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

H 2312

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

Third Semester

Mechanical Engineering

ME 231 — APPLIED THERMODYNAMICS

Time : Three hours Maximum : 100 marks

Approved Tables and charts are permitted.

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define work ratio.
2. Define critical pressure ratio.
3. What is termed as free air delivery in air compressor?
4. Define volumetric efficiency of the air compressor.
5. What is the effect of compression ratio on air-standard efficiency of Otto cycle?
6. Define Break Mean Effective Pressure.
7. Define the modified Rankine cycle.
8. Why reheat and regeneration are used?
9. Mention any two eco-friendly refrigerants.
10. What is sub cooling in vapour compression refrigeration system?

PART B — (5 × 16 = 80 marks)

11. (a) A steam turbine develops 160 kW with a consumption of 19.4 kg/kWh. The pressure and temperature of the steam entering the nozzle are 12 bar and 220°C. The steam leaves the nozzles at 1.2 bar. If the diameter of the nozzle at throat is 7 mm, find the number of nozzles required. If 8% of the total enthalpy drop is used up in frictional reheating in the diverging part of the nozzle, determine the diameter at the exit of nozzle and the quality of steam leaving the nozzle.

Or

(b) The exhaust steam from a locomotive engine at 1.5 bar and dry saturated condition is used in steam-injector to feed the water to the locomotive boiler. The boiler pressure is 20 bar. The pressure of water entering into boiler is 20% above the boiler pressure. Find :

(i) the mass of water pumped per kg of steam supplied if the coefficient of steam nozzle is 0.95.

(ii) The diameters of steam nozzle and water discharge nozzle.

(iii) The temperature of water entering the boiler if the temperature of water taken from the feed tank is 20°C. The rate of water supply is 100 kg/min. Neglect the other quantities which are not given in the problem and assume the flow of steam through the steam nozzle is maximum.

12. (a) A single-stage double-acting air compressor delivers air at 7 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 minute when the compressor is running at 300 rpm. The clearance volume is 5% of the stroke volume. The pressure and temperature of ambient air are 1.03 bar and 20°C.

Index of compression = 1.3, index of re-expansion = 1.35.

Find :

(i) The volumetric efficiency of the compressor.

(ii) I.P. of the compressor and B.P. if the mechanical efficiency is 80%.

(iii) The diameter and stroke of the cylinder if both are equal.

Or

(b) A two-stage single-acting air-compressor delivers air at 20 bar. The pressure and temperature of the air before the compression in L.P. cylinder are 1 bar and 27°C. The discharge pressure of L.P. cylinder is 4.7 bar. The pressure of air leaving the inter-cooler is 4.5 bar and the air is cooled to 27°C. The diameter and stroke of L.P. cylinder are 40 cm and 50 cm respectively. The clearance volume is 4% of stroke in both cylinders. The speed of the compressor is 200 rpm. Assuming the index of compression and re-expansion in both cylinders is 1.3, find :

(i) the I.P. required to run the compressor.

(ii) the heat rejected in inter-cooler per minute.

13. (a) Derive an expression for efficiency for constant volume air cycle with p-v and T-s diagram.

Or

(b) An oil engine works on mixed cycle. The following data is given :

Compression ratio = 14 : 1

Cut off = 4% of the stroke

Maximum pressure limited = 50 bar

Initial pressure = 1 bar

Initial temperature = 47°C.

Find the pressure and temperature at all salient points. Also find the air-standard efficiency and mean effective pressure of the cycle.

14. (a) Steam at 10 bar is supplied to a prime mover and the exhaust takes place at 0.2 bar. Find the Rankine efficiency in the following cases :

(i) Steam is dry saturated at inlet

(ii) Steam is 0.9 dry at inlet and

(iii) Steam has 50°C superheat at inlet. Neglect pump work. Also find the Carnot efficiency assuming constant temperature heat input at the maximum temperature in each case.

Or

(b) A steam turbine using regenerative feed heating cycle generates 27000 kW through a directly coupled electric generator. Steam at 60 bar and 450°C is supplied to the turbine. The condenser vacuum is 730 mm of Hg. The steam is bled from the steam turbine at 3 bar. The heating of the feed water is done in direct contact heater. Assuming the turbine efficiency of each portion of expansion as 87%, find :

(i) the steam bled per kg of steam supplied to the turbine.

(ii) the steam generated per hour and

(iii) assuming that 10% of the generator output is used to run the pumps, the overall efficiency of the plant if the boiler efficiency is 90% and alternator efficiency is 95% and mechanical efficiency from turbine to generator is 98%. Neglect the pump work in calculating the input to the boiler.

15. (a) What is the effect of subcooling and super heating in vapour compression system?

Or

(b) A Bell-Coleman refrigeration cycle works between 1 bar and 5 bar. The adiabatic efficiency of compression is 85% and expansion is 90%. Find out the COP of the system and its tonnage when the air flow rate is 1 kg/sec. The ambient temperature is 27°C and refrigerator temperature is 0°C.
