SPECIAL SUPPLE B.TECH/ME/7TH SEM/MECH 4101/2018

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) Stage efficiency of an impulse turbine is
(a) $\eta_{nozzle} + \eta_{blade}$ (b) $\eta_{nozzle} \times \eta_{blade}$
(c) $\eta_{nozzle} - \eta_{blade}$ (d) none of these.

(ii) Out of the following, which one is used for part recovery of waste heat from flue gases?
(a) feed pump (b) super-heater
(c) blow-off valve (d) evaporator.

(iii) A plant has a peak load of 1000 MW but the average annual load is 350 MW. The annual load factor of the plant is
(a) 0.35 (b) 28.5 (c) 35 (d) 3.5.

(iv) Tangential component of velocity of a steam turbine is called
(a) flow velocity (b) relative velocity
(c) whirl velocity (d) absolute velocity.

(v) Maximum power developed by a single stage impulse turbine having U as blade velocity under symmetrical blading and no friction condition is
(a) U^2 (b) $2U^2$ (c) 2U (d) U^4.

(vi) The function of the economizer is
(a) to utilize the heat of condensing steam
(b) to increase the internal energy of air supplied to the boiler
(c) to utilize the heat of flue gases
(d) to optimize the feed water supply rate.

(vii) Governing of steam turbine is done by
(a) throttle control (b) nozzle control
(c) by pass governing (d) all of these.

(viii) Which of the following is not a part of hydro-electric power plant?
(a) catchment area (b) spillways
(c) conduits (d) BWR.

(ix) In a Parson's reaction turbine, the enthalpy drop in fixed blade is 20 KJ/Kg. Enthalpy drop in moving blade in kJ/kg is
(a) 40 (b) 10 (c) 20 (d) 30.

(x) Steam is expanded in a set of nozzles from 10 bar and 200°C to a pressure which gives maximum discharge. The pressure of steam coming out of nozzle is
(a) 20 bar (b) 5.5 bar (c) 0.5 bar (d) 5 kPa.

Group – B

2. (a) Draw T-S diagram of Rankine Cycle Under the following steam conditions:
(i) steam from boiler is superheated, exhaust steam from turbine is wet, water coming out from condenser is saturated liquid, saturated liquid is pumped to boiler at boiler pressure
(ii) steam from boiler is superheated, exhaust steam from turbine is saturated vapour, water coming out from condenser is sub cooled, sub cooled liquid is pumped to boiler at boiler pressure

(b) Steam at 30 bar and 400° C from the boiler is expanded isentropically in turbine to 1 bar pressure in condenser. Calculate the quality of steam coming out from turbine.

(4 + 4) + 4 = 12

3. (a) What is heat rate? What is the difference between the net cycle heat rate and the gross cycle heat rate?

(b) What is a *supercritical* steam cycle?

(c) State *five* main characteristics of an ideal working in a power cycle.

4 + 3 + 5 = 12

Group – C

4. (a) A chimney is producing a draught equivalent to 13 mm of water which is 80% of the theoretical draught that would have been produced. The chimney is filled with hot gas of 287^{0}C. The temperature of air outside is 21^{0}C. The boiler uses 18 kg of air per kg of fuel consumed. Find the height of the chimney.

   (b) Find the power required by the FD fan with the following data.
   Coal burning rate: 10 tons per hour, Theoretical air required: 9.9 kg of air per kg of coal Excess air supplied: 30%, Pressure head developed: 180 mm of water, Mechanical efficiency of the fan: 60% Ambient temperature: 30^0 C, Ambient pressure: 760 mm of Hg.

6 + 6 = 12

5. (a) Prove that the height h_w (in mm of water column) that produces natural draught is given by $h_w = 353H\left[\frac{1}{T_a} - \frac{1}{T_g}\left(\frac{m_a + 1}{m_a}\right)\right]$, where T_a is the absolute temperature of atmospheric air, H is the chimney height above the fire grate, T_g is the average absolute temperature of flue gases and m_a is the mass of air supplied per kg of fuel?

   (b) Write short notes on the following:
   (i) Economiser (ii) Superheater (iii) Steam stop valve.

6 + 6 = 12

Group – D

6. (a) Write in brief how steam flow into the turbine is governed by throttling.

   (b) Draw the velocity diagram of a single stage impulse diagram, and mark the following:
   (i) whirl velocities (ii) axial velocities (iii) blade velocity and (iv) absolute velocities.

6 + 6 = 12

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

(b) Prove that for a single stage impulse turbine the maximum blading efficiency will occur when the speed ratio is $\frac{\cos \alpha_1}{2}$, where α_1 is the nozzle angle.

6 + 6 = 12

Group – E

8. (a) Define the following factors with respect to a power plant:
(i) Load factor (ii) Capacity factor and (iii) Use factor.

(b) List out the various factors that should be considered for setting up a conventional thermal power plant.

6 + 6 = 12

9. (a) How can total annual cost of a power plant be calculated. Describe the various components of the cost. How can the cost of generation of power be reduced?

(b) Write short notes on the following with respect to hydroelectric power generating station. Catchment Area, Reservoir, Dam, Spillways, Conduits & Power house.

(4 + 2) + 6 = 12