ACHARYA INSTITUTE OF TECHNOLOGY
Bangalore - 560090

CBCS Scheme

USN | | | | | | | | | | 15AE33

Third Semester B.E. Degree Examination, Dec.2016/Jan.2017
Aerothermodynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. Answer FIVE full questions, choosing ONE full question from each module.
2. Use thermodynamics data hand book is permitted.

Module-1

1 a. Distinguish between : i) microscopic and macroscopic approaches of thermodynamics ii) intensive and extensive properties. **(08 Marks)**

b. The readings T_A and T_B of two celsius thermometers A and B agree at ice point and steam point, but elsewhere are related by the equation $T_A = L + MT_B + NT_B^2$ where L, M and N are constants. When both the thermometer are immersed in a fluid, A registers 11°C while B registers 10°C. Determine the reading on A when B registers 37.4°C. **(08 Marks)**

OR

2 a. Distinguish between heat and work in thermodynamics. **(04 Marks)**

b. Derive an expression for work done per unit mass for a reversible isothermal process taking place in a closed system containing an ideal gas. **(04 Marks)**

c. A cylinder contains 1 kg of a certain fluid at an initial pressure of 20 bar. The fluid is allowed to expend reversibly behind a piston according to a law PV^2 = constant, until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the Piston regains its original position : heat is then supplied reversibly with the piston firmly locked in position until the pressure rise to the original value of 20 bar. Calculate the net work done by the fluid, for an initial volume of 0.05 m^3. **(08 Marks)**

Module-2

3 a. Derive an expression for heat transfer for a reversible polytrophic process taking place in a closed system containing an ideal gas. **(06 Marks)**

b. In a system, executing a non – flow process the work and heat per degree change of temperature are given by $\frac{dW}{dT} = 200 \quad W-S/^0C$ and $\frac{dQ}{dT} = 160J/^0C$. What will be the change of internal energy of the system when the temperature changes from T_1 = 55°C to T_2 = 95°C? **(05 Marks)**

c. A cylinder containing the air comprises the system. cycle is completed as follows :
i) 82000 N – m of work is done by the piston on the air during compression stroke and 45 kJ of heat are rejected to the surroundings
ii) During expansion stroke 100000 N–m of work is done by air on the piston. Calculate the quantity of heat added to the system. **(05 Marks)**

OR

4 a. Specify the most widely used sign convention for work and heat interaction. **(04 Marks)**

b. Derive steady flow energy equation. **(06 Marks)**

c. In an air compressor air flows steadily at the rate of 0.5 kg/s through an air compressor. It enters the compressor at 6 m/s with a pressure of 1 bar and a specific volume of 0.85 m^3/kg and leaves at 5 m/s with a pressure of 1 bar and a specific volume of 0.16m^3/kg. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in a jacket surrounding the cylinder absorbs heat from the air at the rate of 60 kJ/s. Calculate : i) The power required to drive the compressor ii) The inlet and output pipe cross–sectional areas. **(06 Marks)**

Module-3

5 a. Prove that Kelvin Planck and clausius statement of second law of thermodynamics are equivalent. (05 Marks)

b. Represent schematically heat engine, heat pump and refrigerator. Give their performance equations. (05 Marks)

c. A fluid undergoes a reversible adiabatic compression from 4 bar, 0.3 m^3 to 0.08 m^3, according to the law, $PV^{1.25}$ = constant. Determine : i) change in enthalpy ii) change in internal energy iii) change in entropy iv) heat transfer v) work transfer. (06 Marks

OR

6 a. Prove that $COP_{\text{Heat pump}} = 1 + COP_{\text{refrigerator}}$. (04 Marks)

b. Define entropy and hence prove that for a system executing a cyclic process $\oint \frac{\delta\phi}{T} \leq 0$. (06 Marks)

c. The specific heats of a gas vary linearly with absolute temperature according to the following relations : $C_p = (0.85 + 0.00025\ T)$ kJ/kg°K

$C_v = (0.56 + .00025\ T)$ kJ/kg°K

If the entropy of the gas at 1 bar pressure and 273 K is zero, find the entropy of the gas at 25 bar and 750 K temperature. (06 Marks)

Module-4

7 a. Define the following : i) triple point ii) critical temperature iii) dryness fraction iv) saturation temperature. (04 Marks)

b. Name the widely used thermodynamic property diagrams for a pure substance, and sketch them. (04 Marks)

c. A vessel having a capacity of 0.05 m^3 contains a mixture of saturated water and saturated steam at a temperature of 245°C. The mass of the liquid present is 10 kg. Find the following: i) The pressure ii) the mass iii) the specific volume iv) the specific enthalpy v) the specific entropy vi) specific internal energy. (08 Marks)

OR

8 a. Write notes on the following : i) Clausius – Clapeyron equation ii) Maxwells equations. (08 Marks)

b. For mercury, the following relation exists between saturation pressure (bar) and saturation temperature (K) : $\log_{10}P = 7.0323 - 3276.6/T - 0.652 \log_{10}T$ calculate the specific volume V_g of saturation mercury vapour at 0.1 bar. Given that the latent heat of vapourisation at 0.1 bar is 294.54 kJ/kg. Neglect the specific volume of saturated mercury liquid. (08 Marks)

Module-5

9 a. With the help of T–S and P–V diagrams, derive an expression for the air standard efficiency of a diesel cycle. (08 Marks)

b. In a constant volume 'OTTO cycle' the pressure at the end of compression is 15 times that at the start, the temperature at the beginning of compression is 38°C and maximum temperature attained in the cycle is 1950°C. Determine : i) compression ratio ii) thermal efficiency of the cycle iii) work done. Take γ for air = 1.4. (08 Marks)

OR

10 a. Why is Carnot cycle not practicable for a steam power plant? Briefly explain. (02 Marks)

b. Discuss the effect of : i) boiler pressure ii) condenser pressure iii) superheat on the performance of a Rankine cycle (06 Marks)

c. A simple Rankine cycle works between pressure 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Calculate the cycle efficiency, work ratio and specific steam consumption. (08 Marks)

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