



B.E DEGREE EXAMINATIONS: MAY 2018

(Regulation 2015)

Sixth Semester

MECHATRONICS

U15MCT603 : Thermodynamics and Heat Transfer

COURSE OUTCOMES

- CO1:** Define the laws of thermodynamics and calculate the properties of the system.
CO2: Estimate the various air standard cycle efficiency and describe the working of I.C engines.
CO3: Explain the various modes of heat transfer for different applications.
CO4: Describe the boundary layer concepts and different modes of convection.
CO5: Explain the different laws in radiation heat transfer concepts.
CO6: Discuss the concepts of mass transfer and derive their correlations.

Time: Three Hours

Maximum Marks: 100

**Answer all the Questions:-
PART A (10 x 1 = 10 Marks)**

1. Matching type item with multiple choice code

CO1 [K₁]

List I		List II	
A. Volume		i. Path function	
B. Density		ii. Intensive property	
C. Pressure		iii. Extensive property	
D. Work		iv. Point function	

- | | | | | | |
|----|-----|----|-----|----|--|
| | A | B | C | D | |
| a) | ii | i | iii | iv | |
| b) | iii | iv | ii | i | |
| c) | ii | iv | iii | i | |
| d) | iii | ii | iv | i | |
2. Majority of people wear white or light colored clothes in summer, because light colors
- | | |
|----------------------|-----------------------|
| a) reflect more heat | b) absorb more heat |
| c) reflect less heat | d) transfer less heat |

CO5 [K₁]

9. The following question consists of two statements, Assertion and Reason. While answering these questions choose any of the following four responses. CO1 [K₁]

Assertion (A): Heat supplied during an isochoric process is stored as internal energy.

Reason (R): No work is accomplished during an isochoric process.

- a) Both A and R are Individually true and R is the correct explanation of A b) Both A and R are Individually true but R is not the correct explanation of A
c) A is true but R is false d) A is false but R is true

10. The ratio of mass concentration of species A to the total mass density of the mixture is known as CO6 [K₁]

- a) Mass fraction b) Mass density
c) Concentration d) Mole fraction

PART B (10 x 2 = 20 Marks)
(Answer not more than 40 words)

11. Define quasi- static process, and discuss its importance. CO1 [K₂]
12. Efficiency of a work producing device cannot be 100%. Justify. CO1 [K₂]
13. What is an air standard cycle? CO2 [K₂]
14. Draw the Brayton cycle on p-V and T-s diagram. CO2 [K₂]
15. Define conduction. CO3 [K₂]
16. Does conduction play any role in the process of convection heat transfer? Justify. CO4 [K₂]
17. Comment on the significance of boundary layer. CO4 [K₂]
18. A person who sits in front of a fireplace feels warm. Name the mode of heat transfer through which he receives heat and comment on that. CO5 [K₂]
19. Give examples of mass transfer. CO6 [K₂]
20. Discuss the analogy between heat and mass transfer. CO6 [K₂]

Answer any FIVE Questions:-
PART C (5 x 14 = 70 Marks)
(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. a) State the law of conduction. (4) CO3 [K₃]
b) A furnace wall consists of three layers. The inner layer of 10 Cm thickness is made of fire brick (K=1.04 N/mK). The intermediate layer of 25 Cm thickness is made of masonry brick (K=0.69 N/mK) followed by a 5Cm thick concrete wall (K=1.37 N/mK). When the furnace is in continuous operation the inner surface is maintained at 800° C while the outer concrete the rate of heat loss per unit area of the wall and interface temperature. (10)

22. A gas of mass 1.5kg undergoes a quasi- static expansion which follows a relationship $p=a+bV$, a and b are constants. The initial and final pressures are 1000kPa and 200kPa respectively and the corresponding volumes are 0.2m^3 and 1.20m^3 . The specific internal energy of the gas is given by the relation, $u=1.5pv-85$ kJ/kg, where p is in kPa and v is in m^3/kg . Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion. CO1 [K₃]
23. A heat pump working on the Carnot cycle takes in heat from a reservoir at 5°C and delivers heat to a reservoir at 60°C. The heat pump is driven by a reversible heat engine which takes in heat from a reservoir at 840°C and rejects heat to a reservoir at 60°C. The reversible heat engine also drives a machine that absorbs 30 kW. If the heat pump extracts 17 kJ/s from the 5°C reservoir, determine
(a) The rate of heat supply from the 840°C source
(b) The rate of heat rejection to the 60°C sink CO1 [K₃]
24. Draw the Otto cycle on p-V and T-s diagrams. Derive the expression for its efficiency. CO2 [K₃]
25. Air at 30°C is flowing across a tube with a velocity of 25 m/s. The tube could be either a square with a side of 5 cm or a circular cylinder of diameter 5 cm. Compare the rate of heat transfer in each case if the tube surface temperature is 124°C. CO4 [K₃]
26. Two circular discs of diameter 0.3 m each placed parallel to each other at a distance of 0.2 m. One disc is maintained at a temperature of 750°C and the other at 350°C and their corresponding emissivities are 0.3 and 0.6. Calculate heat exchange between the discs. CO5 [K₃]
27. a) Ammonia and air are in equimolar counter diffusion in a cylindrical tube of 2.5mm diameter and 15 mm length. The total pressure is 1 atm and the temperature is 25°C. One end of the tube is connected to a large reservoir of ammonia and the other end of the tube is open to atmosphere. If the mass diffusivity for the mixture is $0.28 \times 10^{-4} \text{m}^2/\text{s}$. Calculate the following (10) CO6 [K₃]
a) Mass rate of ammonia in kg/h
b) Mass rate of air in kg/h

b) State Fick's law of diffusion. (4)
