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10ME/AU43

### Fourth Semester B.E. Degree Examination, June/July 2018

### Applied Thermodynamics

Time: 3 hrs.

Max. Marks:100

Note: Answer any FIVE full questions, selecting at least TWO questions from each part.

#### PART – A

- 1 a. Define the following:
- Higher and lower calorific values
  - Combustion efficiency
  - Dew point temperature
  - Adiabatic flame temperature
  - Percent excess air
- (10 Marks)
- b. One kg of ethane ( $C_2H_6$ ) is burnt with 90% of theoretical air. Assuming complete combustion of hydrogen in the fuel determine the volumetric analysis of the dry products of combustion. (10 Marks)
- 2 a. What is air-standard cycle? State the assumptions made in the analysis of air standard cycle. (05 Marks)
- b. Show that if an Otto cycle works between the temperature limits  $T_3$  and  $T_1$ , the compression ratio for maximum workdone/cycle/kg is expressed as,  $r_v = \left[ \frac{T_3}{T_1} \right]^{\frac{1}{\gamma-1}}$  where  $r_v$  is compression ratio. (05 Marks)
- c. An engine operating on the ideal diesel cycle has a compression ratio 16. Heat is added during constant pressure process upto 8% of the stroke. If the engine inhales  $0.04 \text{ m}^3/\text{s}$  at 101 kPa and  $25^\circ\text{C}$ , determine:
- The maximum pressure and temperature in the cycle.
  - The thermal efficiency of the engine.
  - The power developed. (10 Marks)
- 3 a. Derive an expression for indicated power of multi cylinder IC engine for Morse test. (04 Marks)
- b. Define: i) Mean effective pressure  
ii) Specific fuel consumption  
iii) Volumetric efficiency (06 Marks)
- c. A four cylinder 4-stroke petrol engine has a bore of 60 mm and a stroke of 90 mm. Its rated speed is 2800 rpm and it is tested at this speed against brake which has a torque arm of 0.37 m. The net brake load is 160 N and the fuel consumption is 8.966 litres/hr. The specific gravity of petrol used is 0.74 and it has a lower calorific value of 44100 kJ/kg. A Morse test is carried out and the cylinders are cut out in the order 1, 2, 3, 4 with corresponding brake loads of 110, 107, 104 and 110 N respectively. Calculate for this speed:
- Brake power
  - Brake mean effective pressure
  - Brake thermal efficiency
  - Mechanical efficiency (10 Marks)
- 4 a. Explain the effect of variation of pressure and super heat on Rankine cycle efficiency with the help of a T-S diagram. (10 Marks)
- b. In a Rankine cycle the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine:
- The pump work
  - The turbine work
  - The Rankine efficiency
  - The dryness at the end of expansion. (10 Marks)
- Assume flow rate of steam is 9.5 kg/s. (10 Marks)

**PART – B**

- 5 a. Explain the condition for minimum work for a reciprocating compressor and also define isothermal efficiency based on the indicator diagram. (05 Marks)
- b. Derive an expression for the volumetric efficiency of reciprocating air compressor. (05 Marks)
- c. A single stage single acting air compressor delivers 0.6 kg of air per minute at 6 bar. The temperature and pressure at the end of suction stroke are 30°C and 1 bar. The bore and stroke of the compressor are 100 mm and 150 mm respectively. The clearance is 3% of the swept volume. Assuming the index of compression and expansion to be 1.3, find:
- Volumetric efficiency of the compressor
  - Power required if the mechanical efficiency is 85% and
  - Speed of the compressor (rpm). (10 Marks)
- 6 a. What is the role of combustion chamber in gas turbine plant? Explain how the actual gas turbine cycle differs from the theoretical cycle. (06 Marks)
- b. Draw the flow diagram and h-s diagram for open cycle gas turbine with perfect intercooling. (04 Marks)
- c. In a constant pressure open cycle gas turbine air enters at 1 bar and 20°C and leaves the compressor at 5 bar. The maximum cycle temperature is 680°C, pressure loss in the combustion chamber is 0.1 bar. Isentropic efficiencies of compressor and turbine are 85% and 80% respectively,  $\gamma = 1.4$  and  $C_p = 1.024$  kJ/kgK for air and gas. Find:
- The quantity of air circulation if the plant develops 1065 KW.
  - Heat supplied per kg of air.
  - The thermal efficiency of the cycle. (10 Marks)
- 7 a. Derive an expression for COP for an air refrigeration system working on reversed Carnot cycle. (10 Marks)
- b. A refrigeration system of 10.5 tonnes capacity at an evaporator temperature of -12°C and a condenser temperature of 27°C is needed in a food storage locker. The refrigerant ammonia is subcooled by 6°C before entering the expansion valve. The vapour is 0.95 dry as it leaves the evaporator coil. The compression in the compressor is of adiabatic type. Using p-h chart find:
- Condition of volume at outlet of the compressor
  - Condition of vapour at entrance to evaporator
  - C.O.P
  - Power required in KW
- Neglect valve throttling and clearance effect. (10 Marks)
- 8 a. With a neat sketch describe the working of summer air conditioning system for hot and dry weather. (07 Marks)
- b. Define:
- Dry bulb temperature
  - Wet bulb temperature
  - Relative humidity. (03 Marks)
- c. Air at 20°C, 40% RH is mixed adiabatically with air at 40°C, 40% RH in the ratio of 1 kg of the former with 2 kg of the latter (on dry basis). Find the final condition of air. (10 Marks)

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