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10ME/AU43

Fourth Semester B.E. Degree Examination, Dec.2017/Jan.2018

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 thermodynamic data handbook is permitted.

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.

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PART – A

1 a. With a neat sketch, explain the analysis of exhaust gases by Orsat apparatus. **(10 Marks)**

b. Methane (CH_4) is burned with atmospheric air. The analysis of the products on a 'dry' basis is as follows: CO_2 = 10%, O_2 = 2.37%, CO = 0.53%, N_2 = 87.10%.

i) Determine the combustion equation.

ii) Calculate the air-fuel ratio.

iii) Percent theoretical air. **(10 Marks)**

2 a. Derive the expression for the air standard efficiency of a diesel cycle with usual notations. State the assumptions made and represent the process on P-V and T-S diagram. **(10 Marks)**

b. A 4-stroke dual fuel cycle operates on 10 liters of air at 1 bar and 27°C per cycle. The addition of heat at constant volume is adjusted for a maximum pressure in the cycle of 70 bar. The heat addition continuous for 5% of the stroke. Calculate:

i) Pressure ratio ii) Heat added per cycle

iii) Cut-off ratio iv) Heat rejected per cycle

v) Net work done vi) Thermal efficiency

vii) Power developed, when engine runs at 200 rpm. **(10 Marks)**

3 a. Briefly explain how the indicated power of a multi-cylinder is measured. **(06 Marks)**

b. Write a short note on heat balance sheet. **(04 Marks)**

c. In a constant speed CI engine operating on 4-stroke cycle and fitted with a hand brake. The following observations were taken:

Brake wheel diameter = 600 mm
Band thickness = 5 mm
Speed = 450 rpm
Load on band = 200 N
Spring balance reading = 30 N
Area of indicator diagram = 415 mm^2
Length of the indicated diagram = 63 mm
Spring number = 0.11 N/mm^2 per mm
Bore = 100 mm
Stroke = 150 mm
Specific fuel consumption = 0.22 kg/KW-hr
Calorific value of fuel = 42000 kJ/kg.

Determine:

i) Brake power ii) Indicated power iii) Mechanical efficiency

iv) Indicated thermal efficiency v) Brake thermal efficiency **(10 Marks)**

4 a. With the help of a schematic diagram and T-S diagram, explain the working of a regenerative vapour power cycle and derive an expression for its overall efficiency. **(12 Marks)**

b. In a steam power cycle, the steam supply is at 15 bar and dry and saturated. The condenser pressure is 0.4 bar. Calculate the Carnot and Rankine efficiency of the cycle. Neglect pump work. **(08 Marks)**

PART – B

5 a. Derive the expression for the work done for a single stage single acting reciprocating compressor with clearance volume. **(06 Marks)**

b. Discuss applications of compressed air, and derive an expression for the volumetric efficiency of reciprocating air compressor. **(06 Marks)**

c. A single stage double acting air compressor is required to deliver 14 m^3 of air per minute measured at 1.013 bar and 15°C. The delivery pressure is 7 bar and the speed is 300 rpm. Take the clearance volume as 5% of the swept volume with compression and expansion index of n = 1.3. Calculate:
i) Swept volume of the cylinder
ii) The delivery temperature
iii) Indicated power. **(08 Marks)**

6 a. Derive an expression for the work output of a gas turbine in terms of pressure ratio and maximum and minimum temperature T_3 and T_1. Hence show that the pressure ratio for maximum specific work output is given by $R_p = \left[\frac{T_3}{T_1}\right]^{\frac{\gamma}{2(\gamma-1)}}$. **(12 Marks)**

b. In a simple gas turbine cycle, the compressor pressure ratio is 8:1. The maximum cycle temperature is 827°C. If the compressor inlet conditions are 1 bar and 27°C. Determine per unit mass of air.
i) Compressor work ii) Turbine work iii) Work ratio
iv) Cycle efficiency v) Specific air consumption in kg/hr. **(08 Marks)**

7 a. With a neat sketch describe clearly the working of a vapour absorption refrigeration system. **(08 Marks)**

b. Write a brief note on properties of refrigerants. **(04 Marks)**

c. A simple vapour compression plant produces 5 tonnes of refrigeration. The enthalpy values at inlet to compressor, at exit from the compressor, and at exit from the condenser are 183.19, 209.41 and 74.59 kJ/kg respectively. Estimate:
i) The refrigerant flow rate
ii) The COP
iii) The power required to drive the compressor and
iv) The rate of heat rejection to the condenser. **(08 Marks)**

8 a. Define: i) Saturated air ii) Dry bulb temperature iii) Dew point temperature
iv) Relative humidity v) Specific humidity **(05 Marks)**

b. Explain briefly:
i) Summer air conditioning
ii) Winter air conditioning **(08 Marks)**

c. The sling psychrometer in a laboratory test recorded the following readings: Dry bulb temperature = 35°C, wet bulb temperature = 25°C. Calculating the following:
i) Specific humidity
ii) Relative humidity
iii) Vapour density in air.
Take atmosphere pressure = 1.0132 bar. **(07 Marks)**

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