Sr. No. 002406

August/September 2022

B.Tech(Civil) IV SEMESTER

MECHANICAL ENGINEERING (ESC-209)

Time: 3 Hours **Max. Marks:75**

Instructions:

1. *It is compulsory to answer all the questions (1.5 marks each) of Part -A in short.*
2. *Answer any four questions from Part -B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*
4. *Use of steam tables, mollier diagram is allowed.*

PART -A

Q1 (a) Give the thermodynamic definition of work. (1.5)

(b) Differentiate between thermal and thermodynamic equilibrium. (1.5)

(c) Define Perpetual Motion Machine of First kind (PMM-I). (1.5)

(d) Two thermometers, one Celsius and other Fahrenheit are immersed in a fluid. After the thermometers reach equilibrium with the fluid, it is noted that both the thermometers indicate the same numerical value. Find the identical numerical value shown by the thermometers. (1.5)

(e) Define COP. How does it differ from thermal efficiency? (1.5)

(f) In a Brayton cycle, the turbine output is 600 kJ/kg, the compressor work is 400 kJ/kg and the heat supplied is 1000 kJ/kg, determine the thermal efficiency of the cycle. (1.5)

(g) Differentiate between I law and II law efficiencies. (1.5)

(h) Show the basic Rankine cycle on p-V and T-S plots. (1.5)

(i) Differentiate between high grade and low grade energy with examples. (1.5)

(j) Define specific humidity and relative humidity. (1.5)

PART -B

Q2 (a) Derive the expressions for work transfer for isothermal and adiabatic processes for a closed system. (5)

(b) A piston cylinder device operates 1 kg of fluid at 20 bar. The initial volume is 0.04 m^3. The fluid is allowed to expand reversibly following a process $pV^{1.45}=$ constant, so that the volume becomes double. The fluid is then cooled at constant pressure until the piston comes back to its original position. Keeping the piston unaltered, heat is added reversibly to restore it to the initial pressure. Calculate the work done in the cycle. (10)

Q3 (a) State and prove the Carnot Theorem. (5)

(b) What is Irreversibility? What are its types and causes? Discuss at least two causes in detail. (10)

Q4 In a steady flow apparatus, 135 kJ of work is done by each kg of fluid. The specific volume of the fluid, pressure and velocity at the inlet are 0.37 m^3/kg, 600 kPa and 16 m/s respectively. The inlet is 32 m above the floor, and the discharge pipe is at floor level. The discharge conditions are 0.62 m^3/kg, 100 kPa and 270 m/s. The total heat loss between the inlet and discharge is 9 kJ/kg of fluid. In flowing through this apparatus, does the specific internal energy increase or decrease, and by how much? (15)

Q5 (a) Derive the expression for COP of heat pump and show that COP of heat pump is always greater than COP of refrigerator. (5)

(b) Air at 20°C and 1.05 bar occupies 0.025m^3. The air is heated at constant volume until the pressure is 4.5 bar, and then cooled at constant pressure back to original temperature. Calculate: (i) The net heat flow from the air, (ii) The net entropy change. Sketch the process on T-S plot. (10)

Q6 (a) Derive the expression for air standard thermal efficiency of an Otto cycle. (5)

(b) Define the following terms related to steam formation: (10)

(i) Sensible heat of water
(ii) Latent heat of vaporization
(iii) Total heat of steam
(iv) Dryness fraction of steam
(v) Volume of superheated steam

Q7 (a) Explain adiabatic evaporative cooling process and also show it on the psychrometry chart. (5)

(b) Explain the basic cycle on which the domestic refrigerators work with the help of p-h and T-S diagrams. Explain the effect of superheat and subcooling on this cycle. (10)

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