MAHARASHTRA STATE BOARD OF VOCTIONAL EDUCATION EXAMINATION, MUMBAI 51

1	**Name of Course**	**Diploma Course in Boiler attendant**
2	**Course Code**	303433
3	**Max no. of Students**	25
4	**Duration**	2 year
5	**Course Type**	Full Time
6	**No. of Days per week**	6 days
7	**No. of hours per day**	7 Hrs
8	**Space require**	Theory Class Room – 200 sqft Three Practical Lab – 500 sqft each
9	**Entry qualification**	S.S.C. Pass
10	**Objective of syllabus**	1. Awareness of safety precaution 2. Knowledge of engineering skill, use of tools in assembly 3. Awareness of chemical plant 4. Awareness of maintenance of boiler & steam turbine in chemical plant 5. Awareness of basic fitting , turning & machinery
11	**Employment opportunities**	The trainee will either to be able to take up jobs with agencies which develop, maintain, repairs operation & maintenance of boiler & steam turbine. Work as or with working experience will be in a position to start his own independent business.
12	**Teachers Qualification**	1) For Vocational subject - B.E.Mech. 2) For Non Vocational Subject - Master Degree in Concern subject

13 **Teaching Scheme –**

Sr.	Subject	Subject Code	Clock Hours / Week		Total
			Theory	Practical	
1	**English (Communication Skill)**	90000001	2 Hrs	1 Hrs	3 Hrs
2	**Elective – I**		2 Hrs	1 Hrs	3 Hrs
3	**Elective – II**		2 Hrs	1 Hrs	3 Hrs
4	MECH. TECHN. MATERIAL SCIENCE	30340001	3 Hrs	8 Hrs	11 Hrs
5	**BOILER THEORY**	30340044	3 Hrs	8 Hrs	11 Hrs
6	**UNIT OPERATION & PROCESS**	30340034	3 Hrs	8 Hrs	11 Hrs
Total					**42 Hrs**

14	**Internship**	Two Month Summer Internship from 1st May to 30th June is Compulsory.

15 **Examination Scheme – Final Examination will be based on syllabus of both years.**

Paper	Subject	Subject Code	Theory			Practical			Total	
			Duration	Max	Min	Duration	Max	Min	Max	Min
1	English Communication skill)	90000001	3 Hrs	**70**	**25**	3 Hrs	**30**	**15**	**100**	**40**
2	Elective – I		3 Hrs	**70**	**25**	3 Hrs	**30**	**15**	**100**	**40**
3	Elective – II		3 Hrs	**70**	**25**	3 Hrs	**30**	**15**	**100**	**40**
4	MECH. TECHN. MATERIAL SCIENCE	30340001	3 Hrs	**100**	**35**	3 Hrs	**100**	**50**	**200**	**85**
5	BOILER THEORY	30340044	3 Hrs	**100**	**35**	3 Hrs	**100**	**50**	**200**	**85**
6	UNIT OPERATION & PROCESS	30340034	3 Hrs	**100**	**35**	3 Hrs	**100**	**50**	**200**	**85**
	Total								**900**	**375**

16 **Teachers –** Three Teachers per batch for vocational component. For English, Elective-I & II guest faculty on clock hour basis.

17 a) For Elective I – Student can choose any one subject

Code	Subject Name
90000011	**Applied Mathematics**
90000012	**Business Economics**
90000013	**Physical Biology (Botany & Zoology)**
90000014	**Entrepreneurship**
90000015	**Psychology**

b) For Elective II – Student can choose any one subject

Code	Subject Name
90000021	**Applied Sciences (Physics & Chemistry)**
90000022	**Computer Application**
90000023	**Business Mathematics**

Subject Name - Mechanical Technology and Material Science

Subject Code - 30340001

Theory – 1st year	Practical – 1st year
1] **Fundamental of material** □ Introduction of metals and non metals □ Structure of metal □ Formation of grain □ Imperfection in crystals □ Deformation in metal and change in properties □ Fracture □ Equilibrium diagram □ Iron, carbon equilibrium diagram □ Time temperature transformation diagrams	1. Take the tensile test of M.S. specimen & Draw stress strain diagram, yield pts.
2 **Ferrous metals and alloys** □ Pig iron and cast iron □ Effect of chemical elements on iron □ Classification of steel and its application □ Alloy steel and special alloy steel 3 **Non Ferrous metals and alloys** Introduction to non ferrous alloys □ Aluminum and its alloys □ Copper and its alloys □ Lead and its alloys □ Nickel and its alloys □ Alloys for high temperature service □ Metal for nuclear energy 4 **Crystal Structures** □ Fundamental concept □ Unit Cells □ Metallic crystal structures □ FCC Structure □ BCC Structure □ HCP Structure □ Weld ability 5 **Properties of Metal** □ **Mechanical properties of Metal** Elasticity, ductility, malleability, brittleness, Toughness, Stress strain behavior, Elastic limit, hooks Law, UTS, poisons ratio, factor of safety, hardness and hardness tests shear strength, resistance. □ **Electrical properties of Metal** Electrical conductivity, resistivity, electrical Characteristic of commercial alloys	2. Study the mechanical properties like Elasticity, ductility, malleability, Brittleness, toughness of Different materials – M.S., C.S. Bronze, Copper, Aluminum Study the Hardness test □ Brinnel Hardness test □ Rockwell hardness test

Theory – 1st year	Practical – 1st year
Thermal properties of metal Heat capacity, thermal expansion, thermal Conductivity, thermal stress 6 **Magnetic Properties of metal** Basic concepts, diamagnetism and Para magnetism, ferromagnetism, influence of temperature on magnetic behavior, domain and hystersis, soft and hard magnetic material. 7 **Heat Treatment of material** Normalizing Hardening Quenching and tempering Annealing Stress Relieving Case carburizing and case hardening. Toughening Weld ability of Metal definition and concept Effect of alloying elements on weld ability Purpose and types of weld ability tests	3. Study the Electrical Properties of some conductors (conductivity, Resistively) Aluminum, Copper, Brass, Tungsten
8 **Cracking phenomena in steel** Cold crack due to hydrogen Hydrogen cracking Measurement and control of hydrogen in the deposited weld metal Cracking mechanism in the weld metal and HAZ Weld decay Lamellar tearing Hot cracking Reheat cracking	4. Study the effect on materials with heat treatment Normalizing, Hardening, Quenching & Tempering Anne ling, Stress Reliving, Case Hardening, Toughing For Different Material's M.S., C.S.,Nickel,Capper

Theory – 2nd year	Practical – 2nd year
1 Bench work and fitting Introduction- Vices – Hammers- Chisels- Chipping- Files- Filling- Scrapper-Scraping- Grinding and Polishing- Hacksaw sawing- Marking tools – Surface plate- Scriber – Punch- V block- Angle plate- Try square – Marking out – Drill- Drilling- Reamer- Reaming- Taps- Tap drill size-Tapping – Dies and stock- Dieing. **2 Sheet Metal Work** Introduction – Metal used in sheet metal work- Sheet metal hand tools- Sheet metal operation-Sheet metal joint- Hems and Sems – Sheet metal allowance- Sheet Metal working machine-Laying out a pattern **3 Plumbing, Threading, Fasteners & joints** Plumbing- Specifications of pipes- Material used for pipes-Pipe fitting & Joints-Taps & valves – Plumber tools – Threaded fasteners- screw threads and their uses- Indian standard threads-Cap screw and machine screw-Set screw- Methods of producing screw threads- Bolts- Studs- Forms of nuts- Riveting joints. **4 Smithy and Forging** Maintenance and application of smith health- Anvil- Swage block-Tongs-Hammer-Flatters- Measuring tools e.g.-Try square- Steel rules- Calipers-Operations e.g. up setting- drawing down- bending setting- forge welding. **5 Welding Technology** Welding Welding introduction to different welding processes, like gas Welding, ARC welding TIG, MIG, submerged arc welding, spot Welding, electrodes etc. Brazing methods & application, Knowledge of welding skills. **6 Metal Turning (Lathe)** 6.1 Function of lathe, Types of lathe, the size of lathe, Descriptions & function of lathe parts, 6.2 Lathe accessories and attachments. 6.3 Operation on Lathe 6.4 Cutting Tools, Classification , Influence of tool angles. 6.5 Types of tools, cutting speed, Feed, Depth of cut, 6.6 Machining time. Cutting tool signature.	**Fitting** 1. Filing Flat surfaces: Checking flatness and square ness using a try square – Types of filing – Cleaning files. 2. Chipping: Hints on chipping 3. Hack sawing: Selection of blades for different metal sections - Fix hack sawing the material for the job blades maintaining. Correct tension and direction – Hack sawing. Filing 'V groove and complex profile by file & check with profile gauge. 4. Filing radius –check with radius gauge 5. Check profile with profile gauges. 6. Drill plate, Drilling, counter sinking, counter boring. Operations on job 7. Drilling and Tapping: Internal threading of holes by using hand taps – determine the tap drill size, drilling, counter-sinking and tapping – precautions with tapping a blind hole. 8. External thread cutting using die.

Theory – 2nd year	Practical – 2nd year
7 DRILLING Introduction Types of drilling machine, Portable drilling machine, Sensitive drilling machine. Upright drilling machine, Radial Drilling Machine; Gang drilling machine, Multiple spindle drilling machine Automatic drilling machine, Deep hole drilling machine; The size of a drilling machine, Upright drilling machine parts. Radial drilling machine parts, Work holding devices, Tool holding devices, Drilling machine operation, Drilling machine tools. Twist drill nomenclature. Drill size Designation of drill material Reamer, reamer nomenclatures. Counter bore, Countersinks and spot face, Taps. Tap nomenclatures. Cutting speed Feed, Depth of cut, Machining time in drilling	**Basic Workshop Practice** 1. Step turning and Radius forming: Free hand form turning – by using form tool. 2. Drilling and Boring-Use of inside caliper and outside Micrometer for bore measurement. 3. Drilling and reaming: by hand-Method of checking the bore With a plug gauge. 4. Drilling and step Boring: Boring blind hole with a boring tool.
8 SHAPER Introduction. Types of shapers. Principal parts. Shaper size; Shaper mechanism; Work holding devices. Shaper operations. Shaper tools; Cutting speed, feed and depth of cut; Machining time. **9 SLOTTING** Introduction. Types of slotting machine; Slotter size; Slotting machine parts; Work holding devices; Slotter operation; Slotter tools; Cutting speed, feed and depth of cut.	5. Drilling, Boring and Recessing: Internal recessing to a size broader than the width tool – Form a recess. 6. Shaping blind & open keyways on shaping machine 7. Shaping irregular surfaces.(Concave / Convex)
Powder Metallurgy Introduction- Process Description-Manufacture of metal powder- Blending of powders- competing profiteering- Sintering-Secondary operation –ISO Static pressing – Product of powder metallurgy-Advantages of process – Disadvantages and limitation-Design considerations Introduction to CNC	8. Slotting internal grooves on slotting machine 9. Welding Practical-fusion run with/without filler rod on MS Sheet – squire butt joint on MS sheet LAP,T& Edge joint on M.S. Sheet

List of Books

1 M. N. Uppal A Text - book of ngineering Chemistry
2 V. P. Mehta A Text - book of polytechnic Chemistry
3 Banswal, Mahajan and Mehta A Text - book of,Applied Chemistry
4 Hazra Choudhary Elements,of workshop technology
5 S.K.Hajra Choudhary Elements of workshop technology Vol-I First 1964 Media promoters & Publisher pvt. Ltd.
6 Mahajan Mechanical Technology Third 1989 Vrinda publication

Sr. No.	Name of the equipment/ machinery	NOS.
1	TRAINEES TOOL KIT	5
2	Try Square 10 cm Blade	5
3	Calipers outside 15 cm spring	5
4	Caliper inside 15 cm spring	5
5	Dividers 15 cm Spring	5
6	Calipers 15 cm Hermaphrodite	5
7	Scriber 15 cm	5
8	Punch center 10 cm	5
9	Screw driver 15 cm	5
10	Chisel cold 20 cm	5
11	Trammel 30 cm	5
12	Hammer ball peen 0.5 kg with handle	5
13	Hammer Mallet	5
14	Hammer Plastic	5
15	Hammer ball peen 0.5 kg with handle	5
16	File flat 25 cm second cut	5
17	File flat 25 cm second cut	5
18	Hacksaw frame adjustable 20-30 cm	5
19	Dot slot punch	5
20	Steel rule 15 cm English and metric	5
21	Steel rule 30 cm English and metric	5
22	Try square 20 cm Blade	5
23	Steel tool box	5
24	Scriber	5
25	Lock and keys	5
26	Combination plier	5
27	Jenny calipers	5
28	Aluminum tray 15 cm X 10 cm	5
29	Fellow polish cloth standard size	5

	SHOP OUTFIT & MEASURING INSTRUMENTS	
30	Straight edge 45 cm X 45 cm	1
31	Marking table 90X90 cm	1
32	Surface plate 45 cm X 45 cm	1
33	Vee Block pair 7 cm and 15 cm with clamps	1
34	Angle plate 10 X 20cm	1
35	Number Punch 3 mm set	2
36	letter Punch 3 mm set	2
37	Round punch 3 mm X 4 mm set of 2	2
38	File flat 20 cm bastard	2
39	Oil Stone 15 X 5 cm X 2.5 cm	
40	Spanner adjustable 10 cm	1
41	Chisel cold 20 cm cross cut	2
42	Chisel 10 cm flat	2
43	Drill twist 1.5 mm to 15mm (various sizes) by 0.5	2
44	Files assorted sizes and type including safe edge	10
45	Micrometer inside 50-150 mm with screen	2
46	Bench Vice 12 cm jaw	5
47	Work Bench 240 X 120 60 mm with screen	3
48	Drill point angle gauge	1
49	Vernier Calipers 20 cm	2
50	Vernier height gauge 30 cm	1
51	Huntington and diamond dresser	1
52	Taps and dies complete set (metric)	2 set
53	Hacksaw frame	5
54	Fire buckets with stand	1
55	Thread pitch gauge metric, BSX, BSF, MC, MF & SAE	1 each
56	D.E. spanner ser of 12 metric 6 mm to 32 mm	1 set
57	Ring spanner set at 12 metric 6 mm to 32	1 set
58	Stud extractor set of 3	1 set
59	Universal puller for removing pulleys, bearings	1 set
60	Unserviceable engine/gear box rear axle	1
61	Stud remover with socket handle	1
62	Combination pliers 15 cm	5
63	Depth guage (inch and metric	1
64	Screw pinch gauge (inch and metric)	1 set
65	Feeler gauge 20 blades (inch and metric)	1
66	Aluminum tray 45 X 30 mm	5
67	Oil can 0.5 liter capacity	1
68	Surface gauge	1
69	Cylinder bore gauge (mercer)	1
70	Telescopic gauge	1
71	Steel measuring tape 10 meter in a case	2
72	Sets of Morse socket MT 0-1,1-2,and 2-3	1 set
73	Blow lamp	1
74	Torque wrenches 5-35 Nm,12-68 Nm&50-225 Nm.	1 each
75	Outside micrometer English 0-1,1-2,2-3,3-4,4-5,And 5-6 inches	1 each

76	Micrometer outside 1 to 25 mm,25mmto 50mm ,50 to75 mm,75 to100mm,100 to 125mm,125 to 150mm.	1
77	Surface gauge with dial test indicator plunger type i.e. 0.01 mm	1
78	Printed wall chart framed for display showing measuring instruments.	10
79	Inside micrometer English 2” to 6” with extension road	1
80	Vernier bevel protractor (metric and inch)	1
81	Vernier calipers (inch and metric) 6”x12”	1
82	Vernier micrometers(inch and metric)	1
83	Vernier height gauge 150 mm height (inch and metric)	1
84	Dial micrometer (inch and metric)	1
85	Small bore gauge (standard)	1
86	Dial test indicator to read (inch an metric)0.02mm	1
	GENERAL INSTALLATOIN /MACHINERIES	
87	Radial Drilling Machine 25mm capacity	1
88	Power Hacksaw	1
89	Rotary Cut off Machine	1
90	Shaping machine	1
91	Hydraulic Press 2 ton capacity	1
92	Surface plate (small)	1
93	Surface plate (big)	1
94	Standard Arc Welding machine	1
95	Horizontal milling machine	1
96	Bench Drilling machine 6-12mm cap Motorized with chuck and key	1
97	Grinding machine (general purpose)D.E. pedestal with 300mm dia wheels rough and smooth	1
98	Hydraulic Trainer with Power pack	1
99	Pneumatic Trainer	1
	Workshop furniture	
100	Suitable Work Tables with vices As required	1
101	Stools 25 Nos	25
102	Tool Cabinet 2 nos	2
103	Trainees locker 2 nos	2
104	Fire fighting equipment , first aid box etc As required	1
105	Book shelf (glass panel) 1 nos	1
106	Storage Rack As required	2
107	Storage shelf As required	2

SUBJECT NAME : BOILER THEORY
SUBJECT CODE : 30340044

FIRST YEAR

1. Reading & recording of process variable like pressure, temperature, flow etc.
2. Cleaning work area and equipments removing dust, washing etc. precaution in case of moving machinery
3. Lubrication: - Pumping out lubricating oil from drums, Reading oil to bearing of equipments, pump etc. Use of grease gun operation oil filters both centrifugal and stationary.
4. Operation of various types of valves , by pass valves , gate valve, beedle valve , steam valve etc, setting of feed water and steam regulators as well as serve control valves
5. Pumps – Operation of different types pumps including reciprocating , centrifugal and gear , pumps , starting including priming where applicable normal stopping g emergency stopping (in case of power failure) central of flow etc.
6. Operation of fan and blowers like forced drafts fans, induce draft fans etc. Including starting, stopping capacity adjustment etc.
7. Operation of steam driven equipments like feed water pumps, fans , etc including starting , stopping & capacity adjustment
8. A) Operation of fuel (i.e. coal/ oil / gas) feeding mechanism including adjustment of flow of coal , Create drive and draft regulation for proper combustion .use of mechanical stoker
   b) Study burners for oil and gas and also filters
9. Operation of ash disposal plant. Function and maintenance of pumps, hydro actors, hydroajectors, clinker grinder and submerged type ash plants
10. Normal level control in boilers- Operation & reading of gauge glass etc. level control during the emergency operation and use of blow down valves
11. Reading and control of stem pressure and steam flow.
12. Operation of super heater and re – heater control of superheat and reheat temperature
13. Operation of steam pressure reducing station for auxiliary steam supply for oil heater, detractor passing and process steam, if any
14. Operation of water softener equipment including feed water softener, Clarificulators precipitators, filters, chemical dosing etc. Pre and post chlorination system. Reactivation of ion exchanges etc.
15. Working and management of steam boiler and economizer
16. Operation of pulverizes, exhausters, P.A. fans , coal scale, coal feeders , coal classifiers etc. Regulation of primary air , secondary air and flame shape , use of pilot oil terches both as flame stabilizer and at start , use of load carrying oil burners , if any and regulation of air for proper combination of oil . Adjustment of coal fitness.
17. Correct use of various types of cocks, mounting and accessories used on boilers
18. Firing and raising, steam and blow down in Boilers – Precautions to be taken – procedure to be observed before starting, firing & when raising steam

19. Operation of boiler feed pump – starting & stopping, including emergency operation. Purpose of balance chamber, leak off & recirculation line. Checking & correctness of pressure gauges.
20. Internal conditioning of boiler water by checking the TDS & alkenity by blow down to prevent, sealing, priming, carry over & caustic gauging
21. Conditioning of steel & condensate cycle, importance of silica in high pressure boilers & how it is controlled
22. Periodical cleaning in the boiler with deminraled & cons ate for prevention of scale or other deposit on heating surfaces
23. Periodical inspection of boilers. Preparation of boiler for testing , hydraulic test & stem test
24. Precaution to be taken before entering or alloying person to enter a boiler which is connected to another boiler on the steam
25. Correct method of firing & combustion control for prevention of smoke
26. Testing the correctness of gauge glass & cocks by blowing through them
27. Priming of boiler – the danger of water logging steam pipes & precaution to be observed in running
28. Replacement of gauge glass
29. Procedure to be followed in the event of shortage of water , bulging or facture of furnace of flat plates or bursting of tubes or of any accident to a boiler or steam pipe
30. Adjustment of safety valves for correct blowing pressure
31. Precaution to be taken when starting ansconomiser to work after period of rest.
32. Detection of false water level and knowledge of alarm device.
33. Procedure to be adopted in putting as economizer into commission and also in putting it out of commission when boiler is on steam.
34. Checking and renewal of gland packing of pump and valve.
35. Correct method of stocking boiler including cleaning and banking fires in a workman like manner to prevent avoidable smoke.
36. Checking and adjustment of cocks and valve.
37. Working knowledge and fitting of feed pump and injector.
38. Working of feed water heaters and daierstors.
39. Boiler safety precaution.
40. Observation of easing a safety valve. Use of blow down cock or valve.
41. Cleaning oil torches.
42. Adjustment of high stream and low water safety valve. Renewal of fusible plage.
43. Use of spark igniters and oil sump for oil torches.
44. Cleaning of economizer by using appropriate appliances.
45. Interlock tripping of boiler auxiliaries and basic knowledge of purgainers lock
46. Operation and working of multicar dust collectors & electrostatic precipitators
47. Emergency operation of boiler in the event of –
    a) Loss of fire
    b) Failure of one FD fan
    c) Failure of one ID fan
    d) Failure of one Air pre – heater
    e) Boiler tube

f) Failure of economizer tube furnace tube & super heater tube

g) Failure of boiler feed pump and sudden leas of read

j) Blooking of coal passage

k) Failure of lagging

l) Jamming of the grate. Failure of gauge glass

48) Soot blowing and boiler furnace cleaning during operation. Use and care of different types of soot blowers.

49) Importance of draft temperature reading at special loads. Interpretation of , deviation from slandered reading for identical loads .

50) Economical working of boilers

51) Entry and up keeping of log sheet, trouble log etc.

52) Observation of use, operation & maintenance of modern package type and automatic boilers

SECOND YEAR

1. Safeties at work – accident do not happen they are caused. Fire precautions causes and types of fire, precautions against outbreak of fire .fire extinguisher type's end uses. Boiler safety rules knowledge of boiler, rules & safety precautions & using electrical appliances.
2. Revision of the work of previous year.
3. Industrial fuels solid, liquid and gaseous solid fuels coal & deterioration of coal in storage. Principal constituents &classification of coals .coal size grading &moisture conditioning volatile matter , matter moisture & ash content ,calorific value fusion of ash & clinkering liquid &gaseous fuel slow speed diesel ,bunker (heavy &light furnace oil) blast equivalent of fuels ,grading of fuels &effect of impurities on combustion.
4. Fuel handling plant :-arrangement for receiving ,storage &conveying of coal to bounders , arrangement for receiving ,storage transporting fuel oil, need of heaters when using high density fuel oils.
5. Pulverize(coal mill) different types of pulverizes used in modern boiler , difference in design provision for removal of tramp iron &pyrites methods used for removal of moisture from coal undergoing pulverization ,function &theory of operation of classifiers importance of fine ness of pulverized fuel & methods of controlling it factors effecting fineness range of outlet temperature for direct fired installation bin system of firing hazard with pulverized fuel &precaution ,measure necessary to minimize these hazards .coal feeders their types &use . Grind ability of coals &its importance to pulverize operation precautions to be observed in case emergence shut down &in case of fire in pulverizes.
6. Elementary principle of combustion & methods of firing different fuels in boilers. Chemical reaction & factors affecting combustion such as temperature surface area etc the product of combustion specific heat of gases. Air supply and affects of excess and in sufficient primary & secondary air on combustion. Ash fusion – analysis of the gases
7. Steam – Its heating & power properties; Principles of stem and application in modern Boiler. Steam preventing, escape of heat. Lagging stem, steam distribution, charging of steam quality, condsate 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 super heat , reheat and total heat . Use of steam table and entropy chart.
8. Heat transmission - Methods of heat transfer – conduction- transmission of heat trough boiler plate & composite as well as pipe coverings, convection – natural and forced , convectioning in liquids , heat transfer from condensing vapour – boiler circulation and radiation.
9. Steam generator – (Boiler) – Internal pressure versus stress, elementary knowledge of boiler drum construction and development and drum internals. Boiler metallurgy, types of boiler . fire tube boiler ,locomotive boiler , Cornish boiler , lancagire boiler ,water tube boiler , vertical tubular boiler, economic boiler , waste heat boiler , electric boiler . Advantages of water tube boiler over fire tube boiler and bent tube boilers over straight tube boiler. 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 circulations effects of high temperature on boiler steel.
10. Boiler Auxiliary plant -
    Boiler mountings and fitting , Description and use of water safety valves , Blow down valves , check valves, combustion stop and check valves , gauge glasses (mounted and remove type) draught pressure gauge , fusible plug , reheated , chain grate and spreader stocker etc. Different types of drum water level gauges and flame indicators. Use and advantages of televised viewers for drum water level and furnace flame.

DRAUGHTS

i) Methods for obtaining draughts and their management neutral forced regulated draught; pressurized and balanced draught furnace. Advantages and disadvantages of each – General arrangements of ID fans and F.D. fans Control by gas circulation spread regulation of ID fans

ii) Burner and firing –

Types of pulverized fuel burners and their control function of each component of the burner – purpose of primary and secondary air supply method of transporting ovlvarised fuel from coal mills to burners. Arrangement of burners for tangential firing, horizontal front firing, and single down shot and double down shot firing etc causes and remedies of fires in coal burners and burner pipes. Safety precautions to be adopted in case of fires causes, effects and preventions of furnace explosive. Importance of furnace purging and how it is achieved, types of oil burners in use. Injection of oil steam, mechanical automation of oil, study of typical oil burners and purpose of each component. Types of oil ignition touch their function and use. Description and use of spark igniters and oil gas firing system.

11. Stoking and boiler operation –

Methods of hand and mechanical firing water level glow down. Cleaning fires banking to fires. Cleaning heating surface care of refractoriness' – carbon losses clinkers. Formation – difference between the use pulverized fuel in the ocilers and firing on grates. Emergency operation explosion hazard feed pump failure FD fan failure, grate or stocker failures and fuel oil pump failure.

12. Super heaters , Reheater and De – super heater :-

Different types of super heaters and their function – Location of super heater vin high temperature and high pressure boiler. Requirement of super heat temperature of steam. Effects of temperature on superheated tube. Purpose and general application of de – super heaters. Advantage & disadvantages of two general types of de- superheated. Importance of drain and vents in super heaters.

13. Economizer:- types of economizer &their function in high temp. &high pressure boilers procedure to be followed if economizer gets steam bound .purpose of reciprocating, lines in economizer.
14. Soot Blowers.:-purpose & types of soot blowers .fixed &retarding types &their use precautionary measures taken while soot blowing .methods of soot blowing &cleaning boiler furnace during operation .
15. Air Pre-heater:-recuperative & regenative types of air pre heater &their advantage &disadvantage, location of air pre heater & f.o.fans temp. Limit to which air can be pre heater.
16. Feed water heaters.- bleeding of turbine & use of bled steam for heater feed water. Description &use of closed type of feed water & deacrator feed water heater.
17. Feed water regulator:-method of regulation feed water to boiler description &use of bailes types of feed water regulation valve &purpose of by pase valvation the system.
18. Boiler feed water pumps :- different types of feed water pumps .construction details of a multistage pump .use of circulation line & balance chamber .purpose balance draw &of pump waiming line & speed control

19. Water treatment-
    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 solid – methods of purification - use of decameters – priming and foaming, scale formation and corrosion, chemical cleaning of boilers, softening and demineraliser plant
20. a) Use of Co2 indicator and reconder, smoke density indicators and reconder, stem flow meter , hot water meter 10 pt , thermometer
    b) Boiler protection system
21. Boiler inspection
    Knowledge of Indian boiler act & rules. Isolating boiler for cleaning and inspection. Offering boiler for hydraulic test and open inspection
22. Ash handling system: Typical methods of handling bottom ash and fly ash in boilers using pulverized fuel. Description and use of cyclone type of mechanical dust collectors and multicores.Description,function and use of hydrovactors,hydroijectors,clinkers and grinders, method of ash disposal in these plants, vacuum system for disposal of fly ash and bottom ash. Principle and function of an electro static precipitator. Constructional detail of a typical precipitator. Description and function of sub merged type of ash plant.
23. Lubrication: Elementary knowledge of principle of lubrication. Lubricants – oil and greases as used in boilers and accessories, importance of lubrication for machinery, methods of lubrications.
24. Knowledge of different methods of fixing tubes by expanding with ferrules, changing of gland packing, grinding and adjusting cocks and valves etc
25. Knowledge of modern packages types boilers and automatic boilers, their advantages over other boilers, Different types, efficiency of boilers, (overall and thermal)
26. Modern development in trade – New techniques etc.

26 (a) Boiler Testing – Losses due to incomplete combustion, escape of solid combustion, matter with ash, soot, etc. Loss due to escape of combustible gases .Chimney loss, heat carried away by moisture from by hydrogen, loss due to radiation and other losses

27. Quality and finish of work – Importance of quality and finish of job at all stages
28. Introduction to work amplification – job study, job analysis including the planning of sequences of operation, critical approach and method of working, Estimation of time & material
29. Revision & test
    ISI specification to be understood and followed
    i) Colour code for identification of pipe lines used in thermal power station – 9404 - 1979
    ii) Parameters of stationary steam boilers recommended 8596-1977
    iii) Parameters of stationary stem boilers , terminology for 8595 – 1977

SUBJECT NAME : UNIT OPERATION & UNIT PROCESS
SUBJECT CODE : 30340034

THEORY	PRACTICAL
Flow of fluids	Pipes – Method of joining them, Expansion joints, Valves, Safety devices, Diaphragm control valve, Steam trap, Reynolds numbers, Bernoulli's, equation
Heat transfer	Modes of heat transfer thermal conductivity,
Evaporation	Horizontal, vertical tube, forced circulation and falling film evaporators
Distillation	Introduction boiling point diagram equilibriums curve
Extraction and leaching	Extraction and leaching application of liquid - liquid extraction, Theory, definition, choice of solvent, distribution coefficient
Absorption and Adsorption stripping	Introduction, equilibrium mass transfer coefficient, factors affecting rate of absorption, absorption towers
Crystallization	Introduction, classification of crystallizes
Drying	Introduction, vapor pressure, curve for water, relative humidity and other definitions tray drier
Filtration	Introduction, factors affecting filtration, classification of filters
Size reduction and screening	Introduction and classification of equipments, crushing and grinding
Humidification and cooling towers Refrigeration and air conditioning	Introduction, defamations, Humidity, and types of cooling towers Introduction, definitions, terms involved various equipments used in refrigeration and air cooling
Mixing	Mixing liquids with liquid, mixing solids with solids, mixing solids with liquid and equipment used
Introduction Laboratory preparation 1) Oil and Soap	Introduction to unit process. Manufacturing of soap and glycerin with flow sheets, its uses , chemical reaction
2) Nitro Benzene 3) Aspirin	Manufacturing process of Nitric Acid by Oswald process with flow sheets , chemical reactions , process description and uses
4) Cl_2 Gas	Manufacturing of Sulfuric Acid by contact process, raw material Manufacturing of Caustic Soda and chlorine Process classification, raw material, chemical reactions, flow sheets and uses.

UNIT OPERATION:-

UNITS	PRACTICAL	THEORY
Flow of Fluids	To determine Reynolds no. at different velocities. Determine frictional losses in a straight pipe, pipe fitting, valvs Study of head vs. capacity curve for pumps	Mechanism of Fluid Flow ,nature of fluid, Reynolds number ,Bernoulli's Theorem, losses due to friction, contraction, enlargement and fitting, various meters for fluid flow, control of flow and its use. Transportation of fluids. Classification, Principle and function of pumps, blower fan compressors and conveyor elevators ,pneumatic transportation – Pressure and vacuum, Different types of valves and pipe fittings
Heat transfer	Calculate overall heat transfer coe. For a shell & tube heat exchanger.	Mechanism of Heat Transfer in solid, liquid and gases and their application in industries Different types of transfer equipment-Heat exchangers, coolers, condenser and chillers Different types of boiler , steam traps, Reboilers, heaters, vaporizers, Funnels Kilns Fouling of heat transfer surfaces-maintenance of heat exchange equipment,
Evaporation	To find rate of evaporation for vertical tube evaporator.	.Capacity, steam economy of evaporators Surface and contact condensers, barometric condensers, Vacuum Producing devices-Steam jet ejectors, Vacuum pumps,Multi effect evaporation and methods of feeding Vapor recompression
Distillation	Separation of liquid mixture by distillation using packed tower	Introduction, Vapor-liquid equilibrium. Boiling point diagram, Raoult's law , Henry's Law, Relative volatility, constant boiling mixture, equilibrium diagram, distillation methods, Flash differential, rectification, Isotropic, Extractive, vacuum. Steam distillation Binary and multi compound distillation (Batch & Continuous). Determination of number of plates by Macabetale, Ponchan-Savarit method, minimum total –optimum reflux ratio. location of fed place-line, types of distillation column, plate efficiency-overall Murphree. point /local. factor affecting efficiency

Extraction and leaching	Study of spray extraction column	Introduction definition terms feed solvent extract solute raffinate selection of solvent to its properties application of extractions equipment used for extractions classification of equipment-single stage extraction – Agnited mixer, flow mixer settler multistage extraction Multistage mixer settler equipment spray towers packed towers perforated plate towers leaching introduction, field of application , leaching equipment , percolation tanks, counter current multiple contact , shanks system agitated vessels, turbine type agitator , Dorr agitator , oil extraction from oil seeds.Leaching- leaching equipment, percolation tanks.Counter current multiple contact , shanks system agitated vessels, turbine type agitator. Dorr agitator , oil extraction seeds.
Absorption and stripping introduction	Calculation of flooding velocity by using packed tower	Equipments used for absorption – columns, tower packing, flooding velocity, method of stripping .
Crystallization	Study of super saturation	Introduction method of super saturation and different types of crystallizes and their specific applications in industries.
Drying	Findig rate of drying by using tray dryer.	Theory , equilibrium moisture content , factors controlling constant drying rate , constant rate period falling rate period factor affecting rate of drying , types of dryers and their uses .
Filtration	Operation of plate & frame filter press	Theory, different type of filters such as plate frame filter press , rotary drum filter and centrifuges
Size reduction	Size reduction using ball mill,hammer mill. To carry out sieve analysis with sieve shaker.	Size reduction and screening , separation ,Classification of crushing and grinding machineries , sedimentation – gravity session, cyclone separators Types, use of size reduction equipment i.e black jaw crusher ,hammer mill, ballmill.
Humidification and cooling towers	Determination of wet bulb & dry bulb temperater.	Theory of Humidification and different terms related to Humidification .Theory and different types of cooling towers
Mixing	Operation of mixer settler	Introduction , classification of mixing equipments and it's applications , mixers for mixing solid- solid, solid-liquid, solid-gas

Refrigeration	Study of refrigeration units	Vapor absorption and vapor recompression system, different types of refrigents and their properties and specific use in industries
Transportation of material	Study of Conveyor, elevators	Conveyor, elevators Pneumatic transportation – pressure and vacuum

SECOUND YEAR

UNIT PROCESSES:-

- Introduction of chemical industries in India.
  - Inorganic chemical industries
  - Sulphur and Sulphuric acid
  - Fuel and industrial gasses
  - Fertilizer industries
  - Nitrogen industries
  - Phosphorous industries
  - Cement and lime etc.
- Natural product industries
  - Oils, soaps and detergents , glycerin
  - Paints and varnishes
  - Carbohydrate and fermentation industries
  - Food industry
  - pulp and paper products
  - Petroleum etc
- Synthetic organic chemical industries
  - Petrochemicals
  - Aromatics
  - Pesticides
- Pharmaceutical Industry
- Polymerization industries
- Metallurgical Industries
  - Iron and steel
  - Aluminum
  - Copper
  - Lead and zinc
- Biotechnology
  - Fermentation
  - Formulation

- Micro biology
- Dyes and pigments
- Pesticides

- <u>Drugs (Medicine)</u>

- EFFLUENT TREATMENT (WATER MANAGEMENT SYSTEM) & AIR POLLUTION:-

1. Sources of water and water quality
2. Water pollutants-Organic inorganic, Sediments, thermal, Radioactive, biological
3. Sources of water pollution
4. Treatment of water – purification, Sedimentation, Coagulation, Filtration, Sterilization (Physical and Chemical methods of Sterilization
5. Water Softening (Removal of hardness) - Boiling, Distillation, Clark's Method, Caustic soda process, Ion exchange
5. Effluent, Types and sources of effluents
6. Effluent analysis (PH, COD, BOD, TSS, Clarity)
7. Treatment of effluent
8. Types of equipments use for treatment

9. Permissible standards
10. Air pollution
11. Types of pollutants
12. Sources of pollutants
13. Effect of air pollution
14. Analysis of air pollutant
15. Equipment use for measurement and control of air pollution
16. Permissible standards

MAINTENANCE TECHNIQUE:-

UNIT	PRACTICAL	THEORY
Maintenance of pipe line and valves	Cutting and threading of pipes. Bending and fitting of pipe as per drawing. Fitting of different types of pipe joints use of quick released coupling.	Pipe and pipe joints. Pipe bending fixture. Standard pipe threads. Tap and dies Standard pipefitting.
	Maintenance of globe valve , Gate valve, Stop cock, Non return valve, ball valve , needle valve, Plunger valve, Piston valve, Pneumatic valve, Electrical glass line button valve, butterfly valve Testing and fitting of different type of valves on pipe line .	Construction and future of different types of valves. Metallurgy – Corrosion along with respect to corrosion . selection of metal for chemical application . lining material . Metal testing method destructive and non destructive .
Maintenance of Pumps	Maintenance and assembly of different type of pump such as centrifugal pump , gear pump , plunger pump , vacuum pump , hydraulic pump, screw pump, and multistage pump application of voice , RPM ,	Type of pumps their construction details and use .
	Fitting of bearing such as ball bearing , roller bearing, bush bearing etc. Their care . lubrication and maintenance . removing bearing with bearing puller .	bearing their type material and use information about bearing removing and fitting kit. Lubricant and lubrication type of lubricant and method of lubrication . Properties of lubricant
Maintenance of machinery	Maintenance compressor , blowers, crushers, mixers and pulverizes .	Construction use of compressor, blower, crusher, mixer, and pulverizes.

ADVANCED UNIT OPERATION:-

VALVS– Pneumatically operated valve, electrically operated valve, rotary air lock valve , piston valve , solenoid valve ,plunger valve .

PUMPS – Vacuum pump with mechanical seal, vaccum Pump with normal gland packing, metering Pump, srew pump for viscous flow

HEAT EXCHANGERS – Multipass heat exchanger, Plate heat exchanger, spiral heat exchanger. cooling tower.

BOILER – Oil fire boiler, rice hurk boiler, gas fire boiler.

EXPLOSIVE METER FOR SAFETY – Gas detector ,smoke detector, fire alarm system,sprinkerls system for safety

For Unit Operation Laboratory

Sr. No.	*Name of the equipment*	Qty
01	*Reynolds's Experiment equipment*	01 Set
02	*Shell and tube heat exchanger glass type*	01 No.
03	*Boiler (Electrically Heated)*	01 No.
04	*Vertical Tube Evaporator*	01 No.
05	*Packed tower of glass for flooding velocity experiment*	01 No.
06	*Top driven centrifuge*	01 No.
07	*Rotary vacuum filter*	01 No.
08	*Tray drier*	01 No.
09	*Hammer mill*	01 No.
11	*Ball mill*	01 No.
12	*Blake jaw crusher*	01 No.
13	*Mixer settler type extractor*	01 No.
14	*Spray extraction tower*	01 No.
15	*Multistage compressor fitted with inter cooler*	01 No.
16	*Sieve shaker and sieves*	01 No.
17	Annular (for flow of fluids)	01 No
18	Vacuum pump with mechanical	01 No
19	Seals	1
21	Pneumatically operated valve	1
22	Electrically operated valve	1
23	Multipass heat exchanger	
24	Thermal mass flow meter	11
25	.Magnetic flow (Rotameter)	1
26	.Screw pumps for viscous flow	
27	.Metering pump	1
28	.Rotary air lock valve	1
29	.Plate heat exchanger	1
30	.Spiral heat exchanger	11
31	.Glass Tube heat exchanger	1
32	Oil fire boilers	1
33	.Rice hurk fire boiler	1
34	Gas fired boiler	1
35	.Rising film and fallowing film Evaporators	1
36	Bruck fild viscometer	1
37	.Crystlisers – Flickers	
38	.Absorption- striping	1
39	dryer , Pedal dryer ,	1
40	Droplet formation , Uses of nozzle , and water Distribution concept in cooling towers	1
41	Filtration – Lift filter , Sparker filter, Star filter , Notch filter , filtration media , Micron size	1

42	Explosive meters for safety i) Gas detector ii) Smoke detector iii) Fire alarm system iv) Sprinklers system for safety	 1 1 1 1
43	*Humidification /Dehumidification and air handling unit*	1
44	Piston valve	2
45	Solenoid valve	2
46	Plunger valve	2
47	Pneumatic control valve	2
48	Safety valve	2
49	Rotary air lock valve	2
50	Cooling tower (common for instrumentation lab)	2
51	Pressure vessel with all accessories (training type)	2

TOOL KIT FOR (1 TRAINEE)

S.N.	Name of Tool	Q.R
1	Caliper outside spring 6”/15”cm	1
2	Caliper inside spring 6”/15cm	1
3	Divider spring 6”/15cm	1
4	Center punch 4”/10cm	1
5	Prick punch 6”/15cm	1
6	Chisel cold flat 1”/2.5cm	1
7	Chisel cross cut 3”/8” X 1/8”	1
8	Chisel diamond point 3”/8”/10mm	1
9	Chisel half round 3/8”/10mm	1
10	Hammer ball pain 1lb handle	1
11	Hammer ball pain ½ lb handle	1
12	Hack saw frame adjustable with pistol gripe for 8”-12” blade by 20cm-30cm	1
13	Steel rule 12” English & metric /30cm	1
14	Screw diver set	1
15	Square engg. 6” blade /15cm	1
16	Scriber	1
17	Safety goggles	1
18	Soldering gun with stand	1
19	De soldering pump	1
20	Connector	1
21	Safety shoes	1
22	Neon tester	1
23	Magnetic point screw driver	1
24	Combination pliers	1
25	Long nose pliers	1
26	Insulator fine cutter	1

Sr No	Name of tools & equipments	Quantity Total
1	Rule steel 15 cm with metric gradutations also	10
2	Square try 10 cm blade	10
3	Caliper outside 15 cm spring	10
4	Caliper inside 15 cm spring	10
5	Caliper 15 cm Aermophrodits	10
6	Devider 15 cm spring	10
7	Scriber 15 cm	10
8	punch Centre 10 cm	10
9	Screw Driver 15 cm	10
10	Chiesel Cold 19 cm	10
11	Hammer Ball Peen 0.45 Kg with handle	10
12	Hammer Ball Peen 0.22 Kg with handle	10
13	File flat 25 cm second cut	10
14	File flat 25 cm smooth cut	10
15	File half round second cut 15 cm	10
16	Hacksaw frame adjustable 20-30 cm	10
17	Safety goglee (Pistol grip - tabular)	10
18	Dot a lot punch	10

Sr No	Name of tools & equipments	Qty
19	Rule steel 30 cm with TO Read metric also	4
20	Rule Steel 60 cm	4
21	Straight edge 45 cm steel	2
22	Plate surface 45 cm x 45 cm	2
23	Marking Table 91 x91 x 122 cm	1
24	Universal scribing block 22 cm	2
25	Block Vee pair 7 cm & 15 cm with clamp	2
26	Angle plate 10 x 20 cm	2
27	Level sprit 15 cm metal	1
28	Punch latter 5 cm set	1
29	Punch figure set 3 cm	1
30	Punch Bellow 6 mm to90 mm set of 5	2
31	Punch round 3 mm x 4mm set of 3	2
32	Portable hand drill (Electric) 0 to 6 mm	2
33	Drill brace hand 0 to 12 mm	2
34	Drill twist s/s 1.5 mm to 12 mm by 0.4 mm	1
35	Drill twist s/s 3 mm to 15 mm by 1/2 mm	1
36	Tap & Dies complete set in box B.A.	1
37	Tap & Dies complete set in box B.S.F.	1
38	Tap & Dies complete set in box with worth.	1
39	Tap & Dies complete set in box American	1
40	Tap & Dies complete set in box Matric	1
41	File Knife edge 15 cm smooth	4
42	File warding edge 15 cm smooth	4
43	File cant saw 15 cm smooth	4

44	File pnather edge 15 cm smooth	4
45	File triangular 15 cm smooth	2
46	File round 20cm cord cut	8
47	File square edge 15 cm second cut	4
48	File square edge 25 cm second cut	4
49	Filler gauge	1 set
50	File triangular 20 cm second cut	8
51	File flat 30 cm second cut	8
52	File flat 20 cm bastered	8
53	File flat 30 cm bastered	8
54	File swiss type needle set of 12	2
55	File half round 25 cm second cut	8
56	File half round 25 cm Bastered	8
57	File round 30 cm Bastered	4
58	File hand 15 cm second cut	8
59	Iron soldring 350 gm	2
60	Lamp blow 0.55 littero	2
61	Spanner adjustable 15 cm	2
62	Spanner whito worth 0.6mm to 25mm set of	4
63	Interchangable Ratenet socket set with a 12 mm Driver socket range 4 mm to 14 mm set of 7	1 set
64	APPOLO Box spanner set in mm 3x4, 6x7, with a tommy bar	1 set
65	Glass magnifying 7 cm	2
66	Clamp tool maker 5 cm & 7.5 cm set of 2	8
67	Clamp "C" 5 cm	2
68	Clamp "C" 10 cm	2
69	Reamer adjustable max 9 mm, 12mm, 19mm set of 3	1
70	Reamer taper 4 mm to 9 mm set of 4	1
71	Reamer parallel 6 mm to 12mm set of 5	1
72	Scraper flat 15 cm	8
73	Scraper 3 corner 15cm	8
74	Scraper half round 15 cm	8
75	Chisel cold 9 mm cross cut, 9mm diamond	8
76	Chisel cold 19 flat	8
77	Chisel cold 9 mm round nose	8
78	Extractor stud Ezy – out	2
79	Micrometer 0-2.5 cm out side	8
80	Micrometer 0-25 cm out side	4
81	Micrometer 25-50 cm out side	3
82	Micrometer 50-75 cm out side	2
83	Micrometer inside 5 cm to 20 cm with extension rods 50-75 cm out side	1
84	Vernier caliper 20 cm	1
85	Vernier level protractor 20 cm	1
86	screw pitch gauge	10
87	Drill twist T/S 6 mm to 25 mm x1.5mm	1
88	Drill chock 12 mm	1
89	Pipe wrench 40 cm	1
90	Pipe wrench 30 cm	1

91	Pipe vice No. 4	2
92	Adjustable pipe die 0-205 cm cap.	1
93	Wheel dresser (one for 4 units)	1
94	Machine vice 10 cm	1
95	Sleev drill morse 0-0, 0-1, 1-2, 2-3	1 set
96	Vice bench 12 cm jaw	10
97	Vice leg 10 cm jaw	2
98	Bench working 240	4
99	Almirah 180 x 90 x 30 cm	2
100	lockers with 8 drawers (Standard) size	2
101	Matal rack 182 x 182 x .5 cm	1
102	Fire extinguisher (for 4 units)	2
103	Fire Buckets	2
104	Hand hammer 1 kg. with handle	2
105	Mallet	2

1	Anvil 50 kg on stand	1
2	Drilling machine piller sensitive 0-20 mm cap with swivel table motorise with clock and key	1
3	Drilling machine bench sensitive 0-12 mm cap motorise with clock and key	2
4	Forge portable hand blower 38 cm to 45 cm	1
5	Grinding machine (General purpose)D. E. pedastal with 17 mm dia wheels rough & smooth with twist drill grinding attachment.	1

Note :- The Practical should be conducted in industries having boiler's capacity more than 50 sq.mt. heating surface area.

REFERENCES

Safety Codes Act and Regulations under the Act
Boiler Operation and Maintenance Manuals
Manufacturer s operation manuals

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