USN | | | | | | | | | | |

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:
i) Higher and lower calorific values ii) Combustion efficiency
iii) Dew point temperature iv) Adiabatic flame temperature
v) 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, $r_v = \left[\frac{T_3}{T_1}\right]^{\frac{1}{2(\gamma-1)}}$ where r_v is compression ratio. **(05 Marks)**

c. An engine operating on the ideal diesel cycle has a compression ratio 16:1. Heat is added during constant pressure process upto 8% of the stroke. If the engine inhales 0.04 m^3/s at 101 kPa and 25°C, determine:
i) The maximum pressure and temperature in the cycle.
ii) The thermal efficiency of the engine.
iii) 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:
i) Brake power ii) Brake mean effective pressure
iii) Brake thermal efficiency iv) 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:
i) The pump work ii) The turbine work
iii) The Rankine efficiency iv) The dryness at the end of expansion.
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:
i) Volumetric efficiency of the compressor
ii) Power required if the mechanical efficiency is 85% and
iii) 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:
i) The quantity of air circulation if the plant develops 1065 KW.
ii) Heat supplied per kg of air.
iii) 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 if leaves the evaporator coil. The compression in the compressor is of adiabatic type. Using p-h chart find:
i) Condition of volume at outlet of the compressor.
ii) Condition of vapour at entrance to evaporator
iii) C.O.P
iv) 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:
i) Dry bulb temperature
ii) Wet bulb temperature
iii) 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)**

* * * * *