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B.E. / B.Tech (FT) DEGREE END SEMESTER EXAMINATIONS, NOV / DEC 2013

MECHANICAL ENGINEERING BRANCH

Regulation : 2004 / 2008 Semester : 4

ME284 / ME9254 THERMAL ENGINEERING I

INSTRUCTIONS

Assume any data required suitably with proper justification

Answer All Questions

Time : 3 Hrs **Max Marks : 100**

PART A (10 X 2 = 20 Mark)

1. What is the influence of cut-off ratio on diesel cycle efficiency?
2. What are the characteristics of isentropic flow?
3. What is the clearance ratio and how does it affect the volumetric efficiency?
4. List various types of compressors with their working principle.
5. What is the role of flywheel?
6. How are stroke length and rpm related to the piston speed?
7. What is transfer port?
8. What is the Air-fuel ratio for methane?
9. What is work ratio?
10. List gas turbine components and suitable materials.

PART B (5 x 16=80 Mark)

11) (i) For maximum work done in an Otto cycle, show that the optimum compression ratio for maximum work is $(T_3/T_1)^{1.25}$, if T_1 and T_3 are the minimum and maximum temperatures of the cycle, respectively. (6)

(ii) In an ideal Diesel cycle, the pressure and temperature at the beginning of compression are 1.03 bar and 27°C respectively. The maximum pressure attained during the cycle is 50 bar and the heat supplied during the cycle is 745 kJ/kg of working fluid. Determine the following (a) the compression ratio, (b) the temperature at the end of isentropic compression, constant pressure combustion (c) air standard efficiency. Assume k =1.4 and c_p = 1.004 kJ/kg-K. (10)

12) a) (i) Plot single stage compression with clerance volume in reciprocating compressors on P-V and T- S diagrams (6)

(ii) A reciprocating air compressor takes the air in at 1 bar, 15°C and discharges at 7 bar. The compression process (and also the expansion) in the cylinder can be taken as $pv^{1.3}$ = constant. The compressor cylinder has 10 cm diameter and 12 cm stroke. The clearance volume is 5% of the swept volume. The compressor runs at 1450 r.p.m. Estimate the work required per kg, mass flow rate of air and required power input in kW. Take R = 0.287 kJ/kg.K for air. (10)

(OR)

b) (i) Derive the expression for optimum intermediate pressure of a 2 stage reciprocating air compressor with perfect inter cooling. (6)

(ii) A single acting two stage air compressor with perfect intercooling delivers air at 5 kg/min at a pressure of 16 bar. The compressor runs at 300 rpm and the clearance ratio is 0.06 and 0.08 for the first and second stage respectively. If the intake conditions are 1 bar and 300 K and the index of compression and expansion is 1.35, calculate a) the power required for the compressor, b) the isothermal efficiency, c) the swept and clearance volume for each cylinder. (10)

13) a) (i) List out the major components of IC engine and their functions. (6)

(ii) Draw the theoretical and actual valve timing diagram of 4 stroke diesel engine and explain the reasons for the deviations in actual diagram. (10)

(OR)

b (i) Explain the working of a 2 stroke petrol engine. (6)

(ii) Compare SI engines with CI engines with suitable reasons for any difference. (10)

14) a) (i) Discuss a suitable method for exhaust gas analysis. (6)

(ii) In a 4-cylinder 4-stroke petrol engine air flow is measured by means of a 6.8 cm diameter sharp edged orifice, Cd = 0.6. The engine has the following test data: Bore = 11 cm, stroke = 14 cm, engine speed = 2850 rpm, brake power = 50 kW, pressure drop across the orifice = 4.2 cm of water. Atmospheric pressure and temperature are 20°C and 101.3 kPa. Calculate air capacity of the engine and volumetric efficiency based on free air conditions. (10)

(OR)

b (i) Explain the process of knocking in SI engines. (6)

(ii) Fuel for a SI engine contains 84% C and 16% H_2 by mass. The fuel to air ratio is 1:14. Assuming complete combustion of H_2 and no Carbon residue, calculate (i) the mass of C per kg of fuel used to form CO and CO2, (ii) volumetric composition of CO in the product gas and (iii) percentage of heat energy loss, given that 34 MJ/kg of heat is released if C is burnt to CO_2 and 10 MJ/kg of heat is released if C is burnt to CO and 128 MJ of heat is released if H2 is burnt to H_2O. (10)

15) a) (i) Explain the working of closed cycle power plant. (6)

(ii) In an open cycle gas turbine power plant, air enters the compressor at 300 K and 1 bar. The pressure ratio of the compression process is 9. There is a pressure drop of 1 bar in the combustion chamber and the maximum temperature of the gas is 1200 K. The isentropic compressor and turbine efficiencies are 88% and 95% respectively. Determine the turbine work, the compressor work, the network per kg, work ratio and the efficiency of the cycle. Also calculate the power developed for the mass flow rate of 10 kg/s. (10)

(OR)

b) In an open cycle gas turbine power plant, air enters the compressor at 300 K and 1 bar. It is pressurised to optimal pressure in the low pressure compressor and then intercooled to 280 K before entering the high pressure compressor. The pressure in the combustion chamber is 9 bar and the turbine inlet temperature (TIT) is 1200 K. It is then expanded in a high pressure turbine till the optimum pressure and then reheated to 1100 K at constant pressure before being expanded in the low pressure turbine to the atmospheric pressure. Determine the net work per kg and the efficiency of the cycle. (16)