Code: 13A03502

R13

B.Tech III Year I Semester (R13) Regular & Supplementary Examinations November/December 2016

THERMAL ENGINEERING – II

(Mechanical Engineering)

(Use of Steam tables and Mollier charts is permitted in the examination hall)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

*****

1 Answer the following: (10 X 02 = 20 Marks)

(a) Regeneration employed in Rankine Cycle consumes some Steam mass tapped from Steam turbine/engine thereby resulting in Loss of Work output? How does Regeneration improve the performance of Rankine cycle?

(b) List any four thermal power plants installed in Andhra Pradesh giving the type of power cycle employed in each of them.

(c) Name some mountings used in boilers for the control of Pressure in Boiler.

(d) What is artificial draught in thermal power plant?

(e) What are the parameters affect the nozzle efficiency?

(f) Why there is a need of an air extraction pump in the condenser?

(g) Distinguish between operating features of an impulse and reaction turbines.

(h) The blade height in an axial flow turbine is increased towards the low pressure end why?

(i) What are the advantages of closed cycle gas turbine over open cycle?

(j) What do you mean by propulsive power and propulsive efficiency?

PART – B

(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

2 (a) Draw the configuration diagram, p-v and T-s diagram of a Simple Rankine Steam Power cycle and explain its working principle.

(b) Steam at a pressure of 15 bar and 250^oC is expanded through a turbine at first to a pressure of 4 bar. It is then reheated at constant pressure to the initial temperature of 250^oC and finally expanded to 0.1 bar. Using Mollier chart, estimate the work done per kg of steam flowing through the turbine and amount of heat supplied during the process of reheat. Assume all expansion process to be isentropic.

OR

3 In a single-heater regenerative cycle the steam enters the turbine at 30 bar, 400^oC and the exhaust pressure is 0.10 bar. The feed water heater is a direct contact type which operates at 5 bar. Find: (i) The efficiency and the steam rate of the cycle. (ii) The increase in mean temperature of heat addition, efficiency and steam rate as compared to the Rankine cycle (without regeneration). Pump work may be neglected.

UNIT – II

4 A thermal power station works on natural draught. The height of the chimney is restricted to 40 m. The ambient temperature of the air is 20℃ and the temperature of the flue gases passing through the chimney at its base is 300℃. The air-fuel ratio is 17 : 1. Calculate the diameter of the chimney at the base, if head lost due to friction is 25% of the ideal draught

OR

5 (a) With a neat sketch explain the principle of working of a Babcock and Wilcox water tube steam boiler.

(b) What are the advantages of fire tube over water tube boiler?

UNIT – III

6 A convergent- divergent steam nozzle is required to deliver 2 kg of steam per second. The nozzle is supplied with steam at 10 bar (abs) and temperature 200^oC, while discharge takes place against a back pressure of 0.34 bar (abs). Calculate the throat and exit areas of the nozzle. Assume the flow of steam through the nozzle to be isentropic and the index of expansion to be 1.3. If the nozzle efficiency is assumed to be 85 %, calculate the exit area of the nozzle.

OR

7 In a surface condenser a section of tubes near the air pump section is screened off so that the air is cooled to a temperature below that of the condensate, separate extraction pumps being provided to deal with air and condensate respectively. The steam condensed per hour is 15000 kg, and air leakage is 12 kg/hr. The temperature of the steam entering the condenser is 32.55^0C, the temperature of condensate at entrance at entrance to the air cooler is 30.69^0C, and the temperature at the air pump suction is 25^0C. Assuming a constant vacuum throughout the condenser find: (i) The weight of steam condensed in the cooler per hour. (ii) The volume of air in m^3/hr to be dealt with by the air pump. (iii) The percentage reduction in the air pump capacity following the cooling of the air.

Contd. in page 2

UNIT – IV

8 In two stage impulse turbine, the steam issue from the nozzle with a speed of 600 m/sec. And blade speed is 120 m/sec. The velocity is compounded by passing through a ring of moving blades, then through a ring of fixed blades and finally through a ring of moving blades. The nozzle angle is 18^0 and blade exit angles and relative velocity coefficient (K) are given below.

First row of moving blades = 20^0, k = 0.8
Fixed row of blades = 25^0, k = 0.85
Second row of moving blades = 30^0, k = 0.9

Find:

(a) The diagram efficiency.
(b) Power developed by the turbine if the flow of steam is 5 kg/sec.

OR

9 A Parson's turbine has the following data for a particular group of blading :

Mean diameter of the blades = 100 cm
RPM = 300
Number of stages = 4
Ratio of blade speed to steam speed = 0.75
Blade outlet angle = 20^0
Carry over factor = 0.75
Efficiency of conversion of heat into kinetic energy in fixed as well as moving blades = 90 %
Steam flow rate through the turbine = 20 kg/s

Find: (i) The total heat drop. (ii) The power developed. (iii) Gross stage efficiency

UNIT – V

10 Air is drawn in a gas turbine unit at 17^0 C and 1.01 bar and the pressure ratio is 8:1. The compressor is driven by the H.P turbine and the L.P. turbine drives a separate power shaft. The isentropic efficiencies of the compressor and the H.P. and L.P turbine are 0.8, 0.85 and 0.83, respectively. Calculate the pressure and temperature of the gases entering the power turbine, the net power developed by the unit per kg/s of mass flow, the work ratio and the thermal efficiency of the unit. The maximum cycle temperature is 650^0C.

For the compression process take c_p = 1.005 kJ/kg K and γ = 1.4

For the combustion process and expansion process, take C_p = 1.15 kJ/kgK and γ = 1.333 neglect the mass of fuel.

OR

11 A simple turbo-jet unit operates with a turbine inlet temperature of 1040^0C. The following data also refer to this unit under design conditions.

$Cp_a = 0.24$: $\gamma_a = 1.4$;
$Cp_g = 0.276$: $\gamma_g = 1.33$.

Compressor pressure-ratio	7.5
Compressor efficiency	84%
Turbine efficiency	84%
Nozzle efficiency	98%
Atmospheric pressure	1.03 kgf/ cm^2
Atmospheric temperature	27^0C
Pressure drop in combustion chamber	0.21 kgf/ cm^2
Mass flow of air	25 kg / sec.

Neglect the weight of fuel and mechanical efficiencies. Calculate the design thrust ; pressure and temperature at the inlet to the jet nozzle; temperature; velocity and Mach number at the nozzle exit and specific fuel consumption

*****