September 2021

ENGINEERING THERMODYNAMICS

Time Allowed: 1.5 Hours | Full Marks: 70

Answer to Question No.1 is compulsory and Answer any two questions from the rest.

1. Answer the following questions (any twenty): 20x2

Choose the correct answer from the given alternatives:

i. Which properties of below is extensive properties –(a) Temperature, (b) Volume, (c) Pressure, (d) Density.

ii. SI unit of enthalpy is– (a) Joule/kgK, (b) Joule/K, (c) Joule/kg, Joule/s.

iii. Entropy is a–(a) path function, intensive property, (b) path function, extensive property, (c) point function, intensive property, (d) point function, extensive property.

iv. The perfect example of an ideal gas is–(a) air, (b) hydrogen, (c) water vapor, (d) none of the above.

v. Gases of the same volume contain the same number of molecules. This is the description of– (a) Avogadro's law, (b) Boyle's law, (c) Charles' law, (d) Dalton's law

vi. Critical temperature of water is–(a) 320°c, (b) 273°c, (c) 374°c, (d) 474°c.

vii. The dryness fraction (x) of superheated steam is taken as– (a) x= 0, (b) x= 0.9, (c) x= 0.999, (d) x= 1.

viii. A pure substance exists in– (a) solid phase, (b) liquid phase, (c) gaseous phase, (d) all of the above.

ix. Which thermodynamics cycle used in steam power plant (steam engine)? (a) Carnot cycle, (b) Otto cycle, (c) Rankine cycle, (d) Brayton cycle.

x. Rankine cycle efficiency range is a– (a) 20 - 30 %, (b) 30 - 40 %, (c) 40 - 50 %, (d) 50 - 60 %.

xi. Which of the following cycle is used for Spark Ignition (SI) engine? (a) Otto cycle, (b) Diesel cycle, (c) Dual cycle, (d) Carnot cycle.

xii. Convective heat transfer coefficient doesn't depend on–(a) Surface area, (b) Space, (c) Time, (d) Orientation of solid surface.

xiii. In isochoric process– (a) Temperature is constant, (b) Volume is constant, (c) Pressure is constant, (d) Entropy is constant.

xiv. Open system example is–(a) Compressor, (b) Turbine, (c) Nozzle, (d) All of above.

State whether the following statements are True or False:

xv. Entropy is zero at triple point.
xvi. Heat and work transfer have exact differential.
xvii. In free expansion of gas, the work transfer is zero.
xviii. Internal energy is zero at triple point.
xix. A reversible adiabatic process is an isentropic process.
xx. Enthalpy of evaporation of water Increased with increase in pressure.
xxi. Dryness fraction (x) for saturated water is zero.

xxii. Critical pressure for water is 28.52 MPa.
xxiii. A gas turbine power plant uses Brayton cycle.
xxiv. Diesel cycle is also known as constant pressure cycle.
xxv. The unit of overall coefficient of heat transfer is w/m.

2. a) A refrigerator is to remove heat from the cooled space at a rate of 300kJ/min to maintain its temperature at –8°C. If the air surrounding the refrigerator is at 25°C, determine the minimum power input required for this refrigerator.
b) Define the thermal efficiency of a heat engine cycle. Can this be 100%? 8+(5+2)

3. a) Give the Kelvin-Planck statement of the second law.
b) What is PMM2? Why is it impossible?
c) Show that the COP of a heat pump is greater than the COP of a refrigerator by unity. 3+(3+3)+6

4. a) What is Avogadro's law?
b) A constant volume chamber of 0.3 m^3 capacity contains 2 kg of gas at 5^0C. Heat is transferred to the gas until the temperature is 100^0C. Find the work done, the heat transferred, change in internal energy, enthalpy and entropy. The specific heats are: c_p = 1.968 kJ/kg K and c_v = 1.507 kJ/kg K. 5+10

5. a) What is quality of steam? What are the different methods of measurement of quality?
b) Find the enthalpy, entropy and volume of steam at 1.4 MPa, 380^0C. (3+3)+9

6. a) What is a pure substance?
b) Draw a phase equilibrium diagram for a pure substance on T-S plot with relevant constant property line.
c) What do you understand by triple point? 3+9+3

7. a) What are the four basic components of a steam power plant?
b) What is Rankine cycle? Draw the p-v and T-s diagrams of this cycle.
c) What do you understand by steam rate? 3+(3+6)+3

8. a) State the four processes of the Otto cycle with p-v and T-s diagram.
b) Derive an expression for efficiency of Otto cycle. 7+8

9. a) State the Fourier's law of heat conduction.
b) Explain the principle of heat exchanger.
c) What is black body and Gray body? 3+6+6

10. a) What is a thermodynamic system?
b) What is the difference between a closed system and an open system?
c) What are the intensive and extensive properties? 3+6+6

11. a) Deduce an expression of displacement work for isothermal process.
b) A mass of 1.6 kg of air is compressed in a quasi-static process from 0.1 MPa to 0.7 MPa for which PV=constant. The initial density of air is 1.15 kg/m^3.Find the work done by the piston to compress the air. 7+8