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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, HYDERABAD
B. Tech III Year I Semester Examinations, May/June – 2013
Applied Thermodynamics-II
(Common to ME, AME)

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

Answer any five questions
All questions carry equal marks

1.a) Explain the construction and working of a simple vertical boiler with the help of a neat diagram.

b) 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 20^0C and the temperature of the fuel-gas passing through the chimney at its base is 300^0C. 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. [15]

2.a) Establish the energy balance in a boiler. How can its performance be improved?

b) Calculate the equivalent evaporation of a boiler per kg of coal fired, if the boiler produces 50,000 kg of wet steam per hour with a dryness fraction of 0.95 and operating at 10 bar. The coal burnt per hour in the furnace is 5500 kg and feed-water temperature is 40^0C. [15]

3.a) What is the significance of critical pressure ratio on discharge though a nozzle?

b) Steam at 15 bar and 200^0C is supplied to a convergent –divergent nozzle against a back pressure of 4 bar. Expansion is superheated up to the throat and the nozzles are rectangular in shape, its width being 2.5 times the breadth. For a mass-flow rate of 0.3 kg/s, find
i) Dimensions of undercooling at the throat at the exit,
ii) Degree of undercooling and super saturation,
iii) Increase in entropy. [15]

4.a) Differentiate between Jet and Surface condensers.

b) During a trial on a condenser, the following readings were recorded:

Barometer reading	= 766 mm of Hg
Actual vacuum recorded by gauge	= 716 mm of Hg
Temperature of exhaust steam	= 35^0C
Temperature of hot well	= 29^0C
Inlet temperature of cooling water	= 15^0C
Outlet temperature of cooling water	= 24^0C

Calculate
a) Corrected vacuum to standard barometer reading of 760 mm of mercury,
b) Vacuum efficiency,
c) Under cooling of condensate, and
d) Condenser efficiency. [15]

5.a) Derive an expression for optimum stage efficiency of a reacting turbine.

b) Steam with velocity of 800 m/s enters an impulse turbine ring and drives the rotor at 3000 rpm. The jet angle is 20^0 and the mean drum diameter is 1.4 m. Assuming that inlet and exit angles of the moving blades are equal and a blade velocity coefficient of 0.85, find

i) The blade angles

ii) Diagram efficiency

iii) Power developed per kg per second of steam flow

iv) Stage efficiency, if the nozzle efficiency is 95%. [15]

6. Steam issues from the nozzles of a de-Laval turbine with the velocity of 920 m/s. The nozzle angle is 20^0, the mean diameter of the blades is 25 cm and the speed of rotation is 20,000 rpm. The steam flow through the turbine is 0.18 kg/s. If the ratio of relative velocity at outlet from the blades to that at inlet is 0.82, calculate

a) Tangential force on blades per second

b) Work done on blades per second

c) Power of the wheel

d) Efficiency of blading

e) Axial force on blades,

f) Inlet angle of blades for shock-less in flow of steam.

Assume that the outlet angle of blades is equal to the inlet angle. [15]

7.a) What are the different methods used to improve efficiency of a gas turbine power plant? Explain any one method.

b) A gas turbine takes in air at 27^0C and 1 bar. The pressure ratio is 4. The maximum temperature of the cycle is 560^0C. The efficiency of the compressor and turbine is 0.83 and 0.85, respectively. Find the overall efficiency, if the regenerator effectiveness is 0.75. [15]

8.a) Explain the working of a turbojet engine with the help of sketch

b) The diameter of jet of a turbojet is 2.5 m and it files at 500 km/h at an elevation of 8 km for flight to jet speed 0.75 the density of air is 0.525 kg/m^3. Calculate

a) mass flow rate of air, b) fuel flow rate,

c) propulsive efficiency, and d) overall efficiency. [15]

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