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

Question Paper Code: 43703

B.E. / B.Tech. DEGREE EXAMINATION, NOV 2019

Third Semester

Mechanical Engineering

14UME303 – ENGINEERING THERMODYNAMICS

(Regulation 2014)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

(Use of Steam table and Psychrometric chart are permitted)

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. The heat absorbed by water at its saturation temperature to get converted into dry steam at the same temperature is called

(a) sensible heat (b) specific heat (c) total heat (d) latent heat

6. For a given set of operating pressure limits of a Rankine cycle the highest efficiency occurs for

(a) Saturated cycle (b) Superheated cycle
(c) Reheat cycle (d) Regenerative cycle

7. The difference of specific heats for the ideal gases is

(a) Joule - Thomson coefficient (b) Characteristics gas constant
(c) Molecular mass (d) None

8. Isothermal compressibility α

(a) $\alpha = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$ (b) $\alpha = -\frac{1}{V}\left(\frac{\partial P}{\partial V}\right)_T$
(c) $\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_P$ (d) $\alpha = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$

9. A humidification process means

(a) Decrease in relative humidity (b) An increase in specific humidity
(c) A decrease in temperature (d) An increase in temperature

10. In an adiabatic saturation process

(a) The enthalpy remains constant (b) The temperature remains constant
(c) The absolute humidity remains constant (d) The relative humidity remains constant

PART - B (5 x 2 =10 Marks)

11. What is the difference between classical and the statistical approaches to thermodynamics?

12. What is irreversibility?

13. What do you understand by triple point?

14. What is the value of the Clapeyron equation in thermodynamics?

15. What is evaporative cooling?

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) The compressor of a large gas turbine receives air from the ambient surrounding at 95 *kPa*and 20° *C* with a low velocity. At the compressor discharge, air exits at 1.52 *MPa* and 430° *C* with celocity of 90 *m/s*. The power input to the compressor is 5000*kW*. Determine the mass flow rate of air through the unit. (16)

17. (a) A heat pump working on a Carnot cycle takes in heat from a reservoir at 5^0C and delivers heat to a reservoir at 60^0C. The heat pump is driven by a reversible heat engine which takes in heat from a reservoir at 840^0C and rejects heat to a reservoir at 60^0C. The reversible heat engine also drives a machine that absorbs 30 *kW*. If the heat pump extracts 17 *kJ/s* from the 5^0C reservoir, determine (a) the rate of heat supply from the 840^0C source, and (b) the rate of heat rejection to the 60^0C sink. (16)

Or

(b) 50kg of water is at 313 K and enough ice at -5°C is mixed with water in an adiabatic vessel such that at the end of the process all the ice melts and water at 0°C is obtained. Find the mass of ice required and the entropy change of water and ice. Take C_p of water = 4.2 kJ/kgK, C_p of ice = 2.1 kJ/kgK and latent heat of ice = 335 kJ/kg. (16)

18. (a) Explain steam formation with relevant sketch and label all salient points and explain every point in detail. (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^{o}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^{o}C. If '*a*' = 0.946, '*b*' = 0.662 and '*k*' = 10-4, calculate the work done in the expansion. (8)

Or

(b) Weighing of mass gives a mixture at 60° *C* 225 *kPa* with 0.5 *kg* O_2, 1.5 *kg* N_2 and 0.5 *kg* CH_4. Find the partial pressures of each component, the mixture specific volume, mixture molecular weight and the total volume. (16)

20. (a) An industrial process requires an atmosphere having a *RH* of 88.4% at 22 ^{0}C, and involves a flow rate of 2000 m^3/h. The external conditions are 44.4% *RH*, 15^{0}C. The air intake is heated and then humidified by water spray at 20^{0}C. Determine the mass flow rate of spray water and the power required for heating, if the pressure throughout is 1 bar. (16)

Or

(b) Explain the following with neat sketches

(i) Adiabatic saturation process

(ii) Adiabatic evaporative cooling

(iii) Cooling tower (16)
