Group – E

8. (a) The following loads are connected to a power plant

Type of load	Max. Demand	Diversity Factor	Demand factor
Domestic	15	1.25	0.70
Commercial	25	1.20	0.90
Industrial	30	1.30	0.98

If the overall diversity factor is 1.5, determine (i) the max. load and (ii) the connected load of each type.

(b) The outlet and inlet temperatures of cooling water to a condenser are 40°C and 29°C respectively.If the vacuum in the barometer is 700 mm of Hg with barometer reading 760 mm of Hg, determine the condenser efficiency.

6 + 6 = 12

9. (a) Explain the working principle of PWR and BWR in Nuclear Power Plant.

(b) What do you mean by hydrograph and flow duration curve?

6 + 6 = 12

B.TECH/ME/7TH SEM/MECH 4101/2019

POWER PLANT ENGINEERING
(MECH 4101)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The exhaust steam from the steam turbine is cooled in condenser at 0.2 bar from saturated vapour to saturated liquid at the rate of 5 kg/s. The heat rejection rate in the condenser is
(a) 11.8 KW (b) 11.8 MW (c) 11.8 W (d) 2358 KW.

(ii) In a binary Mercury-vapour cycle, Hg cycle operates at 50% efficiency and the overall efficiency is 70%. The efficiency of steam cycle is then
(a) 50% (b) 60% (c) 75% (d) 40%.

(iii) While doing flue gas analysis by ORSAT apparatus, the pyrogallic acid absorbs _____ gas.
(a) O_2 (b) N_2 (c) CO_2 (d) CO

(iv) Keeping the condenser pressure constant, if the boiler pressure is increased, then the dryness fraction of exhaust steam from turbine
(a) increases (b) decreases
(c) it remains the same (d) cannot be concluded.

(v) Out of the following which is not regarded as coal ?
(a) Anthracite (b) Lignite
(c) Peat (d) Bituminous.

(vi) The draught which the chimney produces is called
(a) natural draught (b) forced draught
(c) induced draught (d) balanced draught.

(vii) The blade velocity of Parson's reaction turbine operating at the condition of maximum blading efficiency having nozzle velocity of 400 m/s and nozzle angle 18° is approximately of
(a) 420 m/s (b) 300 m/s
(c) 200 m/s (d) 380 m/s.

(viii) Off the following , which one is not a boiler mounting?
(a) Water level indicator (b) Economiser
(c) Steam stop valve (d) Fusible plug.

(ix) The point in steam power plant, where the minimum temperature between the flue gas and the working fluid occurs is called
(a) critical point (b) boiling point
(c) threshold point (d) pinch point .

(x) "Peak load" of a power plant when multiplied by "load factor" gives _____ on the plant.
(a) average load (b) connected load
(c) maximum demand (d) plant capacity

Group – B

2. (a) A regenerative cycle operates with steam supplied at 30 bar and 300°C, and the condenser pressure is 0.08 bar. The extraction points for two heaters are at 3.5 bar and 0.7 bar respectively. Calculate the thermal efficiency of the plant neglecting pump work.

(b) In a power plant the efficiencies of the electric generator, turbine (mechanical), boiler, cycle and the overall plant are 0.97, 0.95, 0.92, 0.42 and 0.33 respectively. What percentage of the total electricity generated is consumed in running the auxiliaries?

10 + 2 = 12

3. In a cogeneration plant, steam enters the h.p. stage of a two-stage turbine at 1 MPa, 200°C and leaves it at 0.3 MPa. At this point some of the steam is bled off and passed through a heat exchanger which it leaves as saturated liquid at 0.3 MPa. The remaining steam expands in the I.p. stage of the turbine to 40 kPa. The turbine is required to produce a total power of 1 MW and the heat exchanger to provide a heating rate of 500 kW. Calculate the required mass flow rate of steam into the h.p. stage of the turbine. Assume (i) steady condition throughout the plant, (ii) velocity and gravity terms to be negligible, (iii) both turbine stages are adiabatic with isentropic efficiencies of 0.80.

(4 + 4 + 4) = 12

Group – C

4. (a) The ultimate analysis of a fuel oil is given to be: carbon 82.7%, hydrogen 13.7%, sulphur 0.7%, nitrogen 1.7% and oxygen 1.2%. The combustion air has a dry bulb temperature of 27°C and wet bulb temperature of 21°C. With 30% excess air and assuming complete combustion, find (a) the total

volume of combustion products at 200°C and 1.013 bar, and (b) the dry flue gas analysis based on CO_2, O_2 and N_2 at DBT = 27°C and WBT = 21°CS pecific humidity = 0.0132 kg moisture / kg dry air.

(b) State the function and location of FD and ID fan in boiler?

8 + 4 = 12

5. The following data were obtained in a boiler trial:
mass and temperature of feed water = 680 kg/hr and 20°C
steam pressure and its temperature = 15 bar and 300°C
coal used and its calorific value = 98 kg/hr and 26500 kJ/kg
flue gas formed and its temperature at chimney = 18 kg/kg of coal supplied and 300°C
Ash and unburnt coal is ash-pit = 4 kg/hr with 2200 kJ/kg calorific value
Mean specific heat of flue gases and feed water = 1 kJ/kg K and 4.187 kJ/kgK
If the ambient temperature in the boiler room is 28°C, determine the
(i) Boiler efficiency
(ii) Equivalent evaporation from and at 100°C
(iii) Total heat loss
(iv) Draught produced in mm of water column if the height of chimney is 50 m

(3 × 4) = 12

Group – D

6. (a) Show that the maximum discharge of steam through the nozzle takes place when the ratio of steam pressure at the throat to the inlet pressure is given by, $\frac{p_2}{p_1} = \left(\frac{2}{n+1}\right)^{\frac{n}{n+1}}$.

(b) In a stage of an impulse turbine, provided with single row wheel, the mean diameter of the blade ring is 800 mm and the speed of rotation is 3000 rpm.The steam ejects from the nozzles with a velocity of 300 m/s and the nozzle angle is 20°.The rotor blades are equiangular and the blade friction factor is 0.85. What is the power developed in the blading when the axial thrust on the blades is 140 Newtons.

6 + 6 = 12

7. (a) Derive the expression for the diagram efficiency of a 50% reaction turbine and hence show that maximum efficiency is $\eta_{max} = \frac{2\times\cos^2\alpha_1}{1+\cos^2\alpha_1}$ where, α_1 = nozzle angle.

(b) A convergent-divergent nozzle receives dry saturated steam and discharges it at a velocity of 800 m/s into a chamber at a pressure of 1.4 bar. The nozzle efficiency is 85% and n=1.135. Estimate the pressure of steam supply. Neglect inlet velocity. If the mass flow rate of steam is 10 kg/s, determine the throat and exit areas of the nozzle.

7 + 5 = 12