Code No: 125ER JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD B.Tech III Year I Semester Examinations, May/June - 2019 THERMAL ENGINEERING – II (Common to ME, AME)

Time: 3 hours

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

- 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.
 - 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.
 - f) Explain the working of a signe stage impulse turbine with the help of sketch.
 - g) Is it always useful to have a regenerator in a gas turbine power cycle? Why? [2]
 - h) Derive the expression of the simple gas turbine cycle.
 - i) What are the various propulsive devices for aircrafts and missiles?
 - j) How rockets are classified? What is the essential difference between rocket propulsion and turbojet propulsion? [3]

PART - B

(50 Marks)

Max. Marks: 75

(25 Marks)

[2]

[2]

[3]

[3]

[2]

- 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 ^oC expands isentropically in a steam turbine till the temperature falls to 80 ^oC. 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]

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- 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]

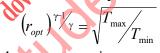
OR

- 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° C. Supersaturated expansion according to the law $PV^{l.3}$ = constant, occurs in the nozzle down to an exit pressure of 0.36 MN/m². 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 $\cos \alpha$, 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



Where, r is the pressure ratio

OR

[5+5]

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 °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]

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- 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 °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]