KUMARAGURU
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B.E. DEGREE EXAMINATIONS: NOV/DEC 2023

(Regulation 2018)

Third Semester

AUTOMOBILE ENGINEERING

U18AUT3103: Thermodynamics and Thermal Engineering

(Steam Table, Psychrometric Chart and HMT Data books are permitted)

COURSE OUTCOMES

CO1: Familiarize laws of Thermodynamics.

CO2: Apply energy balance to systems and control volumes, in situations involving heat and work Interactions.

CO3: Compare the performance of thermal systems with idealized systems.

CO4: Make use of the properties of pure substance in vapour power cycles.

CO5: Solve problems using thermodynamic concepts related to air compressor, refrigeration and air conditioning.

CO6: Utilize modes of heat transfer to design thermal equipment.

Time: Three Hours   **Maximum Marks: 100**

Answer all the Questions:-
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

1. Describe thermodynamic equilibrium of a system.	CO1	[K$_2$]
2. What is first law of thermodynamics?	CO1	[K$_1$]
3. Define Volumetric efficiency of the reciprocating compressor	CO3	[K$_1$]
4. Compare Otto, Diesel and Dual Cycle.	CO2	[K$_2$]
5. Name some of the equipments used in automobile air conditioning system	CO4	[K$_1$]
6. Why inter-coolers are required for multi-stage reciprocating compressors?	CO2	[K$_3$]
7. What is the difference between perfect inter cooling and imperfect inter cooling?	CO3	[K$_1$]
8. List down psychometric process.	CO5	[K$_1$]
9. State Fourier's law of conduction.	CO6	[K$_1$]
10. What is difference between free convection and forced convection?	CO6	[K$_2$]

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11. 0.1 m^3 of an ideal gas at 300 K and 1 bar is compressed adiabatically to 8 bar. It   16   CO1   [K$_3$]
is then cooled at constant volume and further expanded isothermally so as to
reach the condition from where it started.

Calculate:

      (i) Pressure at the end of constant volume cooling.

      (ii) Change in internal energy during constant volume process.

      (iii) Net work done, and

      (iv) Heat transferred during the cycle.

Assume $C_p = 14.3$ kJ/kg K and $C_v = 10.2$ kJ/kg K.

12. a)   Derive Steady flow energy equation.   6   CO2   [K$_2$]

    b)   A turbine, operating under steady-flow conditions, receives 4500 kg of steam per   10   CO2   [K$_3$]
hour. The steam enters the turbine at a velocity of 2800 m/min, an elevation of
5.5 m and a specific enthalpy of 2800 kJ/kg. It leaves the turbine at a velocity of
5600 m/min, an elevation of 1.5 m and a specific enthalpy of 2300 kJ/kg. Heat
losses from the turbine to the surroundings amount to 16000 kJ/h. Determine the
power output of the turbine.

13   An engine with 200 mm cylinder diameter and 300 mm stroke works on   16   CO3   [K$_4$]
theoretical Diesel cycle. The initial pressure and temperature of air used are 1 bar
and 27°C. The cut-off is 8% of the stroke.

Determine:

      (i) Pressures and temperatures at all salient points.

      (ii) Theoretical air standard efficiency.

      (iii) Mean effective pressure.

      (iv) Power of the engine if the working cycles per minute are 380.

Assume that compression ratio is 15 and working fluid is air. Consider all
conditions to be ideal.

14. A steam power plant working on Rankine cycle has the range of operation from 40bar dry saturated to 0.05bar.   16   CO4   [K₃]

Determine:

    (i) Dryness at the end of expansion

    (ii) The pump work

    (iii) Turbine work

    (iv) Rankine efficiency and

    (v) Condenser heat flow. Assume mass flow rate of steam is 10 kg/s.

Absolute pressure in bar (P)	Temperature in °C	Sp. Volume (m³/kg) Water (V_f)	Specific enthalpy in kJ/kg			Specific entropy in kJ/kg.K		
			Water (h_f)	Evaporation (h_{fg})	Steam (h_g)	Water (S_f)	Evaporation (S_{fg})	Steam (S_g)
40	250.3	0.0013	1087.4	1712.9	2800.3	2.797	3.272	6.069
0.04	28.98	0.0010	121.39	2432.3	2553.7	0.422	8.0510	8.473

15. a) In a cooling coil application, moist air enters the refrigeration coil at the rate of 100kg of dry air per minute at 35°C DBT and 50% RH. The apparatus dew point (ADP) of coil is 5°C and by-pass factor (BPF) is 0.15. Determine the outlet state of moist air and cooling capacity of coil in TR.   10   CO5   [K₂]

   b) Explain the properties of refrigerants.   6   CO5   [K₂]

16. a) Calculate the rate of heat loss through the vertical walls of a boiler furnace of size 4 m by 3 m by 3 m high. The walls are constructed from an inner fire brick wall 25 cm thick of thermal conductivity 0.4 W/mK, a layer of ceramic blanket insulation of thermal conductivity 0.2 W/mK and 8 cm thick, and a steel protective layer of thermal conductivity 55 W/mK and 2 mm thick. The inside temperature of the fire brick layer was measured at 600° C and the temperature of the outside of the insulation 60⁰ C. Also find the interface temperature of layers.   10   CO6   [K₄]

   b) Explain modes of heat transfer.   6   CO6   [K₂]

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