

R09

Code No: 09A50306

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

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- 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  $20^{\circ}\text{C}$  and the temperature of the fuel-gas passing through the chimney at its base is  $300^{\circ}\text{C}$ . 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  $40^{\circ}\text{C}$ . [15]
- 3.a) What is the significance of critical pressure ratio on discharge through a nozzle?
- b) Steam at 15 bar and  $200^{\circ}\text{C}$  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
- Dimensions of undercooling at the throat at the exit,
  - Degree of undercooling and super saturation,
  - 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        | = $35^{\circ}\text{C}$ |
| Temperature of hot well             | = $29^{\circ}\text{C}$ |
| Inlet temperature of cooling water  | = $15^{\circ}\text{C}$ |
| Outlet temperature of cooling water | = $24^{\circ}\text{C}$ |
- Calculate
- Corrected vacuum to standard barometer reading of 760 mm of mercury,
  - Vacuum efficiency,
  - Under cooling of condensate, and
  - 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  $20^\circ$  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
- The blade angles
  - Diagram efficiency
  - Power developed per kg per second of steam flow
  - 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  $20^\circ$ , 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
- Tangential force on blades per second
  - Work done on blades per second
  - Power of the wheel
  - Efficiency of blading
  - Axial force on blades,
  - 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  $27^\circ\text{C}$  and 1 bar. The pressure ratio is 4. The maximum temperature of the cycle is  $560^\circ\text{C}$ . 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 flies at 500 km/h at an elevation of 8 km for flight to jet speed 0.75 the density of air is  $0.525 \text{ kg/m}^3$ . Calculate
- mass flow rate of air,
  - fuel flow rate,
  - propulsive efficiency, and
  - overall efficiency. [15]

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