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10ME43

Fourth Semester B.E. Degree Examination, June/July 2019

Applied Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of Steam table and thermodynamic data hand books are allowed.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Define the following:
i) Excess air ii) Enthalpy of formation
iii) Enthalpy of combustion iv) Higher calorific value and lower calorific value
v) Combustion efficiency **(10 Marks)**

b. In an engine test, the dry volumetric analysis of the products are $CO_2 = 5.27\%$, $O_2 = 13.38\%$ and $N_2 = 81.35\%$. Assuming that the fuel is a pure hydro carbon and that it is completely burnt, estimate the percentage of carbon and hydrogen in the fuel by mass and the air fuel ratio by mass. **(10 Marks)**

2 a. Derive an expression for air standard efficiency of constant pressure cycle stating the assumptions made. **(10 Marks)**

b. An engine works on a limited pressure cycle with pressure and temperature before the beginning of adiabatic compression is 102 kPa and 27°C. Heat added during constant volume process is 232 kJ/kg, where as heat added during constant pressure process is 3.2% of the expansion stroke. If the compression ratio is 16, $\gamma = 1.4$ and $Cp = 1.005$, find:
i) Pressure and temperature at end of compression
ii) Pressure and temperature at end of constant volume heat addition
iii) Temperature before beginning of expansion
iv) Heat added during constant pressure. **(10 Marks)**

3 a. Define the following:
i) BSFC
ii) Indicated thermal efficiency
iii) Relative efficiency **(06 Marks)**

b. What do you mean by heat balance sheet? Explain on percentage basis. **(04 Marks)**

c. A trial is carried out on 4-S single cylinder oil engine working on Otto cycle gave the following results duration of trial is one hour. Bore = 18 cms, stroke length = 36 cms, clearance volume = 1830 cc, speed = 280 rpm, area of indicator diagram = 4.25 cm^2, length of indicator diagram = 6.25 cms, spring scale = 1000 kPa/cm, load on brake drum = 600 N, dia of brake drum = 1 mtr, dia of rope = 0.2 mtr, volume of fuel = 4.25 ltr, specific gravity of fuel = 0.8, calorific value of fuel = 43,000 kJ/kg, mass of water = 420 kg, rise in temperature of water = 27°C, air fuel ratio = 34:1, temperature of gas = 410°C, $C_{p_g} = 1.005$ kJ/kg°K, find:
i) Mechanical efficiency ii) Indicated thermal efficiency
iii) Air standard efficiency iv) Heat balance sheet **(10 Marks)**

4 a. With T-S diagram, explain the effect on Rankine cycle by decreasing condenser pressure and increasing boiler pressure. **(04 Marks)**

b. Explain the working of a regenerative Rankine cycle for one feed water heater with line and T-S diagram. **(06 Marks)**

c. In a regenerative vapour cycle with open feed water heater steam enters turbine at 90 bar and 350°C and expands to 9 bar where a part of steam is extracted and passed to the open feed water heater. The remaining steam expands in a turbine upto 0.1 bar. If net output of the cycle is 120 MW, find (i) Thermal efficiency (ii) Mass flow rate. **(10 Marks)**

PART – B

5 a. Find the optimum pressure ratio for minimum power of a multi stage reciprocating compressor. What are the assumptions made? **(10 Marks)**

b. A single acting two stage air compressor deals with 4 m^3/min of air at 1 bar and 15°C with a speed of 250 rpm. The delivery pressure is 80 bar. Assuming preface inter cooling, find the minimum power required by the compressor, bore, stroke of the compressor. Assume the piston speed is 3 m/s. Take mechanical efficiency 75% and volumetric efficiency 80% per stage. Assume n = 1.25 for both stages neglect the clearance. **(10 Marks)**

6 a. With line diagram and T-S diagram, explain intercooler and reheat methods to improve the efficiency of a gas turbine. **(06 Marks)**

b. With a neat sketch, explain Rocket propulsion. **(05 Marks)**

c. Find the required A:F ratio in a gas turbine where the efficiency of turbine and compressor are 85% and 80% respectively. Air enters the compressor at 1 bar and 27°C and maximum cycle temperature is 875°c. The pressure ratio is 4. Take the calorific value of fuel 42000 kJ/kg. There is a loss of 10% of calorific value in the combustion chamber. **(09 Marks)**

7 a. What are the desirable properties of a goof refrigerant? **(04 Marks)**

b. With p-h and T-S diagram explain effects of evaporator pressure, condenser pressure. **(06 Marks)**

c. An ammonia refrigerator operates between –16°C and 50°C respectively. The vapour is day saturated at the inlet of compressor, calculate:

i) The refrigerator effect
ii) Power/KW cooling effect
iii) COP
iv) Mass of refrigerant/KW cooling

Take C_p for NH_3 as 3 kJ/kg°K. The properties NH_3 are

Temperature	h_f	h_g	S_g
–16°C	-	1424.4	5.56
50°C	421.7	1437.1	4.7696

(10 Marks)

8 a. With a diagram, explain psychrometric chart. **(05 Marks)**

b. With neat sketches, explain summer air conditioning and winter air conditioning. **(06 Marks)**

c. In a room the DBT is 35°C and WBT = 25°C, calculate:

i) Specific humidity
ii) Relative humidity
iii) Vapour density
iv) Enthalpy of mixture without psychrometric chart. **(09 Marks)**

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