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Code No: 136EB

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year II Semester Examinations, December - 2019

THERMAL ENGINEERING – II

(Mechanical Engineering)

Time: 3 hours **Max. Marks: 75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

(25 Marks)

1.a) Write two differences between Carnot cycle and Rankine cycle. [2]
b) Why boiler mountings and accessories are essential. [3]
c) Define the terms nozzle efficiency and velocity coefficient. [2]
d) Briefly explain the phenomenon of supersaturated flow expansion of steam through the nozzle. [3]
e) What is the necessity of reducing the rotor speed of steam turbine? [2]
f) What is the effect of blade friction on the turbine performance? [3]
g) State the advantages of incorporating the steam condenser in the steam power plant. [2]
h) Show with a sketch that closed cycle gas turbine is similar to steam turbine plant. [3]
i) How rockets are classified? [2]
j) What are the applications of liquid propellant rockets? [3]

PART - B

(50 Marks)

2.a) Explain the effect of temperature and pressure on the Rankine cycle efficiency.
b) A power generating plant uses steam a working fluid and operates at a boiler pressure of 50 bar dry saturated and a condenser pressure of 0.05 bar. Calculate for these limits i) cycle efficiency for Carnot cycle and Rankine cycle, ii) work ratio and specific steam consumption for Carnot cycle and Rankine cycle. [4+6]

OR

3.a) Derive an expression connecting the height of a chimney and the draught it produces in terms of temperature of outside air and the mean temperature of the flue gases. State clearly the assumptions made
b) Sketch and describe the working of any high pressure boiler. [5+5]

4. Steam at a pressure of 10 bar and a dryness of 0.97 is to be discharged through a convergent divergent nozzle to a back pressure of 0.15 bar. The mass flow rate of steam through the nozzle is at a rate of 6 kg/kW hr. If the turbine develops 150 kW, determine a) throat pressure b) number of nozzles required, the diameter of a nozzle at throat is 6.5 mm and c) suitable diameter for exit of the nozzle assuming that 10 % of the overall isentropic enthalpy drop reheats the steam in the divergent portion of the nozzle. [10]

OR

5.a) Derive the expression for maximum discharge in steam nozzle per unit area from the first principle.

b) A nozzle is supplied with steam at 7 bar and 275 ^{0}C. Find the temperature and velocity at the throat. If the diverging portion is 50 mm long and the throat diameter 6 mm determine the angle of the cone so that the steam may leave the nozzle at 1 bar. Assume a friction loss of 15% of the heat drop in the diverging portion. [5+5]

6.a) Explain the working principle of reaction turbine with the help of diagram. Sketch the pressure and velocity variations along the axis of the turbine.

b) A simple impulse turbine has one ring of moving blade running at 150m/s; velocity of steam reaching the nozzle 90 m/s; nozzle efficiency 0.85; absolute velocity of steam at exit from the stage 85 m/s at an angle of 80^0 with tangent of wheel; blade velocity coefficient 0.82; rate of steam flowing 2 kg/s. Assuming moving blade to be equiangular. Find the blade angles, nozzle angle, absolute velocity of steam at entrance, axial thrust and power developed. [4+6]

OR

7.a) Sketch the inlet and exit velocity diagrams of a single stage impulse turbine and determine the expressions for the force, work done, diagram efficiency and axial thrust.

b) Discuss the differences between impulse and reaction turbines. [5+5]

8.a) With the help of neat sketch explain the working of an evaporative condenser.

b) A steam turbine discharges 5000 kg of steam per hour at 40 ^{0}C and 0.85 dryness. The estimated air leakage is 15 kg/hr. The temperature at the suction of the air pump is 32 ^{0}C and the temperature of the condenser is 35 ^{0}C . Calculate i) the vacuum gauge reading, ii) capacity of air pump and iii) loss of condensate in kg/hr. [4+6]

OR

9. At design speed the following data apply to a gas turbine set employing a separate power turbine, heat exchanger and reheater. Pressure ratio across the compressor is 4 : 1, Isentropic efficiency of compressor is 80%, isentropic efficiency of compressor turbine is 87% and power turbine is 80%, transmission efficiency is 99%, effectiveness of heat exchanger is 0.75, pressure loss in combustion chamber is 0.15 bar, combustion efficiency of the main combustion chamber and the reheater is 98% each, maximum cycle temperature 1000 K, temperature after reheating is 1000 K, air mass flow rate 25 kg/s, ambient conditions are: 15 ^{0}C temperature and 1 bar pressure. Take the calorific value of fuel as 42 MJ/kg and pressure loss in each side of heat exchanger as 0.1 bar. Find the net power output, overall thermal efficiency and specific fuel consumption. [10]

10.a) Describe with a sketch operation of turbojet engine.

b) The exit are/throat area ratio of a rocket nozzle is 3:1. The combustion pressure and temperature are 20 bar and 300 K and atmospheric pressure is 1 bar. Assume that expansion is isentropic, estimate the thrust per unit throat area and the specific impulse. For gases assume molecular weight of 33.5 and $\gamma = 1.2$. [5+5]

OR

11.a) Describe with a sketch the principle of ram jet. Where it is used? Why?

b) What is meant by thrust augmentation? When is it necessary? Describe the two main methods of thrust augmentation. [5+5]

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