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Question Paper Code : 77218

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Fourth Semester

Mechanical Engineering

ME 6404 — THERMAL ENGINEERING

(Regulation 2013)

Time : Three hours Maximum : 100 marks

(Use of approved Thermodynamics Tables, Mollier diagram, Psychrometric chart and Refrigerant property tables permitted in the Examinations)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are assumptions made in air standard cycles?

2. Draw the Brayton cycle on P-v and T-s diagrams.

3. What are the functions of a flywheel?

4. What are the advantages of four stroke cycle engine over two stroke cycle engines?

5. What is supersaturated flow?

6. What is pressure compounding?

7. Define the terms : Free-air delivery and volumetric efficiency compression.

8. What are the advantages of multistage compression?

9. Define tonne of refrigeration?

10. Define the terms gross sensible heat factor and effective sensible heat factor.

PART B — (5 × 16 = 80 marks)

11. (a) An engine with 200 mm cylinder diameter and 300 mm stroke works on theoretical Diesel cycle. The initial pressure and temperature of air used are 1 bar and 27°C. The cut-off is 8% of the stroke. Determine :

(i) Pressures and temperatures at all salient points

(ii) Theoretical air standard efficiency

(iii) Mean effective pressure

(iv) Power of the engine if the working cycles per minute are 380

Assume that compression ratio is 15 and working fluid is air.

Or

(b) Air enters the compressor of a gas turbine plant operating on Brayton cycle at 1 bar, 27°C. The pressure ratio in the cycle is 6. If $W_T = 2.5\ W_c$ where W_T and W_c are the turbine and compressor work respectively, calculate the maximum temperature and the cycle efficiency.

12. (a) Discuss the difference between theoretical and actual valve timing diagrams of a diesel engine.

Or

(b) Explain the phenomena of knocking in diesel engines. What are the different factors which influence the knocking?

13. (a) Dry saturated steam at a pressure of 11 bar enters a convergent–divergent nozzle and leaves at a pressure of 2 bar. If the flow is adiabatic and frictionless, determine :

(i) The exit velocity of steam

(ii) Ratio of cross-section of exit and that at throat.

Or

(b) In a De Laval turbine steam issues from the nozzle with a velocity of 1200 m/s. The nozzle angle is 20°, the mean blade velocity is 400 m/s and the inlet and outlet angles of blades are equal. The mass of steam flowing through the turbine per hour is 1000 kg. Calculate :

(i) Blade angles

(ii) Relative velocity of steam entering the blades

(iii) Tangential force on the blades

(iv) Power developed

(v) Blade efficiency.

Take blade velocity co-efficient as 0.8

14. (a) A single-stage single-acting air compressor delivers 0.6 kg of air per minute at 6 bar. The temperature and pressure at the end of suction stroke are 30°C and 1 bar. The bore and stroke of the compressor are 100 mm and 150 mm respectively. The clearance is 3% of the swept volume. Assuming the index of compression and expansion to be 1.3, find :

(i) Volumetric efficiency of the compressor,

(ii) Power required if the mechanical efficiency is 85%, and

(iii) Speed of the compressor (r.p.m.).

Or

(b) In a single – acting two – stage reciprocating air compressor 4.5 kg of air per min. are compressed from 1.013 bar and 15°C through a pressure ratio of 9 to 1. Both stags have the same pressure ratio, and the law of compression and expansion in both stages is $pV^{1.3}$. Calculate :

(i) The indicated power

(ii) The cylinder swept volumes required

Assume that the clearance volumes of both stages are 5% of their respective swept volumes and that the compressor runs at 300 r.p.m.

15. (a) An ammonia refrigerator operates between evaporating and condensing temperatures of – 16°C and 50°C respectively. The vapour is dry saturated at the compressor inlet, the compression process is isentropic and there is no undercooling of the condensate. Calculate :

(i) The refrigerating effect per kg.

(ii) The mass flow and power input per kW of refrigeration and

(iii) The C.O.P.

Or

(b) Saturated air leaving the cooling section of an air – conditioning system at 14°C at a rate of 50 m^3/min is mixed adiabatically with the outside air at 32°C and 60 percent relative humidity at a rate of 20 m^3/min. Assuming that the mixing process occurs at a pressure of 1 atm, determine the specific humidity, the relative humidity, the dry-bulb temperature and the volume flow rate of the mixture.

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