Reg. No. : | | | | | | | | | | |

Question Paper Code: 41373

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2016

Third Semester

Mechanical Engineering

14UME303 - ENGINEERING THERMODYNAMICS

(Regulation 2014)

Duration: Three hours — Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. Which of the following is point function?

   (a) entropy (b) enthalpy (c) work (d) none

2. The ratio of specific heat capacities at constant volume and constant pressure for air is

   (a) 1.4 (b) 0.714 (c) 1.005 (d) 0.718

3. Which of the following is correct?

   (a) $COP_{HP} = 1+COP_{Ref}$ (b) $COP_{Ref} = 1+COP_{HP}$
   (c) $COP_{HP} + COP_{Ref} = 1$ (d) none

4. No engine which gives higher efficiency other than Carnot engine when working at same temperature limits is called

   (a) Kelvin statement (b) Clausius statement
   (c) Carnot theorem (d) Clausius inequality

5. In pure substances, when the heat transfer takes place, which of the following is correct

   (a) Phase change may takes place and chemical formula unchanged
   (b) No phase change takes place and chemical formula unchanged
   (c) No phase change takes place and chemical formula changed
   (d) Both phase and chemical formula changed

6. The latent heat is the heat required to

(a) rise the temperature of the substance
(b) change the phase of the substance
(c) both (a) and (b)
(d) none of these

7. In the Vander Waal's equation $\left(P+\frac{a}{V^2}\right)(V-b)=RT$, b is called

(a) co volume
(b) co efficient of volume
(c) a constant which is equal to 0.0266 m^3/mol
(d) forces of cohesion

8. Air flows steadily through a compressor. It is compressed reversibly from 0.1 *MPa* and $30^o C$ to 0.9 *MPa*, then the non flow isothermal specific work of compression is

(a) -265.8 *kJ/kg* (b) -189.9 *kJ/kg* (c) -190.7 *kJ/kg* (d) zero

9. The temperature at which the water vapor starts condensing is called

(a) degree of saturation
(b) dry bulb temperature
(c) wet bulb temperature
(d) dew point temperature

10. The difference between the dry bulb and wet bulb temperatures is known as

(a) degree of saturation
(b) dew point temperature
(c) specific humidity
(d) wet bulb depression

PART - B (5 x 2 = 10 Marks)

11. Give any two examples for intensive and extensive properties.

12. Define COP of refrigeration.

13. State Gibb's phase rule and mention the terms.

14. Define the Joule –Thomson coefficient by relation.

15. Name the different Psychrometric processes and mention the processes on Psychrometric chart.

PART - C (5 x 16 = 80 Marks)

16. (a) (i) A steam power plant generates 180,000 *kg/h* of steam. Heat input required to raise this amount of steam in the boiler of the plant is 2600 *kJ/kg* of steam. The power output of the plant is 55 *MW*. What is the thermal efficiency of the plant? (8)

(ii) In the above plant, if the coal consumption is 20, 000 *kg/h* while the heat of combustion of the coal is 29,600 *kJ/kg*, determine

(1) thermal efficiency of the steam generator (boiler)

(2) overall thermal efficiency of the power plant. (8)

Or

(b) Exhaust steam at 50 *kPa*, 150^o *C* enters a supersonic diffuser with a velocity of 180 *m/s*. The area at the diffuser inlet is 1000 cm^2. During the passage of steam through the diffuser, its velocity decreases to 90 *m/s* and the pressure increases to 1 *bar*. Also 120 *kW* of heat is lost to the surroundings from the diffuser surface. Determine the area at diffuser outlet. (16)

17. (a) 1 *kg* of fluid is contained in a cylinder at an initial pressure of 20 *bar* and an initial volume of 0.05 m^3. The fluid is allowed to expand reversibly behind a piston according to the law $PV_2 = C$ until the volume is doubled. The fluid is then cooled at constant pressure until the piston regains its initial position. Heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value of 20 *bar*. Calculate the net work done by the fluid. Sketch the processes on P-V diagram. (16)

Or

(b) A series combination of two Carnot engines operates between the temperature of *T1* and *T2*. Calculate the intermediate temperature *T3*, if the engines produce

(i) equal amount of work and

(ii) equal efficiency. (16)

18. (a) Steam at 20 *bar*, 360^o *C* is expanded in a steam turbine to 0.08 *bar*. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. If the turbine and pump have each 80% efficiency, find the net work and Rankine efficiency. (16)

Or

(b) Calculate the increase in entropy of ice as it heated from -5^o*C* to steam at 250^o*C* at 1 *atm*. Use the following data

Cp of ice = 2.093 *kJ/kgK*

Latent heat of fusion of ice = 334.96 *kJ/kg*

Cp of water = 4.187 *kJ/kgK*

Latent heat of vaporization 2257 *kJ/kg* and

Cp of steam at 250°*C* = 2.093 *kJ/kgK* (16)

19. (a) (i) The specific heats of a gas are given by $C_p = a + kT$, and $C_v = b + kT$. Where *a*, *b* and *k* are constants and *T* is in *K*. Show that for an isentropic expansion of this gas $T^b\ V^{(a-b)}\ e^{kT} = C$. (8)

(ii) From the above, 1.5 *kg* of this gas occupying a volume of 0.06 m^3 at 5.6 *MPa* expands isentropically until the temperature is 240°*C*. If '*a*' = 0.946, '*b*' = 0.662 and '*k*' = 10-4, calculate the work done in the expansion. (8)

Or

(b) (i) Prove that from the mathematical theorems, among the thermodynamics variables *P*, *V* and *T*, the following relation holds good

$$\left(\frac{\partial P}{\partial V}\right)_T \left(\frac{\partial V}{\partial T}\right)_P \left(\frac{\partial T}{\partial P}\right)_V = -1$$

(8)

(ii) Show that $C_p - C_v = -T\left(\frac{\partial V}{\partial T}\right)_p^2 \left(\frac{\partial P}{\partial V}\right)_T$. (8)

20. (a) 1 *k*g of air at 24°*C* and a *RH* of 70*%* is to be mixed adiabatically in a steady state, steady flow device with 1 *kg* of air at 16°*C* and a RH of 10*%*. Assuming that the mixing is carried out at a constant pressure of 1 *atm*, determine the temperature and *RH* of the leaving stream. (16)

Or

(b) Explain the following with neat sketches

(i) Adiabatic saturation process

(ii) Adiabatic evaporative cooling

(iii) Cooling tower (16)