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| **Name:**<br>**Enrolment No:** | |

**UPES**

**End Semester Examination, December 2023**

**Course: Automotive Thermal Management** **Semester : 5th**

**Program: B.Tech-Automotive Design Engineering** **Time : 03 hrs.**

**Course Code: MECH-3042** **Max. Marks: 100**

**Instructions: Assume any missing data and mention it clearly.**

**SECTION A**
**(5Qx4M=20Marks)**

| S. No. | | Marks | CO |
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| Q 1 | State the importance of Prandtl Number with its mathematical formulation. | **5** | **CO1** |
| Q 2 | Discuss Stefan Boltzmann law for radiative heat transfer. | **5** | **CO2** |
| Q 3 | Analyze the concept of radiosity in radiative heat transfer. | **5** | **CO3** |
| Q 4 | Analyze how the fins enhance heat transfer from a surface. Also, evaluate how the addition of fins may decrease heat transfer from a surface. | **5** | **CO4** |
| Q 5 | Draw and explain, P-H and T-S diagram of Vapor compression refrigeration system | **5** | **CO5** |

**SECTION B**
**(4Qx10M= 40 Marks)**

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| Q 6 | A composite wall separates combustion gasses at 260℃ from a liquid coolant at 100℃, with a gas and liquid side convection coefficient of 50 and 1000 $W/m^2K$, respectively. The wall is composed of 10 mm thick layer of beryllium oxide on gas side and a 20 mm thick slab of stainless steel on liquid side. What is the heat loss per unit area of the composite? Sketch the temperature distribution from the gas to the liquid. | **10** | **CO2** |
| Q 7 | The base plate of an iron has a thickness of 7 mm and made from aluminum alloy (density 2800 $kg/m^3$, $C_p$=900 J/kg. k, K=180 W/m K). An electrical resistance of heater is attached to the inner surface of the plate, while the outer surface is exposed to atmosphere at 25℃. The area of both inner and outer surface are 0.04 $m^2$. If an approximately uniform heat flux of $1.25 \times 10^4 W/m^2$ is applied to the inner surface of the base plate and convection coefficient at the outer surface is $10\,W/m^2K$. Estimate the time required for the plate to reach a temperature of 135℃. | **10** | **CO3** |

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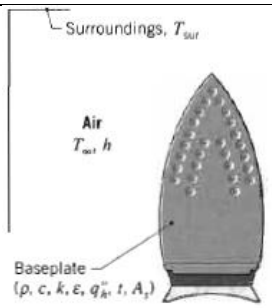
| |  | | |
| Q 8 | Consider a hollow-core printed circuit board 12 cm high and 18 cm long, dissipating a total of 20 W. The width of the air gap in the middle of the PCB is 0.25 cm. The cooling air enters the 12-cm-wide core at 32°C at a rate of 0.8 L/s. Assuming the heat generated to be uniformly distributed over the two side surfaces of the PCB, determine (a) the temperature at which the air leaves the hollow core and (b) the highest temperature on the inner surface of the core. | **10** | **CO4** |
| Q 9 | Deduce mathematical formulation for three-dimensional heat conduction equation with internal heat generation in cylindrical coordinates.<br>**OR**<br>Deduce mathematical formulation for three-dimensional heat conduction equation with internal heat generation in spherical coordinates. | **10** | **CO5** |
| **SECTION-C<br>(2Qx20M=40 Marks)** | | | |
| Q 10 | In the condenser of a steam power plant, steam is to be condensed at a temperature of 50°C ($h_{fg}$=2305 kJ/kg) with cooling water ($C_p$ =4180 J/kg °C) from a nearby lake, which enters the tubes of the condenser at 18°C and leaves at 27°C. The surface area of the tubes is 58 $m^2$, and the overall heat transfer coefficient is 2400 W/$m^2$°C. Determine the mass flow rate of the cooling water needed and the rate of condensation of the steam in the condenser. | **20** | **CO5** |
| Q 11 | The rear window of an automobile is defogged by passing warm air over its inner surface.<br>a) if the warm air is at 40℃ and corresponding convection coefficient is $30\ W/m^2K$, What are the inner and outer surface temperatures of 4 mm thick window glass, if ambient temperature is $-10$℃ and associated convective heat transfer coefficient is $65\ W/m^2K$.<br>b) In practice ambient temperature and convective heat transfer coefficient vary with car speed and weather conditions. Compute the plot of inner and outer temperature when convective heat transfer coefficient is 2, 65 and 100 $W/m^2K$.<br>**OR** | **20** | **CO5** |

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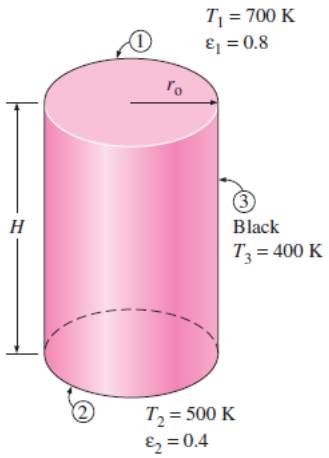
| | Consider a cylindrical furnace with radius and height of 1 m, as shown in figure .The top (surface 1) and the base (surface 2) of the furnace has emissivity $\varepsilon_1$=0.8 and $\varepsilon_2$=0.4, respectively, and are maintained at uniform temperatures $T_1$=700 K and $T_2$=500 K. The side surface closely approximates a blackbody and is maintained at a temperature of $T_3$=400 K. Determine the net rate of radiation heat transfer at each surface during steady operation and explain how these surfaces can be maintained at specified temperatures.<br>  <br> | | |