CBCS SCHEME

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18AU32

Third Semester B.E. Degree Examination, Jan./Feb. 2023
Engineering Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Use of thermodynamic Data Hand Book is permitted.

Module-1

1 a. Explain a thermodynamic system. State whether the following systems are open or closed with reason.
i) A scooter engine
ii) Battery of an EV
iii) Radiator fan
iv) Cooling water pump. **(10 Marks)**

b. The resistance of the winding of a motor at room temperature 28°C and at full load under steady state conditions is given as 75Ω and 90Ω respectively. The windings are made of copper with temperature t°C is given by $R_t = R_0(1+ 0.004t)$. If R_0 is the resistance at 0°C, find the temperature of the coil at full load. **(10 Marks)**

OR

2 a. Explain with a system diagram : i) Shaft work ii) Electrical work. Write corresponding equations to calculate them. **(10 Marks)**

b. A battery is charged with a battery charger. The charger operates 1 hour at 15V and a current of 30A. Calculate the work done on the battery. **(05 Marks)**

c. Define heat and explain its sign convention. Why heat is regarded as 'low grade energy'? **(05 Marks)**

Module-2

3 a. From fundamentals derive an expression for steady-state steady-flow energy equation, for an open system. **(10 Marks)**

b. A compressor is required to provide 0.5MPa and 200°C air for a stationary power plant. The air intake is 0.1MPa and 20°C, the outlet velocity is 25m/s. Estimate the work done per unit mass needed for an adiabatic compressor. Take C_p = 1.005kJ/kg K for air. **(10 Marks)**

OR

4 a. Establish the equivalence of Kelvin – Planck and clausius statements of second law of thermodynamics. **(10 Marks)**

b. What is PMM – II and why it is not possible? Prove. **(05 Marks)**

c. An inventor claims to have developed an engine with power developed = 76KW, by burning 4kg of fuel per hour, which has a calorific value of 75000kJ/kg. The engine operates between limits of 727°C and 27°C. You being a testing authority verify this claim. **(05 Marks)**

Module-3

5 a. Define entropy and using the principle of increase of entropy show that $ds \geq \delta Q/T$. **(08 Marks)**

b. Define available and unavailable energy. Represent graphically. **(04 Marks)**

c. 3.5KW of heat is removed in a constant pressure cooling process. Determine the mass flow rate and change in entropy for the following cases.
i) Air decreasing in temperature from 0°C to –15°C if C_p = 1.005kJ/kg K
ii) Refrigerant ammonia condensing at –20°C, if latent heat is 1329 kJ/kg. **(08 Marks)**

OR

6 a. Define dryness fraction. With a schematic sketch explain the working of a separting and throttling calorimeter. **(10 Marks)**

b. A tank contains 2kg of water consisting of liquid and vapour in equilibrium at 20 bar. If the liquid and vapour each occupy half the volume of the tank what is the enthalpy of contents of the tank? **(10 Marks)**

Module-4

7 a. Sketch and explain the working of a vapour compression refrigeration system. Make a thermodynamic analysis using a p–h diagram. **(10 Marks)**

b. In an ideal vapour compression refrigerator of 15kW cooling capacity, the saturated refrigerant vaopur leaves the evaporator with an enthalpy of 178kJ/k. The enthalpies at the exit of the compressor and condenser are 210 kJ/kg and 65kJ/kg respectively. Show the cycle on a p–h diagram and calculate :

i) COP

ii) refrigerant flow rate

iii) Power required to drive the compressor. **(10 Marks)**

OR

8 a. Define :

i) Dew point temperature

ii) Wet bulb temperature

iii) Specific humidity

iv) Saturation ratio

Write applicable equations. **(10 Marks)**

b. A sling psychrometer reads 28°C WBT and 40°C DBT. If the total pressure is 101.325KPa and gas constant of vapour and air are respectively 461 J/kg K and 287 J/kg K, find :

i) Specific humidity

ii) Relative humidity

iii) Dew point temperature

iv) Vapour density in air. **(10 Marks)**

Module-5

9 a. With the help of a p-v diagram discuss the condition for minimum work and isothermal efficiency of a reciprocating compressor. **(10 Marks)**

b. A double acting air compressor of 180mm diameter and 1.2m stroke runs at 2rps and operates between 1 bar and 10 bar. If the inlet temperature is 15°C determine the power, final temperature and the temperature rise if the compression index is 1.3. **(10 Marks)**

OR

10 a. Analyse a simple open gas turbine cycle and derive an expression for cycle efficiency interms of pressure ratio. Represent all the processes on a T–S diagram. **(10 Marks)**

b. With schematic diagrams explain the principles of jet and rocket propulsion. **(06 Marks)**

c. List out advantages (any four) of a closed cycle gas turbine. **(04 Marks)**

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