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Code No: 155DG

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year I Semester Examinations, July/August - 2023

THERMAL ENGINEERING - II

(Mechanical Engineering)

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

Note: i) Question paper consists of Part A, Part B.
ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.
iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A

(25 Marks)

1.a)	What are the merits of artificial draught over natural draught.	[2]
b)	How does the Rankine cycle differ from the Carnot cycle for a vapour?	[3]
c)	Briefly explain the saturated flow through the nozzle.	[2]
d)	Explain the physical concept of critical pressure ratio.	[3]
e)	Classify the turbines.	[2]
f)	Explain the importance of velocity triangles in impulse turbine.	[3]
g)	What are the sources of air in the condensers?	[2]
h)	Write the requirement of a good combustion chamber for a gas turbine.	[3]
i)	What are the various propulsive devices for aircrafts and missiles?	[2]
j)	What is meant by thrust augmentation? When it is necessary.	[3]

PART – B

(50 Marks)

2.a) Describe the intercooling arrangement in Rankine cycle with the help of neat sketch. Also represent the cycle on T-S diagram.

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. [5+5]

OR

3.a) Derive the formula to calculate the draught produced (in terms of height of mercury column) in chimney. Also derive condition for maximum efficiency.

b) Sketch and describe the working of a Babcock and Wilcox boiler. [5+5]

4.a) A group of convergent-divergent nozzles are supplied with steam at a pressure of 2 MN/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.

b) Derive the expression relating the critical pressure ratio to index of expansion *n*, for expansion in a nozzle. [5+5]

OR

5. A convergent-divergent nozzle is required to discharge 2 kg of steam per second. The nozzle is supplied with steam at 100 bar and 200^0 C and the discharge takes place against back pressure of 0.34 bar. Estimate the throat and exit areas. Assume isentropic flow and take the index n = 1.3. If the nozzle efficiency is assumed to be 85 %, determine the exit area. [10]

6. 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, and absolute velocity of steam at entrance, axial thrust and power developed. [10]

OR

7.a) Prove that maximum diagram efficiency as a function of nozzle angle, for a simple impulse steam turbine with symmetric blades and no friction in blade passage.

b) At a particular stage of Parson's reaction turbine the mean blade speed is 60 m/s and the steam pressure is 3.5 bar with a temperature of 175 ^{0}C. The identical fixed and moving blades have inlet angles of 30^0 and outlet angles of 20^0. Determine i) power developed by the stage, ii) the blade height if it is $1/10^{th}$ of the blade ring diameter for a flow rate of 810 kg/min, and iii) the specific enthalpy drop if the stage efficiency is 85%. [5+5]

8. In a condenser test the following observations were made: vacuum 70 cm of Hg, barometer 76 cm of Hg, mean temperature of condensate 34 ^{0}C, hotwell temperature 29 ^{0}C, mass of cooling water 102000 kg per hour, inlet temperature 17 ^{0}C, outlet temperature 31 ^{0}C, mass of condensate per hour 2620 kg. Find a) mass of air present per m^3 of condenser volume, b) state of steam entering the condenser and c) vacuum efficiency. [10]

OR

9. In a gas turbine, the pressure ratio to which air at 15 ^{0}C is compressed is 6. The same air is then heated to a maximum permissible temperature of 750 ^{0}C, first in a heat exchanger and then combustion chamber. It is then expanded in two stages such that the expansion work is maximum. The air reheated to 750 ^{0}C after the first stage. Determine the cycle thermal efficiency, work ratio and net shaft work per kg of air. Take the compressor and turbine efficiency as 80% and 85% respectively. [10]

10.a) Explain the principle of jet propulsion and mention how the jet propulsion engines are classified.

b) Describe the two main methods of thrust augmentation. [5+5]

OR

11. The exit velocity from a jet unit is 650 m/s for airflow of 40 kg/s through the unit. The aircraft is flying at 250 km/hr. Calculate the thrust developed, thrust power and the propulsion efficiency. Neglect the effect of fuel. [10]

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