

Directorate General of Employment & Training

COURSE CURRICULA IN THE AREA / SECTOR  
OF

**Advanced Modules**

“PROCESS PLANT MAINTENANCE”

**FOR UPGRADATION OF**

ITI's into

CENTRE OF EXCELLENCE

INDEX  
UPGRADATION OF ITI's INTO  
CENTRE OF EXCELLENCE  
SECTOR: **PROCESS PLANT MAINTENANCE**  
ADVANCE TRAINING (2nd Year)

<b>ADVANCE MODULE</b>	<b>NAME OF THE ADVANCE MODULE</b>	<b>DURATION IN WEEKS</b>	<b>Space Required Sq. mt.</b>
PPMAM-01	Operator Chemical Plant	24 Weeks	100
PPMAM-02	Operation & Maintenance of Boiler & Steam turbine	24 Weeks	100
PPMAM-03	Mechanical Maintenance of Process Plant	24 Weeks	100

**Upgradation of ITIs into Centres of Excellence-**  
**Broad guidelines for implementation of Advanced Module of Sector**  
**“Processes Plant Maintenance”.**

These Centres will be providing multiskill training to meet the skill requirement of particular sector of industry with their active involvement in all aspects of training. The training will be provided in three parts as given below:

- ◆ Training in Basic skill areas for a period of one year.
- ◆ Training in Advanced modules of six months duration after Broad based basic Training(BBBT)
- ◆ Testing & Certification both for the Broad Based Basic Training & Advanced Module Training during subsequent six months will be conducted under the aegis of NCVT .
- ◆ Training in specialized modules mainly by the industry (The course curricula, duration etc will be designed in consultations with the IMC/local industry). The trade testing & certification for specialized module will be done jointly by the State Government & Industry. Said certificate will have recognition from NCVT
- ◆ As per the recommendations of the EFC, Training in the shop floor should constitute atleast 25-40% of the curriculum.

The training programme will have multi-entry and multi-exit provisions as given below:

- trainee can opt to go to the labour market after completing broad based basic training of one year duration or after completing advanced module/s.
- multi-entry and multi-exit provisions would enable a trainee to take admission for advanced/ additional advanced /specialized module as per his/her need .

**Guidelines for Training in Advanced modules**

- ▷ A minimum of three modules would be essentially needed , so as to ensure that all the 96 trainees are accommodated in the three modules may be selected in consultation with IMC for which in two shifts .
- ▷ If it is felt that available modules for which the course curricula has been developed at National Level are not sufficient to cater to the needs of local industry in a particular state, States are free to select module as per need in consultation with industry . They may develop suitable module(s) accordingly in consultations with the industry clearly indicating tool & equipment list , instructor qualifications , space norms etc. & forward the same to DGE&T for seeking approval of NCVT.
- ▷ A trainee at a time can opt only for one Advanced Module .
- ▷ Admission Criteria, Space requirement, Qualification of instructor of the various modules of **“Processes Plant Maintenance ”** sector are attached herewith.

**Admission to Advanced Module for the graduates of ITI in related trades:**

There is a provision for lateral entry for graduates of ITIs (NTC /NAC passed outs from conventional system ) of the related trades subject to availability of seats in Advanced Module. Trades of conventional system mentioned against each advanced module in the enclosed statement, could be offered admission in Advanced Module .

MODULE NO.	NAME OF THE MODULE	Admission criteria	Space requirement	Duration In Weeks	Qualification/Status Of Instructors
PPMA M-01	Operator Chemical Plant	Completed BBBT in Processes Plant Maintenance (PPM) OR NTC/NAC in relevant trade OR Diploma in relevant trade	100 sq m	24 weeks	Degree in Chemical Engg with minimum three years teaching/industrial experience in the relevant field
PPMA M-02	Operation & Maintenance of Boiler & Steam turbine	Completed BBBT in PPM OR NTC/NAC in relevant trade OR Diploma in relevant trade			OR Diploma in Chemical Engineering with min five years teaching/industrial experience in the relevant field
PPMA M-03	Mechanical Maintenance of Process Plant	Completed BBBT in PPM OR NTC/NAC in relevant trade OR Diploma in relevant trade			OR HNTC in Related area with min five years teaching/industrial experience in the relevant field .

## Members of the Trade committee for Advance Module of Process Plant Maintenance

- 1- Y. N. Singh  
General Manager (Tech.)  
Kashi Vishwanath Steels Ltd.,  
Kashipur (U. S. Nagar)
- 2- Manav Sharma  
Dy. Gen. Manager  
India Glycols Ltd.,  
Kashipur (U. S. Nagar)
- 3- Mayank Agrawal  
Principal  
Govt. I. T. I.,  
Kashipur (U. S. Nagar)
- 4- R. P. Gupta  
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Kashi Vishwanath Steels Ltd.,  
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- 7- Raj Deep Sharma  
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- 8- Abhishek Kumar  
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The Co-operative Sugar Mill  
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- 9- Dixit  
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India Glycols Ltd.,  
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- 11- Prabhu Nath  
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- 12- Shailendra Singh  
Asstt. Engineer  
U.A.S. & D. C.  
Haldi (U. S. Nagar)
- 13- Lokendra Singh  
Mech. Foreman  
Banwari Paper Mills Ltd.,  
Kashipur (U. S. Nagar)
- 14- Ram Iqbal  
Instrument Sup.  
D. S. M. Sugar Mill Ltd.,  
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## Syllabus for the trade of Advance Module

PPMAM – 1 Operator Chemical Plant

Duration – 24 Weeks

Week No.	Practical	Theoretical
1	2	3
1	Introduction to safety equipment and their uses etc. Awareness of First aid, fire fighting equipments & hydrant system, MSDS, PPEs.	Importance of safety & general precautions observed In the workshop. Role of maintenance mechanic in the chemical Industries. Course contents, duration. Rules pertaining facilities available in the institute medical library and gymkhana.
2	Physics (1) To study triangular and parallelogram of force with the help of mechanical board. (2) Determination of efficient of static friction using inclined plan. (3) Determination of mechanical advantage. Velocity ratio & % efficiency of simple machine. (4) Determination of acceleration due to gravity by simple pendulum. (5) Determination of young's modulus by Searle's apparatus.	Objectives procedure apparatus required explanation & calculation involved in the experiments.
3	(1) Determination of coefficient of expansion of solid and liquid. (2) Determination of coefficient of thermal conductivity of metal rod. (3) Determination of rotation constant of optically active substance by polarimeter.	Objectives procedure apparatus required explanation & calculation involved in the experiments.
4	(1) To study of Ohm's Law and Kirchoff's Law about current and Voltage. (2) To study of electric Cell using series and parallel connections. (3) Determination of specific resistance using Wheat stone's bridge. (4) Verification of Faraday's 1st Law of electrolysis. (5) Determination of mechanical equivalent of heat using electrical method.	Objectives procedure apparatus required explanation & calculation involved in the experiments.
5	Chemistry Separation of mixture by distillation	Objectives procedure apparatus required explanation & calculation involved in the experiments.
6	Preparation of following (a) Soap (b) Nitrobenzene (c) Aniline (d) Copper sulphate (e) Ferrous ammonium & sulphate	Objectives procedure apparatus required explanation & calculation involved in the experiments.
7	To study the allotropic forms of sulphur.	Objectives procedure apparatus required explanation & calculation involved in the experiments.
8	To study of properties of mixture (Fe+S) and compound (FeS)	Objectives procedure apparatus required explanation & calculation involved in the

		experiments.
9	To study action of pure and salt water on metal and alloys.	Objectives procedure apparatus required explanation & calculation involved in the experiments.
10	To study action of acids and bases on metals alloys.	Objectives procedure apparatus required explanation & calculation involved in the experiments.
11	To study the corrosion of metal.	Objectives procedure apparatus required explanation & calculation involved in the experiments.
12	Volumetric analysis. Qualitative analysis (Inorganic) (Simple with out interfering radicals). Determination of flash point.	Objectives procedure apparatus required explanation & calculation involved in the experiments.
13	Use and maintenance of lagging materials such as glass wool, thermocol etc.	Lagging materials, types and uses.
14	(1) Installation of venturimeter orifice meter and Rota meter. (2) Determination of viscosity of liquids by viscometer.	Procedure of installing venturimeter orifice and rotameter precautions to be observed.
15	To Determine Reynolds's number at different velocities.	Procedure of installing venturimeter orifice and rotameter precautions to be observed
16	Determine friction losses in a straight pipe fitting, valve.	Procedure of installing venturimeter orifice and rotameter precautions to be observed
17	To calculate overall heat transfer co-efficient for a cell and tube heat exchange.	Procedure of installing venturimeter orifice and rotameter precautions to be observed
18	To find rate of evaporation of vertical tube of evaporator.	Procedure of installing venturimeter orifice and rotameter precautions to be observed
19	Separation of a liquid mixture by distillation using Packed tower.	Procedure of installing venturimeter orifice and rotameter precautions to be observed
20	Flooding velocity experiment using a packed tower made of glass.	Procedure of installing venturimeter orifice and rotameter precautions to be observed
21	Finding rate of drawing curve by tray drier. Calibration of resistance thermocouple. Experiment on a level measurement	Procedure of installing venturimeter orifice and rotameter precautions to be observed
22	Operation of (1) Plate and frame fitter press. (2) Top driven centrifuge (3) Ball mill (4) Blake jaw crusher	Construction, principle, trouble, shooting and precautions to be observed during operation of the equipments. Sketches of the equipment.
23	(1) To carry out sieve analysis with sieve shaker. (2) Operation of a mixture settler. (3) Operation of a spray extraction tower. Calibration of Bi-metallic	Procedure of conducting experiments calculation and precautions to be observed sketch of the equipment.
24	Calibration Of Bourdon tube pressure gauges. (1) Manometers Calibration of mercury in glass thermometer.	Units of pressure, measurements of pressure by different methods. Temperature, its units and different methods of measurements.

**LIST OF TOOLS AND EQUIPMENT: ATTENDANT OPERATOR  
(CHEMICAL PLANT)**

Sr No	Particulars	Quantity
<b>1</b>	<b>2</b>	<b>3</b>
	<b>For Unit Operation Laboratory</b>	
1	Venturimeter	01
2	Orificemeter	01
3	Rotameter	01
4	Centrifugal pumps – 2 Nos	02
5	Gear pump	01
6	Reynolds experiment equipment	01
7	Shell and tube heat exchanger	01
8	Boiler	01
9	Vertical tube evaporator	01
10	Packed distillation column	01
11	Packed tower of glass for flooding velocity experiment	01
12	Plate and frame filter press	01
13	Top – driven centrifuge	01
14	Rotary vacuum filter	01
15	Tray drier	02
16	Hammer Mill	01
17	Ball Mill	01
18	Black jaw crusher	01
19	Mixer-settler type extractor	01
20	Spray extraction tower	01
21	Viscometer	04
22	Lobe blower for filter press	01
23	Weighing machine	01
24	Multistage compressor fitted with inter-coolers and after coolers	01
25	Sieve shaker and sieves	01 set
	<b>For Physics Laboratory</b>	
1	Physical balance (with weight box)	01 set
2	Chemical balance (with weigh box)	03 sets
3	Viscometer (a) CS Wald Viscometer (b) Redwood viscometer (c) Stop watch(1/10 <sup>th</sup> Second) (d) Thermostatic bath	3 pieces 3 pieces 6 pieces 2 pieces
4	Stalagmeter	6 pieces
5	Travelling microscope	03
6	Specific gravity bottle	06
7	Pyknometer	06
8	Mechanical board for testing triangle and parallelogram of forces including all accessories	6 sets
9	Spirit level	3 sets
10	Inclined plane with pulley, pan, weights etc	2 sets
11	Simple machines (wheel and axel), Screw jack inclined plane with roller or trolley, pulleys or pulley blocks for first, second and third system of pulleys)	1 set
12	Different types of levers	1 set
13	Instrument for determining 'g' (simple pendulum)	2 sets
14	Barometer	01
15	Altimeter	01
16	Searle's apparatus for young's module	02 sets
17	Nicolson Hydrometer with glass jar	02 sets
18	Wet and dry bulb thermometer	02 sets
19	Apparatus for measurement specific heat of solid and liquid (Regnaults Apparatus)	2 sets
20	Apparatus for measurement of co-efficient of expansion (thermal) of solid and liquid.	2 sets
21	Apparatus for measurement of thermal conductivity of good and bad conductors.	2 sets
22	Salorimeter for determining 'Soules' Mechanic equivalent of heat and specific heat.	4 sets
23	Thermometers : (i) 0 to 11 C (ii) 0 to 36 C (iii) 0 to 250 C	2 dozen 1 dozen 1 dozen
24	Polarimeter with monochromatic light	2 sets
25	Abbe refractometer	2 sets
26	Fulfrish Refractometer	2 sets
27	Equipment to study Kirchoff's law and electro chemical equivalent	1 set
28	Potentiometer	2 sets
29	Wheatstone's bridge	2 sets
30	Resistances centre zero Galvanometer	4

31	pH meter	1 set
32	Charger for battery accumulator	1 set
33	12 volt hand operated Dynamo, Daniell cell, Weston cell, Acidic cell, head accumulator, Alkali cell with variable resistance leclanche cell,	2 sets
34	Multimeter	2 sets
35	Battery eliminator	02
36	Diode valve	04 sets
37	Triod valve	04
38	Electric dry oven 200 <sup>o</sup> c	1
39	Furnace 1100 <sup>o</sup> c.	1
40	Water bath electrically heated	2
41	Microscopes	3
42	Refrigerator 200 lit	1
<b>FURNITURE</b>		
1	Instructor table 1200x760mm	02
2	Instructor chair with arm	02
3	Steel stool 300x300x450mm	16
4	Discussion table 3000x1200x760mm	02
5	Steel almirah 1980x900x450mm	06
6	Steel rack 6 shelves	05
7	Steel lockers 8 holes	06
8	Fire extinguishers foam, CO2,DCP,ABC,Water CO2	04
9	Fire buckets on stand	08
10	Artificial respiration chart	04
11	First aid box	01
12	Black board with stand	01
13	Student table	16
14	Working bench size 2000 x 1200 x1000 mm	04

## Syllabus for Advance Module

### PPMAM – 2 Operations and Maintenance of Boiler & Steam Turbine

WEEK NO.	PRACTICAL	THEORY
1	Operation of various types of valves. Check valve, stop valve, by pass valve, Gate valve, beadle valve, steam valve etc.	<b>Industrial fuels:</b> Solid, liquid and gaseous Solid fuels – coal, peat, lignite, etc.. Properties of coal – coal preparation and cleaning, size of coal and storage of coal, Oxidation and deterioration of coal in storage.
2	Operation of fans and blowers like forced draft fans, induced draft fans etc including starting, stopping capacity adjustment etc.	Elementary principles of combustion and methods of firing different fuels I n boilers. Chemical re-action and factors affecting combustion such as temperature, surface area etc. The product of combustion specific heat of gases. Air supply and effects of excess and in sufficient primary and secondary air o n combustion. Ash fusion – analysis of the gases.
3	Operation of fuel (i.e. Coal/Oil/Gas) feeding mechanism including adjustment of flow of coal, Grate drive and draft regulation for proper combustion. Use of mechanical stoker.	<b>Steam.</b> its heating and power properties. Principles of steam and application in Modern Boilers. Steam preventing, escape of heat, lagging, stream distribution, charging of steam and water line, steam quality, condensate handling, traps etc. Wet steam saturated steam, super heated steam and their properties. Boiling point, temperature and pressure relations, sensible heat, latest heat super heat, reheat and total heat, Use of steam table and entropy chart.
4	Normal level control in Boilers. Operation and reading of gauge glass etc. Level control during the emergency operations and use of blow down valves.	<b>Heat Transmission:</b> Methods of heat transfer – conduction - transmission of heat through boiler plate and composite walls as well pipe coverings, convection – natural and forced, convection in liquids, heat transfer from condensing vapors – Boiler circulation and Radiation.
5	Reading and control of steam pressure and steam flow. Operation of super heater and re-heater. Control of super heat and reheat temperature.	<b>Steam Generator. (Boiler)</b> Internal pressure versus stress; elementary knowledge of Boiler drum construction and development and drum internals. Boiler metallurgy. Types of boilers. Fire tube boilers, locomotive boilers, cornish boiler, Lancashire boiler, water tube boilers, vertical tubular boiler, Economic boiler, Waste heat Boilers and Electric Boilers. Advantages of water tube boilers – Over fire tube boilers and bent tube boilers, over straight tube boilers. Difference between box type header and sectional header. Types of water walls used for furnace and their purpose. Use and types of baffles. ,Feed water temperature Elementary furnace design – water circulation. Effects of high temperature o n boiler steel.
6	Operation of water softener equipment including feed water softener. Clarificulators precipitators, filters, chemical dosing etc. Pre and post chlorination system. Reactivation of I on exchanges etc.	<b>Boiler Auxiliary Plant.</b> Boiler mountings and fittings; Description and use of safety valves, Blow down valves, check valves, combination stop and check valves, gauge glasses (mounted and remote type) draught pressure gauges, fusible plugs, re-heater, chain grate and spreader stoker etc. Different types of drum water level gauges and flame indicators. Use and advantage of televised viewers, for drum water level and furnace flame.
7	Correct use of various types of cocks, mountings and accessories used on Boilers. Firing and raising, steam and blow down in Boilers – precautions to be taken – procedure to be	<b>Burners and Firing.</b> Types of pulverized fuel burners and their control function dof each component of the burner – purpose of primary and secondary air supply methods of transporting pulverized fuel from coal mills to

	observed before starting, firing and when raising steam.	burners. Arrangements of burner for tangential firing, horizontal front firing, single down shot and double down shot firing etc. Causes and remedy of fires in coal burners pipes. Safety precautions to be adopted in cases of fires causes, effects and preventions of furnace explosives. Importance of furnace purging and how it is achieved, types of oil burners in use. Injection of oil steam, mechanical atomization of oil, study of typical oil burners and purpose of each component. Types of oil ignition torches – their function and use. Description and use of spark ignitors and oil sweeps of oil torches. Gas firing system.
8	Operation of boiler feed pumps – starting and stopping, including emergency operation. Purpose of balance chamber, leak off and recirculation line. Checking and correctness of pressure gauge.	<b>Stocking and boiler operation.</b> Methods of hand and mechanical firing water level- glow down – cleaning fires – banking up fires – cleaning heating surface – case of refractories – carbon losses clinker formation – difference between the use pulverized fuels in boilers and firing on grates, Emergency operations explosion hazards feed pumps failure. I.D. or F.D.. fan failure, Grate or stocker failures and fuel oil pump failure.
9	Internal conditioning of Boiler water by checking the TDS and alkalinity by blow down to prevent scaling, priming, carry over and caustic gauging. Conditioning of steam and condensate cycle. Importance of silica in high pressure Boilers and how it is controlled.	<b>Super Heater, Re-heater and De-Super heaters.</b> Different types of super heaters and their function – Location of super heaters in high temperature and high pressure boilers. Requirement of a super heater. Methods of controlling super heat temperature of steam. Effects of temperature on super heater tubes. Purpose and general application of De-super heaters. Advantage and disadvantage of two general types of De-super heater. Importance of drains and vents in super heaters.
10	Periodic cleaning and filling the boiler with demineralized or condensate for prevention of scale or other deposits on heating surfaces.	<b>Soot Blowers.</b> Purpose and types of soot blowers. Fixed and Retarding types and their use. Precautionary measures taken while soot blowing. Methods of soot blowing and cleaning boiler furnace during operation.
11	Periodical inspection of Boilers – preparation of boilers for testing – Hydraulic test and steam test. Precautions to be taken before entering or allowing persons to enter a boiler which is connected to another boiler on the steam.	<b>Feed Water Regulator and boiler feed water pumps.</b> Method of regulating feed water to boiler. Description and use of bailes type of feed water regulation valve and purpose of by-pass valve in the system. Different types of feed water pumps. Constructional details of multistage pump. Use of re-circulation line and balance chamber. Purpose of balance drum and of pump warning line and speed control.
12	Correct method of firing and combustion control for prevention of smoke. Testing the correctness of gauge glass and cocks by blowing through them.	<b>Water Treatment.</b> Object of feed water treatment – water analysis water of high pressure boilers. Impurities in water and their harmful effects. Effects of other suspended matter such as oil, alkalinity, hardness etc. In feed water – total dissolved solids – methods of purification – use of Deaerators – priming and foaming – scale formation and corrosion. Chemical cleaning of boiler, softening and demineraliser plant.
13	Priming of Boiler – the danger of water logging steam pipes and precautions to be observed in running. Replacement of gauge glass.	<b>Boiler Inspection.</b> Knowledge of Indian boilers Act and rules,. Isolating Boiler for cleaning and inspection. Offering boiler for hydraulic test and open inspection.
14	Adjustment of safety valves for correct blowing – pressure. Detection of false water level and knowledge of alarm devices.	Knowledge of modern packages types boilers and automatic boilers, their advantages over other boilers. Different types. Efficiency of Boiler (Overall and thermal).
15	Boiler safety precautions. Observation of easing a safety valve. Use of blow down cock or valve.	<b>Boiler Testing.</b> Losses due to incomplete combustion, loss due to escape of solid combustible matter with ash, soot, etc. Loss due to escape of combustible gases.

		Chimney loss, heat carried away by moisture formed from Hydrogen, loss due to radiation and other losses – summarized neat account.
16	Cleaning of oil torches. Adjustment of high steam and low water safety valve. Renewal of fuseable plus. Use of spark ignitors and oil pumps for oil torches.	Knowledge of different methods of fixing tubes by expending with ferrules, changing of gland packings, grinding and adjusting coocks and valve etc. <b>Study of Boiler Act/ Rules 1923</b>
17	Study of turbine-construction of different parts. Study of steam cylinder, steam chest, diaphragms rotor blades, discs, glands, coupling, bearing etc.	Steam turbine-fundamental principals, impulse and reaction, their meanings, examples of impulsive and reactive forces, conversion of heat energy in a steam turbine, condensing and non- condensing turbines, mixed pressures, back pressures and pass out machines compounding, pressures compounding and velocity compounding.
18 & 19	Study, Operation and adjustment of turbine governor, different types, method of working of synchronizing governor, over speed governor, speed limit governor and emergency shut off devices. The trainee must get a through practical idea of manual remote control of governors	Classification of steam turbine. According to – 1-Blading or nozzle arrangement impulse reaction and impulse reaction, delaval curties, reteau, zeely parsons systems. 2-Service and steam conditions: high pressure, non-condensing, exhaust steam turbine. 3-Kinds of stage: single, Double or multiple velocity stages only, reaction stages only, pressure stages only, pressure and velocity stages. Reaction and velocity stages compounding, pressure compounding, velocity compounding. Direction of flow: axial, tangential and radial. Division of flow: single, double, semi-doubles, Types of construction: horizontal or vertical.
20 & 21	Turbine plant operation- starting an condensing plant, starting a steam turbine from cold condition, method of running up to speed necessity of slow and uniform heating, critical speed avoiding, vibration at critical speeds, care to be taken when removing and applying load on turbo-alternators, stopping a turbine , sequence of operations, stopping the condensing plant and other auxiliaries, Study of feed water and steam cycle, Turning gear.	Nomenclature and parts of a turbine, simple features of construction and functions of nozzles, blades, rotors, discs, cylinders, steam chest, diaphragms, glands, coupling, bearing, thrust balancing, reduction gear, lubrication system, governors, pressure regulators, protective devices etc. Turbine plant auxiliary: condensers including air ejectors- types, surface condenser, jet condenser function and construction.
22	Operation of steam pressure reducing station and H.P.,L.P. by pass station.	Governing mechanism and regulating systems both hydrodynamic and mechanical system: Principal of governing, nozzle and throttle governing, by-pass governing, stability and sensitivity of governors, their construction and method of working, over speed governors, speed limit governors, emergency shut off governors, oil relay, compound oil relay.
23	Turbine troubles and remedies-study of abnormalities during operation and remedical measures. Troubles, such as loss of vacuum, air leakage, low oil pressure, hot bearing etc. vibration-their causes and remedies	Turbine plant operation: general instruction for starting and stopping a steam turbine, running up turbines from cold and warm and hot conditions, steady load operation, effect of load changes, emergency operations, shutting down, care to be taken when removing and applying load to turn-alternators, routes care and inspection during normal operation, isolation for maintenance, defects in glands and bearing, loss of vacuum, causes and remedy, condenser tube leakage, air leakage detection.
24	Condensers- water flow, steam flow, constant water level control starting a condensing plant and stopping it. Care and precautions to prevent loss of vacuum, causes of loss of vacuum, remedies,	Turbine troubles and remedies: Vibration of shaft, disc, blade, internal defects of material, failure due to faulty machining of rotor, discs, critical speed damage due to unbalance of rotating parts- avoiding it. Failure of

<p>air leakage, condenser cleaning methods.</p> <p>Pumps-centrifugal and reciprocating, starting a centrifugal pump, different method of priming, putting the pumps on load, care and maintenance of running pumps.</p> <p>Air ejectors- different types steam hydraulic, starting ejectors, sequence of operation, stopping it, starting an ejector in conjunction with a condensing plant.</p> <p>Function and use of evaporators, drain collars and feed heaters, putting them into operation and taking them out of operation, maintenance of proper feed water temperature.</p> <p>Atmospheric relief valve and others safety devices.</p> <p>Compressors, operations, care and maintenance.</p> <p>Cooling water system.</p> <p>Reheat and regenerative system.</p>	<p>diaphragms distortion, corrosion and erosion of turbine blades, their causes and remedies, checking up of blades, coupling, alignment of turbine and alternator rotors.</p>
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## List of Tools and Equipments of Operation & Maintenance of Boiler & Steam Turbine

Sr. 1	Particulars 2	Quantity 3
1	Measuring tape 3 meter	16
2	Inside spring caliper 200 mm	16
3	Outside spring caliper 200 mm	16
4	Ball pin Hammer – 200 gm	16
5	Fix spanner 23 mm set 9 spanner	16
6	Ring spanner 6 to 23 mm	16
7	Chisel cold flat 20x150 mm	16
8	Steal scale 300 mm engineering	16
9	Try square 200 mm	16
10	Screw driver 300 mm	16
11	Centre punch 100 mm x 100 mm	16
12	Scriber 150 mm	16
13	Bradawl 200 mm	16
14	Odd leg caliper spring type 200 mm	16
15	Out side spring caliper 400 mm	02
16	Inside spring caliper 400 mm	02
17	Ball pin hammer 400 gm	04
18	Flat chisel cold 25 x 200 mm	02
19	Cross cut chisel 150 mm	02
20	Sledge hammer 2 kg	01
21	Cross pin hammer 400 gm	02
22	Mallet	02
23	Teflon hammer	01
24	Vernier caliper 200 mm digital type	01
25	Vernier caliper 150 mm digital type	01
26	Micrometer 0-25 mm	01
27	Depth meter 0-300 mm	01
28	Slip gauge set	01
29	Feeler gauge leaf type 26 blades eng. & metric	02
30	Radius gauge leaf type 1to 15 mm	01
31	Digi matic thickness gauge	01
32	Universal Bevel protector	01
33	Pipe wrench 200 mm	02
34	Pipe wrench 300 mm	02
35	Adjustable wrench 250 mm	02
36	Combination pliers 200 mm	08
37	Long nose pliers 200 mm	04
38	Flat file bastard 250 mm	08
39	Flat file smooth 250 mm	08
40	Flat file rough cut 250 mm	04
41	Flat file rough cut 300 mm	08
42	Half round file smooth - 250 mm	04
43	Half round file rough – 250 mm	04
44	Round file smooth – 200 mm	04
45	Round file Smooth – 200 mm	04
46	Triangular file – 150 mm	04
47	Square file – 200 mm	04
48	Needle file set	04
49	Allen key 12,14,15,16,18,20,22 mm	02 each
50	Ring spanner 25x28, 24x26	02 each
51	Torque wrench	01
52	Tap set B S W	01
53	Die set B S W	01
54	Box spanner socket set 12.7 mm square drive hexagonal sockets set of size 10,11,12,13,14,15,16, 17,18,19, 21, 22,23,24,26,27,28,29,30,32,33,34 with accessories	02
55	Anvil big size	01
56	Surface plate 400x400 mm	01
57	'V' Block	02
58	Hack saw frame adjustable 300 mm	08
59	Grease gun	02
60	Oil cane 500 ml	02
61	Screw Driver 400 mm	02
62	Screw Driver 300 mm	02
63	Try square 300 mm	02
64	Tap set metric	01

65	Die set metric	01
66	Bench vice 150 mm	04
<b>General Machinery</b>		
1	IBR fire tube boiler of capacity 4 ton pressure 8 kg/cm <sup>2</sup> with all IBR accessories and general safety devices required to operate it like ID fan, FD fan, chimney, pressure safety valve, burner, feed pumps, pre -heater, fuel tank cap. 10 kl, fuel pump, with DCS/PLC based control panel	01
2	IBR water tube boiler trainer model	01
3	Steam turbine driven with the help above steam boiler with all accessories general and safety devices with DCS/PLC based control panel	01
4	Stream turbine trainer model	01
5	Pressure safety valve 12 kg/ cm <sup>2</sup>	01
6	Steam traps of different kinds	01 each
7	Gauge glass	02
8	Oil torches of different types	01 each
9	Pressure gauge 20 kg/ cm <sup>2</sup>	02
10	Temperature gauge 300° C	02
11	Vacuum gauge	02
12	Boiler tube cleaning machine with accessories	01
13	Hydraulic pump with pressure gauge cap. 20 kg/ cm <sup>2</sup>	01
14	Water softening plant required for above boiler with all accessories	01
<b>FURNITURE</b>		
1	Instructor chair with arm	02
2	Instructor Table size 1200 x 760 x 760 mm with 3 drawers	02
3	Steel stool size 450 x 300 x 300 mm	20
4	Discussion table size 3000 x 1200 x 760 mm	02
5	Steel almirah size 1980 x 450 x 1200 mm	06
6	Steel racks size 2400 x 1500 x 450 mm	02
7	Steel racks size 760 x 1500 x 450 mm	06
8	Book shelf	01
9	Black board with stand	01
10	Steel locker containing 10 cell	02
11	Fire extinguisher	02
12	Fire buckets with stand	02
13	First aid box	01
14	Artificial respiration chart	01
15	Working bench size 3000 x 1500 x 1000 mm	02

## Syllabus for Advance Module

**PPMAM -3 Mechanical maintenance of Process Plant  
Weeks**

**Duration – 24**

Week	Practical	Theory
1	2	3
1 to 4	Construction, dismantling and assembling of centrifugal pumps (Single & Multistage) with gland and mechanical seal and its accessories.	Principle of centrifugal force, study and types of centrifugal pumps. Types of impellers according to construction and material.
5	Construction, dismantling and assembling of vacuum pumps its accessories.	Principle of Water ring vacuum pumps etc.
6	Construction, dismantling and assembling of reciprocating pumps with its accessories	Study and principle of positive displacement pumps like reciprocating, gear, vane pumps etc. Use according to type of material.
7	Construction, dismantling and assembling of gear pumps with its accessories	Study and principle of positive displacement pumps like reciprocating, gear, vane pumps etc. Use according to type of material.
8 to 10	Construction, dismantling and assembling of reciprocating compressor – air, refrigerant compressor and its accessories & safety switches.	Study and principle of positive displacement compressors – reciprocating, twin and lobe etc.
11	Construction, dismantling and assembling of centrifugal compressors and its accessories & safety switches.	Study and principle of centrifugal type compressors and its accessories.
12& 13	Construction and operation of different types of valves – Ball, gate, globe, non return valve, diaphragm & needle.	Study and principle of different types of valves and their usages according to their handling.
14 to 15	Construction and maintenance of refrigeration plant with its equipments and safety devices.	Principle of refrigeration, types of refrigerants their usages, types of safety devices etc.
16 & 17	Construction and maintenance of air conditioning plant with its equipments and safety devices.	Principle of air conditioning system, types of refrigerants their usages, types of safety devices etc.
18 & 19	Construction, dismantling and assembling of different types of heat exchangers, gasket cutting, choke removal, tube replacement.	Study of heat exchangers – tube and shell type, plate type. Types of gaskets with their use.
20 & 21	Assembling and opening of pipe lines having different types of joints like flange, screw, weld etc.	Study of pipe material with according to different types of fluids and their joints.
22	Fixing and dismantling of bearings with the help of different types of attachments.	Study of different types of bearings and their uses, lubrication of bearings.
23	Operation and maintenance of types of belts, chains, couplings and joints and chain pulley blocks	Study of types of belts, chains, couplings and joints, chain pulley blocks s
24	Overhauling and maintenance of gearboxes.	Study of different types reduction speed gear boxes.

## List of Tools and Equipments for Mechanical Maintenance of Process Plant

Sr	Particulars	Quantity
1	2	3
1	Measuring tape 3 meter	16
2	Inside spring caliper 200 mm	16
3	Outside spring caliper 200 mm	16
4	Ball pin Hammer – 200 gm	16
5	Fix spanner 23 mm set 9 spanner	16
6	Ring spanner 6 to 23 mm	16
7	Chisel cold flat 20x150 mm	16
8	Steal scale 300 mm engineering	16
9	Try square 200 mm	16
10	Screw driver 300 mm	16
11	Centre punch 100 mm x 100 mm	16
12	Scriber 150 mm	16
13	Bradawl 200 mm	16
14	Odd leg caliper spring type 200 mm	16
15	Out side spring caliper 400 mm	02
16	Inside spring caliper 400 mm	02
17	Ball pin hammer 400 gm	04
18	Flat chisel cold 25 x 200 mm	02
19	Cross cut chisel 150 mm	02
20	Sledge hammer 2 kg	01
21	Cross pin hammer 400 gm	02
22	Mallet	02
23	Teflon hammer	01
24	Vernier caliper 200 mm digital type	01
25	Vernier caliper 150 mm digital type	01
26	Micrometer 0-25 mm	01
27	Depth meter 0-300 mm	01
28	Slip gauge set	01
29	Feeler gauge leaf type 26 blades eng. & metric	02
30	Radius gauge leaf type 1to 15 mm	01
31	Digi matic thickness gauge	01
32	Universal Bevel protector	01
33	Pipe wrench 200 mm	02
34	Pipe wrench 300 mm	02
35	Adjustable wrench 250 mm	02
36	Combination pliers 200 mm	08
37	Long nose pliers 200 mm	04
38	Flat file bastard 250 mm	08
39	Flat file smooth 250 mm	08
40	Flat file rough cut 250 mm	04
41	Flat file rough cut 300 mm	08
42	Half round file smooth - 250 mm	04
43	Half round file rough – 250 mm	04
44	Round file smooth – 200 mm	04
45	Round file Smooth – 200 mm	04
46	Triangular file – 150 mm	04
47	Square file – 200 mm	04
48	Needle file set	04
49	Allen key 12,14,15,16,18,20,22 mm	02 each
50	Ring spanner 25x28, 24x26	02 each
51	Torque wrench	01
52	Tap set B S W	01
53	Die set B S W	01
54	Box spanner socket set 12.7 mm square drive hexagonal sockets set of size 10,11,12,13,14,15,16,17, 18,19,21,22, 23, 24,26,27,28,29,30,32,33,34 with accessories	02
55	Anvil big size	01
56	Surface plate 400x400 mm	01
57	'V' Block	02
58	Hack saw frame adjustable 300 mm	08
59	Grease gun	02
60	Oil cane 500 ml	02
61	Screw Driver 400 mm	02
62	Screw Driver 300 mm	02
63	Try square 300 mm	02
64	Tap set metric	01
65	Die set metric	01
66	Bench vice 150 mm	08

67	Pipe vice 100 mm	02
68	Internal circlip plier straight 150 mm	04
69	External circlip plier spring type 150 mm	04
70	Water pump plier slip joint 250 mm	04
<b>General Machinery</b>		
1	Gland type centrifugal pump with closed impeller Dis. Cap- 1m <sup>3</sup> /hr with suitable ISI motor	02
2	Mechanical seal type centrifugal pump with open impeller Dis. Cap- 2 m <sup>3</sup> /hr with suitable ISI motor	02
3	Gland type four stage centrifugal pump semi open impeller Dis. Cap- 3 m <sup>3</sup> /hr with suitable ISI motor	02
4	Stainless steal centrifugal pump Dis. Cap- 3 m <sup>3</sup> /hr with suitable ISI motor	01
5	Water ring type vacuum pump Dis. Cap- 3 m <sup>3</sup> /hr with suitable ISI motor	02
6	Reciprocating type vacuum pump Dis. Cap- 4 m <sup>3</sup> /hr with suitable ISI motor	01
7	External gear pump (Herring bone gears) Dis. Cap- 4 m <sup>3</sup> /hr with suitable ISI motor	02
8	Internal gear pump (Spur gear ) Dis. Cap- 3 m <sup>3</sup> /hr with suitable ISI motor	01
9	Two stage double acting Air Compressor with all accessories like receiver, safety devices etc. with suitable ISI motor	01
10	Single stage air compressor with all accessories with suitable ISI motor	01
11	Single stage double acting refrigerant compressors with safety devices with suitable ISI motor	01
12	Centrifugal compressor with all accessories with suitable ISI motor	01
13	S.S. Ball valve single piece construction 1"	04
14	C.S. Ball valve one piece construction ½" & two piece construction 2"	04 each
15	C.S. gate valve 2" & 4"	02 each
16	C.S. globe valve 3"	02
17	Non return valve ½", ¾", 1", 4"	02 each
18	Diaphragm valve 1"	02
19	S.S. Needle valve 1½"	02
20	Two pass cast steal U tube type heat exchanger with M.S. shell size dia 12", no of tubes 24, dia ¾"	02
21	Six pass straight tube type heat exchanger with M.S. shell size dia 16", no of tubes 36, dia 1"	01
22	Four pass straight tube type heat exchanger with M.S. shell size dia 10", no of tubes 16, dia ½"	01
23	S.S. plate type heat exchanger having four plates size 36"	01
24	Choke removal pump with accessories	01
25	Flanges as per I.S. Code size 12 mm, 19 mm, 25 mm, 50 mm	05 each
26	Collar type flanges size 50 mm, 75 mm & 100 mm	04 each
27	Bearing puller	02
28	Ball bearing 6004, 6110, 6212, 6420	01 each
29	Roller bearing of different sizes	01 each
30	Taper roller bearing	02 each
31	Needle roller bearing	02 each
32	Flange coupling size 100 mm, 150 mm with rubber bushes	01 each
33	Tyre coupling size 150 mm	02
34	Spider type coupling 75 mm, 100 mm	02 each
35	Knuckle joint size 6"	02
36	Kotter joint	01
37	Different types of chains	01 meter
38	Gear Box reduction type ratio 1:4 rack & pinion	01
39	Gear Box reduction type ratio 1:10 rack & pinion	01
40	Lapping plate along with lapping paste of different grades	01
41	Hydraulic pump with pressure gauge upto 20 kg/cm <sup>2</sup>	01
42	Power hacksaw machine of blade size 600 mm	01
43	Pedestal Grinder with coarse and fine grinding wheels size 300 mm	01
44	Angle hand grinding machine	01
45	Strainer Y-type	02
46	Strainer bucket type	01
47	Spring loaded safety valve capacity 5 kg/cm <sup>2</sup>	01
48	Chain pulley block one tonne	01
49	G.I. Wire rope dia 12 mm	20 meter
50	D shackles	04
51	Root blower	01
52	All geared Lathe machine admit between centres 1500 mm with all accessories	01
53	Drill machine cap. 20 mm geared with all accessories	01
54	All geared shaping machine cap. 450 mm with all accessories	01
<b>FURNITURE</b>		
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4	Discussion table size 3000 x 1200 x 760 mm	02
5	Steel almirah size 1980 x 450 x 1200 mm	06
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7	Steel racks size 760 x 1500 x 450 mm	06
8	Book shelf	01
9	Black board with stand	01
10	Steel locker containing 10 cell	03
11	Fire extinguisher	02
12	Fire buckets with stand	02
13	First aid box	01
14	Artificial respiration chart	01
15	Working bench size 3000 x 1500 x 1000 mm	03
16	Steel bench size 2000 x 450 x 450 mm	06