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Code No: 115ER

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech III Year I Semester Examinations, May/June - 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.

Assume Data if Necessary, Steam Tables:

PART - A

(25 Marks)

1.a) Name the methods adopted for improving the performance of the Rankine cycle. [2]
b) How does friction in the system affect the expansion and compression processes in the working of Rankine cycle? [3]
c) Differentiate the fire tube and water tube boiler. [2]
d) Derive an expression for maximum mass flow through a convergent divergent nozzle when steam is expanded isentropically. [3]
e) What is the difference between impulse and reaction blading. [2]
f) Explain the working of a single stage impulse turbine with the help of sketch. [3]
g) Is it always useful to have a regenerator in a gas turbine power cycle? Why? [2]
h) Derive the expression for thermal efficiency of the simple gas turbine cycle. [3]
i) What are the various propulsive devices for aircrafts and missiles? [2]
j) How rockets are classified? What is the essential difference between rocket propulsion and turbojet propulsion? [3]

PART - B

(50 Marks)

2.a) Discuss the effects of following parameters in a Rankine cycle.
i) Steam pressure at inlet to the turbine and ii) Steam temperature at inlet to the turbine
b) In an engine the dry volumetric analysis of the products was CO_2 =0.0527, O_2 = 0.1338 and N_2 = 0.8135. Assuming that fuel is a pure hydrocarbon and that it is completely burnt, estimate the ratio of carbon to hydrogen in the fuel by mass and the air fuel ratio by mass. [5+5]

OR

3.a) What is adiabatic flame temperature? How flame temperature can be calculated.
b) Steam at 15 bar and 300 ^{0}C expands isentropically in a steam turbine till the temperature falls to 80 ^{0}C. Find the condition of steam at the end of expansion process and the work done per kg of steam. If the steam flow rate is 10 kg/s, what power will be produced by the turbine? [5+5]

4.a) Sketch and describe the operation of Cochran vertical boiler. What are its special features?

b) Why boiler mountings are installed. Explain the operation of fusible plug with the help of simple diagram. [5+5]

OR

5.a) Explain the effect of friction in nozzle flow with the help of *h-s* diagram.

b) A group of convergent-divergent nozzles are supplied with steam at a pressure of 2 N/m^2 and a temperature of 325 ^0C. Supersaturated expansion according to the law $PV^{1.3}$ = constant, occurs in the nozzle down to an exit pressure of 0.36 MN/m^2. Steam is supplied at the rate of 7.5 kg/s. Determine the required throat and exit areas. [4+6]

6.a) A simple impulse turbine has one ring of moving blades running at 150 m/s, absolute velocity of steam at exit is 85 m/s at an angle 80^0 with the tangent of wheel, friction coefficient is 0.82, rate of steam flowing 2 Kg/s. Assuming the moving blades to be a symmetrical, find the i) Blade angles ii) Nozzle angle iii) absolute velocity of steam at entrance and iv) power developed.

b) Describe construction of inlet and exit velocity triangles of simple impulse turbine. [8+2]

OR

7.a) Sketch and describe the operation of central flow surface condenser.

b) Show that for maximum diagram efficiency of a reaction turbine the blade speed ratio is equal to *cos* α, where α is the angle of absolute velocity at inlet. [5+5]

8.a) Explain the stages of combustion in a gas turbine combustion chamber with a neat sketch.

b) Derive an expression for the specific net work output of a simple ideal gas turbine cycle in terms of temperature and pressure ratios. Also prove that

$$\left(r_{opt}\right)^{\gamma-1/\gamma} = \sqrt{T_{\max}/T_{\min}}$$

Where, r is the pressure ratio [5+5]

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 ^0C 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) With a neat sketch and T-s diagram, explain the working of a turbojet engine.

b) A turbojet engine flying at a speed of 800 km/hr consumes air at the rate of 45 kg/s. Calculate i) jet exit velocity, the change in enthalpy for the nozzle is 190 kJ/kg and the velocity coefficient is 0.95, ii) fuel flow in kg/hr and thrust specific fuel consumption, assuming that air-fuel ratio is 80:1, iii) thermal efficiency of plant given calorific value of fuel used is 43890 kJ/kg, iv) propulsive power and thrust power and v) propulsive efficiency and overall efficiency. [4+6]

OR

11.a) An aircraft fitted with a turbojet engine is flying at a higher altitude where, the ambient conditions are 0.07 bar pressure and 1 ^{o}C temperature. The flight speed is 800 kmph. Determine the rate of fuel consumption and thrust specific fuel consumption, when the thrust developed is 25000 N under the following conditions: Ram efficiency is 95%, total head pressure ration across the compressor 5:1, isentropic efficiency of compressor is 85%, isentropic efficiency of turbine is 90%. Consider an isentropic nozzle with expansion upto the ambient pressure. Take C.V. of the fuel as 42 MJ/kg.

b) Describe the operation of ramjet engine. [7+3]

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