

B.E. (Mechanical Engineering / Power Engineering) Sixth Semester (C.B.S.)

Energy Conversion-I

P. Pages : 3

Time : Three Hours

**NRT/KS/19/3479/3505**

Max. Marks : 80

- Notes :
1. All questions carry marks as indicated.
 2. Solve Question 1 OR Questions No. 2.
 3. Solve Question 3 OR Questions No. 4.
 4. Solve Question 5 OR Questions No. 6.
 5. Solve Question 7 OR Questions No. 8.
 6. Solve Question 9 OR Questions No. 10.
 7. Solve Question 11 OR Questions No. 12.
 8. Due credit will be given to neatness and adequate dimensions.
 9. Assume suitable data whenever necessary.
 10. Use of non programmable calculator is permitted.
 11. Use of steam tables & Mollier chart is permitted.

1. a) State the unique features of high pressure boilers, and desirable qualities of a good boiler. **6**
- b) Explain construction and working of Cochran boiler with neat sketch. **7**

OR

2. a) Define boiler mountings & accessories. Enlist the various boiler mountings and accessories. **6**
- b) Explain construction and working of Economizer with neat sketch. **7**
3. a) Calculate the mass of flue gases flowing through the chimney when the draught produced is equal to 1.9 cm of water. Temperature of flue gases is 290°C and ambient temperature is 20°C. The flue gases formed per kg of fuel burnt are 23 kg. Neglect the losses and take the diameter of chimney as 1.8 m. **6**
- b) A 40m high chimney is discharging flue gases at 623K, when the ambient temperature is 303 K. The quantity of air supplied is 13 kg of air per kg of fuel burnt. Determine **7**
- i) Draught produced in mm of water column.
 - ii) Equivalent draught in metres of hot gas column.
 - iii) Efficiency of the chimney, if the minimum temperature of artificial draught is 423 K. The mean specific heat of flue gas is 1.005 kJ/kg. K.
 - iv) Temperature of chimney gases for maximum discharge in the given time and what would be the draught produced correspondingly.

OR

4. The following particulars were recorded during a boiler trial. **14**
- Pressure of steam = 11 bar, Mass of feed
Water = 4600 kg/h, Temperature of feed
Water = 75° C, Dryness fraction of steam = 0.96, coal used = 490 kg/h,
calorific value of coal = 35700 kJ/kg, moisture in coal = 4% by mass, mass of dry flue
gases = 18.57 kg/kg of coal, temperature of flue gases = 300°C, Boiler house temperature
= 16°C, specific heat of flue gases = 0.97 kJ/kg K. Draw up heat balance sheet for the
boiler per kg of coal.

5. Write short notes on **any two**. **14**
 i) Coal Preparation Plant.
 ii) Ash handling system.
 iii) Bubbling fluidized bed boiler.
- OR**
6. Write short notes on **any two**. **14**
 i) Need of cogeneration & its types.
 ii) Steam turbine and gas turbine cogeneration system.
 iii) Topping cycle & bottoming cycle.
7. a) The nozzles of a Delaval steam turbine are supplied with dry saturated steam at a pressure of 9 bar. The pressure at the outlet is 1 bar. The turbine has two nozzles with a throat diameter of 2.5mm. Assuming nozzle efficiency as 90% and that of turbine rotor 35%, find the quality of steam used per hour and the power developed. **7**
- b) State the assumptions used in analysis of steam nozzles & derive the expression for velocity of steam flowing through nozzle. **6**
- OR**
8. a) Explain metastable flow of steam in a nozzle with its effects. **5**
- b) Steam at a pressure of 11 bar and dryness fraction of 0.98 is discharged through convergent divergent nozzle to back pressure of 0.1. The mass flow rate of steam is 12 kg/kWh. if power developed is 250 kW. Determine **8**
 i) Pressure at the throat.
 ii) Number of nozzles required and dimensions of nozzle if each nozzle has throat of rectangular cross section of 5mm × 10mm. If 10% of overall isentropic enthalpy drop reheats the steam by friction in divergent portion.
9. a) Explain with neat sketch velocity diagram for a single stage impulse turbine. **3**
- b) A single stage impulse turbine is supplied with steam at 4 bar and 160°C. and it is exhausted at a condenser pressure of 0.15 bar at the rate of 60 kg/min. The steam expands in a nozzle with an efficiency of 90%. The blade speed is 250 m/s and the nozzles are inclined at 20° to the plane of wheel. The blade angle at the exit of the moving blade is 30°. Neglecting friction losses in the moving blade, determine: **10**
 i) Steam jet velocity. ii) Power developed.
 iii) Blade efficiency and iv) Stage efficiency.
- OR**
10. a) Define the term 'degree of reaction' as applied to a steam turbine. Show that for Parson's reaction turbine the degree of reaction is 50% **6**
- b) A stage of a turbine with parsons blading delivers dry saturated steam at 2.7 bar from the fixed blades at 90 m/s. The mean blade height is 40 mm, and the moving blade exit angle is 20°. The axial velocity of steam is $\frac{3}{4}$ of the blade velocity at the mean radius. Steam is supplied to the stage at the rate 9000 kg/h the effect of the blade tip thickness on the annulus area can be neglected. **7**
 Calculate:
 i) The wheel speed in r. p. m
 ii) The diagram power.
 iii) The diagram efficiency.
11. a) Define, vacuum efficiency and condenser efficiency. **4**

- b) The following observations were taken during a test on a surface condenser: **10**
Vacuum in condenser = 71.5 cm of Hg,
Barometer reading = 76.5 cm of Hg,
Temperature in condenser = 32°C,
Hot well temperature = 30°C,
cooling water circulated = $48000 \frac{\text{kg}}{\text{hr}}$,
Inlet and outlet temperature of cooling water = 14°C & 28°C,
Condensate collected = 1500 kg/hr.
Find
a) The mass of air in kg/m³ of condenser volume.
b) The dryness fraction of steam entering the condenser.
c) The vacuum efficiency.
d) Degree of under cooling.
e) Condenser efficiency.

OR

12. a) Differentiate between induced draught and forced draught cooling tower. **4**
- b) The air leakage into a surface condenser operating with a steam turbine is estimated as 84 kg/h. The vacuum near the inlet of air. **10**
Pump is 700 mm of Hg, when barometer reads 760 mm of Hg. The temperature at inlet of vacuum pump is 20°C. Calculate:
i) The minimum capacity of air pump in m³/h.
ii) The dimensions of the reciprocating air pump to remove the air if it runs at 200 r. p. m. Take L/D ratio = 1.5 and volumetric efficiency = 100% and
iii) The mass of vapour extracted per minute.
