CBCS SCHEME

USN | | | | | | | | | | 21AE/AS71

Seventh Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026

Conjugate Heat Transfer

Time: 3 hrs. Max. Marks: 100

Note : ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Recall the history of Conjugate Heat Transfer. **(10 Marks)**

b. Explain a Conjugate Heat Transfer problem. How does the interaction between a solid and a fluid domain impact the overall heat transfer performance in a conjugate problem? **(10 Marks)**

OR

2 a. Explain how different types of boundary conditions affect the results of a Heat Transfer Analysis. **(10 Marks)**

b. What is Conjugate Heat Transfer and how it is applied across various engineering fields? Provide examples demonstrating how CHT analysis aids in improving thermal management and system efficiency in real world application. **(10 Marks)**

Module-2

3 a. Define Fourier's Law of heat conduction and explain its significance in heat transfer. **(04 Marks)**

b. Express the general 3 – dimensional conduction equation in Cartesian co-ordinates and state the assumptions. **(08 Marks)**

c. Explain the following terms : i) Thermal resistance ii) Efficiency of a fin iii) Effectiveness of a fin iv) Biot number. **(08 Marks)**

OR

4 a. Describe the key details and principles of effective heat transfer. **(10 Marks)**

b. The composite wall is made up of 3 layers of thickness 25 cm , 10 cm and 15 cm of material A, B and C respectively. The thermal conductivity of A & B are 1.7 W/mK and 9.5 W/mK respectively. The outside surface is exposed to air at 20°C, with convection coefficient of 15 W/m^2K and the inside is exposed to gases at 1200 °C with a convection coefficient of 28 W/m^2K and the inside surface is at 1080 °C. Determine the unknown thermal conductivity of layer made up material C. **(10 Marks)**

Module-3

5 a. Define Subsonic flow and describe its impact and a common application where it is relevant in conjugate heat transfer. **(10 Marks)**

b. Briefly discuss the different types of multiphase flows and explain the various flow regimes observed in multiphase systems. **(10 Marks)**

OR

6 a. Compare natural convection and forced convection regarding their mechanisms, applications and influence on heat transfer in thermal management system. **(10 Marks)**

b. Air at 20°C and 1.013 bar flows over a flat plate at 40 m/s. The plate is 1m long and it is maintained at 60°C. Assuming unit depth. Calculate the heat transfer from the plate.
Use the following correlation : $Nu_L = (Pr)^{0.33} [\, 0.037 (Re_L)^{0.8} - 850]$
Properties of air : $\rho = 1.128$ kg/m^3 , $C_P = 1.005$ kJ/kg °C , K = 0.0275 W/m°C ,
$r = 16.96 \times 10^{-6}$ m^2/s and $P_r = 0.699$. **(10 Marks)**

Module-4

7 a. Define Radiative Heat Transfer and explain its key mechanisms. Discuss how surface temperature , area and emissivity influence the rate of radiative heat transfer. **(10 Marks)**

b. Explain with sketch the following boundary layer :
i) The velocity boundary layer
ii) The thermal boundary layer. **(10 Marks)**

OR

8 a. Two large parallel planes are at 1000 K and 600 K. Determine the heat exchanger per unit area i) If surface one black
ii) If the hot one has an emissivity of 0.8 and color one 0.5
iii) If a large plate is inserted between these two, having emissivity of 0.2. **(10 Marks)**

b. Define a Heat Exchanger. Briefly explain the classifications of heat exchangers, providing examples for each type. **(10 Marks)**

Module-5

9 a. Describe the characteristic problem in the context of heat conduction and explain how it can be solved using the harmonic law of oscillation. **(10 Marks)**

b. Explain the significance of the universal algorithm in determining the factors of conjugation in heat transfer scenarios. **(10 Marks)**

OR

10 a. With the help of a sketch, explain the different regimes of pool boiling. **(10 Marks)**

b. Briefly explain the following terms :
i) Drop wise condensation
ii) Turbulent heat transfer. **(10 Marks)**

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