Name:_____ **Roll No.:** 267

BOILER OPERATION ENGINEERS EXAMINATION – 2021
MACHINE DRAWING (Paper -I)

Time: Two Hours **Max Marks: 100**

Notes to the candidates:

- Write your name and roll no. on the question paper. Do not write or mark anything else on the question paper.
- **Qn. 1 of Section A** is compulsory and candidates can attempt any four questions out of remaining questions of this section. **In Section B,** candidates need to attempt **any two questions out of three. In Section C,** candidates need to attempt **only one question out of two.**
- Use of mini-drafter is not mandatory. Free hand sketches or use of other drawing instruments is allowed wherever required.
- Answer in brief and to the point. Draw neat sketches wherever necessary.
- Assume missing data suitably, if any. Also assume suitable scaling wherever necessary.
- Candidate should answer the paper in English only and in legible hand writing.
- This paper contains four pages and total eleven Nos. of questions.

Section A

Q. 1 Out of the given options, select most appropriate option as an answer: **(1×10)**

I. The dimensions (mm) of 'A1' drawing sheet as per ISO-A series is:
a. 590 X 840 b. 594 X 841 c. 596 X 842 d. 598 X 843

II. ***In the first angle projection, the _____ lies between _____ and _____***
a. object, projection plane, observer ***c. reference line, side view, front view***
b. projection plane, object, observer ***d. reference line, left side view, right side view***

III. *Thread Designation SQ 40 × 10 stand for:*
a. SQUARE thread of core diameter 40 mm and pitch 10 mm
b. SQUARE thread of pitch diameter 40 mm and pitch 10 mm
c. SQUARE thread of nominal diameter 40 mm and pitch 10 mm
d. SQUARE thread of nominal diameter 40 mm and lead 10 mm

IV. *Which of the following is removable foundation bolt?*
a. Eye foundation bolt c. Rag foundation bolt
b. Bent foundation bolt d. Lewis foundation bolt

V. Which of the following keys are made integral with the shaft?
a. Saddle keys b. Sunk keys c. Splines d. All of these

VI. The diameter of the rivet (mm) can be calculated as
a. $d = 5\,t^{1/2}$ b. $d = 5\,t^{1.2}$ c. $d = 6\,t^{1/2}$ d. $d = 6\,t^{1.2}$
(where 't' is the thickness of plates to be joined in mm)

VII. Basis Hole means:
a. Lower deviation zero c. Both a and b
b. Upper deviation zero d. None of these

VIII. The maximum interference after the assembly between a bush of size $30\ ^{+0.06}_{+0.02}$ and shaft of size $30\ ^{+0.04}_{-0.01}$ mm is:
a. 0.07 b. 0.04 c. 0.05 d. 0.02

IX. The value of flank angle in ACME thread:
a. 29° b. 30° c. 45° d. 60°

X. According to Bureau of Indian Standards, SP-46:1998, "Engineering Drawing Practice for Schools and Colleges" preferred:

a. First angle projection
b. Third angle projection
c. Both a and b
d. None of these

Q.2 Differentiate between machine drawing and production drawing. **(5)**

Q.3 Name and illustrate the two features with free hand sketch, which should not be shown hatched, when they are sectioned longitudinally. **(5)**

Q.4 Sketch the method of dimensioning chamfers and counter-sunks. **(5)**

Q.5 What are boiler joints? How they are different from structural joints? Name two joints usually used in the boilers. **(5)**

Q.6 Give illustration and symbols of Flat (flush) single-V butt weld, Convex double-V butt weld, Single-bevel butt weld with broad root face and Concave fillet weld used in the machine drawing. **(5)**

Section B

Q.7 Draw the sectional FV, TV and LSV of the object, shown in Figure 1, using first angle projection. **(15×2)**

Q.8 Draw the isometric drawing from the given orthographic views (third angle projection), shown in Figure 2.

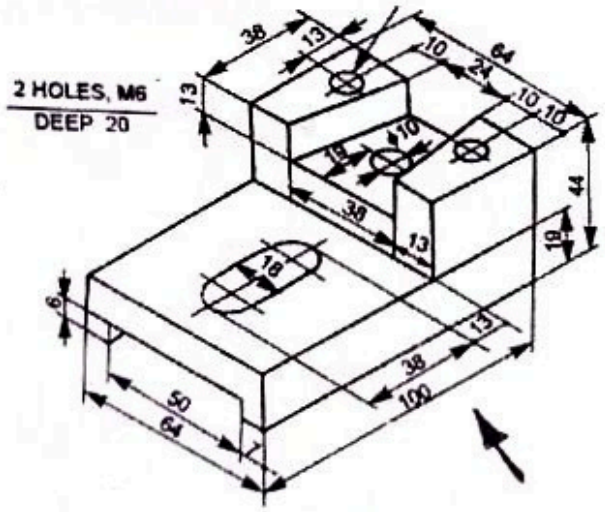

Figure 1

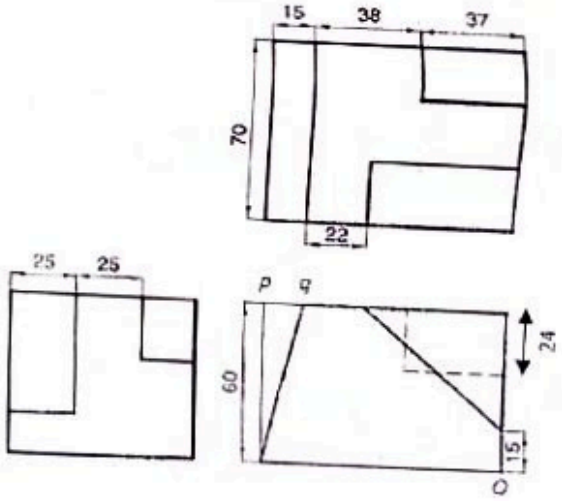

Figure 2

Q.9 Sketch free hand drawings of any two types of pipe fittings: (*a*) GI (*b*) CI and (c) PVC.

Section C

Q.10 Draw the following assembled views of the cylinder relief valve parts, shown in Figure 3: **(40×1)**

a. Elevation in section showing assembled valve
b. End elevation
c. Plan view

Q.11 Draw the following assembled views of a flow control valve parts, shown in Figure 4.

(a) Sectional elevation through assembled valve with fulcrum pin vertically above right-hand branch,
(b) End elevation
(c) Plan view

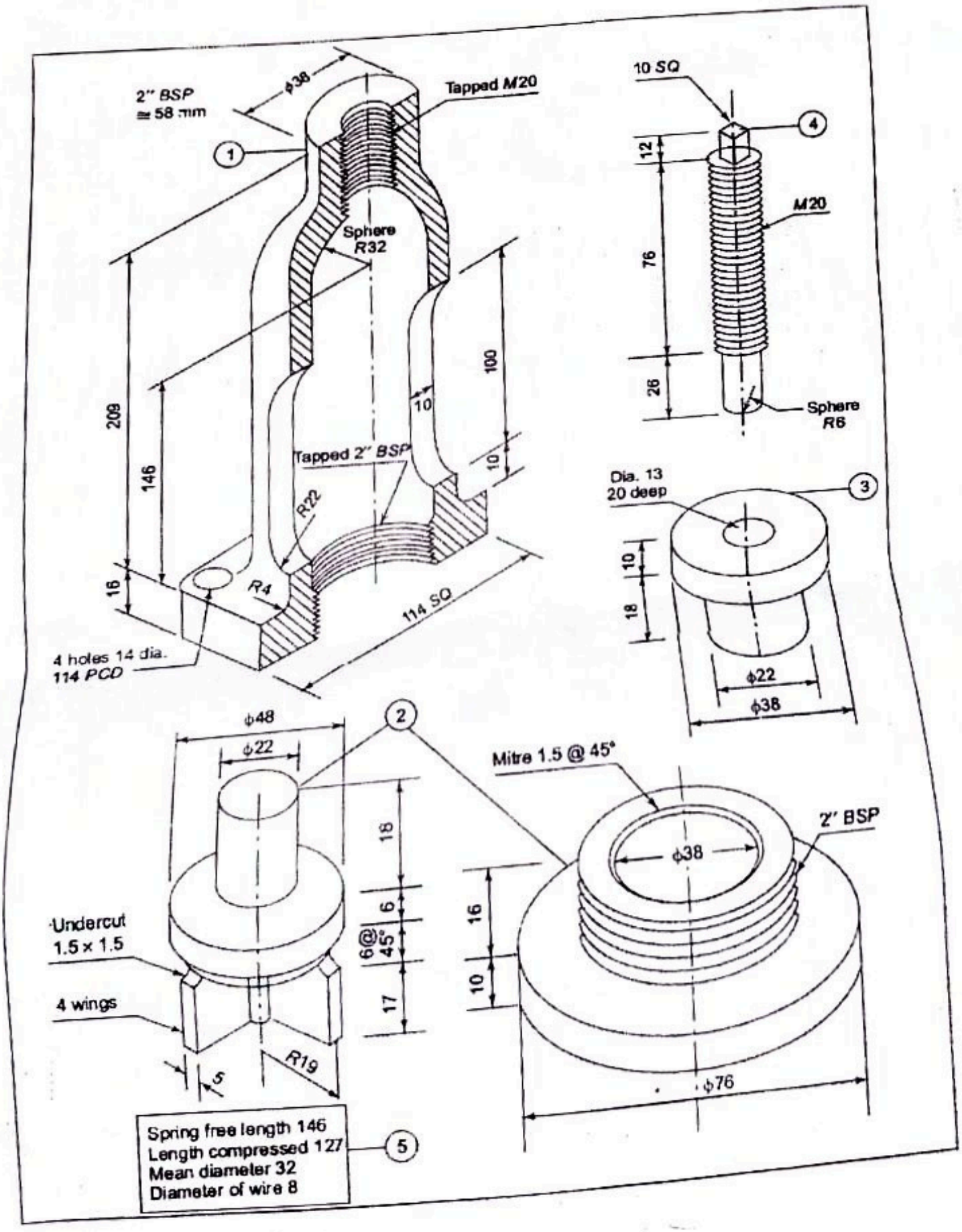
2" BSP
≅ 58 mm
ϕ38
Tapped M20
1
Sphere
R32
209
146
16
100
10
10
Tapped 2" BSP
R22
R4
114 SQ
4 holes 14 dia.
114 PCD
10 SQ
4
12
76
26
M20
Sphere
R6
Dia. 13
20 deep
3
10
18
ϕ22
ϕ38
ϕ48
ϕ22
2
18
6
6@
45°
17
Undercut
1.5 x 1.5
4 wings
5
R19
Mitre 1.5 @ 45°
2" BSP
ϕ38
16
10
ϕ76
Spring free length 146
Length compressed 127
Mean diameter 32
Diameter of wire 8
5

Figure 3

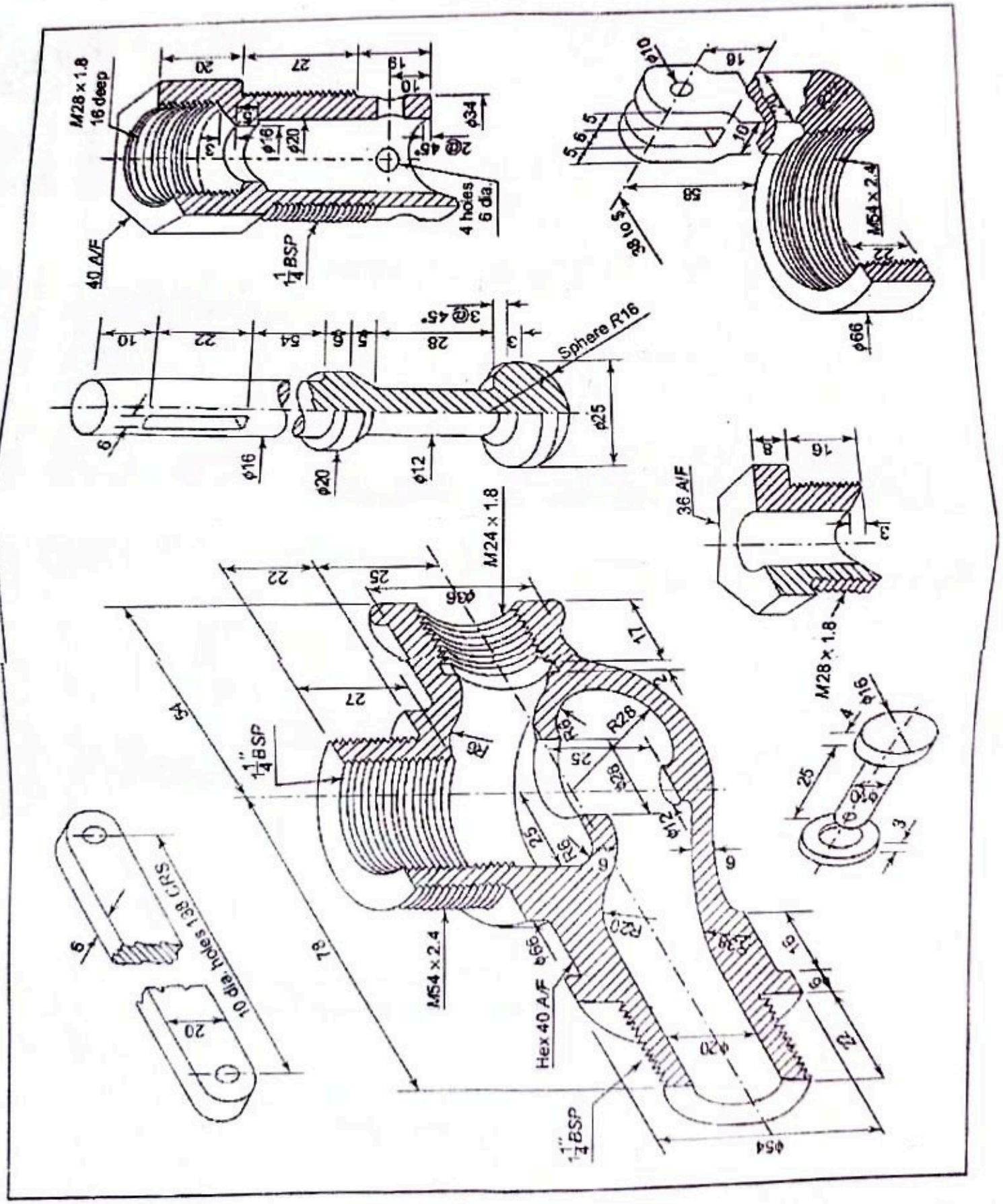
M28 x 1.8
16 deep
40 A/F
1¼ BSP
4 holes
6 dia.
Sphere R16
M24 x 1.8
M54 x 2.4
Hex 40 A/F
36 A/F
10 dia. holes 138 C/RS

Figure 4

Punjab BOE-2021 Paper-2

Name: _____ Roll No.: 267

BOILER OPERATION ENGINEERS EXAMINATION-2021
Paper-II (Thermal-I)

Time: 2.5 hrs **Maximum Marks: 100**

Read the following instructions carefully before attempting the question paper:

- Do not write or mark anything on the question paper except your **name and roll no.** at the designated space.
- This question paper is divided into two sections A and B.
- Section-A contains **TWO** questions of 20 mark each.
- Section-B contains **FOUR** questions of 20 mark each. Attempt any **THREE** questions.
- Answer all questions in serial order. All parts/sub-parts must be answered together and must not be interposed by answer(s) of other question(s).
- Draw neat sketches wherever necessary.
- Use of steam table, Mollier chart and scientific calculator is permitted.
- Assume any missing data suitably (if any).
- Candidate should answer the paper in **ENGLISH** only and in legible handwriting.
- This Paper contains **FOUR** pages and total **SIX** questions.

SECTION-A
(This Section is COMPULSORY)

1. *Attempt all questions at one place only* **(20 × 1=20)**

(i) ***Main objective of a boiler trial is***

a) To determine the generating capacity of the boiler
b) To determine the thermal efficiency of the boiler, when working at a definite pressure
c) To prepare heat balance sheet for the boiler
d) All of the above

(ii) **Device used to put off fire in the furnace of the boiler, when the level of water in the boiler falls to an unsafe limit, is**

a) Safety valve
b) Fusible plug
c) Blow off cock
d) Stop valve

(iii) **The shell of the Cochran boiler is made hemispherical**

a) To provide maximum strength and space
b) To withstand high pressure inside
c) Both (a) and (b)
d) None of these

(iv) **The dryness fraction of steam within a turbine is not allowed to fall below**

a) 0.5
b) 0.9
c) 0.95
d) 0.99

(v) **With increase in pressure**

a) Enthalpy of dry saturated steam increases
b) Enthalpy of dry saturated steam decreases
c) Enthalpy of dry saturated steam remains same
d) Enthalpy of dry saturated steam first increases and then decreases

(vi) **An analysis which includes the steam in the exhaust is called**

a) Dry analysis
b) Wet analysis
c) Dry and wet analysis
d) None of the above

(vii) **Bending moment M and torque T is applied on a solid circular shaft. If the maximum bending stress equals to maximum shear stress developed, then M is equal to**

a) T/2
b) T
c) 2T
d) 4T

(viii) **Rankine cycle efficiency of a good steam power plant may be in the range of**

a) 35-45%
b) 85-95%
c) 15-25%
d) 70-80%

(ix) **For forced draught system, the function of chimney is mainly**

a) To produce draught to accelerate the combustion of fuel
b) To discharge gases high up in the atmosphere to avoid environmental hazard
c) To reduce the temperature of hot gases discharged
d) None of the above

(x) **A shaft was initially subjected to a bending moment and then subjected to torsion if the magnitude of bending moment is found to be the same as that of the torque, then the ratio of maximum bending stress to shear stress would be**

a) 0.25
b) 0.5
c) 2.0
d) 4.0

(xi) **Junction valve is used to**

a) Regulate flow of steam
b) Regulate water supply
c) Put off fire in the furnace
d) Indicate water level in the boiler

(xii) **If the value of Poisson's ratio is zero, then it means that**

a) The material is rigid
b) The material is perfectly plastic
c) There is no longitudinal strain in the material
d) None of these

(xiii) **Maximum heat is lost in the boiler due to**

a) Unburnt carbon
b) Flue gases
c) Incomplete combustion
d) Moisture in fuel

(xiv) **Latent heat of vaporization at critical point is**

a) Less than zero
b) Greater than zero
c) Equal to zero
d) None of the above

(xv) **The specific volume of water when heated at 0 ^{0}C**

a) First increases and then decreases
b) First decreases and then increases
c) Increases steadily
d) Decreases steadily

(xvi) **The draught produced by steel chimney as compared to that produced by brick chimney for the same height is**

a) Less
b) More
c) Same
d) Can't determine

(xvii) **When bending moment M and torque T is applied on a shaft, then equivalent torque is**

a) M+T
b) $\sqrt{M^2+T^2}$
c) $\frac{1}{2}\sqrt{M^2+T^2}$
d) $\frac{1}{2}\left(M+\sqrt{M^2+T^2}\right)$

(xviii) **For maximum discharge of hot gases through the chimney the height of hot gas column producing draught is**

a) Twice the height of chimney
b) Equal to the height of chimney
c) Half the height of chimney
d) None of the above

(xix) **Regenerative heating i.e. bleeding steam to reheat feed water to boiler**

a) Decreases thermal efficiency of the cycle
b) Increases thermal efficiency of the cycle
c) Does not affect the thermal efficiency of the cycle
d) None of the above

(xx) **Principal stress at a point in a plane stressed element are: $\sigma_x = \sigma_y = 500$ kg/cm^2 Normal stress on the plane inclined at 45^0 to x-axis will be**

a) *0*
b) 500 kg/cm^2
c) *707 kg/cm^2*
d) 1000 kg/cm^2

2. Attempt any <u>FOUR</u> questions in SHORT and at one place only **(4 × 5 =20)**

(i) Discuss the various methods to express the boiler performance. **5**

(ii) Two boilers one with superheater and other without superheater are delivering equal quantity of steam into a common main. The pressure in the boilers and main is 20 bar. The temperature of steam from a boiler with a superheater is 350 ^{0}C and temperature of the steam in the main is 250 ^{0}C. Determine the quality of steam supplied by the other boiler. Take c_{ps} = 2.25 kJ/kg. **5**

(iii) What do you mean by the term vacuum efficiency of a condenser? What are the factors that affects this efficiency? Support your answer with technical reasoning. **5**

(iv) What is the function of boiler mountings? Can a boiler work without mountings? How do accessories differ from mountings? **5**

(v) State the purpose and reasons for which different types of boilers are employed. **5**

SECTION-B

(Attempt any THREE questions)

3 **(i)** Give a schematic sketch of a boiler plant. What are the observations to be recorded during a boiler trial. **10**

(ii) What do you mean by high pressure boiler? Explain their unique features and list the advantages of high pressure boilers. **10**

4 **(i)** What do you mean by boiler draught? Discuss various types of draughts and differentiate between artificial and natural draught. **10**

(ii) A sample of fuel has the following percentage composition by weight: **10**

Carbon = 84 %
Hydrogen = 10 %
Oxygen = 3.5 %
Nitrogen = 1.5 %
Ash = 1 %

a) Determine the stoichiometric air-fuel ratio by mass
b) If 20 % excess air is supplied, find the percentage composition of dry flue gases by volume.

5 **(i)** What are fluidized-bed boilers and why are they gaining ground for utility power and generation industries? **10**

(ii) The following data refer to a boiler plant consisting of an economizer, a boiler and a superheater. **10**

Mass of water evaporated per hour =5940 kg, Mass of coal burnt per hour = 675 kg, LCV of coal = 31600 kJ/kg, pressure of steam at boiler stop valve = 14 bar, temperature of feed water entering the economizer = 32 ^{0}C, temperature of feed water leaving the economizer = 115 ^{0}C, dryness fraction of steam leaving the boiler and entering superheater = 0.96, temperature of steam leaving the superheater = 260 ^{0}C, specific heat of superheated steam = 2.33 kJ/kg K.

Determine:

a) Percentage of heat in coal utilized in economizer, boiler and superheater.
b) Overall efficiency of boiler plant.

6 **Explain the following with neat sketch** **(4 × 5 =20)**

(i) Water level indicator
(ii) Blow-off cock
(iii) Junction or stop valve
(iv) Feed check valve

Punjab BOE-2021 Paper-3

Name: _____ Roll No: 267

BOILER OPERATION ENGINEER EXAM – 2021

PAPER – III (Thermal – II)

Maximum Marks: 100

Time: 2.5 Hours

NOTES TO THE CANDIDATES:

- Write your **name and roll no.** on the question paper. Do not write or mark anything else on question paper.
- This question paper has been divided into **Section – A (Multiple Choice Questions)** and **Section – B (Short Answer Type Questions)** and **Section C (Long Answer Type Questions).**
- Section – A and Section – B are **COMPULSORY**.
- Candidate must attempt **ANY THREE** questions from **Section – C**. Each of the questions carries 20 marks in **Section – C**.
- All parts / sub parts of **Section – A, Section B** and **Section C** must be answered together and must not be interposed by answer(s) of other question(s).
- Answer should be brief and to the point.
- Draw neat sketches wherever necessary.
- Use of **Scientific Calculator, Steam Table and Mollier Diagram** is permitted.
- Assume any missing data suitably.
- Candidate should answer the paper in **ENGLISH only and** in legible handwriting.
- This paper contains three (05) pages and total six questions (06).

Section – A

1. *Attempt all parts at one place only.* **(20 × 1 = 20)**

i. *The purpose of thermal cleaning in boiler is*

a.	*The sticky deposits get dried up while the sulphuric acid is vaporized.*
b.	*Raising the temperature of regenerative air heater to 800°C.*
c.	*The acoustic waves set the tubes vibrating which weakens the bond between deposits and tube metal.*
d.	None of the above.

ii. The purpose of overfire air system in stoker fired boilers is / are

a.	To provide turbulence of the volatile gases.	**b.**	Thorough mixing of the volatile gases.
c.	To assure complete combustion.	**d.**	All of the above.

iii. The angle of attack of gas flow for greatest abrasive wear of staggered tubes in the cross flow of the gas path is

a.	$15^0 - 25^0$	**b.**	$55^0 - 75^0$
c.	$30^0 - 60^0$	**d.**	None of the above

iv. The intensive corrosion due to the attack of H_2SO_4 condensing on the fireside heating surface of boiler takes place in the temperature range

a.	$50^0 - 80^0$	**b.**	$90^0 - 120^0$
c.	$125^0 - 145^0$	**d.**	$160^0 - 180^0$

v. In a three element control system; feedwater control system uses a

a. Single control loop that provides regulation of feed water flow in response to change in the drum water level from its set point.
b. Control loop that provides regulation of feedwater flow in response to the changes in steam flow with a second control loop correcting the feed water flow to ensure the correct drum water level.
c. Predetermined ratio of feed water flow input to steam flow output to provide regulation of feedwater flow in direct response to boiler load.
d. None of the above

vi. How much (%) of the total ash content is collected in dry bottom hopper?

a. About 15 – 20% of the total ash content of the fuel.	**b.** About 5 – 10% of the total ash content of the fuel.
c. About 20 – 30% of the total ash content of the fuel.	**d.** None of the above.

vii. The installation of heat recovery equipments (economizer and air heater) may boost the overall efficiency of the boiler

a. 3 – 5%	**b.** 6 – 8%
c. 9 – 12%	**d.** None of the above

viii. What is the height of nozzles above the base plate?

a. 50 – 100 mm	**b.** 130 – 155 mm
c. 110 – 125 mm	**d.** None of the above

ix. Device used to put off fire in the furnace of the boiler when the level of water in the boiler falls to an unsafe limit is

a. Safety Valve	**b.** Fusible
c. Stop Valve	**d.** Blow Off Cock

x. The maximum discharge through a chimney occurs when the chimney height is

a. Infinitely long	**b.** Equal to the height of the hot gas column producing drought
c. Outside temperature is very low	**d.** More than the tallest building nearby

xi. The steam injector lifts the water but fails to force it into the boiler; the trouble may not be due to

a. Dry Steam	**b.** Insufficient Steam Pressure
c. Leak in the water pipe	**d.** All of the above

xii. The material is used in construction of convective and radiant superheaters

a. High Allowed Cr – Ni austenitic – class steel.	**b.** Aluminum Alloys
c. Cast Iron	**d.** Any Steel

xiii. The pH value of water in steel tube economizers should be

a. 5 – 6	b. 8 – 9
c. 10 – 12	d. 13 – 14

xiv. Economizer tubes are generally made of

a. Steel for high pressure and cast iron for low pressure steam generation
b. Cast Iron for high pressure and steel for low pressure steam generation
c. Aluminum for high pressure and copper for low pressure steam generation
d. None of the above

xv. Feedwater level control is ensured through

a. Flow Measurement	b. Pressure Measurement
c. Temperature Measurement	d. All of the above

xvi. A packaged boiler is one in which various parts like firing equipment, fans, feed pumps and automatic controls are

a. Supplied by same manufacturer in loose and assembled at site
b. Supplied mounted on a single base
c. Purchased from several parties and packed together at site
d. Does not exist

xvii. The best suited coal for chain or travelling grate stoker boiler is

a. Caking Coal	b. Non Caking Coal
c. Pulverized Coal	d. High Sulphur Coal

xviii. Which is not correct statement about the effect of Sulphur in fuel

a. It has heating value
b. It helps in electrostatic precipitation of ash in the flue gases
c. It leads to corrosion of air heater, ducting etc; if flue gas exit temperature is low
d. It erodes the furnace walls

xix. Orsat meter is used for

a. Gravimetric analysis of flue gas	b. Volumetric analysis of flue gas
c. Mass flow of the flue gas	d. Measuring smoke density of the flue gases

xx. The equivalent evaporation of a boiler is a measure to compare

a. Two different boilers of the same make
b. Two different makes of boilers operating under the same operating conditions
c. Two boiler of same make but operating under different conditions
d. Any type of boilers operating under any conditions

Section – B (Short Answer Type Questions)

2. Attempt all parts at one place only. **(10 × 2 = 20)**

a. What factor(s) determines the quantity of primary air to be used for drying and transportation of pulverized coal

b. Describe the convenient way to estimate chimney height and diameter.

c. What do you mean by boiler oversizing?

d. What are the redundant steam lines and how does it impact the fuel consumption?

e. What are the major disadvantages of gas recirculation method of superheat control?

f. What are the two major advantages of condensate recovery?

g. How does selective corrosion occur in the valves?

h. What are the causes behind the flame to move forward towards the burner diffuser and then backward?

i. How do stack height and diameter get influenced with elevations?

j. What are the three methods of fuel oil atomization?

Section – C (Long Answer Type Questions)

3. (a) If instead of installing heat recovery equipments, in order to conserve as much combustion-gas heat as possible: The entire temperature drop of flue gas is allowed to take place over boiler surface, what would happen? **(10 Marks)**

3. (b) Write atleast ten general requirements for a safe and efficient boiler house? **(10 Marks)**

4. (a) A water tube boiler operates 8400 hours per year at 80% efficiency. The unit rated at 27215 kg/hr operates at 7.82 atm. It burns natural gas for six months and fuel oil for rest of the period. Assume average annual boiler loading is 60% with an output of 11347303 kcal/hr. **(12 Marks)**

Boiler operates without economizer:

I. Consumption of natural gas at 60% loading conditions: 1274.25 m^3/hr

II. Consumption of fuel oil at 60% loading conditions: 1.459 m^3/hr

Boiler operates with economizer:

I. Boiler Feed Water Flow Rate (Including Blowdown) at 60% loading conditions: 17145 kg/hr

II. Feedwater temperature at economizer inlet: 105^{0}C

III. Feedwater temperature at economizer outlet: 136^{0}C

IV. Flue gas temperature at economizer inlet: 260^{0}C

V. Flue gas temperature at economizer outlet: 190^{0}C

Determine the followings:

I. Fuel savings using economizer.

II. Total fuel cost without installing economizer.

III. Total annual savings in fuel cost after installing economizer.

IV. The payback months, if installed cost of economizer is Rs. 600000.00.

4. (b) How steam drums and other pressure vessels; are normally supported? What types of loads must be considered in the design of the structural supports for these vessels? **(08 Marks)**

5. (a) Enlist the difficulties that may be encountered in operating an oil fired steam generation plant. **(10 Marks)**

5. (b) The followings data are provided for the boilers: **(10 Marks)**

Entity	Steam Pressure	Quality of Steam	Evaporation Rate
Boiler – 1	8 bar	0.9	8.5 kg/kg of Coal
Boiler – 2	20 bar	Superheated to 300^{0}C	7.0 kg/kg of Coal

Both the boilers are supplied with feedwater at 40^{0}C. Determine which boiler has the comparatively higher heat utilization rate per kg of coal fired and thermal efficiency.

6. (a) What are the major areas that must be coordinated in the control of boiler? Also briefly explain types of control system in a modern boiler. **(10 Marks)**

6. **(b)** A Waste Heat Boiler (WHB) is hooked up with diesel generator set to produce steam from waste heat. At 100% DG – set loads, saturated steam is produced in the WHB at 80 tons/day. Average electric energy generated per day varies from 65 – 70 MWH. Assume that WHB is an energy saving equipment and qualifies for 100% depreciation in 1st year. The approximate saving in corporate taxes per year is assumed as 55%. Determine the followings: **(10 Marks)**

   1. Estimate the economics of incorporating WHB
   2. The payback period of WHB.