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R 3454

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.

Fourth Semester

(Regulation 2004)

Mechanical Engineering

ME 1251 — THERMAL ENGINEERING

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

Time : Three hours

Maximum : 100 marks

(Use of Steam table/charts and refrigeration table/charts is permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. A Carnot cycle works between the temperatures 300 K and 700 K. Find the maximum work possible per kg of air.
2. Define mean effective pressure of Otto cycle.
3. What is the function of push rod and rocker arm?
4. What are the basic requirements of a fuel injection system of a diesel engine?
5. What is the effect of friction on the flow through a steam nozzle?
6. What is Blading efficiency?
7. What is Isothermic efficiency of a compressor?
8. What are the advantages of multi stage compression?
9. Define COP of refrigeration.
10. Define wet bulb temperature and degree of saturation.

PART B — (5 × 16 = 80 marks)

11. (a) An engine 20 cm bore and 30 cm stroke works on Otto cycle. The clearance volume is 1600 cu cm. The initial pressure and temperature are 1 bar and 60°C. If the maximum pressure is limited to 24 bar, find the following :

- (i) The air standard efficiency of the cycle
- (ii) The mean effective pressure of the cycle.

Or

(b) A gas turbine works on an air standard Brayton cycle. The initial condition of the air is 25°C and 1 bar. The maximum pressure and temperature are limited to 3 bar and 650°C. Determine the following :

- (i) Cycle efficiency
- (ii) Heat supplied and heat rejected/kg of air
- (iii) Work output/kg of air
- (iv) Exhaust temperature.

12. (a) (i) Explain why cooling is necessary in an I.C. engine. (4)

(ii) With neat sketches describe the working of Water Cooling System used for multi-cylinder engine. (12)

Or

(b) The following data refer to a single cylinder four stroke petrol engine :

Compression ratio	=	5.6
Mechanical efficiency	=	80%
Brake specific fuel consumption	=	0.37 kg/kW h
Calorific value of fuel	=	44000 kJ/kg
Adiabatic index for air	=	1.4

Find (i) brake thermal efficiency (ii) indicated thermal efficiency (iii) air standard efficiency (iv) relative efficiency with respect to indicated thermal efficiency and (v) relative efficiency with respect to brake thermal efficiency.

13. (a) Dry saturated steam at 2.8 bar is expanded through a convergent nozzle to 1.7 bar. The exit area is 3 cm^2 . Estimate the exit velocity and the mass flow rate, assuming isentropic expansion and supersaturated flow exists.

Or

- (b) (i) What are the different methods commonly used for governing steam turbines? (4)

- (ii) The following data refer to a single stage impulse turbine :

Isentropic nozzle enthalpy drop = 210 kJ/kg, Nozzle efficiency = 90%, Nozzle angle = 25° , Ratio of blade speed to whirl component of steam speed = 0.5, Blade velocity coefficient = 0.9, the velocity of steam entering the nozzle = 30 m/sec. Find (1) the blade angles at inlet and outlet if the steam enters the blades without shock and leaves the blades in an axial direction (2) blade efficiency and (3) power developed and (4) axial thrust if the steam flow rate is 10 kg/sec. (12)

14. (a) (i) Explain with suitable sketches the working of two stage air compressor with actual p-v diagram. (6)

- (ii) A single acting single stage compressor is belt driven from an electric motor at 400 rpm. The cylinder diameter is 15 cm and the stroke is 17.5 cm. The air is compressed from 1 bar to 7 bar and the law of compression $PV^{1.3} = \text{constant}$. Find the power of the motor, if transmission efficiency is 97% and the mechanical efficiency of the compressor is 90%. Neglect clearance effects. (10)

Or

- (b) A three-stage air-compressor delivers 5.2 m^3 of free air per minute. The suction pressure and temperature are 1 bar and 30°C . The ambient pressure and temperature are 1.03 bar and 20°C . The air is cooled to 30°C after each stage of compression. The delivery pressure of the compressor is 150 bar. The RPM of the compressor is 300. The clearances of LP, I.P and H.P. cylinders are 5% of the respective strokes. The index of compression and re-expansion in all stages is 1.35. Neglecting pressure losses, find the B.P of the motor required to run the compressor if the mechanical efficiency is 80%.

15. (a) (i) Draw a neat sketch of a simple vapour compression refrigeration system and explain its principle of operation. (5)
- (ii) An ammonia refrigerator produces 30 tonnes of ice from and at 0°C in a day of 24 hours. The temperature range in the compressor is from 25°C to 15°C . The vapour is dry saturated at the end of compression and an expansion valve is used. Calculate the coefficient of performance. The properties of the refrigerant are given in the following table : (11)

Temperature $^{\circ}\text{C}$	Enthalpy KJ/kg		Entropy of Liquid KJ/kg-K	Entropy of Vapour KJ/kg-K
	Liquid	Vapour		
25	100.04	1319.22	0.3473	4.4852
-15	-54.56	1304.99	-2.1338	5.0585

Or

- (b) An office is to be air-conditioned for 50 staff when the outdoor conditions are 30°C DBT and 75 RH if the quantity of air supplied is $0.4 \text{ m}^3/\text{min}/\text{person}$, find the following :
- (i) Capacity of the cooling coil in tonnes of refrigeration
- (ii) Capacity of the heating coil in kW
- (iii) Amount of water vapour removed per hour

Assume that required air inlet conditions are 20°C DBT and 60% RH, Air is conditioned first by cooling and dehumidifying and then by heating.

- (iv) If the heating coil surface temperature is 25°C , find the by-pass factor of the heating coil?