Reg. No. : | | | | | | | | | | | |

# J 3308

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2009.

Fourth Semester

Mechanical Engineering

ME 1251 — THERMAL ENGINEERING

(Common to B.E. (Part-Time) Third Semester Regulation 2005)

(Regulation 2004)

Time : Three hours Maximum : 100 marks

(Use of standard thermodynamic tables, Mollier diagram, Psychrometric chart and refrigerant property tables are permitted)

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Mention the assumptions made on the air standard cycle analysis.

2. In an Otto cycle, pressure ratio during compression is 11. Calculate the air standard efficiency.

3. During peak power operation, why petrol engine requires rich mixture?

4. What do you mean by 'mist' lubrication?

5. What are the effects of super saturation in a nozzle?

6. List out some internal losses in steam turbines.

7. What is the effect of clearance volume on the power required and work done in a reciprocating air compressor?

8. Give two examples for positive displacement rotary compressors.

9. Which thermodynamic cycle is used in air conditioning of airplanes using air as a refrigerant?

10. Define 'Wet bulb depression'.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Fuel supplied to an SI engine has a calorific value 42,000 kJ/kg. The pressure in the cylinder at 30% and 70% of the compression stroke are 1.3 bar and 2.6 bar respectively. Assuming that the compression follows the law $pV^{1.3}$ = Constant. Find the compression ratio, if the relative efficiency of the engine compared with the air-standard efficiency is 50%. Calculate the fuel consumption in kg/kW-hr. (12)

(ii) A gas engine working on the Otto cycle has a cylinder of diameter 0.2 m and stroke 0.25 m. The clearance volume is 1570 cc. Find the air standard efficiency. Assume $c_p$ = 1.004 kJ/kg-K and $c_v$ = 0.717 kJ/kg K for air. (4)

Or

(b) (i) A diesel engine has a compression ratio of 20 and cut-off takes place at 5%of the stroke. Find the air standard efficiency. Assume $y$ = 1.4. (6)

(ii) In an engine working on the diesel cycle the ratios of the weights of air and fuel supplied is 50 : 1. The temperature of air at the beginning of the compression is 333 K and the compression ratio used is 14 : 1. What is the ideal efficiency of the engine calorific value of fuel used is 4200 kJ/kg. Assume $c_p$ = 1.004 kJ/kg K and $c_v$ = 0.717 kJ/kg K for air. (10)

12. (a) (i) Compare four stroke and two stroke cycle engines. (9)

(ii) Explain with a sketch the non-exhaust emission from a vehicle. (7)

Or

(b) An eight-cylinder, 4 stroke engine of 0.09 m bore and 0.08 m stroke with a compression ratio of 7 is tested at 4500 rpm on a dynamometer which has 0.54 m arm. During a 10 min test the dynamometer scale beam reading was 42 kgf and the engine consumed 4.4 kg of gasoline having a calorific value of 44,000 kJ/kg. Air 300 K and 1 bar was supplied to the carburettor at the rate of 6 kg/min. Find the brake power delivered, brake mean effective pressure, brake specific fuel consumption, brake specific air consumption, brake thermal efficiency, volumetric efficiency and the air fuel ratio.

13. (a) (i) Derive an expression for maximum mass flow rate through convergent divergent nozzle for steam. (12)

(ii) Dry air at a pressure of 12 bar and 573 K is expanded isentropically through a nozzle at a pressure of 2 bar. Determine the maximum mass flow rate through the nozzle of 0.00015 $m^2$ area. (4)

Or

(b) Dry saturated steam at a pressure of 8 bar enters a convergent-divergent nozzle and leaves it at a pressure of 1.5 bar. If the flow is isentropic, and the corresponding expansion index is 1.135; find the ratio of cross-sectional area at exit and throat for maximum discharge.

14. (a) A single stage, single acting reciprocating air compressor has a bore of 0.2 m and a stroke of 0.3 m. It receives air at 1 bar and 293 K and delivers it at 5.5 bar. If the compression follows the law $pV^{1.3}$ = constant and clearance volume is 5% of the stroke volume, Determine the mean effective pressure and the power required to drive the compressor, if it runs at 500 rpm.

Or

(b) (i) Derive the expression for minimum work required for a two stage reciprocating air compressor. (12)

(ii) Estimate the minimum work required to compress 1 kg of air from 1 bar 300 K to 16 bar in two stages if the law of compression is $pV^{1.25}$ = constant and the inter cooling is perfect. Take R = 287 J/kg K. (4)

15. (a) A vapour compression refrigerator uses R–12 as refrigerant and the liquid evaporates in the evaporator at 258 K. The temperature of this refrigerant at the delivery from the compressor is 288 K when the vapour is condensed at 283 K. Find the coefficient of performance if (i) there is no under cooling (ii) the liquid is cooled by 278 K before expansion by throttling. Take specific heat at constant pressure for the super heated vapour as 0.64 kJ/kg K and that for liquid as 0.94 kJ/kg K. The other properties of R12 as follows:

| Temperature (K) | Enthalpy (kJ/kg) | | Entropy(kJ/kg K) | |
|---|---|---|---|---|
| | Liquid | Vapour | Liquid | Vapour |
| 258 | 22.3 | 180.88 | 0.0904 | 0.7051 |
| 283 | 45.4 | 191.76 | 0.1750 | 0.6921 |

Or

(b) Explain the working of Lithium Bromide-water system with a schematic layout.