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Question Paper Code : 23579

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Fourth Semester

Mechanical Engineering

ME 1251/ME 1251 A — THERMAL ENGINEERING

(Regulation 2004/2007)

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

Time : Three hours Maximum : 100 marks

(Use of standard Thermodynamic table, Mollier diagram, Psychrometric chart and refrigerant property table are permitted)

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Air enters the compressor of a Brayton cycle at 100 kPa, 300 K, with a volumetric flow rate of 5 m^3/s. The compressor pressure ratio is 10. The turbine inlet temperature is 1400 K. Determine the thermal efficiency for the cycle.

2. Draw the actual and theoretical pV diagram of a two stroke petrol engine.

3. What is an internal combustion engine?

4. Compare petrol engines with diesel engines.

5. Define the term stage efficiency in case of reaction turbines.

6. Calculate the critical pressure of steam, expanding through a convergent-divergent nozzle from 10 bar, dry saturated, down to atmospheric pressure of 1 bar.

7. A single-stage reciprocating compressor takes in 1.4 kg of air per minute at 1 bar and 17°C and delivers it at 6 bar. Assuming compression process follows the law $pV^{1.35}$ = constant. Calculate the work of compression.

8. Classify the air compressors.

9. State the difference between vapour compression refrigeration systems with vapour absorption refrigeration system.

10. Calculate the relative humidity and humidity ratio of atmospheric air when the DBT is 32°C and WBT is 28°C. The barometer reads 750 mm of Hg.

PART B — (5 × 16 = 80 marks)

11. (a) The compression ratio of an Otto cycle is 8. The pressure and temperature of the air at the beginning of the compression stroke are 1 bar and 300 K respectively. The amount of energy added to the air as a result of combustion is 1500 kJ/kg of air. Determine the

(i) Pressure, temperature at all salient points of the cycle,

(ii) The cycle efficiency and

(iii) The mean effective pressure.

Or

(b) The compression and expansion ratios of an oil engine working on air standard dual cycle are 9 and 5, respectively. The initial pressure and temperature are 1 bar and 30°C, respectively. The heat liberated at constant pressure is twice the heal liberated at constant volume. The expansion and compression follow the law $pV^{1.25}$ = constant. Determine

(i) Pressure and temperature at all salient points.

(ii) The mean effective pressure of the cycle

(iii) Thermal efficiency of the cycle.

Take cylinder bore = 250 mm and stroke = 400 mm.

12. (a) Explain the construction, working and applications of a two-stroke petrol engine.

Or

(b) A four-cylinder, four-stroke diesel engine has a bore of 212 mm and a stroke of 292 mm. At full load at 720 rpm the bmep is 5.93 bar and the specific fuel consumption is 0.226 kg/kWhr. The air-fuel ratio as determined by exhaust gas analysis is 25. Calculate the brake thermal efficiency and the volumetric efficiency of the engine. Atmospheric conditions are 1.01 bar and 15°C and calorific value for the fuel may be taken as 44200 kJ/kg.

13. (a) 5.2 kg/s of steam at 30 bar and 350°C is supplied to a group of six nozzles on a wheel diameter maintained at 4 bar pressure. Determine for metastable expansion

(i) Diameter of nozzles at exit without friction

(ii) Degree of under cooling and supersaturation

(iii) Loss in available heat drop due to irreversibility

(iv) Increase in entropy.

Or

(b) A simple impulse turbine has a mean blade ring diameter of 70 cm and runs at 3000 rpm. The blade speed ratio is 0.46 and discharge is axial. The nozzle angle is 21° and blade friction factor is 0.95. Determine

(i) Blade angles and

(ii) Theoretical specific power output.

14. (a) A single stage, double acting air compressor delivers air at 7.5 bar. The pressure and temperature at the end of suction stroke are 1 bar and 27°C. It delivers 2 m^3 of free air per mm when the compressor is running at 300 rpm. The clearance volume is 5% of the stroke volume. The pressure and temperature of the ambient air are 1.03 bar and 20°C. The index of compression is 1.3, and index of expansion is 1.35. Calculate

(i) Volumetric efficiency of the compressor

(ii) Indicated power of compressor.

Or

(b) Explain with a neat sketch, the working of a vane blower compressor and show its p-V diagram.

15. (a) A refrigeration plant uses CO_2 as refrigerant produces 4.5 ton of refrigeration. The condenser and evaporator temperatures are 30°C and -20°C respectively whose properties are as shown in the following table.

Temp. °C	Pressure bar	Enthalpy, kJ/kg		Entropy, kJ/kg		Sp. Heat, kJ/kgK	
		h_f	h_g	s_f	s_g	$C_{p,l}$	$C_{p,g}$
–20°C	19.696	154.45	436.89	0.8328	1.9485	2.165	1.289
30°C	72.137	304.55	365.13	1.3485	1.5433	35.34	55.82

The refrigerant temperature after compression is 42°C. Determine,

(i) Heat rejected from the condenser in kW

(ii) Power input to the compressor

(iii) Percentage of refrigerant vapour after throttling

(iv) COP and relative COP.

Or

(b) The following conditions apply to an air-conditioning system of an industrial process :

Outdoor conditions : 30°C DBT and 65% dry bulb temperature

Indoor conditions : 25°C DBT and 60% relative humidity

Free air circulation : 250 m^3/min.

Calculate

(i) Capacity of cooling coil in tons of refrigeration

(ii) Capacity of heating coil in kW

(iii) Mass of water vapour removed per hour.