

B 2329

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Third Semester

Mechanical Engineering

ME 231 — APPLIED THERMODYNAMICS

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

Use of approved steam tables permitted.

PART A — (10 × 2 = 20 marks)

1. What is meant by critical pressure ratio for a nozzle?
2. What are the functions of steam nozzles?
3. What is the purpose of intercooling the air between two stages of reciprocating compressor?
4. What is meant by volumetric efficiency of reciprocating air compressor?
5. How are the combustion and exhaust processes modeled under air standard assumptions?
6. The clearance volume of an engine working on Otto cycle is 14 % of its stroke volume. Find out its air standard efficiency.
7. Why is excessive moisture in steam undesirable in steam turbines? What is the highest moisture content allowed?
8. What are the ways in which rankine cycle efficiency is increased?
9. What is the purpose of Rectifier used between condenser and Desorber in aqua ammonia absorption system?
10. What is the reason for temperature drop in throttling process in V.C. system?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Briefly explain super saturated flow of steam through nozzle with h-s plot. What is meant by Wilson line? (8)
- (ii) In a steam nozzle, the steam expands from 4 bar to 1 bar. The initial velocity is 60 m/s and the initial temperature is 200°C. Determine the exit velocity if the nozzle efficiency is 92%. (8)

Or

- (b) The nozzles of a Delaval turbine are supplied with dry saturated steam at a pressure of 9 bar. The pressure at the outlet is 1 bar. The turbine has two nozzles with a throat diameter of 2.5 mm. Assuming nozzle efficiency as 90 % and that of turbine rotor 35 % determine the quantity of steam used per hour and the power developed.
12. (a) (i) What are the advantages of multistage compression? (4)
- (ii) A single stage single acting reciprocating air compressor takes in $17 \text{ m}^3/\text{min}$ at suction conditions of 100 kPa and 25°C . The delivery pressure is 700 kPa. The clearance volume is 6% of swept volume. The compression and expansion follows the law $pV^{1.3} = \text{Constant}$. The speed of the compressor is 600 rpm. Stroke to bore ratio is 1.

Find the power required to drive the compressor and Cylinder dimensions. (12)

Or

- (b) A single-acting two stage compressor with complete intercooling delivers $10.5 \text{ kg}/\text{min}$ of air at 16 bar. The suction occurs at 1 bar and 27°C . The compression and expansion processes are reversible, polytropic index $n = 1.3$. The speed of the compressor is 440 rpm. Calculate the following.
- (i) The power required to drive the compressor.
- (ii) Isothermal efficiency
- (iii) Free air delivered
- (iv) The heat transferred in the intercooler.
13. (a) The compression ratio in an air-standard otto cycle is 8. At the beginning of the compression stroke the pressure is 0.1 Mpa and the temperature is 15°C . The heat transfer to the air per cycle is $1800 \text{ kJ}/\text{kg}$ of air. Take C_p and C_v for air as 1.005 and $0.718 \text{ kJ}/\text{kg K}$ respectively. Determine the following
- (i) The pressure and temperature at the end of each process of the cycle.
- (ii) The thermal efficiency.
- (iii) The mean effective pressure.

Or

- (b) An air standard dual cycle has a compression ratio of 16 and compression begins at 1.013 bar, 50°C . The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. Estimate the temperatures at the cardinal points of the cycle and the cycle efficiency.

14. (a) (i) In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine the turbine work and rankine efficiency neglecting the pump work. (10)
- (ii) With the help of T-s chart explain the regenerative rankine cycle. (6)

Or

- (b) Steam at a pressure of 15 bar and 250°C is expanded through a turbine at first to a pressure of 4 bar. It is then reheated at constant pressure to the initial temperature of 250°C and is finally expanded to 0.1 bar. Estimate the work done per kg of steam flowing through the turbine, and the efficiency. Compare these values when there is a single expansion from 15 bar to 0.1 bar without any reheat. Assume all expansion processes to be isentropic and neglect the pump work. Plot the cycle on T-s plot.
15. (a) (i) Explain Bell-Coleman Refrigeration System with T-s plot. (8)
- (ii) Explain aqua-ammonia absorption refrigeration system with a neat sketch. (8)

Or

- (b) A simple saturation refrigeration cycle developing 15 tons of refrigeration using R12 operates with a condensing temperature of 35°C and an evaporator temperature of -6°C. Calculate :
- (i) The refrigerating effect,
- (ii) Refrigerant flow rate,
- (iii) The power required to drive the compressor,
- (iv) COP.
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