

B 2334

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

Third Semester

Electrical and Electronics Engineering

ME 251 — THERMODYNAMICS

Time : Three hours

Maximum : 100 marks

Use of Steam Tables, Mollier chart, HMT data book permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define second law of thermodynamics.
2. Define entropy.
3. Define air standard efficiency.
4. Which is more fuel efficient either two stroke or four stroke? Why?
5. What are the safety provisions in boiler?
6. What is meant by compounding of turbines?
7. What is meant by ton of refrigeration?
8. What is meant by relative humidity?
9. What is critical thickness of insulation?
10. What is meant by grey body?

PART B — (5 × 16 = 80 marks)

(b) (i)

(ii)

11. (a) (i) Air is compressed from an initial state of 0.4 m^3 and 0.1 MPa to a final condition of 0.15 m^3 , and 0.105 MPa . There is a heat transfer of 45 kJ from the gas during the process. Estimate the change in internal energy of gas. (8)
- (ii) Air expands from 3 bar to 1 bar in a nozzle. The initial velocity is 90 m/s . The initial temperature is 150°C . Estimate the final velocity. (8)

Or

- (b) (i) A reversible engine operates between heat reservoirs A, B and C. The engine receives equal quantities of heat from reservoirs A and B at temperatures T_a and T_b respectively and rejects heat to reservoir C at temperature T_c . If the efficiency of the above mentioned engine is α times the efficiency of another reversible engine operating between reservoirs A and C only, prove that

$$\alpha = \frac{1}{2} \cdot \frac{T_a}{T_b} \left(\frac{T_b}{T_a} + \frac{T_b - T_c}{T_a - T_c} \right). \quad (8)$$

13. (a)

- (ii) A reversible engine takes 2400 kJ/min from a reservoir at 750 K and develops 400 kJ of work per minute when executing complete cycles. The engine rejects heat to two reservoirs at 650 K and 550 K . Find the heat rejected to each sink. (8)
12. (a) (i) An indicator diagram taken on a diesel engine shows that the compression curve follows the law $pv^{1.4} = \text{constant}$. At two points lying on the compression curve at $\frac{1}{8}$ th and $\frac{7}{8}$ th of the stroke the pressures are respectively 1.6 bar and 16 bar . Find the compression ratio of the engine. If the cut-off occurs at 6% of the stroke, calculate the air standard efficiency. (8)
- (ii) A Carnot engine operates between temperature limits of 1200 K and 400 K using 0.4 kg of air and running at 500 rpm . The pressure at the beginning of heat addition is 1500 KPa and the end of heat addition is 750 KPa . Determine :
- (1) the heat added/cycle
 - (2) the heat rejected
 - (3) the power
 - (4) the volume at the end of heat addition. (8)

(b)

Or

(b) (i) What is the difference between CI and SI engines? (6)

(ii) An ideal dual combustion cycle has a stroke volume of 0.01 m^3 of the air with a compression ratio of 16. The pressure and the temperature of air at the commencement of adiabatic compression is 1 bar and 27°C respectively. The heat is added at constant pressure of 70 bar and 5% of the stroke. Calculate :

(1) pressure ratio

(2) cut-off ratio

(3) mass of air obtained in the cylinder

(4) work done/cycle

(5) mean effective pressure. (10)

13. (a) A steam prime mover receives steam at 10 bar and discharges at 0.5 bar

(i) If the steam is at 10 bar is dry saturated determine rankine efficiency, the efficiency ratio and specific steam consumption. Indicated thermal efficiency may be taken as 20%.

(ii) If the steam supplied to the prime mover is 0.87 dry, find the percentage change in Rankine efficiency.

Neglect the pump work in all cases. Take $C_p = 2.25$ for superheated steam. (16)

Or

(b) (i) Compare the impulse and reaction turbine. (6)

(ii) In a stage of impulse reaction turbine operating with 50% degree of reaction, the blades are identical in shape. The out let of the moving blade is 19° , and the absolute discharge velocity of steam is 100 m/s in the direction at 100° to the motion of the blades. If the rate of flow of steam through the turbine is 15000 kg/hr, calculate the power developed by the turbine. (10)

14. (a) (i) Compare reciprocating and rotary compressors. (6)
- (ii) A two stage air compressor with perfect intercooling takes in air at 1 bar pressure and 27°C. The law of compression in both these stages is $pv^{1.3} = \text{constant}$. The compressed air is delivered at 9 bar from the HP cylinder to an air receiver. Calculate per kg of air,
- (1) the minimum work done
 - (2) heat rejected to the intercooler
 - (3) minimum work done in a three stage compressor working under the same condition. (10)

Or

- (b) Explain the working of vapour compression refrigeration cycle with a neat sketch. Mention advantages and disadvantages. (16)

15. (a) A 25 cm steam main, 225 m long is covered with 5 cm of high temperature insulation ($k = 0.095 \text{ W/mK}$) and 4 cm of low temperature insulation ($k = 0.065 \text{ W/mK}$). The inner and outer surface temperatures are 400°C and 50°C respectively. Find :
- (i) total heat lost/hr
 - (ii) the total heat lost/m² of the outer surface
 - (iii) the heat lost/m² of pipe surface
 - (iv) the temperature between the two layers of insulation.
- Neglect the heat conduction through pipe material. (16)

Or

- (b) (i) A counter flow heat exchanger cools 800 kg/hr of oil of specific heat 2.5 kJ/kg K from 100°C to 35°C by water initially at 20°C. The quantity of water fed is 750 kg/hr. Calculate the water out let temperature and that transfer area for overall heat transfer coefficient of 4000 kJ/m²hr °C. (8)
- (ii) The temperature of a black surface 0.25 m² in area is 650°C. Calculate :
- (1) the total rate of energy emission
 - (2) the intensity of normal radiation
 - (3) the wave length of maximum monochromatic emissive power
- Take Stefan-Boltzman constant
- $$\sigma = 56.7 \times 10^{-12} \text{ kW/m}^2\text{K}^4. \quad (8)$$

Time : Three

1. What

2. What

3. Why

4. Defi

5. Wha

6. Wha

7. How

8. Wh

9. Wh

10. Wh

11. (a)

(b)