly location with do consideration to operation stipulations.
		Carry out oiling at desired point at regular interval to achieve smooth touching of the unit.
		Read and interpret information drawing and apply in executing practical work.
		Perform chuck mounting as per the desired job practical.
		Select appropriate tools/instrument required for performing the job; ascertain its functionality and correctness.
		Plan for facing , plain and step turning operation , through and step drilling operation as per drawing and collect necessary information
		Perform for the desired job with maximum accuracy applying range of skills and standard operation procedures.
		Comply with the safety rule while performing the above operations.
9.	Plan, identify & perform different operation – Experiments related to safety & general awareness in chemical industries. (Diff. operations – Select & operate proper fire extinguisher as per demand, identify chemicals hazards, PPE'S, read & obtain relevant data).	Follow and maintain procedures to achieve safe working environment in line with occupational health and safety regulation and requirements.
		Recognize and report all unsafe situation according to the policy.
		Identify and take necessary precautions on fire and safety hazards.
		Identify, handle & store / dispose off dangerous, valuable substances.
		Identify and observe site policies and procedures in regard to illness or accident.
		Identify safety alarms accurately.
		Record if possible accident details correctly according to site accident /injury procedure.
		Identify and observe evacuation procedure according to site policy.
		Identify personnel protective equipments and use the same as per related working environment.

	Identify basic first aid and use them under different circumstances.
	Identify different fire extinguishers and use the same as per the requirements.
	Take opportunities to use energy and materials in an environmental friendly way.
	Avoid and dispose waste as per procedure.
10. Identify different types of tools in fitting workshop, Types of fasteners on locking devices, arranged & perform different operations in shop.(Operations – making key ways, scraping & lapping of surfaces.)	Plan& identify tools instruments and equipment for desired operation and make them available in a timely manner.
	Select raw materials and inspect visually for defect.
	Mark as per specification apply work and observe standard procedure.
	Measure dimension in accordance with standard specification and tolerance.
	Prepare job for marking, hack sawing, chiselling, filling, grinding, and scrapping.
	Perform operations to close tolerance as per specification to make the job.
	Observe safety procedure during above operation as per standard norm and company guidelines.
	Check for dimensional accuracy as per standards.
	Avoid waste, ascertain unused materials and components for disposal/ store them in an environmentally appropriate manner and prepare for disposal.
11. Identify and select lagging materials and apply same in accordance with job condition- hot/cold.	Plan and identify tools/instruments, material for the job and make this available for use in timely manner.
	Select the appropriate insulating material for the given job.
	Apply your skill for lagging of given pipeline & perform the necessary operations sequentially.
	Use appropriate locking devices.
	Use proper PPE's & comply with safety rules when performing the above operation.
	Use appropriate locking devices as per job.
	Avoid waste, ascertain unused material for disposal/store them in an environmentally proper manner.

12. Apply range of skills to execute pipe joints, pipe fittings for assembling the line and test for leakages.	Select & ascertain tools for the job & make them available for use in a timely manner.
	Identify different types of pipe joints.
	Plan mechanical operations to be performed on the surfaces for fitting the joints as per specifications.
	Plan for dismantle, repairs & assembly of mechanical components of different types of valves as per drawing & collect necessary information.
	Select the gasket material/thickness, as per specification/use for the required job. Similarly identify cutting tools for the job.
	Perform dismantling, checking for any defects and replacing of different components of given valve with accuracy, applying range of skills & standard operating procedure.
	Ascertain the gasket material of predetermined size, cut according to the job requirement as per standard procedure, check the dimensions accurately, check for functionality.
	Select proper locking device as per job. Use operational skills for its proper installation & check.
	Comply safety rules while performing all above mentioned operations.
	Assemble all components sequentially as per requirement of job.
	Check proper functioning of assembled parts.
	Avoid waste, unused material for disposal/ store.
13. Identify, describe, install different types of flow meter, and carry out flow measurements & record readings. (Flow meter – Rota meter, Venturi- meter, Orifice meter).	Ascertain and select tools and materials for the job and make this available for use in a timely manner.
	Connect/install the instrument to pipeline/manifold/storage tank.
	Check functionality of instrument/device.
	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.
14. Identify, select dial gauge, it's construction, parts,	Identify the instrument & collect desired information for operational purpose.

	graduations, care & use for checking flatness of job.	Mention different parts, their function, limitation & accuracy of the instrument.
		Set up an instrument & perform the experiment as per standard method.
		Plan for its use & necessary attachments if any for the given job.
		Record observation/reading & report conclusion.
		Comply with safe handling procedures while performing operations.
15.	Identify and install / connect instruments / devices to measure pressure, temperature, flow & level, record readings. (Instruments / Devices - bourden tube, capsule type gauge, mercury in glass, bimetallic thermometer, RTD, Orifice, venturimeter, Rotameter, sight glass type, Air purge type & capacitance type level indicator.	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.
	SECOND YEAR	
16.	Carryout testing of different types of maintenance- Online, Predictive, Preventive and break down and frequent record keeping.	Study maintenance procedure and familier with maintenance tools.
		Select and ascertain tools for maintenance and make this available for use in a timely manner.
		Overhauling workshop equipments
		Record maintaining in each history sheet
		Comply with safety rules when performing the above operations.
17.	Plan, dismantle, trouble shoot, clean & reassemble different mechanical components for power transmission & check their	Plan to dismantle, clean and assemble mechanical components used for power transmission as per drawing and collecting necessary information.
		Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and

functionality.	appropriate cleaning processes.
	Check for any damages to components/parts.
	Assemble the cleaned mechanical components observing standard procedure.
	Comply with safety rules when performing the above operations.
	Check for functionality of power transmission system or any assembly as per standard parameters.
18. Identify leakage and replace or repair relevant gasket or gland packing.	Identify leakage and prepared gasket.
	Lay out gasket dimension on gasket sheet
	Marking all dimensions and cutting with chisel
	Drill bolt hole on gasket using hollow punch with appropriate size.
	Refit this gasket in flange and properly tight nut bolt.
19. Identify different types of valve, their specific application. Carry out overhauling procedure for different types of valve.	Select and ascertain tools for the job and make this available for use in a timely manner.
	Plan to dismantle, repair and assemble mechanical components used for valve as per drawing and collecting necessary information.
	Perform dismantling, checking for any defects and replacing of different components with accuracy applying range of skills and standard operating procedure.
	Comply with safety rules when performing the above operations.
	Assemble different components.
	Check for functionality of part/components.
20. Plan, dismantle, trouble shoot, clean & reassemble different machine, pumps & components for transportation of liquid and check their functionality.	Plan to dismantle, repair and assemble mechanical components used for pumps per drawing and collecting necessary information.
	Perform dismantling, checking for any defects and replacing of different components with accuracy applying range of skills and standard operating procedure.
	Comply with safety rules when performing the above operations.
	Assemble different components.

	Check for functionality of part/components.
21. Verify and plot the graphs for characteristic curve of different types of pump such as centrifugal pump and gear pump.	Rechecks before starting centrifugal pump
	Priming should be done
	Start pump with SOP
	Take three times reading of developed discharge head and flow rate
	Prepared observation table and calculations.
	Plot Head vs. capacity graph.
	Stop centrifugal pump with SOP.
	Use proper PPE's and follow safety rules.
22. Overhaul and troubleshooting of vacuum pump and checking for proper functioning.	Plan to dismantle, clean and assemble vacuum pumps per drawing and collecting necessary information.
	Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
	Check for any damages to components/parts.
	Assemble the cleaned mechanical components observing standard procedure.
	Comply with safety rules when performing the above operations.
	Check for functionality of vacuum pump for producing high vacuum.
23. Identify and Check functionality of Power Transmission Device, Belt, Pulleys.	Plan to dismantle, clean and assemble mechanical components used for power transmission as per drawing and collecting necessary information.
	Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
	Check for any damages to components/parts.
	Assemble the cleaned mechanical components observing standard procedure.
	Comply with safety rules when performing the above operations.
	Check for functionality of power transmission system or any assembly as per standard parameters.

24. Plan and perform method of Alignment of pulley, shaft, motor, coupling by thread, straight edge, laser system.	Plan to alignment of compressor pulley.
	Perform alignment using plane thread.
	Adjust pulley as per alignment required.
	Check for proper functionality.
	Comply with safety rules when performing the above operations.
25. Identify major function of mechanical seals, select and install the same on a pump shaft with care and its maintenance.	Clean and inspect pump parts.
	Check assembly drawing prior to installation.
	Remove surface flange, end cover and impeller
	Remove gland nuts and gland flange.
	Orient position of spring locating collar and mark the same.
	Takeout mechanical seal components i.e. Carbon seal, seal cage, rubber seal, gland flange, slingers etc. Sequentially and note down the same.
	Inspect and clean all parts, check for any damages.
	Place back flange on shaft and fit the ceramic seal and rest of the assembly.
	Fit the spring retainer.
	Position the spring with its locking collar.
	Compress gland against stuffing box.
	Rotate shaft manually to ensure seal is not in bind.
	Inspect after bringing to the operating conditions.
26. Identify Machinery handling and their installation as per standard procedure, it's planning & implementation.	Lift the machine using crowbars.
	Place the wooden block under the load.
	Lower the load on the wooden block.
	Place suitable rollers under the load.
	Remove the wooden blocks from the bed.
	Check the route of the machine movement and ensure that it is free of obstruction.
	Push the machine forward slowly with the crowbars.
	Select suitable anti- vibration pads –depending upon the weight of the machine.
	Prepare foundation plan forgiven machine.
	Layout of foundation for given machine.
	Escalate soil for foundation.

	Prepare template for foundation.
	Prepare concrete for foundation.
	Fixing of foundation bolts.
27. Identify major parts and function of pressure vessel, various pipe fittings, valves, parameters, its care and safety precaution.	Study construction details, operating & working of pressure vessel.
	Plan to dismantle, clean and assemble mechanical components such as pipe fittings, valves, parameters and other attachments and collecting necessary information.
	Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
	Check for any damages to components/parts.
	Assemble the cleaned mechanical components observing standard procedure.
	Comply with safety rules when performing the above operations.
	Check for functionality as per standard parameters.
28. Plan, dismantle, trouble shoot, clean & reassemble different machine & components for transportation of Gases and check their functionality.	Plan to dismantle, clean and reassemble compressor as per drawing and collecting necessary information.
	Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
	Check for any damages to components/parts.
	Resemble the cleaned mechanical components observing standard procedure.
	Comply with safety rules when performing the above operations.
	Check for functionality of compressor.
	Check developed pressure as per slandered.
29. Plan, dismantle, trouble shoot, clean & reassemble Air dryers & Air filters.	Plan to dismantle, clean and assemble air filter and air dryer as per drawing and collecting necessary information.
	Perform dismantling and appropriate cleaning of air filter and air dryer with accuracy applying range of skills and appropriate cleaning processes.
	Check for any damages to components/parts.

	Replace filter and if necessary.
	Assemble the cleaned mechanical components observing standard procedure.
	Comply with safety rules when performing the above operations.
	Check filter and air dryer.
30. Plan, dismantle, trouble shoot, clean scale formation & reassemble Electrode &Oil fired boiler and identify various operating parts.	Study term steam generation. Construction, operating & working.
	Plan to dismantle, clean and assemble electrode boileras per drawing and collecting necessary information.
	Perform dismantling and cleaning of scale formation with accuracy applying range of skills and appropriate cleaning processes.
	Check for any damages to components/parts.
	Replace or repair if necessary.
	Assemble the cleaned mechanical components observing standard procedure.
	Check for functionality of steam generation system.
	Comply with safety rules when performing the above operations.
31. Identify different types of refrigerant &it's uses in chemical industries and dismantle Air handling unit for cleaning and troubleshooting with due care and safety.	Study the refrigeration system and it's industrial utilization.
	Plan to dismantle, clean and reassemble refrigeration unit collecting necessary information.
	Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
	Check for any damages to components/parts.
	Replace or repair if necessary.
	Assemble the cleaned mechanical components observing standard procedure.
	Check for functionality of refrigeration system as per standard parameters.
	Comply with safety rules when performing the above operations.
32. Plan, dismantle, trouble	Plan to dismantle, clean and reassemble hydraulic jack as per

shoot, clean, overhaul & reassemble Hydraulic jack and check oil level for their functionality.	drawing and collecting necessary information.
	Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
	Check for any damages to components/parts.
	Check oil grade and oil level.
	Resemble the cleaned mechanical components observing standard procedure.
	Comply with safety rules when performing the above operations.
	Check for functionality of hydraulic jack.
33. Identify, Plan, dismantle, trouble shoot, clean &reassemble different types of Heat exchangers and check functionality.	Study different mode of heat transfer.
	Study utilization of heat transfer equipments in industries.
	Plan to dismantle, clean and reassemble compressor as per drawing and collecting necessary information.
	Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
	Check for any damages to components/parts.
	Resemble the cleaned mechanical components observing standard procedure.
	Comply with safety rules when performing the above operations.
	Check for functionality of heat exchanger.
34. Plan, dismantle, troubleshoot, clean and reassemble components in different types of distillation column.	Study term distillation and it's method.
	Plan to dismantle, clean and reassemble column as per drawing and collecting necessary information.
	Use appropriate PPE'S as required.
	Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
	Check for any damages to components/parts.
	Clean packings, replace damage packing's if necessary.
	Resemble the cleaned mechanical components observing standard procedure.
	Comply with safety rules when performing the above

	operations.
	Check for functionality of distillation column.
35. Identify different types of filtration unit and carry out its maintenance and trouble shooting.	Study about various separation techniques.
	Plan to clean filtration unit before operating.
	Use appropriate PPE'S as required.
	Prepared slurry and perform filtration.
	Plan to dismantle, clean and reassemble filtration unit as per drawing and collecting necessary information.
	Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
	Check for any damages to components/parts.
	Clean filtration bag & check integrity.
	Resemble the cleaned mechanical components observing standard procedure.
	Comply with safety rules when performing the above operations.
	Check for functionality of power transmission system or any assembly as per standard parameters.
36. Identify different types of Dryer used for loading wet material in tray dryer and carryout its maintenance, trouble shooting for checking proper functionality.	Housekeeping & Equipment cleaning as per SOP.
	Take empty running of tray dryer for checking proper functionality.
	Make preparation for loading wet material in tray dryer.
	Load the wet material in the tray proportionally.
	Start air drying as per PDS.
	Start heating after air drying.
	Sample out for checking moisture balance as per sampling plan.
	After completion of drying unload, the dried material in clean polybags and pack material as per packing SOP.
	Use PPE'S while working on try dryer.
37. Identify term size reduction and operate size reduction machine (Hammer mill, Ball mill).	Study term size reduction, operation &it's working.
	Study utilization of size reduction & screening equipment in chemical industries.

	Carry out size analysis with proper screening equipment's & their maintenance.	Plan to dismantle, clean and reassemble hammer mill & Vibratory sieve shaker.
		Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
		Check for any damages to components/parts.
		Reassemble the cleaned mechanical components observing standard procedure.
		Comply with safety rules when performing the above operations.
		Take empty running for checking functionality of Hammer mill & Vibratory sieve shaker.
		Use appropriate PPE'S as required.
38.	Identify different types of term mixing & agitation. Dismantle, troubleshoot, clean and maintenance of different mechanical components.	Study term mixing &agitation, operation&it's working.
		Study utilization of mixing & agitation in chemical industries.
		Plan to dismantle, clean and reassemble mixing & agitation
		Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
		Check for any damages to components/parts.
		Reassemble the cleaned mechanical components observing standard procedure.
		Comply with safety rules when performing the above operations.
		Take empty running for checking functionality of mixing &agitation.
		Use appropriate PPE'S as required.
39.	Identify Specification of different types of conveyor belts, construction details, materials used and carry out its operations, maintenance, troubleshooting.	Plan to dismantle, clean and reassemble belt conveyor as per drawing and collecting necessary information.
		Perform dismantling and appropriate cleaning of mechanical components with accuracy applying range of skills and appropriate cleaning processes.
		Check for any damages to components/parts.
		Check integrity of belt.
		Resemble the cleaned mechanical components observing

	standard procedure.
	Comply with safety rules when performing the above operations.
	Check for functionality of power transmission system or any assembly as per standard parameters.

7. TRADE SYLLABUS

SYLLABUS FOR MAINTENANCE MECHANIC (CHEMICAL PLANT) TRADE			
FIRST YEAR			
Duration	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
Professional Skill 100 Hrs; Professional Knowledge 28 Hrs	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: ± 0.25mm]*	1. Importance of trade training, List of tools & Machinery used in the trade. (02 hrs) 2. Safety attitude development of the trainee by explaining importance of safety. (05 hrs) 3. Identify various PPEs. (03 hrs) 4. Demonstrate the correct use of appropriate PPE.(05 hrs) 5. First aid methods and basic training. (03 hrs) 6. Safety sign/slogan for Danger. (03 hrs) 7. Safe use of tools and equipment used in the trade. (04 hrs)	• All necessary guidance to be provided to the new comers to become familiar with the working of Industrial Training Institute system including stores procedures. • Introduction about ITI Rules and Regulation. Importance of trade training. SAFETY: • Introduction &Importance of safety, general precautions about safety. PPEs and safety equipment used in chemical industries. Safety slogan. • First aid in workshop &chemical industry. (07 hrs.)
		8. Practice and understand precautions to be followed while working in fitting workshop. (04 hrs) 9. Marking on the job as per drawing with using scriber. (04 hrs) 10. Hold the job in a bench vice	BASIC FITTING: • Safety precautions to be followed in fitting workshop. • Description, construction and uses different • Hand tools - files, chisels, hacksaw & hammer etc.,

		for cutting. (03hrs) 11. Hacksawing over marking (04 hrs) 12. Hold the job in a bench vice horizontally for filing.(03hrs) 13. Select flat files of various grades and length according to a) Size of the job b) Quantity of metal to be removed. c) Material of the job.(06hrs) 14. File flat surface (12hrs) 15. Check & correct the flatness of the filed surface with the blade of try square.(07hrs) 16. Check & correct the squareness of adjacent surfaces (07hrs)	their uses. • Measuring tools - steel rule, caliper, try square • Marking tools - scriber, punches, scribing block combination set etc. (14 hrs.)
		17. File two adjacent sides flat and square.(08 hrs) 18. Apply marking medium on the surface to be marked. (01 hr) 19. Marking dimensions as per drawing (01 hr) 20. File all the other sides to size.(07 hrs) 21. Check flatness & squareness using try square.(01 hr) 22. Check dimensions using outside calliper.(01 hr) 23. Check dimensions with a steel rule.(01 hr) 24. Mark parallel lines using a	**JOB HOLDING DEVICES:** • Description, construction and uses of different job holding devices such as vice, V' Block with clamp etc. • Types of Vice – Bench vice, leg vice, pipe vice, pin vice etc. (07 hrs.)

		jenny calliper & scriber.(02 hrs) 25. Mark curves & circles by jenny calliper & divider.(01 hr) 26. Punch the centre of circle with centre punch and ball peen hammer. (02 hrs)	
Professional Skill 50 Hrs; Professional Knowledge 14 Hrs	Test various steps fit of components for assembling as per required tolerance. [Step fit, required tolerance: ±0.04 mm]	27. Check the raw material size as per drawing (01 hr) 28. Marking on the job as per drawing with using scriber (02 hrs) 29. Hacksawing over marking (04 hrs) 30. Hold the job in a bench vice for filing.(01 hr) 31. File two adjacent sides at right angles to each other. (12hrs) 32. File two reference surfaces flat &square.(09hrs) 33. Mark & punch the job as per drawing (Both 'A' & 'B'). (03hrs) 34. Separate the part 'A' & 'B' by sawing or drilling.(06hrs) 35. File & finish part 'A' & 'B'. (06hrs) 36. Check & correct dimensions and then assemble two parts.(06hrs)	Linear Measuring Instruments • Description, construction, calculation and uses. • Vernier Calliper, Vernier Depth gauge, Height gauge, Outside Micrometre, Bevel protector. (14 hrs.)
Professional Skill 50 Hrs; Professional Knowledge	Plan and organize the work to make job as per specification applying different types of basic fitting operations and Check	37. File surface flat & parallel within an accuracy. (08 hrs) 38. Mark/locate drilling positions.(01 hr) 39. Prick and centre punch hole locations.(02 hrs)	• Drilling, Countersinking, counter boring. Reaming and tapping. • Description, Nomenclature and uses of Drill, Reamer etc.

14 Hrs	for dimensional accuracy. *[Basic fitting operation – marking, Hack-sawing, punching, Chiselling, Filing, Drilling, countersinking, counterboring, reaming, Taping etc. Accuracy: ± 0.25mm*	40. Centre drill each hole location using appropriate standard centre drills. (05 hrs) 41. Countersink holes to match standard screw heads.(03 hrs) 42. Counter bore holes as per drawing. (03 hrs) 43. Ream the holes to a size by hand-reamer.(02 hrs) 44. Check the reamed holes for their dimensional accuracy with the help of standard cylindrical pins. (01 hr)	(07 hrs.)
		45. Check the given raw material for its size. (01 hr) 46. File and finish the given material to given size.(12 hrs) 47. Determine the tap drill size.(02 hrs) 48. Drill the hole to the required tap drill size.(05 hrs) 49. Cut the threads with the set of taps. (05 hrs)	• Introduction about threading. • Description, nomenclature and uses of different types of threads – metric, BSW, BSF, and BSP etc. • Calculation of tap drill size. (07 hrs.)
Professional Skill 25Hrs; Professional Knowledge 07Hrs	Set the Oxy-acetylene gas welding plant, set Oxy-acetylene flames & join metal components by edge joint observing safety precautions.	50. Demonstration about Safety precautions to be observed in welding workshop. (02 hrs) 51. Demonstration about safety equipment used in Gas welding. (03 hrs) 52. Demonstration about safety equipments& general precaution in welding workshop. (05hrs) 53. Setting up of oxy-acetylene	Gas Welding Safety: • Safety & General precautions observed in welding workshop. • Importance of Welding in maintenance of chemical plant and equipment. • Welding terms and their definition. • Types of welding. (07 Hrs)

		plant. (05 hrs) 54. Setting of oxy-acetylene flames (Neutral, oxidizing, carburizing). (03 hrs) 55. Fusion run without & with filler rod. (05hrs) 56. Edge Joint without & with filler rod.(02 hrs)	
Professional Skill 25 Hrs; Professional Knowledge 07 Hrs	Select and ascertain measuring instrument and measure dimension of components and record data.	<u>Vernier caliper</u> 57. Calculate least count& zero error. (05 hrs) 58. Calculate thickness of given object. (08 hrs) <u>Outside Micrometer</u> 59. Calculate least count& zero error. (05 hrs) 60. Calculate thickness of given object. (07 hrs)	Basic physics • Introduction about physics. • Measurement using Vernier calliper and micrometer.(07 hrs)
Professional Skill 125 Hrs; Professional Knowledge 35Hrs	Set up apparatus, instrument and conduct experiments in Physics laboratory to determine physical quantity/constants and verify laws.	<u>Simple pendulum</u> 61. Measure diameter of bob with the help of Vernier calliper. (02 hrs) 62. Find the length of Pendulum. (02 hrs) 63. Record time for 20 oscillations. (04 hrs) 64. Tabulate all readings.(02 hrs) 65. Calculate acceleration due to gravity(g). (02 hrs) 66. Plot the graph of L & T^2. (02 hrs) <u>Law of parallelogram of forces</u>	• Introduction about physics. • Define scaler and vector quantities, their representation, resultant and use. • Laws of oscillations, parallelogram. (07 hrs.)

		67. Attach two pulleys to the mechanical board fixed to the wall as shown in figure.(02 hrs) 68. Fix drawing sheet to the board with pins.(02 hrs) 69. Apply two forces to the pulley by hanging a mass of 100 & 200 grams.(03 hrs) 70. Find resultant force by completing parallelogram and drawing diagonal.(02 hrs) 71. Calculate resultant by formula. (02 hrs)	
		<u>Inclined plane</u> 72. Weigh separately the roller/wooden block and the pan with balance.(02 hrs) 73. Generate angle of inclination of inclined plane.(30^0, 40^0, 50^0,60^0). (03 hrs) 74. Find weights for upward and downward motion of roller for different inclination of plane.(06 hrs) 75. Plot graph (should be straight line). (02 hrs) <u>Screw Jack</u> 76. Find pitch of screw jack.(02 hrs) 77. Put load on the jack and start applying efforts gradually.(05 hrs) 78. Record the observations as the load just moves.(03	Friction • Definition, units and type of friction. • Advantages and disadvantages of friction. • Definition of simple machine. • Types – Screw jack, Lever etc. • Definition – mechanical advantage, percentage velocity ratio, efficiency etc. (07 hrs.)

		hrs) 79. Calculate Mechanical Advantage, velocity. (02 hrs)	
		<u>Young's Modulus</u> 80. Measure Length of wire with meter scale and diameter of wire with screw gauge.(05 hrs) 81. Calculate least count of micrometer.(04 hrs) 82. Start applying weights gradually to hanger by 500 grams (loading) and then removing weights gradually by 500 grams (unloading). (12 hrs) 83. Record the readings for loading and unloading. (02 hrs) 84. Calculate Young's Modulus for wire.(02 hrs)	Elasticity • Definition – Elasticity, stress, strain, elastic limit. • Law – Young's modulus of elasticity. (07 hrs.)
		<u>Ohm's law</u> 85. Arrange the apparatus as per the circuit diagram.(02hrs) 86. Adjust the rheostat to get small deflection in ammeter and voltmeter. (02hrs) 87. Record the readings of ammeter and voltmeter. Take at least six sets of readings.(04hrs) 88. Connect two resistances in series & record readings. (02hrs) 89. Connect two resistances in	Electricity • Introduction about electricity. • Unit of current & voltage • Ohm's law. • Set up of electric cell using series and parallel connections. Electrolysis • Definition of electrolysis. • Faraday's first law • Electroplating • Definition of electrolytic and non-electrolytic solutions. (07 hrs.)

		parallel & record readings. (02hrs) 90. Calculate and prove the ohm's law. (02 hrs) <u>Faraday's first law</u> 91. Prepare copper sulphate solution. (02hrs) 92. Weigh copper electrodes & record their masses. (01 hrs) 93. Connect the electrodes to a cell and ammeter as shown in fig.(04hrs) 94. Pass a steady current for definite time &record.(02 hrs) 95. Calculate electrochemical equivalent of copper.(01 hr) 96. Find out electrolytic property of solution.(01 hr)	
		<u>Coefficient of expansion of solid</u> 97. 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) 98. Fill the steam generator two-thirds full of water and turn it on. (01 hr) 99. Place thermometer in the opening provided. (01 hr) 100. Allow the steam to flow	• Modes of heat transfer – conduction, convection and radiation. • Determination of thermal conductivity. • Temperature &expansion of solid, liquid. • Coefficient of linear and cubical expansion. (07 hrs.)

		through the jacket of apparatus until a steady temperature is reached. (02 hrs) 101. Record the final temperature and spherometer reading. Find coefficient of expansion of rod. (02 hrs) <u>Coefficient of expansion of liquid</u> 102. Weigh empty specific gravity bottle, fill it with water and weigh it again. (02 hrs) 103. Record the initial temperature of water.(01 hrs) 104. Heat the liquid and container (specific gravity bottle) & observe the increase in level of liquid. (02hrs) 105. Calculate coefficient of expansion of liquid. (02 hrs) <u>Thermal conductivity of metal rod</u> 106. Measure the diameter of copper rod using Vernier calliper. Measure the distance (d) between two thermometers. (02 hrs) 107. Place the rod in Searle's apparatus. Place thermometers in the holes provided. (01 hr) 108. Pass the steam through	

		the steam chamber and water through a copper tube surrounded to the other end of the bar.(03 hrs) 109. Record the water flow rate, steady temperatures and time for collecting water. (02 hrs) 110. Calculate the thermal conductivity. (02 hrs)	
Professional Skill 100 Hrs; Professional Knowledge 28Hrs	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.	<u>Simple distillation by laboratory method</u> 111. Take about 100 ml salty water in distillation flask and arrange expt. Setup as shown in fig. (02 hrs) 112. Heat the water till it vaporizes. (02 hrs) 113. Collect purified water. (01 hr) 114. Record observations and result. (01 hr) <u>Preparation of standard solutions</u> 115. Calculate the equivalent weight of HCl, H_2SO_4, NaOH, (02 hrs) 116. Record the identification code, % composition for above chemicals from reagent bottle. (01 hr) 117. Calculate the normality of chemicals using % composition & from that calculate how many millilitresof concentrated acid/base to make	Chemistry • Introduction to Chemistry, branches of chemistry. Importance of chemistry. • Safety precautions to be taken in Chemistry Laboratory. • Different equipment and apparatus used in Chemistry Laboratory. • Acids, bases and salts-their properties and uses. • Element, atom and molecule. • Definition - Compound, mixture, Physical change, chemical change, Molecular weight, equivalent weight, atomic weight, Normality, molarity and molality. • Volumetric analysis-titrimetric analysis-determination of the amount of substance in solution. Detection of end

		predetermined quantity. (02 hrs) 118. Follow the procedure for the preparation of standard solution. (02 hrs) <u>Titration- HCl- NaOH</u> 119. Prepare standard solution of Hydrochloric acid. (02 hrs) 120. Titrate standard solution of HCl against NaOH using Phenolphthalein indicator. (02 hrs) 121. Repeat titration three times to obtain mean burette reading and record observations. (01 hr) 122. Find Normality & strength of NaOH. (01 hr) <u>Titration – HCl- Na_2CO_3</u> 123. Prepare standard solution of Sodium Carbonate. (02 hrs) 124. Titrate standard solution of HCl against Na_2CO_3 using methyl orange indicator. (02 hrs) 125. Repeat titration three times to obtain mean burette reading and record observations. (01 hr) 126. Find Normality & strength of HCl. (01hr)	point. • Types of Titrimetric analysis.(07 hrs.)
		<u>Allotropic forms of sulphur</u> 127. Prepare monoclinic	Atomic structure • Electrons, protons, neutrons.

		sulphur using filter paper, funnel test tube, spatula, Bunsen burner by melting sulphur and then filtering it to form crystals. Record observations. (03 hrs) 128. Prepare amorphous crystal sulphur and rhombic sulphur following procedure, and record observations. (08 hrs) <u>Properties of mixture and compound</u> 129. Prepare mixture of iron and sulphur. (02 hrs) 130. Prepare compound iron sulphide by heating the mixture. (03 hrs) 131. Perform tests mentioned and record observations. (05 hrs) 132. Compare properties of iron sulphide with mixture of iron and sulphur. (04 hrs)	• Electronic theory of valence. • Classification of elements, • Modern periodic law, periodictable, Groups, periods, periodic properties Allotropy • Allotropy of hydrogen, carbon, phosphorus and sulphur. • Allotropic forms of sulphur –monoclinic, amorphous and rhombic sulphur.(07 hrs.)
		<u>Action of pure and salt water on metals</u> 133. Take pure and salt water separately in two beakers. Take six iron nails and shine them to expose their surfaces. (02 hrs) 134. Place three of them into the beaker containing pure water and place another three nails into salt water for several hours. (02 hrs)	Water • Sources, hard and soft water, causes and removal of hardness, • water for industrial purposes. • Corrosion- causes, effects and prevention. • Introduction to Effluent treatment plant (ETP) (07 hrs.)

		135. Record the observations. (01hr) <u>Action of acid and base on metals</u> 136. Take Hydrochloric acid and sodium Hydroxide separately. (01 hr) 137. Take six iron nails and shine them to expose their surfaces.(01 hrs) 138. Place three of them into the beaker containing acid and place another three nails into salt base for several hours. (02 hrs) 139. Perform tests mentioned and record observations. (04 hrs) <u>Laboratory preparation Soap</u> 140. Weigh chemicals accurately- caustic soda, vegetable oil. (02 hrs) 141. Add caustic to water in a beaker and stir it to dissolve. Cool the solution. (01 hr) 142. Gradually add vegetable oil to the solution with stirring. (02 hrs) 143. Cool the solution till solid form of soap is obtained. Record observations. (02 hrs) <u>Laboratory preparation copper sulphate</u> 144. Take dilute sulphuric acid in a beaker, add few	

		grams of cupric oxide and stir well. (02 hrs) 145. Let the solid be added in excess. Wait till the effervescence is over. (01 hr) 146. Filter the solution; evaporate the filtrate slowly and carefully. Blue colored copper sulphate crystals are obtained. (02 hrs)	
		<u>Determination of pH</u> 147. Prepare solutions (acidic, basic, neutral) (02 hrs) 148. Calibrate PH meter with buffer solutions. (03 hrs) 149. Dip electrode in each solution and record pH of given solution. (02 hrs) <u>Boiling point determination</u> 150. 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) 151. Introduce the tube into boiling point apparatus in inverted fashion near the bulb of thermometer. (02 hrs) 152. Heat the apparatus and note down the boiling point when bubble enlarges and moves in upward direction. (05 hrs)	Organic chemistry • Definition of pH, pH scale, measurement of pH • Introduction, purification processes, organic reactions- substitution, addition, Elimination, rearrangement reactions, examples. • Nomenclature-Basic rules for Common name &IUPAC name system for alkenes, alkenes &alkynes, their examples. • Boiling point and melting point of organic compounds. (07 hrs.)

		Melting point determination 153. 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) 154. Suspend the thermometer in the Thieles tube containing paraffin liquid. (02 hrs) 155. Heat the Apparatus uniformly from its side arm carefully and record temperature as the substance melts. (5 hrs)	
Professional Skill 100 Hrs; Professional Knowledge 28Hrs	Plan, identify and perform different operations related to safety and Arc welding *[Different Operations – select and operate fire extinguisher, straight line beads, single V-butt joint]*	156. Importance of trade training tools & machineries required. (05 hrs) 157. General house-keeping & good shop floor practices. (03 hrs) 158. Development of safety attitude by demonstrating its importance. (02 hrs) 159. Demonstrate safety equipment's & their applications. (05 hrs) 160. Demonstrate firefighting equipment's & their use. (05 hrs) 161. Safe way of using tools & equipment's used in the trade. (01 hrs) 162. Environmental guidelines	Arc Welding • Importance and discipline in arc welding workshop, application in various industries. • Description and application of safety equipment's, toxic fumes, light intensity, ventilation and housekeeping. Environmental hazard, waste management, types of fire and fire extinguishers. • Safety before, during and after are welding operation. (07 hrs.)

		(02 hrs) 163. Disposal of waste. (02 hrs)	
		164. Apply coating & perform marking on job as per drawing. (06 hrs) 165. Carry out punching operation (04 hrs) 166. Hold the job in vice & perform hack-sawing operation as per drawing. (07 hrs) 167. Illustrate electrode coating & their function. (04 hrs) 168. Illustrate function of welding transformer. (04 hrs)	• Precision measuring instruments- verniercaliper, micrometer. • Introduction and definition of welding, Tools and machinery required. • Types of transformer single phase, three phase, step up, step down transformer. • Basic electricity applicable, related electrical terms and definitions. (07 hrs.)
		169. Prepare job to be welded as per given specification. (06 hrs) 170. Perform clamping &grounding operation. (02 hrs) 171. Set- up an arc welding machine. (02 hrs) 172. Strike an arc on the job 173. Straight line bed on MS flat in flat position. (02 hrs) 174. Prepare job for single ' V ' butt joint in flat position. (06 hrs) 175. Perform clamping & grounding. (02 hrs) 176. Strike an arc. (02 hrs) 177. Clean weld with chipping hammer. (03 hrs)	• Heat, temperature and terms related to welding. • Principle and characteristic of arc welding. • Arc length, types, effects of arc length. • Types of welding joints, welding positions, symbols. • Selection of electrode. (07 hrs.)
		178. Prepare job for fillet lap	• Welding detects, causes

		joint as per the drawing. (06 hrs) 179. Take welding run & complete the job. (02 hrs) 180. Prepare job for ' T' joint on MS plate in horizontal position as given. (06 hrs) 181. Take welding run & perform the job. (02 hrs) 182. Clean the welding area with suitable tool. (03 hrs) 183. Shut down the plant. (03 hrs) 184. Put accessories in place. (03 hrs)	and their remedies. • Storage and baking of electrode. • Types of cracks. (07 hrs.)
Professional Skill 100 Hrs; Professional Knowledge 28Hrs	Set different shaped jobs on different chuck and demonstrate conventional lathe machine operation observing standard operation practice. *[Different operations: - plain turning, facing, step turning, through & step drilling].*	185. Enlist tools & machinery required. (06 hrs) 186. Safe shop floor practices& safety. (04 hrs) 187. Personal protective equipment's & their uses. (04 hrs) 188. Mention preventive measures for electrical accidents &steps to be taken. (02 hrs) 189. Operate the given fire extinguisher. (06 hrs) 190. Mention health& environmental guidelines. (03 hrs)	Turning • Safety precautions in industry and shop floor. • Description of parts of lathe and its accessories. PPE's, their application, study of different fire extinguishers, electrical accidents. Their causes, prevention. • First aid, • Definition of machine-tools and its classification. • History and gradual development of lathe. (07 hrs.)
		191. Inspect the given job for rusting, scaling, corrosion. (01 hr) 192. Practice on hammering, chipping & chisel grinding. (02 hrs) 193. Use of precision measuring instruments.	• Method on using precision measuring instruments, verniercalliper, micrometer depth gauges, sine bars, graduations, reading least count. • Brief description of

		(02 hrs) 194. Identify different components of lathe. (02 hrs) 195. Identify lever positions. (02 hrs) 196. Perform lubrication at various lubricating point. (06 hrs) 197. Cut a round bar in power saw (06 hrs) 198. Mount the check on machine spindle & unload. (04 hrs)	different types of hand tools hammers. • Chisel-material, types and their uses. Study of marking tools, outside, inside callipers, center punch, prick punch, scriber types and uses. Chucks their types, uses, methods, of jobholding in chuck. • Lubrications and maintenance of lathe, lubrications points. • Vice- types and uses classification of lathe in function and construction of different parts of lathe. (07 hrs.)
		199. Identify cutting tools & angles. (01 hr) 200. Hold the job in three jaw chuck. (02 hrs) 201. Perform trueing operation on the given job. (04 hrs) 202. Perform facing operation on job to correct length. (06 hrs) 203. Carryout plain turning operation on job as per drawing specifications. (06 hrs) 204. Perform step turning operation on job as per specification. (06 hrs)	• Lathe cutting tools- different types, shapes and different angles. • Lathe accessories- brief description of Centre, mandrel, catch plate, face plate. • Different operations- performed on lathe-facing, plain turning step turning etc. (07 hrs.)
		205. Identify drill bits. (02 hrs) 206. Draw any drill bit & name its various parts. (04 hrs)	• Parts of drills-name and their function, tang, shank, etc.

		207. Prepare MS flat as per the specification. (04 hrs) 208. Coat the given job. (02 hrs) 209. Perform marking &punching on the job. (04 hrs) 210. Select drill bit. (02 hrs) 211. Perform through drilling on the job. (06 hrs) 212. Remove drill bit & job and place in position. (01 hr)	• Cutting angle of drills. • Types and sizes of drill, their specification. • Cutting angles of drill clearance angle, rake angle.(07 hrs.)
Professional Skill 50 Hrs; Professional Knowledge 14 Hrs	Plan, identify & perform different operation – Experiments related to safety & gen. awareness in chemical industries. (Diff. operations – Select &operate proper fire extinguisher as per demand, identify chemicals hazards, PPE'S , read & obtain relevant data).	213. Importance of trade in industry. (05 hrs) 214. Importance of PPE's. (04 hrs) 215. Safety signs for danger. (04 hrs) 216. Illustrate basic first aid. (04 hrs) 217. Practice on maintenance documentation. (04 hrs) 218. Prepare MSDS of common chemicals used in chemical industries. (04 hrs)	Maintenance • Role of maintenance mechanic in chemical industries. • General safety in industry. • Study of PPE's and safety equipment, their application. • Work permit system • Material safety data sheet (MSDS). • Standard operating procedures. (SOP) (07 hrs.)
		219. Types of fire & fire extinguishers. (02 hrs) 220. Demonstration about fire extinguisher. (03 hrs) 221. Demonstration Fire fighting. (03 hrs) 222. Demonstration about Fire & smock alarm system. (02 hrs) 223. Disposal of workshop waste material like cotton waste, chips. (05 hrs)	• Fires-their types, prevention and control. • Fire triangle. • Classification of fire. • Fire fighting equipments – Fire extinguisher, fire bucket, fire blanket, Hydrant system. • Fire-alarm, smoke, fume. • Environmental pollution. • Types of pollution-noise, water air, their resources

		224. Housekeeping &workshop cleaning. (05 hrs) 225. Show PPT on pollution control and 5's concept. (05 hrs)	and control, permissible limits. • Importance of good shop practices ISO standards. • Introduction of 5s, concept of their application. (07 hrs.)
Professional Skill 100Hrs; Professional Knowledge 28 Hrs	Identify different types of tools in fitting workshop, Types of fasteners on locking devices, arranged & perform different operations in shop. (Operations – making key ways, scraping & lapping of surfaces.)	226. Identify various fitting tools. (04 hrs) 227. Identify precision measuring instruments. (04 hrs) 228. Measure depth of the given opening with suitable instrument. (04 hrs) 229. Perform calculations. (04 hrs) 230. Identify files. (02 hrs) 231. Draw parallel line on the job with odd leg calliper. (04 hrs) 232. Check level of the machine with spirit level. (03 hrs)	• Description & application of different fitting workshop tools-files, chisel, punch, scribers, callipers, etc. their specifications & use. • Methods of measurement, with spirit levels • Marking block, scribers, micrometers.(07 hrs.)
		233. Identify locking devices. (02 hrs) 234. Perform positive locking with castle nut & split-pin. (08 hrs) 235. Name different types of washers. (02 hrs) 236. Prepare inside square fit. (10 hrs) 237. Demonstrate sequence of operation. (03 hrs)	• Fasteners & locking devices- their types, uses &importance. • Definition of limits, fits & tolerance. • Terminology of limits & fits, their basic size Actual size & deviation. (07 hrs.)
		238. Identify types of chisels. (02 hrs) 239. Nam parts of chisels. (02	• Brief description of different type of keys. • Tappers & allowable

		hrs) 240. Select shaft for preparing key-way. (02 hrs) 241. Select chisel for preparing key way as per specification. (03 hrs) 242. Clamp the job. (05 hrs) 243. Perform chipping operation. (08 hrs) 244. Mention safety taken. (03 hrs)	clearance. • Proportion of key depending upon shaft dia. • Repairing of key ways. (07 hrs.)
		245. Mention types of scrapers& their application. (03 hrs) 246. Select a scraper. (02 hrs) 247. Prepare better mating parts for given bush bearing. (05 hrs) 248. Clean the surfaces. (03 hrs) 249. Check the lapping plate for any foreign material. (02 hrs) 250. Select abrasive. (03 hrs) 251. Perform hand lapping on given flat job. (05 hrs) 252. Care while lapping operation and cleaning surfaces. (02 hrs)	• Description & application of scrapper method of using them • Types of scrappers flat, triangular etc. • Testing the scrapped surfaces, maintain seq. of operation. • Lapping – necessary importance, types of abrasives. • Lapping methods and tools for external, internal and flat surface. (07 hrs.)
Professional Skill 25 Hrs; Professional Knowledge 07 Hrs	Identify & select lagging materials and apply same in accordance with job condition – hot / cold.	253. Cut thermocol sheet of required length. (04 hrs) 254. Insulate given cold pipeline with thermocol. (05 hrs) 255. Retain sheet in position by clamping. (02 hrs) 256. Take required quantity of glass wool. (02 hrs) 257. Insulate hot pipe line. (05	• Lining-importance, necessity required. • Radiation hazards. Corrosion and thermal insulators. • Brief description and application of lead, rubber, FRP and glass lining. • Lagging materials their importance and type of

		hrs) 258. Cut the tin sheet (02 hrs) 259. Coat the glass wool. (03 hrs) 260. Put screws to retain the tin sheet in position. (02 hrs)	application. (07 hrs.)
Professional Skill 50 Hrs; Professional Knowledge 14 Hrs	Apply range of skills to execute pipe joints, pipe fittings for assembling the line and test for leakages. -	261. Differentiate different pipe joints. (04 hrs) 262. Selects tools required for flanged joint. (02 hrs) 263. Choose suitable gasket sheet. (02 hrs) 264. Cut gasket sheet of required size. (04 hrs) 265. Prepare screwed joint for the pipe line. (06 hrs) 266. Select dia.-die stokes. (02 hrs) 267. Perform threading operation on given pipe line. (04 hrs) 268. State precautions. (01 hr)	• Pipes- knowledge of different pipe materials their specification. • Brief description of different type of pipe joints such as screwed joint, flanged joints etc. • Standard pipe threads, BSP. (07 hrs.)
		269. Identify pipe fittings. (04 hrs) 270. Install given pipe fitting and assemble the pipe line. (06 hrs) 271. Close one end of the pipeline with appropriate pipe fitting. (04 hrs) 272. Cut the gasket as per flange size. (08 hrs) 273. Prepare blind flange on pipeline. (03 hrs)	• Fluid mechanics- definition and types of fluid. • Compressible and incompressible • Knowledge of different types of pipe fittings –Tee, bend, elbow, etc. • Specification of pipe fittings and their applications. • Material of construction, • Gasket-types, uses. (07 hrs.)
Professional	Identify, describe, install different types	274. Identify flow meters. (02 hrs)	• Variable area meters, their principle of operation,

Skill 50 Hrs; Professional Knowledge 14 Hrs	of flow meter, carry out flow measurements &record readings. (Flow meter – Rota meter, Ventury meter, Orifice meter)	275. Install manometer. (04 hrs) 276. Put manometric fluid. (01 hr) 277. Measure differential pressure. (02 hrs) 278. Note down readings. (02 hrs) 279. Install Rotameter. (04 hrs) 280. Measure flow rates and corresponding float positions. (04 hrs) 281. Take readings. (02 hrs) 282. Calibrate. (02 hrs) 283. Safety measures and precaution. (02 hrs)	construction and working. • Measurement of reading • Eye positioning. (07 hrs.)
		284. Identify the orifice meter. (02 hrs) 285. Install orifice meter on given pipeline. (06 hrs) 286. Install manometer. (04 hrs) 287. Measure differential pressure for various flow rates. (04 hrs) 288. Collect the liquid discharged for a specific time. Calculate flow rates. (04 hrs) 289. Calibrate the readings. (04 hrs) 290. Safety measures to be taken. (01 hr)	• Differential pressure measurement. • Knowledge of different types of flow meter. • Description of variable head meters as orifice meter. (07 hrs.)
Professional Skill 25 Hrs; Professional Knowledge 07 Hrs	Identify, select dial gauge, it's construction, parts, graduations, care & use for checking flatness of job.	291. Install given venturimeter. (04 hrs) 292. Install manometer. (02 hrs) 293. For different flow rates-measure differential	• Venturimeter-principle of operation, construction, working, calculation formulas and their coefficients. • Dial gauge indicator,

		pressure. (04 hrs) 294. Measure the volume collected for a specific time. Calculate flow rates. (04hrs) 295. Calibrate the readings. (02 hrs) 296. Identify the dial gauge indicator. (02 hrs) 297. Clamp the dial gauge. (04 hrs) 298. Check flatness with dial gauge indicator. (03 hrs)	construction, its parts, material construction. • Application, care and maintenance of dial gauge. (07 hrs.)
Professional Skill 25 Hrs; Professional Knowledge 07 Hrs	Identify and install / connect instruments / devices to measure pressure, temp., flow & level, record readings. (Instruments / Devices - bourden tube, capsule type gauge, mercury in glass, bimetallic thermometer, RTD, Orifice, venturi, Rotameter, sight glass type, Air purge type & capacitance type level indicator.	299. Identify thermometers. (02 hrs) 300. Measure temperature with thermocouple. (06 hrs) 301. Determine level with the help of float type level indicator. (02 hrs) 302. Note down float position. (02 hrs) 303. Measure volume of container. (04 hrs) 304. Calculate quantity of liquid in containers. (02 hrs) 305. Connect the bourdon tube. (02 hrs) 306. Measure the pressure. (02 hrs) 307. Note down readings. (03 hrs)	Basic Instrumentation • Study of basic instruments for measuring temperature pressure, level and flow. (07 hrs.)
Project Work/ Industrial Training			

SYLLABUS FOR MAINTENANCE MECHANIC (CHEMICAL PLANT) TRADE			
SECOND YEAR			
Duration	**Reference Learning Outcome**	**Professional Skills (Trade Practical) With Indicative Hours**	**Professional Knowledge (Trade Theory)**
Professional Skill 25Hrs; Professional Knowledge 09Hrs	Carryout testing of different types of maintenance- Online, Predictive, Preventive and break down and frequent record keeping.	308. Illustrate different type of maintenance. (04 hrs) 309. Differentiate between preventive & breakdown maintenance. (04hrs) 310. Safe shop floor practices &safety. (04hrs) 311. P.P.E.s, their uses.(03hrs) 312. Check machines for any uneven sound. (02hrs) 313. Explain check list. (04hrs) 314. Maintenance record of equipment. (04hrs)	Maintenance • Maintenance – definition. • Types of maintenance. • Advantage of preventive maintenance. • Breakdown maintenance disadvantages. • Making of check list. (09 hrs)
Professional Skill 100 Hrs; Professional Knowledge 36 Hrs	Plan, dismantle, trouble shoot, clean & reassemble different mechanical components for power transmission & check their functionality.	315. Importance of lubrication.(03hrs) 316. Explain characteristics of good lubricant. (04hrs) 317. Name different lubrication system. (04hrs) 318. Select appropriate lubricant forgiven job. (03hrs) 319. Apply lubricant. (03hrs) 320. Safety observed. (04hrs) 321. Protective equipment's used during lubricant application. (04hrs)	• Lubricant– Definition. • Quality of good lubricant. • Selection of good lubricant. • Methods of lubrication systems. (09 hrs)
		322. Demonstrate importance of bearing's in workshop industry. (05 hrs)	Bearing • Classification of different types of bearings.

		323. Illustrate different types of bearings. (05 hrs) 324. Identify different parts of given bearings. (05 hrs) 325. Safe way of handling bearing. (05 hrs) 326. Precautions while mounting and un-mounting on shafts. (05 hrs)	• Bush bearing, solid bearing, ball bearing, self-alignment bearing etc. Thrust bearing, roller bearing their construction. • Application, care and handling of bearings. (09 hrs)
		327. Inspect shaft mounted bearing. (02hrs) 328. Select proper size bearing puller.(02hrs) 329. Set the puller on the jobby proper positioning of its parts.(04hrs) 330. Perform bearing removal operation.(04hrs) 331. Clean bearing and apply proper lubricant.(02hrs) 332. Select appropriate size of ball bearing.(02hrs) 333. Ensure that pressing block, fitting sleeve etc. Are free of burrs.(04hrs) 334. Mount bearing on shaft by standard procedure with proper tools.(04hrs) 335. Check the bearing for free movement. (01hr)	• Methods of fitting and removing of bearing. • List of tools required for the operation. • Care and handling tools. (09 hrs)
		336. Check the gear box physically, note down the defects.(04 hrs) 337. Mark relative positions of parts using punch etc.(04 hrs) 338. Dismantle gears box by removing it's parts gear	Gear • Types of gears-spur gear, helical gear, bevel gear, worm gear. • Their use and care. • Types of gear boxes. (09 hrs)

		keys, nut bolts etc.(05 hrs) 339. Clean all its parts. (04 hrs) 340. Check for any damages and replace if necessary. (03 hrs) 341. Assemble all parts as markings sequentially. (05 hrs)	
Professional Skill 25Hrs; Professional Knowledge 09Hrs	Identify leakage and replace or repair relevant gasket or gland packing.	342. Inspect given pipeline flange.(02 hrs) 343. Select appropriate gasket material. (03 hrs) 344. Select tools for working.(02 hrs) 345. Carryout necessary if any marking operation. (04 hrs) 346. Select cutting tool.(02 hrs) 347. Perform gasket cutting operation. (05 hrs) 348. Perform punching operation with required tool. (02hrs) 349. Place gasket in position. (03 hrs) 350. Properly tight of flange. (02 hrs)	• Types of gasket and gland packing's. • Material of construction. • Application. (09 hrs)
Professional Skill 75 Hrs; Professional Knowledge 27 Hrs	Identify different types of valve, their specific application. Carry out overhauling procedure for different types of valve.	351. Dismantle gate valve using proper hand tools.(02hrs) 352. Check controlling elements for damages, take necessary action. (01hr) 353. Clean, Lubricant, replace gland packing.(01hr) 354. Reassemble valve	Valves: • Differentiate their types and applications. • Principal, Construction, Operating and working of gate valve, globe valve, needle valve. • Their maintenances and troubleshooting. (09 hrs)

		sequentially and check for leakage.(02hrs) 355. Dismantle globe valve with required hand tools. (02hrs) 356. Perform lubrication elements for damages. (02hrs) 357. Perform lubrication, cleaning and replace gland packing. (02hrs) 358. Reassemble all Globe valve and check it for leakage. (02hrs) 359. Dismantle given needle valve. (02hrs) 360. Remove lock nut, bonnet and inspect threads on the stem at terminal ends and vice–versa. (02hrs) 361. Clean all parts with kerosene oil. (04hrs) 362. Reassemble Needle valve and check for proper Functioning. (03hrs)	
		363. Take ball valve and remove its hand wheel, gland nut, bonnet etc. (02hrs) 364. Remove stem. (01hr) 365. Observe parts for any damage, seepage.(02hrs) 366. Clean all parts with appropriate solvent.(02hrs) 367. Reassemble sequentially. (02hrs) 368. Dismantle given plug	Valves: • Differentiate their types and applications. • Principal, Construction, Operating and working of Ball valve, Plug valve, NRV, PSV • Their maintenances and troubleshooting. (09 hrs)

		valve.(02hrs) 369. Remove stem and controlling device. (02hrs) 370. Inspect parts for damage. (01hr) 371. Clean the parts with solvent. (01hr) 372. Reassemble and check for functioning. (02hrs) 373. Take NRV & dismantle parts with suitable tools. (02hrs) 374. Check for hinge & disk. (02hrs) 375. Clean inner part with kerosene. (02 hrs) 376. Reassemble &check for its proper functioning. (02hrs)	
		377. Study construction details, operating & working of diaphragm valve. (02hrs) 378. Select appropriate tools and remove hand wheel bonnet etc. (02hrs) 379. Inspect diaphragm for any damage, take necessary action. (02hrs) 380. Reassemble sequentially and check for proper functioning. (03hrs) 381. Study construction details, operating & working of butterfly valve and remove gland flange by suitable tools. (02hrs) 382. Check ropes and rotate the handle to see	Valves: • Differentiate their types and applications. • Principal, Construction, Operating and working of Diaphragm valve, Butterfly valve, Control valve. • Their maintenances and troubleshooting. (09 hrs)

		tightness of ropes. (02hrs) 383. Replace the gland flange. (02hrs) 384. Check disc movement and locking arrangement. (02hrs) 385. Study the parts of control valve. (02hrs) 386. Dismantle and check for damage/replacement. (02hrs) 387. Reassemble sequentially. (04hrs)	
Professional Skill 75 Hrs; Professional Knowledge 27 Hrs	Plan, dismantle, trouble shoot, clean & reassemble different machine, pumps & components for transportation of liquid and check their functionality.	388. Check the centrifugal pump physically and note down the defects.(02hrs) 389. Remove the end cover using proper tools.(03hrs) 390. Remove the impeller gently. (02hrs) 391. Check for key/keyway. (02 hrs) 392. Check the shaft for any kind of damages or play.(03 hrs) 393. Remove gland cover & check for gland packing and replace if required. (04hrs) 394. Check bearing for play. (02hrs) 395. Clean all parts with solvent. (02hrs) 396. Assemble all parts sequentially.(03hrs) 397. Replace gasket/oilpaper if damage & fitend cover. (01hr) 398. Check for proper	Pumping Device for Liquid Centrifugal Pump • Classification of pumps. • Working principal, Construction details, Operating & working, uses of centrifugal pump. • Definition of NPSH • Head vs. capacity relation • Starting & shutting down procedure. • Cavitations& Priming • Maintenance of pump • Trouble shooting. • Types(volute/ diffuser ring type) • Types of impeller • Advantages & disadvantages. (018 hrs)

		functioning (01 hr)	
		399. Check &inspect the test rig. (01hr) 400. Collect the necessary apparatus. (02hrs) 401. Set valve at a certain position &switch on the centrifugal pump.(01hr) 402. Attain steady state. (01hr) 403. Inspect and note down the head developed. (02hrs) 404. Collect the discharge for certain time interval.(02hrs) 405. Calculate the volumetric flow rate. (02hrs) 406. Conduct the procedure for different valve positions & calculate flow rates. (07hrs) 407. Co-relate head developed and capacity of the pump. (04hrs) 408. Interpret the graph of head vs. capacity. (03 hrs)	
		409. Check &inspect reciprocating pump physically not down for any defect.(03hrs) 410. Mark relative positions of parts. (02hrs) 411. Dismantle piston rod, cylinder, and valve assembly.(05hrs) 412. Check NRV'S for proper functioning/ replace it for any warn out parts.	Positive Displacement Pump Reciprocating Pump • Classification of pumps. • Working principal, Construction details, Operating &working, uses of centrifugal pump. • Starting & shutting down procedure. • Maintenance of pump • Trouble shooting.

		(03hrs) 413. Check inside cylinder wall. (02hrs) 414. Check piston head / piston ringer place if necessary. (03hrs) 415. Lubricate moving parts. (02hrs) 416. Assemble all parts sequentially. (05hrs)	• Types(Plunger/ Piston and Single acting / Double acting) • Advantages & disadvantages. (09 hrs)
Professional Skill 50 Hrs; Professional Knowledge 18 Hrs	Verify and plot the graphs for characteristic curve of different types of pump such as centrifugal pump and gear pump.	417. Check the gear pump physically note down for any defects. (01hr) 418. Mark relative positions of gear mesh, body. (01hr) 419. Remove lower casing wear plate, seal ring.(02hrs) 420. Remove drive shaft gear, idle shaft gear, load ring, seal ring.(02 hrs) 421. Coat seals with sealing grease.(01 hrs) 422. Assemble sequentially. (03 hrs) 423. Check alignment of drive & idle shaft.(01 hrs) 424. Check &inspect test ring for gear pump.(01 hrs) 425. Collect apparatus required. (01 hrs) 426. Check inlet &outlet valve, set discharge valve at certain opening position.(01 hr) 427. Switch on the gear pump. (01 hr)	Rotary Pump • Working principal, Construction details, Operating &working, uses of centrifugal pump. • Starting & shutting down procedure. • Maintenance of pump • Trouble shooting. • Types(Gear pump, Screw pump, Lobe pump) • Advantages & disadvantages (09 hrs)

		428. Attain steady state.(01 hr) 429. Note down, head developed by the pump. (01 hr) 430. Collect discharge volume for specific time interval. (01 hr) 431. Calculate Volumetric flow rate.(01 hr) 432. Conduct same procedures for different valve positions. (02 hr) 433. Co-relate head developed capacity of the pump. (01 hr) 434. Interpret the graph of head against capacity of pump. (1 hr) 435. Inspect, clean all components & replace if damaged. (02 hrs)	
		436. Inspect Lobe pump physically. (01hr) 437. Close suction delivery valves. (02hrs) 438. Remove pump cover. (01hr) 439. Remove lobe screw, check “o” ring. (02hrs) 440. Remove job.(02hrs) 441. Dis-assemble mechanical seal.(02hrs) 442. Remove Allen screws, rotor case.(01hr) 443. Remove casing seal ring. (02hrs) 444. Remove stud bolt,	

		Inspect "o" ring & seashore-use. (02 hrs) 445. Inspect rotor for any damage. (02hrs) 446. Inspect burro rotor bolt, grooves.(01 hr) 447. Make sure that pump housing &gear box are clean.(01hr) 448. Reassemble sequentially. (06hrs)	
Professional Skill 25Hrs; Professional Knowledge 09Hrs	Overhaul and troubleshooting of vacuum pump and checking for proper functioning.	449. Switch off power supply & disconnect motor.(01hr) 450. Drain installation within pump area.(02hrs) 451. Remove key, hexagonal bolts, bearings cover, and bearing safely. (04hrs) 452. Unscrew hexagonal bolt and remove stuffing box. (02hrs) 453. Pullout mechanical seal. (02hrs) 454. Unscrew nut and takeout casing.(02 hrs) 455. Open lock nut and pullout rotor. (01hr) 456. Remove control plate. (01hr) 457. Clean all parts carefully and observe sealing and guide disc for any kind of grooves. (04hrs) 458. Coat running surface by sealing gasket. (02hrs) 459. Carryout assembling procedure sequentially. (03hrs) 460. Turn shaft by hand to	Vacuum Pump • Definition of vacuum pump and it's utilisation in chemical industries. • Working principal, construction details, operating & working, and maintenance. • Types - Water and steam jet ejector, Water / Oil Ring vacuum pump • Procedure for vacuum line up and vacuum break up. (09 hrs)

		ensure that pump runs freely before restarting. (01hr)	
Professional Skill 50 Hrs; Professional Knowledge 18 Hrs	Identify and Check functionality of Power Transmission Device, Belt, Pulleys.	461. Identify the misalignment of motor and pump. (03hrs) 462. Clean the pump and motor. (03hrs) 463. Check and find out the type of parallel misalignment. (04hrs) 464. Move the motor and pump shaft closer to each other and tighten. (04hrs) 465. Keep the straightedge and observe the gap between the straightedge surface and coupling surface. (03 hrs) 466. If gap is found. Adjust provided suitable shim in between basement and gearbox/motor. (02hrs) 467. Keep the straightedge at the rear/front side of the motor pump and observe the gap. (02hrs) 468. If the gap is found. Adjust it by moving the motor. (04hrs)	Power transmission Couplings. • Types of couplings– muff coupling, flange coupling, type coupling. • Application of couplings. (09 hrs)
		469. Select correct size of puller depending upon the size of the shaft and pulley. (01hr) 470. Clean and of the shaft using flat file. To remove any burrs or bulging on the end of the shaft. (02 hrs)	Power transmission Pulleys and Belts. • Size & specification • Belt material • Selection of belt • Load & belt tension • Advantages & disadvantages of belts. (09 hrs)

		471. Place the legs of the puller, diagonally opposite sides of the pulley to hold the pulley firmly. (02hrs) 472. Complete removal of the pulley from the shaft. (01hrs) 473. Apply few drops of oil around the shaft before removing.(01hrs) 474. Tighten the centre screw grandly using correct size spanner and check whether the pulley is coming-out freely from the shaft. (02hrs) 475. Remove burr from the key way in the shaft and the hub. (02hrs) 476. Select a gib head key of the correct section and length. (05 hrs) 477. Fit key with a firm blow with hammer. (02hrs) 478. Measure the longest span length of belt between the pulleys using a steel tape. (01hrs) 479. Find the middle of the longest span of the belt between the pulleys.(01hrs) 480. Push this midpoint inwards then pull tout & note the total reflection. (02hrs) 481. Loosen the lock nuts. (01hrs)	

		482. Tighten the clapping bolt. (01hrs) 483. Tighten the lock nuts. (01hrs)	
Professional Skill 25Hrs; Professional Knowledge 09Hrs	Plan and perform method of Alignment of pulley, shaft, motor, coupling by thread, straight edge, laser system.	484. Familiarization with terms.(02hrs) 485. Learn about machine to be aligned.(02hrs) 486. Carryout sag check.(02hrs) 487. Prepare the machine. (02hrs) 488. Clean mounting surface, file of burrs.(02hrs) 489. Carryout all measurements. (02hrs) 490. Logout graph paper. (04 hrs) 491. Carry preliminary horizontal move. (01hrs) 492. Check off soft foot.(02hrs) 493. Perform vertical moves. (01hrs) 494. Rectify the error.(02hrs) 495. Tight all bolts and recheck indicator reading.(02hrs) 496. Remove alignment brackets. (01hrs)	Alignment of pump • Causes and effects of misalignment • Methods of testing misalignments • Alignment by two dial gauge. • Advance laser alignment techniques. (09 hrs)
Professional Skill 25Hrs; Professional Knowledge 09Hrs	Identify major function of mechanical seals, select and install the same on a pump shaft, discuss care and it's maintenance.	497. Clean and inspect pump parts.(02hrs) 498. Check assembly drawing prior to installation. (02hrs) 499. Remove surface flange, end cover and impeller.(01hrs) 500. Remove gland nuts and gland flange. (01hrs) 501. Orient position of spring	Mechanical seal. • Types of seal. • Material of seal. • Application of mechanical seal. • Oil seals specification. (09 hrs)

		locating collar and mark the same. (02 hrs) 502. Takeout mechanical seal components i.e. Carbon seal, seal cage, rubber seal, gland flange, slingers etc. Sequentially and note down the same. (04hrs) 503. Inspect and clean all parts, check for any damages. (02hrs) 504. Place back flange on shaft and fit the ceramic seal and rest of the assembly. (03hrs) 505. Fit the spring retainer. (02 hrs) 506. Position the spring with its locking collar. (02hrs) 507. Compress gland against stuffing box. (01hrs) 508. Rotate shaft manually to ensure seal is not in bind. (01hrs) 509. Inspect after bringing to the operating conditions. (02hrs)	
Professional Skill 25Hrs; Professional Knowledge 09Hrs	Identify Machinery handling and their installation as per standard procedure, it's planning & implementation.	510. Lift the machine using crowbars. (02hrs) 511. Place the wooden block under the load. (02hrs) 512. Lower the load on the wooden block. (01hr) 513. Place suitable rollers under the load.(02hrs) 514. Remove the wooden blocks from the bed.(02hrs) 515. Check the route of the	• Machinery installation. • Receiving. • Foundation. • Levelling • Installation. • Grouting. • Trail. (09 hrs)

		machine movement and ensure that itis free of obstruction .(02hrs) 516. Push the machine forward slowly with the crowbars. (02hrs) 517. Select suitable anti-vibration pads – depending upon the weight of the machine. (02hrs) 518. Prepare foundation plan forgiven machine. (02hrs) 519. Layout of foundation for given machine.(02hrs) 520. Escalate soil for foundation.(01hrs) 521. Prepare template for foundation. (01hrs) 522. Prepare concrete for foundation.(03hrs) 523. Fixing of foundation bolts. (01hrs)	
Professional Skill 25Hrs; Professional Knowledge 09Hrs	Identify major parts and function of pressure vessel, various pipe fittings, valves, parameters, its care and safety precaution.	524. Inspect the pressure vessel physically. (02hrs) 525. Examine system components including structural attachment and vessel connections. (04 hrs) 526. Identify evidence of leakage or inadequate insulation. (02hrs) 527. Check pressure, reset devices for leakages if any, and rectify the same. (03hrs) 528. Conduct an internal	Pressure vessel • Their types • Care and maintenance • Lifting devices • Working of– chain block, screw jack, hydraulic jack. • Material handling devices • Working of - hand trolley, fork lift etc. (09 hrs)

		inspection for corrosion and wear around nozzles, vessel connections, external fittings or controls. (03hrs) 529. Carryout necessary rectification steps. (04hrs) 530. Keep valve protection caps in place until ready to use. (01hrs) 531. Conduct pressure test for appropriate pressure, (02hrs) 532. Carryout preventive maintenance, determined by the manufacturer. (02hrs) 533. Records all maintenance as per norms for repairs and alternations (R1, R2). (02 hrs)	
Professional Skill 75Hrs; Professional Knowledge 27Hrs	Plan, dismantle, trouble shoot, clean & reassemble different machine & components for transportation of Gases and check their functionality.	534. Operate Reciprocating Compressor. (02 hrs) 535. Remove belt on pulley and check physically. (01hrs) 536. Study Construction details of R. 537. Trouble searching before dismantling. (02 hrs) 538. Safety precautions and Housekeeping, Area cleaning while dismantling. (01hrs) 539. Dismantling. (02 hrs) 540. Trouble searching after dismantling. (02 hrs) 541. Trouble shooting. (02 hrs) 542. Cleaning and Overhauling. (02 hrs)	Utility : Pumping Device for Gas • Compressor • Compressed air and it's utilization in chemical industries. • Type of compressor • Reciprocating Compressor • Working Principal of Reciprocating Compressor • Application, construction, operating, working & maintenance of single stage and multistage reciprocating compressor. (09 hrs)

		543. Reassembling. (02 hrs) 544. Empty running and checking. (01 hr)	
		545. Operate Centrifugal Compressor. (02 hrs) 546. Remove belt on pulley and check physically. (01 hrs) 547. Study Construction details (02 hrs) 548. Trouble searching before dismantling. (02 hrs) 549. Safety precautions and Housekeeping, Area cleaning while dismantling. (01 hrs) 550. Dismantling. (02 hrs) 551. Trouble searching after dismantling. (02 hrs) 552. Trouble shooting. (02 hrs) 553. Cleaning and Overhauling. (02 hrs) 554. Reassembling. (02 hrs) 555. Empty running & Checking. (01 hrs)	• Centrifugal Compressor • Working Principal of Centrifugal Compressor • Type of compressor • Application, construction, operating, working & maintenance of Centrifugal Compressor. (09 hrs)
		556. Operate Screw Compressor and Lobe Compressor. (02 hrs) 557. Study working. (02 hrs) 558. Study Construction details. (02 hrs) 559. Trouble searching before dismantling. (02 hrs) 560. Safety precautions and Housekeeping, Area cleaning while dismantling. (01 hr) 561. Dismantling (02hrs) 562. Trouble searching after dismantling. (02 hrs)	Screw and Lobe Compressor • Working Principal of Screw and Lobe Compressor • Type of compressor • Application, construction, operating, working & maintenance. (09 hrs)

		563. Trouble shooting. (02 hrs) 564. Cleaning and Overhauling. (02 hrs) 565. Reassembling.(02hrs) 566. Empty running & Checking. (01 hrs)	
		567. Operate Fan and blower. (01hrs) 568. Study working. (02 hrs) 569. Study Construction details. (02 hrs) 570. Trouble searching before dismantling. (02 hrs) 571. Safety precautions and Housekeeping, Area cleaning while dismantling. (01 hrs) 572. Dismantling. (02 hrs) 573. Trouble searching after dismantling. (02 hrs) 574. Trouble shooting. (02 hrs) 575. Cleaning and Overhauling. (02 hrs) 576. Reassembling. (02 hrs) 577. Empty running & checking. (01 hrs)	Fan • Working principal, uses, construction details, working and it's maintenance. Blower • Working principal, uses, construction details, working and it's maintenance. (09 hrs)
Professional Skill 50 Hrs; Professional Knowledge 18 Hrs	Plan, dismantle, trouble shoot, clean & reassemble Air dryers & Air filters.	578. Study working and types of filter. (02hrs) 579. Study Construction details. (02 hrs) 580. Dismantling. (03hrs) 581. Trouble searching after dismantling. (02 hrs) 582. Trouble shooting. (02 hrs) 583. Cleaning and Reassembling. (02 hrs) 584. Study working and types of Air Dryer. (02 hrs) 585. Study Construction details.	• Air treatment - Introduction, RH, Dew point, water trap, Air filters-dry filter, wet filter, coarse filter, micro filter, pressure regulator. • Air dryers-classification, components of a typical compresses air system. (09 hrs)

		(02 hrs) 586. Trouble searching before dismantling. (02 hrs) 587. Dismantling (02 hrs) 588. Trouble shooting. (02 hrs) 589. Cleaning and Reassembling. (02 hrs)	
		590. Operate Cooling Tower pump. (02 hrs) 591. Study working of Cooling Tower. (02 hrs) 592. Study Construction details (02 hrs) 593. Trouble searching before dismantling pump. (02 hrs) 594. Safety precautions and Housekeeping, Area cleaning while dismantling. (01 hrs) 595. Dismantling ID fan and Cooling Tower pump. (02 hrs) 596. Trouble searching after dismantling. (02 hrs) 597. Trouble shooting. (04 hrs) 598. Remove Scale formation and Overhauling Cooling Tower pump and ID fan. (02 hrs) 599. Reassembling.(04 hrs) 600. Checking. (02 hrs)	COOLING TOWER: • Water(Cooling, child, hot, D I) • Construction, types& uses of cooling tower. • Trouble& trouble shooting. • Scale formation, preventive maintenance. • De foaming agent.(09 hrs)
Professional Skill 50 Hrs; Professional Knowledge 18 Hrs	Plan, dismantle, trouble shoot, clean scale formation & reassemble Electrode &Oil fired boiler and identify various operating parts.	601. Operate Electrical Boiler. (02 hrs) 602. Study working. (02 hrs) 603. Study Construction details. (02 hrs) 604. Trouble searching before dismantling. (02 hrs) 605. Safety precautions and	STEAM GENERATION • Steam &its types. • Types of boiler, • Electrode Boiler • Mountings & accessories. • Types of draught, • Working Principal of

		Housekeeping, Area cleaning while dismantling. (01 hrs) 606. Dismantling Boiler and make up pump. (02 hrs) 607. Trouble searching after dismantling. (02 hrs) 608. Trouble shooting. (04 hrs) 609. Remove Scale formation and overhauling make up pump. (02 hrs) 610. Reassembling.(04 hrs) 611. Checking. (01 hrs) 612. Check steam trap for proper functioning (01 hrs)	Electrode Boiler. • Application, construction , operating , working & maintenance, trouble & trouble shooting • Scale formation. • Types of Electrode. • Types of steam trap. • Panel control system (09 hrs)
		613. Operate Oil fired Boiler. (02 hrs) 614. Study working. (02 hrs) 615. Study Construction details. (02 hrs) 616. Trouble searching before dismantling. (02 hrs) 617. Safety precautions and Housekeeping, Area cleaning while dismantling. (01 hr) 618. Dismantling Ignition system. (02 hrs) 619. Trouble searching after dismantling. (02 hrs) 620. Trouble shooting. (04 hrs) 621. Remove Scale formation and overhauling oil pump. (02 hrs) 622. Reassembling. (04 hrs) 623. Checking. (02 hrs)	Oil fired Boiler • Working Principal of Oil fired Boiler • Application, construction, operating, working & maintenance, trouble & trouble shooting • Types of fuel • Scale formation. • Ignition system • Panel control system (09 hrs)
Professional Skill 25Hrs;	Identify different types of refrigerant & it's uses in chemical	624. Study of Refrigeration system. (02 hrs) 625. Study of Refrigerant, its	REFRIGERATION: • Definition of Refrigerant • Types of refrigerant and its

Professional Knowledge 09Hrs	industries and dismantle Air handling unit for cleaning and troubleshooting with due care and safety.	types and properties. (02 hrs) 626. Study of vapor absorption and vapor compression. (02 hrs) 627. Handling of Refrigerants. (02 hrs) 628. Maintenance of Refrigeration unit. (03hrs) 629. Study of Air Handling Unit system. (02 hrs) 630. Maintenance of AHU system. (02hrs) 631. Trouble searching. (03 hrs) 632. Trouble shooting. (04 hrs) 633. Cleaning (02 hrs) 634. Housekeeping and area & equipment cleaning. (01 hr)	properties, • Handling of refrigerant, (09 hrs)
Professional Skill 25Hrs; Professional Knowledge 09Hrs	Plan, dismantle, trouble shoot, clean, overhaul & reassemble Hydraulic jack and check oil level for their functionality.	635. Operate Hydraulic Jack and Hydraulic Trainer. (02 hrs) 636. Study working. (02 hrs) 637. Study Construction details. (02 hrs) 638. Trouble searching before dismantling. (02 hrs) 639. Safety precautions and Housekeeping, Area cleaning while dismantling. (01 hrs) 640. Dismantling Hydraulic Jack. (02 hrs) 641. Trouble searching after dismantling. (02 hrs) 642. Trouble shooting. (04 hrs) 643. Check oil level and grade. (02 hrs) 644. Reassembling.(04 hrs) 645. Checking. (02 hrs)	HYDRAULICS: • Basic principal of Hydraulics • Inherent physical properties of liquids, comparison of molecular structure of solids, liquids & gases, • Basic terms &definition in hydraulics i.e. Force, Pressure, Work, Viscosity, Pascal's law, Hydraulic jack] (09 hrs)

Professional Skill 50 Hrs; Professional Knowledge 18 Hrs	Identify, Plan, dismantle, trouble shoot, clean & reassemble different types of Heat exchangers and check functionality.	646. Study Types and uses of heat exchanger. (02 hrs) 647. Study working of Shell & Tube Heat Exchanger. (02 hrs) 648. Study Construction details. (02 hrs) 649. Trouble searching before dismantling. (02 hrs) 650. Safety precautions and Housekeeping, while dismantling. (01 hr) 651. Dismantling. (03 hrs) 652. Trouble searching after dismantling. (02 hrs) 653. Trouble shooting. (04 hrs) 654. Cleaning shell and tube side. (02 hrs) 655. Reassembling.(04 hrs) 656. Checking. (01 hrs)	HEAT TRANSFER: • Definition Heat transfer. • Mode of heat transfer. • Heat exchanger equipment's (condenser, cooler, chiller, boiler, heat recovery boiler, re-boiler) • Types of heat exchanger (double pipe HE, shell& tube HE,) • Advantage disadvantage of the Shell & Tube Heat Exchanger.(09 hrs)
		657. Study Construction details of Vertical Evaporator. (01 hrs) 658. Trouble searching. (02 hrs) 659. Safety precautions and Housekeeping, Area cleaning while dismantling. (02 hrs) 660. Dismantling. (02 hrs) 661. Trouble shooting. (02 hrs) 662. Cleaning scale formation. (02 hrs) 663. Reassembling. (04 hrs) 664. Checking. (02 hrs) 665. Preparation before operating (02 hrs) 666. Start up of Vertical Evaporator (02 hrs) 667. Study working. (02 hrs)	EVAPORATION: • Definition – Evaporation & Condensation. • Working principal, construction details, operating & working, its maintenance. • Types of evaporator. • Triple effect evaporator. • Trouble& trouble shooting. (09 hrs)

		668. Checking. (02 hrs)	
Professional Skill 25 Hrs; Professional Knowledge 09 Hrs	Plan, dismantle, troubleshoot, clean and reassemble components in different types of distillation column.	669. Study Construction details of Distillation column. (03hrs) 670. Safety precautions and Housekeeping, Area cleaning while dismantling. (02hrs) 671. Dismantling. (04 hrs) 672. Trouble searching after dismantling. (02 hrs) 673. Trouble shooting. (05 hrs) 674. Cleaning and refilling of pickings in column. (03 hrs) 675. Refitting of various pipe line (02 hrs) 676. Reassembling.(02 hrs) 677. Column startup & Checking. (02 hrs)	DISTILLATION: • Definition • Method & types of distillation. • Distillation column. • Types of column (packed & plate) • Construction details, operating &working,. Its maintenance, trouble& trouble shooting. • Types of pickings and plate • Channeling (09 hrs)
Professional Skill 50 Hrs; Professional Knowledge 18 Hrs	Identify different types of filtration unit and carry out its maintenance and trouble shooting.	678. Study Construction details of Plate & Frame Filter. (01 hr) 679. Trouble searching. (02 hrs) 680. Safety precautions and Housekeeping, Area cleaning while dismantling. (02 hrs) 681. Dismantling. (02 hrs) 682. Trouble shooting. (02 hrs) 683. Cleaning scale formation on plate & frame and filter cloth. (02 hrs) 684. Reassembling.(03 hrs) 685. Preparation before operating. (02 hrs) 686. Start filtration.(02 hrs) 687. Study working. (02 hrs) 688. Check MLR clarity. (02 hrs) 689. Washing with relevant	FILTRATION: • Definition, • Filtration media& Filter aid. • Filtration equipment (plate &filter, rotary vacuum filter, centrifuge, Buckner filter, nuetch filter, ANFD, sparkler filter) • Working principal, construction details, operating & working, its maintenance, Trouble& Trouble shooting.(18 hrs)

		solvent. (01 hr) 690. Air drying (01 hr) 691. Collect the cake. (01hr) 692. Study Construction details of Centrifuge. (01 hr) 693. Trouble searching. (02 hrs) 694. Safety precautions and Housekeeping, Area cleaning while dismantling. (02 hrs) 695. Dismantling. (02 hrs) 696. Trouble shooting. (02 hrs) 697. Cleaning scale formation. (02 hrs) 698. Reassembling. (04 hrs) 699. Checking. (02 hrs) 700. Preparation before operating. (02 hrs) 701. Startup of Vertical Evaporator. (02 hrs) 702. Study working. (02 hrs) 703. Checking. (02 hrs)	
Professional Skill 25 Hrs; Professional Knowledge 09 Hrs	Identify different types of Dryer used for loading wet material in tray dryer and carryout its maintenance, trouble shooting for checking proper functionality.	704. Study Construction details of Tray Dryer. (01 hrs) 705. Trouble searching. (02 hrs) 706. Safety precautions and Housekeeping, Area cleaning. (02 hrs) 707. Trouble shooting. (02 hrs) 708. Cleaning scale formation on tray. (02 hrs) 709. Checking. (02 hrs) 710. Preparation before operating tray dryer. (02 hrs) 711. Material loading in tray. (02 hrs) 712. Arrange tray. (02 hrs) 713. Start air drying. (02 hrs)	DRYING: • Definition, • Drying equipment (tray dryer, Rotary dryer, Spray dryer, FBD, RCVD). • Working principal, construction details, operating & working, its maintenance, Trouble& Trouble shooting. • Sampling plan • Loading & unloading material. Re-drying.(09 hrs)

		714. Start heating. (01 hrs 715. Sampling program. (01 hr) 716. Material unloading.(02 hrs) 717. Cleaning & housekeeping. (02 hrs)	
Professional Skill 50 Hrs; Professional Knowledge 18 Hrs	Identify term size reduction and operate size reduction machine (Hammer mill, Ball mill). Carry out size analysis with proper screening equipment's &their maintenance.	718. Study working of Hammer mill& ball mill. (02 hrs) 719. Study Construction details. (02 hrs) 720. Trouble searching before dismantling. (02 hrs) 721. Safety precautions and Housekeeping, Area cleaning while dismantling. (02hrs) 722. Dismantling. (04 hrs) 723. Trouble searching after dismantling. (02 hrs) 724. Trouble shooting. (03 hrs) 725. Cleaning and Overhauling. (02 hrs) 726. Reassembling.(04hrs) 727. Empty running & Checking. (02 hrs)	Size Reduction: • Definition, • Advantages of size reduction, • Crushing& Grinding, • Classification, • Equipment's (Blake jaw crusher, Hammer mill, Ball mill, Multimill, Rodmill) • Working principal, construction details, operating & working, its maintenance, Trouble& Trouble shooting.**(09 hrs)**
		728. Study working of Vibratory sieve shaker (02 hrs) 729. Study Construction details. (02 hrs) 730. Trouble searching before dismantling. (02 hrs) 731. Safety precautions and Housekeeping.(02hrs) 732. Dismantling. (04 hrs) 733. Trouble searching after dismantling. (02 hrs) 734. Trouble shooting. (04hrs) 735. Cleaning and Overhauling. (02 hrs) 736. Reassembling.(03 hrs)	SCREENING: • Definition, • Screening equipment (Sieve shaker, vibratory sifter, ultrasonic vibratory sifter) • Working principal, construction details, operating & working, its maintenance, Trouble& Trouble shooting. • Types of sieves • Mesh number • % efficiency of sieve

		737. Empty running & Checking. (02 hrs)	**(09 hrs)**
Professional Skill 25 Hrs; Professional Knowledge 09 Hrs	Identify different types of term mixing & agitation. Dismantle, troubleshoot, clean and maintenance of different mechanical components.	738. Study working of Agitator. (02 hrs) 739. Study Construction details. (02 hrs) 740. Trouble searching before dismantling. (02 hrs) 741. Safety precautions and Housekeeping. (02hrs) 742. Dismantling. (04 hrs) 743. Trouble searching after dismantling. (02 hrs) 744. Trouble shooting. (04hrs) 745. Cleaning and Overhauling Mechanical seal. (02 hrs) 746. Reassembling.(03 hrs) 747. Empty running & Checking. (02 hrs)	MIXER & AGITATORS: • Definition • Types of mixer • Types of agitators, • Application and construction of agitators. • Vortex • Baffled **(09 hrs)**
Professional Skill 25 Hrs; Professional Knowledge 09 Hrs	Identify Specification of different types of conveyor belts, construction details, materials used and carry out its operations, maintenance, troubleshooting.	748. Study working of Belt Conveyor. (03 hrs) 749. Study Construction details. (03 hrs) 750. Trouble searching before dismantling. (03hrs) 751. Safety precautions and Housekeeping, Area cleaning while dismantling. (02 hrs) 752. Trouble shooting. (05hrs) 753. Cleaning and Overhauling of drive & driven roller. (04 hrs) 754. Checking integrity of belt.(03 hrs) 755. Empty running & Checking. (02 hrs)	Conveyor • Types of conveyor – Belt conveyor, Bucket conveyor, Screw conveyor, Pneumatic conveyor. • Selection of conveyor. • Working principal, construction details, operating & working, its maintenance, Trouble& Trouble shooting. (09 hrs)
Project work / Industrial Visit			

SYLLABUS FOR CORE SKILLS
1. Workshop Calculation & Science (Common for two year course) (80 Hrs + 80 Hrs)
2. Engineering Drawing (Common for Group-I (Mechanical Trade Group)) (80Hrs + 80 Hrs)
3. Employability Skills (Common for all CTS trades) (160 Hrs + 80 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.

ANNEXURE-I

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

23.	File - Square - Second Cut	200 mm	6 Nos.
24.	Hammer - Ball Pain	250 grams	6 Nos.
25.	Hammer - Ball Pain	500 grams	6 Nos.
26.	Screw Driver	9 X 300 mm	4 Nos.
27.	Drill Twist Set - Straight Shank	3 mm to 13 mm by 0.5 mm	1 No.
28.	Drill Twist Set - Straight Shank	9.8 mm	1 No.
29.	Hand Reamer Parallel	10 mm	2 Nos.
30.	Tap set	12 mm	2 Nos.
31.	Solid die	12 mm with die stock	2 Nos.
32.	Gauge Screw Pitch	Metric -0.25 to 6 mm	1 No.
33.	Wire Gauge - Metric		1 No.
34.	Allen Key Set - Hexagonal	1 - 12 mm, set of 12 Keys	1 No.
35.	Combination Set	300 mm	2 Nos.
36.	V Block	75 x 75 x 50 mm with Clamp (Hardened & Ground)	1 No.
37.	Bench Vice	125 mm	6 Nos.
38.	Anvil	50 Kg - with stand	1 No.
39.	Scraper	Flat- 250 mm	6 Nos.
40.	Scraper	Half Round - 250 mm	6 Nos.
41.	Scraper	triangular 250 mm	6 Nos.
42.	Surface Plate - Granite	600 x 600 mm with Stand and Cover	1 No.
43.	Specific Gravity bottle		2 Nos.
44.	Joules Calorimeter		1 No.
45.	Bunsen Burners		10 Nos.
46.	Tripods Stand		10 Nos.
47.	Asbestos wire gauge		10 Nos.
48.	Gauge Wire without asbestos		10 Nos.
49.	Burettes	25ml	10 Nos.
50.	Pipettes	10ml	10 Nos.
51.	H.D.P. Distill water bottle		10 Nos.
52.	Clamp holders		12 Nos.
53.	Stands with clamps fosr burette		12 Nos.
54.	Triangles clay		10 Nos.

55.	Measuring cylinder	25 ml Glass(borosilicate)	10 Nos.
56.	Measuring cylinder	50 ml Glass (borosilicate)	10 Nos.
57.	Measuring cylinder	100 ml Glass (borosilicate)	10 Nos.
58.	Volumetric flask	100 ml(borosilicate)	10 Nos.
59.	Volumetric flask	500 ml(borosilicate)	10 Nos.
60.	Volumetric flask	1000 ml(borosilicate)	10 Nos.
61.	Funnels Dia	4cms(borosilicate)	10 Nos.
62.	Beaker	250ml corining(borosilicate)	10 Nos.
63.	Beaker	400ml (borosilicate)	10 Nos.
64.	Bottles for solutions	1000 ml(borosilicate)	6 Nos.
65.	Bottles for solutions	2000 ml(borosilicate)	6 Nos.
66.	Bottles for solutions	500 ml(borosilicate)	6 Nos.
67.	Conical flask	150 ml(borosilicate)	20 Nos.
68.	Conical flask	250 ml(borosilicate)	20 Nos.
69.	China dish	50 ml (borosilicate)	12 Nos.
70.	Watch Glass	3" dia(borosilicate)	10 Nos.
71.	Tong - Flat	300 mm	10 Nos.
72.	Spatule	8"	10 Nos.
73.	First Aid Box		1 No.
74.	Distilled water still	10 lit.	1 No.
75.	Glass test tubes	15 ml	50 Nos.
76.	Round Bottom Distillation flask with side neck	500ml	6 Nos.
77.	Condenser for distillation lebig	30 cm long	6 Nos.
78.	Rubber cork	2.5 cm, 3cm size	10 Nos.
79.	Rubber Tubing (ID- 5mm)	MOC: Borosilicate glass	10 Nos.
80.	Rubber Bulbs for pipettes		6 Nos.
81.	Arc Welding Table -	Metal - 900 X 600 X 750 mm with Positioner	1 No.
82.	Safety google (white)		6 Nos.
83.	Double ended Open spanners set	6x7,8x9,10x11,12x13,14x15,16x17,18x19,20x22,21x23,24x27,25x28,30x32	1 No.
84.	Double ended Ring spanners set	6x7,8x9,10x11,12x13,14x15,16x17,18x19,20x22,21x23,24x27,25x28,30x32.	1 No.

85.	Circlip Plier	8''(internal)	1 No.
86.	Circlip Plier	8''(External)	1 No.
87.	Can oil	½ pt	1 No.
88.	Spanner - Adjustable	200 mm	1 No.
89.	Pipe Wrench	450 mm	1 No.
90.	Spirit Level	300 mm	1 No.
91.	Needle Roller Bearing RNA4908		1 No.
92.	Spherical Roller Bearing 22211 EKC3		1 No.
93.	Hydraulic Bearing puller		1 No.
94.	Grease Gun		1 No.
95.	Gate Valve 2" Cut section	Made up S.S. of 2” Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection	1 No.
96.	Globe valve 2" Cut section	Made up S.S. of 2” Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 No.
97.	Safety Valve (Spring Type) 2" Cut section	Made up S.S. of 2” Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 No.
98.	Needle valve	25 mm Cut section made up S.S. of 2” Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 No.
99.	Butter fly valve 2" Cut section	Made up S.S. of 2” Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 No.
100.	Non-return valve(swing check type & Lift Ball type) 2" Cut section	Made up S.S. of 2” Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 each

101.	Pneumatically operated diaphragm valve. Cut section connection.	Made up S.S. of 2” Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange	1 No.
102.	Ball valve 2" Cut section	Made up S.S. of 2” Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 No.
103.	Solenoid valve	Made up S.S. of 2” Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 No.
104.	Diaphragm valve 2" Cut section	Made up S.S. of 2” Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 No.
105.	Control valve. 1"Cut section	Made up S.S. of 2” Size, Body Design - Globe body, Pneumatic Actuator, Direct Acting, Normally Open, With flange connection.	1 No.
106.	Cut section of Internal gear pump		1 No.
107.	Cut section of External gear pump		1 No.
108.	Fire Extinguisher (C02 ,)		1 No.
109.	Fire Extinguisher (Dry Chemical powder)		1 No.
110.	Sand bucket		2 Nos.
111.	Fire blanket		2 Nos.
C. GENERAL MACHINERY & EQUIPMENT			
MACHINERY:			
112.	Drilling Machine - Bench Type	13 mm Motorized with Standard Accessories	1 No.
113.	Pedestal Grinder	Double Ended - 200 mm	1 No.
114.	Welding Transformer -	300 A, OCV 60 - 100 V, 60% Duty Cycle with Standard Accessories	1 No.
115.	Lathe Machine -	All Geared, Center Height 150 mm, Between Centers 1200 mm, 4 Jaw Chuck, Taper Turning Attachment and all Standard	1 No.

		Accessories	
116.	Pilot plan for flow measurement through, Orifice meter, rotameter, venturi meter	Made up of S.S sump tank, S.S. measuring tank, ½ " centrifugal pump, rotamter, orifice, venturi, U tube manometer with suitable piping.	1 No.
117.	Centrifugal pump Back pullout type with motor and base plate		1 No.
118.	Multistage centrifugal pump	With Balance drum or disk without motor with Type - Two stage centrifugal pump, Capacity of Up to 20 LPM, total Head of Up to 60 Meters, Pump Speed of 2800 RPM.	1 No.
119.	Diaphragm Pump(Air Operated)	made up of polypropylene with C-1500N diaphragm pump series with heavy duty head with bullet cartridge valves, Maximum working pressure: 8.6 Bar, Maximum fluid temperature: 54°C, Maximum ambient temperature: -10 to 50° C, Maximum viscosity: 1000 CP, Maximum suction lift: 10 Ft, Output adjustment range: 5-100% stroke length, Duty cycle: continuous, Size: 6"	1 No.
120.	Cut section of screw pump		1 No.
121.	Cut section sliding vane pump		1 No.
122.	Reciprocating pump (Cut Model)		1 No.
123.	Metering Pump	Made up of S.S. Plunger (MM) 5, Size (MM) 8 x 8, capacity (LPH): 2HP/RPM : 0.5/1440	1 No.
124.	Lazer alignment kit for pump & motor shaft (wireless 3 axix system)	With Wireless Integrated Bluetooth standard on all systems, Simple Step-by-Step Laser Alignment Procedure, Industry's Highest Laser Measurement Accuracy, "Live-Track" Dynamic Graphics, either 3-Axis, Fastest Auto-Sweep Laser Measurement, Full Colour 8" or 10" Touch Tablet, Long Life LiPO	1 No.

		Batteries for up to 15H+ operation Rugged Design, water resistant and dustproof to IP67, Distance/Range: 3m/6m, Extensive Software Features and Options.	
125.	Hydraulic jack		1 No.
126.	Hydraulic Trainer	with Equipment trays - 2nos., Pressure gauge – 2 nos., Hydraulic Motor -1 no., 4/2-way hand lever valve - 3no.s, 4/3-way hand lever valve with relieving mid-position - 3nos., 4/3-way hand lever valve with closed mid-position - 3nos., 4/3-way hand lever valve with recirculating mid-position - 3nos., Pressure sequence valve, pressure relief valve – 3nos., 3-way pressure reducing valve – 2nos., 2-way flow control valve – 2nos., One-way flow control valve - 4nos., Non-return valves – 4nos., Shut-off valve- 4nos., Diaphragm accumulator with shut-off block – 1no., Weight upto 10 kg- 1no., 2/2 way plunger / stem actuated – 2nos., Standard hoses with quick connectors, Flow dividing valve – 1no., 5-way distributor with pressure gauge - 1no.s, mounted on suitable frame structure.	1 No.
127.	Pressure Vessel with Control and Maintenance of Plant like Transmitters, Valves, Pumps and All Parameters Simulation Software and all accessories	Made up of M.S. with pressure transmitter, PLC module, HMI module, control valve, I/P converter, Pressure vessel, air regulator, pressure gauge, air compressor, current meter, safety valve, pressure relief valve, mounted on suitable frame structure.	1 No.

128.	Multistage compressor fitted with inter-cooler and after coolers (Cut model)	Made up of Transparent acrylic casing, with M.S. air compressor, 2 H.P. motor.	1 No.
129.	Screw Compressor - Rotary screw type compressor with 4 HP motor.		1 No.
130.	Lobe Compressor		1 No.
131.	Centrifugal blower		1 No.
132.	Electrical Baby Boiler	Made up of S.S. with electrical heater with thermostatic switch, Temperature indicator, thermally insulated, pressure relief valve, safety valve, pressure gauge, low level alarm, level gauge, drain valve, inlet valve.	1 No.
133.	Forced draft cooling	Tower made up of Acrylic of minimum 1 meter height, S.S.hot water tank with heater, S.S. pump, rotameter, manometer, blower, PID, multi zone temperature indicator, packings, PID with suitable piping, mounted on suitable frame structure.	1 No.
134.	Shell and tube heat	Exchanger made up ofS.S.300 mm long, 75 mm (D), S.S. hot water tank with heater, S.S. cold water tank, S.S. pump, rotameters 2 nos. PID, temp. indicator, temperature sensors 4 nos. with necessary piping, mounted on suitable frame structure.	1 Each
135.	Plate heat exchanger,	Made up of Acrylic of minimum 1 meter height, S.S. hot water tank with heater, S.S. pump, rotameter, manometer, blower, PID, multi zone temperature indicator, packings, PID with suitable piping, mounted on suitable frame structure.	1 Each
136.	Vertical tube evaporator	Made up of S.S. single effect evaporator of 900 mm (H) 100 mm (D), with steam generator,	1 No.

		S.S. feed tank, collecting tank 2 Nos., 2 nos. pumps, rotameters 2 nos., vacuum pump, shell & tube type condenser, PID, temp. indicator with suitable piping, mounted on suitable frame structure.	
137.	Packed distillation Column	Made up of S.S. of 1000 mm (H) 75 mm (D) with sight glasses, feed tank, cold water tank, steam generator, 4 rotameters, multi temperature indicator, Shell & Tube type heat exchanger, 2 S.S. pumps, reflux pump, distillate pump, Reflux drum, solenoid valve, product collection tank with necessary piping, mounted on suitable frame structure.	1 No.
138.	Plate and frame filter Press	Made up of Cast iron structure with plate and frame made up of P.P. of 300 mm x 300 mm size, S.S. slurry tank, S.S. pump, S.S. water tank, 2 cake trays, stirrer with suitable piping, mounted on suitable frame structure.	1 No.
139.	Bottom-driven centrifuge	Made up of S.S. 450 mm Diameter x 225 mm H, basket shell: 450 mm (D), Height of basket shell: 225 mm, Basket capacity, Filter area of basket: 0.32 SQ.MTRS. Basket speed: 1350 RPM, Drive motor: 1 H.P. 1440 RPM, 50 Hz with dual starter, Filter cloth, bottom discharge 1” valve. Ready to use.	1 No.
140.	Tray drier	Made up of S.S. from inside, with heaters, variable speed DC motor, Multi zone temperature indicator, weighing scale, PID. Ready to use instrument.	1 No.
141.	Hammer mill	Made up of M.S. of 200 mm (D) grinding chamber, 6 nos.	1 No.

		hammers, filter cloth, starter, energy meter.	
142.	Ball mill	Made up of S.S. of 450 mm (L) 300 mm (D), 50 S.S. balls, Dual starter, energy meter, RPM indicator, proximate sensor, variable speed.	1 No.
143.	Vibrating screen	Made up of M.S. of 18” width, 24” length, with 3 nos. of vibrating screens, motor, feed Hooper, filter cloth. Ready to use instrument.	1 No.
144.	Belt conveyor	Made up of nylon of 8” width, 60” length, FHP motor with gear box, bins 2 nos.	1 No.
145.	Venire Caliper	0 - 200 mm with least count 0.02mm	1 No.
146.	Venire Height Gauge	0 - 300 mm with least count = 0.02 mm	1 No.
147.	Venire Bevel Protractor	300 mm Blade with Acute Angle Attachment	1 No.
148.	Venire Depth Gauge	300 mm (L...C. 0.02mm)	1 No.
149.	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.
150.	Micrometer - Outside	0 - 25 mm	1 No.
151.	Micrometer - Outside	25 - 50 mm	1 No.
152.	Acetylene Cylinder		1 No.
153.	Oxygen Cylinders		1 No.
154.	Electric Spark Lighter		6 Nos.
155.	Oxygen Gas Pressure Regulator Double Stage		1 No.
156.	Acetylene Gas Pressure Regulator Double Stage		1 No.
157.	Rubber Hose - Acetylene, Diameter = 8 mm, Length = 10 meters		1 No.
158.	Rubber Hose - Oxygen, Diameter = 8 mm, Length = 10 meters		1 No.
159.	Rubber Hose Clips - 1/2 inch		6 Nos.

160.	Tong - Flat - 300 mm		4 Nos.
161.	cylinder Key		4 Nos.
162.	Gas welding torch with nozzle setwith Input voltage 415 (± 10%), Frequency – 50/60, Current range – 30/300, Efficiency - >85		1 No.
163.	Instrument for determining 'g' (Simple Pendulum)		1 No.
164.	Mechanical board for testing triangle and parallelogram of forces including all accessories		1 No.
165.	Inclined plane with pulley, pan, Hanger weights etc.		1 No.
166.	Simple machines - Screw Jack		1 No.
167.	Searle's Apparatus for young's Modulus		2 Nos.
168.	Calorimeter for determining Joule's mechanical Equivalent of heat and specific heat		1 No.
169.	Apparatus for measurement of co-efficient of expansion(thermal) of solid (pullinger's apparatus)with hot plate with heater, thermometer 2 nos. Ready to use instrument.		2 Nos.
170.	Apparatus for measurement of thermal conductivity of good and bad conductors made up of Diameter300 mm M.S. 20 mm,Asbestos15 mm, Wooden Slab 10 mm, J type sensors 8 nos.		1 No.
171.	Rheostat		
	(a) Rheostat 25 ohms		2 Nos.
	(b) Rheostat 100 ohms		2 Nos.
	(c) Rheostat 500 ohms		2 Nos.
172.	Resistance box	0 to 100 ohms	2 Nos.
173.	Resistance box	0 to 500 ohms	2 Nos.
174.	Resistance coils	(2 ohms, 5 ohms, 10 ohms, 100 ohms)	2 Nos.
175.	Ammeter		
	0 to 1000 mA. (DC)		2 Nos.
	0 to 1000 µA. (DC)		2 Nos.
	0 to 10 Amp. (AC, DC)		2 Nos.

176.	Voltmeter		
	0 to 1 volt (DC)		2 Nos.
	0 to 4 volt (DC)		2 Nos.
	0 to 5 volt (DC)		2 Nos.
	0 to 10 volt (DC)		2 Nos.
177.	Battery eliminator		2 Nos.
178.	Multi meter(digital)		2 Nos.
179.	Milli voltmeter	1) 0 - 5mv 2) 0- 500mv	2 Nos.
180.	Digital Stop Watch 1/10 Second		1 No.
181.	Steam generator (copper) Cap. 500ml		2 Nos.
182.	Arc Welding Cables Multi Cored Copper - 400 A, 50 Meter		1 No.
183.	Tip Cleaner Set		17 Nos.
184.	Welding goggle		6 Nos.
185.	Auto Darkening Welding Helmet		2 Nos.
186.	Gauge Feeler / Thickness	- 0.05 mm to 1 mm by 0.05 and	1 No.
187.	Pliers – combination	8”/20 cm	4 Nos.
188.	Phillips head screw driver set	1-4 sizes	1 No.
189.	Lapping Plate	300x300mm	1 No.
190.	Stud Extractor	Set of 8	1 No.
191.	Single row deep groove Ball Bearing no.6309		1 No.
192.	Cyndrical Roller Bearing NU307		1 No.
193.	Taper Roller Bearing 30208		1 No.
194.	Needle Roller Bearing		1 No.
195.			1 No.
196.	3 leg Bearing puller 6"		1 No.
197.	Bearing fitting kit including standard sleeve, mallet, Bearing induction heater		1 No.
198.	Bearing Testing Kit		1 No.
199.	Gear Box Reduction Type(Cut Section)	Made up of M.S Internal Part Transparent acrylic casing, 8” (D), Input- 1400 RPM, Output 140 RPM, Reduction Ratio - 10:1, Rated Torque - 630 Nm, Rated power - 5.0 KW at 1400	1 No.

		Rpm, Radial load - 7460 N, Thermal rating - 7.5 KW, Cut Section - 25 % of the casing, mounted on suitable frame structure.	
200.	Gear Box Planetary Bevel Gear Type(Cut Section)	Made up of Cast iron Casing, transparent Acrylic Casing, Size - 6", Input - 1400 Rpm, Output - 140 Rpm, Reduction Ratio - 10:1, Rated Torque - 630 Nm, Rated Power - 5.0 Kw At 1400 Rpm, Radial Load - 7460 N, Thermal Rating - 7.5 Kw, Cut Section of 25 % Of The Casing, mounted on suitable frame structure.	1 No.
201.	Cut section of Centrifugal pump of back pullout type		1 No.
202.	Mechanical seal (multiple spring)		1 No.
203.	Mechanical seal (Bellows seal)		1 No.
204.	Mechanical seal (single spring)		1 No.
205.	Pressure sensor with transmitter and display unit		1 No.
206.	Temperature sensor with transmitter and display unit		1 No.
207.	Level sensor with transmitter and display unit		1 No.
208.	Flow Meter		1 No.

Note:

1. *All the tools and equipment are to be procured as per BIS specification.*
2. *Internet facility is desired to be provided in the class room.*

ANNEXURE-II

The DGT sincerely acknowledges contributions of the Industries, State Directorates, Trade Experts, Domain Experts and all others who contributed in revising the curriculum.

Special acknowledgement is extended by DGT to the following expert members who had contributed immensely in this curriculum.

List of Expert members participated for finalizing the course curriculum of Maintenance Mechanic (Chemical Plant) at ITI, Ambernath, Maharashtra and ITC, Vadodara, Gujarat.

S No.	Name & Designation Sh./Mr./Ms.	Organization	Remarks
1.	Laxmidas Hinduja	Transpek Industries ltd, Gujarat	Chairman
2.	S. A. Pandav, RDD, Vadodara	DET, Gujarat	Coordinator
3.	L. K. Mukherjee, DDT	CSTARI, Kolkata	Coordinator
4.	AkashVergurlekar, Mechanical Maintenance Executive	VVF India Ltd. Taloja, Raigad	Member
5.	Jayesh Karnik, Instrumentation Maintenance Executive- Engg. Service	-do-	Member
6.	Pradeep Kumar Pandey, Asst. Deputy Manager	Century Rayon, Mumbai	Member
7.	Deepak M Kanitkar, Executive	Huhtamaki PPL Ltd, Bansri, Thopoli, Rigad	Member
8.	Atul D. Taksande, Sr. Executive P&A	Bombay Dyeing & Manufacturing Co., Patulganga	Member
9.	K. M. Unni Krishnan, Sr. Manager HR & Admin.	ASB International Pvt. Ltd., Ambernath	Member
10.	Ajit D. Bagwe, Manager- Molding	-do-	Member
11.	Rohan Kadlay, General Manager	Siemens Ltd., Mumbai	Member
12.	VidyadharTakle, Asst. Manager- Engg. Service	Godrej Industries Ltd., Ambernath	Member
13.	Roshan Vagade, QC- Engineer	Indore Composite Pvt. Ltd., Mumbai	Member
14.	Sandip D. Pisal, Asso. Chief Manager- Painter	Godrej & Boyce Manufacturing Co. Ltd, Mumbai	Member
15.	Rajendra Agashe, Manager- HR	Asian Paints India ltd. Taloja	Member
16.	Mahesh Bandekar, Coating Officer	Indore Composite Pvt. Ltd. Mumbai	Member
17.	Prashant A Bhosale, Sr. Manager- Production	Jubilant Life Science Ltd., N-34 Additional, Ambernath	Member
18.	Udayraj Ransing, Dy. Manager Engg.	-Do-	Member
19.	Pravin P. Khairnar	Gulbransenchemicals pvt. Ltd, Gujarat	Member

20.	Sudhir C. joshi	GNFC, Vadodara	Member
21.	N.C. Chauhan	Deepak nitrate ltd, Vadodara	Member
22.	S.S. Singh	Alembic ltd	Member
23.	Mukeshm. chauhan	Centurian remedies pvt ltd, Vadodara	Member
24.	Kamlesh G. Prajapati	Technology exchange pvt. Ltd, Gujarat	Member
25.	Kundan kumar	Lupin limited, Gujarat	Member
26.	Nitin R. Patel	Reliance industries, Gujarat	Member
DGT & Training Institute			
27.	A.N. Mancharkar, CI	ITI Ambernath, Thane	Member
28.	S. D. Bait, Craft Instructor	ITI Ambernath, Thane	Member
29.	H. N. Bargal, Group Instructor	ITI Ambernath, Thane	Member
30.	Sudhakar P. Patil, CI	BTRI Mahad	Member
31.	Prashant R. Patil, CI	ITI Nagothane	Member
32.	S.G. Thakur, Jr. App. Advisor	BTRI Mahad	Member
33.	G. N. Rathwa (Principal)	ITI Sankheda, Vadodara	Member
34.	Ku. B. P. Solanki (SI MMCP)	ITI Tarsali, Vadodara	Member
35.	MK Batyabal, TO	CSTARI, Kolkata	Member
36.	PK Bairagi, TO	CSTARI, Kolkata	Member

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


कौशलं बलम्