Hall Ticket No | | | | | | | | | | Question Paper Code: AAE515

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-II

B. Tech V Semester End Examinations (Regular), May – 2019

Regulations: IARE-R16

HEAT TRANSFER

(AERONAUTICAL ENGINEERING)

Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I **Marks**

1. a) What do you understand by thermal conductivity and thermal diffusivity of material? Explain the properties that vary with diffusivity **[7M]**

   b) A storage plant is made from two 8mm thick glass sheets separated by a uniform air-gap of 1mm. The temperature of the air inside the room is -20^{0}C and the ambient air temperature is 30^{0}C. Assuming the heat transfer coefficient between glass and air to be 23.26 W/m^{2}K. Determine the rate of heat leaking in to the room per unit area of the door. Neglect the convection effects in the air-gap. **[7M]**

   K_{glass} = 0.75WmK ; k_{air} = 0.02W/mK

2. a) specify the basic laws which govern the heat transfer and explain in brief with suitable examples **[7M]**

   b) A plate 2 cm thick and 8cm wide is used to heat a fluid at a 25°C. The heat generation rate inside the plate is 7×10^8 W/m^2. Determine the heat transfer coefficient to maintain the temperature of the plate below 140°C. Given k (plate) = 22 W/m °C. Neglect heat losses from the edge of the plate. **[7M]**

UNIT-II

3. a) What is critical radius of insulation? Explain its importance in electrical and thermal system **[7M]**

   b) A furnace wall consists of two layers, 22.5cm of fire brick(k=1.2kcal/hr m ^{0}C)and 12.5cm of insulating brick (k=0.15kcal/hr m ^{0}C) . The temperature inside the furnace is 1650 ^{0}C and the inside heat transfer coefficient is 60kcal/hr m ^{0}C. The C and the outside heat transfer°temperature of the surrounding atmosphere is 27 C . Determine the rate of heat of loss per square meter of°coefficient is 10kcal/hr m2 the wall. **[7M]**

4. a) Define Biot and Fourier numbers, and point out their physical significance. **[7M]**

b) C has an I.D. of 15cm. The convection°A pipe carrying steam at 220 coefficient on the inside wall is 60W/m2K . The pipe wall thickness is 15mm and the C with°thermal conductivity is 35W/mK . The outside is exposed to a chemical at 130 a convection coefficient of 15W/m2K . If the pipe wall is covered with two insulation layers, the first 3cm thickness with k=0.12W/mK and the second 4cm thickness with k= 0.35W/m K. Determine the rate of heat transfer. **[7M]**

UNIT-III

5. a) Using Buckingham π dimensional analysis, derive an expression for heat transfer coefficient for a free convection. The variables involved are h (heat transfer coefficient), ρ (fluid density), D (tube diameter), μ (fluid viscosity), c_p (specific heat), k (thermal conductivity), βg Δt (β - coefficient of volume expansion of the fluid, Δt - difference of temperatures between the heated surface and the undisturbed fluid). **[7M]**

b) Estimate the heat loss from a vertical wall exposed to nitrogen at one atmospheric pressure and 4 ^{0}C. The wall is 0.2 m high and 2.5 m wide, and is maintained at 56 ^{0}C. The average Nusselt number NuH over the height of the plate for natural convection is given by NuH = 0.13(Gr. Pr) 1/3. The properties for nitrogen at a mean film temperature of (56 + 4)/2 = 30^{0}C are given as ρ= 1.142 kg/m^3, k = 0.026 W/m K, v = 15.63 × 10-6 m^2 /s, Pr = 0.713. **[7M]**

6. a) Explain the natural convection heat transfer on a Vertical hot plate with the help of velocity and temperature profiles. **[7M]**

b) An exterior wall of a house may be approximated by a 10cm layer of common C) followed by a 3.75cm layer of gypsum plaster°brick(k=0.7W/m C).What thickness of loosely packed rock-wool insulation°(k=0.48W/m C) should be added to reduce the heat loss through the wall by°(k=0.065W/m 80%?. **[7M]**

UNIT-IV

7. a) Explain with neat sketch, the various regimes in boiling and explain the condition for the growth of bubbles. What is the effect of bubble size on boiling? **[7M]**

b) Two parallel plates 0.5 by 1.0 m are spaced 0.5 m apart. One plate is maintained at 1000 ^{0}C and the other at 500 ^{0}C. The emissivities of the plates are 0.2 and 0.5, respectively. The plates are located in a very large room, the walls of which are maintained at 27 ^{0}C. The plates exchange heat with each other and with the room, but only the plate surfaces facing each other are to be considered in the analysis. Find the net transfer to each plate and to the room. **[7M]**

8 a) How does film-wise condensation differ from drop-wise condensation? Which type has a higher film coefficient and point out the reason thereof. **[7M]**

b) A glass plate 30 cm square is used to view radiation from a furnace. The transmissivity of the glass is 0.5 from 0.2 to 3.5 μm. The emissivity may be assumed to be 0.3 up to 3.5 μm and 0.9 above that. The transmissivity of the glass is zero, except in the range from 0.2 to 3.5 μm. Assuming that the furnace is a blackbody at 2000 ^{0}C, calculate the energy absorbed in the glass and the energy transmitted. **[7M]**

UNIT-V

9. a) Derive an expression for LMTD in case of a counter flow double pipe heat exchanger **[7M]**

   b) 3000 kg/hr of furnace oil is to be heated from 10^0C in a shell and tube type heat exchanger. The oil is to flow inside the tubes while steam at 120^0C is flowing through the shell. If the tube size is 1.9cm outer diameter and 1.65cm Inner diameter determine the number of passes, number of tubes per pass and the length of each tube **[7M]**

10. a) What is heat exchanger? Classify the heat exchanger types with example. **[7M]**

    b) A flow of 0.1kg/s of exhaust gases at 70^0K from a gas turbine is used to preheat the incoming air, which is at the ambient temperature of 30^0K. It is desired to cool the exhaust to 40^0K and it is estimated that an overall heat coefficient of $30W/m^2K$ can be achieved in an appropriate exchanger. Determine the area required for a counter flow heat exchanger. Take the specific heat of exhaust gasses the same as for air, Which is1000J/kg.K. **[7M]**

COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basic modes of heat transfer like conduction, convection and radiation with and without phase change in solid liquids and gases.
II	Design and analyze thermal fluidic components in engineering systems to energy mechanisms (in the form of heat transfer) for steady and unsteady state.
III	Conduct experiments in laboratories and analyze the results with theoretical ones to evolve research oriented projects in the field of heat transfer as well as propulsion.
IV	Apply the concepts of heat transfer with convective mode in internal and external flows involved in engineering components and work in real time problems in Industry.

COURSE OUTCOMES (COs):

CO 1	Describe the basic concept of the mechanism of heat transfer and understand the law of energy exchange in heat transfer mechanisms
CO 2	Derive and formulate the mathematical models for steady state heat transfer phenomenon and comprehend the applicability to different surfaces and geometries
CO 3	Understand the concept heat convection and its forms like free and forced convection.
CO 4	Explore the concept of Boundary layer and derivation of empirical relations; also understand the concept of condensation and boiling.
CO 5	Understand the concept of Radiation heat transfer. Introduction to the methods of solving real time problems

COURSE LEARNING OUTCOMES (CLOs):

AAE016.01	Understand basic concepts of heat transfer modes, Fourier Law and First law of thermodynamics.
AAE016.02	Remember the basic laws of energy involved in the heat transfer mechanisms.
AAE016.03	Understand the physical system to convert into mathematical model depending upon the mode of Heat Transfer.
AAE016.04	Understand the thermal response of engineering systems for application of Heat Transfer mechanism in both steady and unsteady state problems.
AAE016.05	Understand heat transfer process and systems by applying conservation of mass and energy into a system.
AAE016.06	Understand the steady state condition and mathematically correlate different forms of heat transfer
AAE016.07	Analyse finned surfaces, and assess how fins can enhance heat transfer
AAE016.08	Remember dimensionless numbers which are used for forced and free convection phenomena.
AAE016.09	Understand the applications of Buckingham Pi Theorem in deriving various non dimensional numbers and their applications in heat transfer
AAE016.10	Remember and use the methodology presented in tutorial to solve a convective heat transfer problems
AAE016.11	Understand the various forms of free and forced convection and the application of the sAAE in day to day problems

AAE016.12	Calculate local and global convective heat fluxes using Nusselt's Theory.
AAE013.13	Understand the method to evolve hydrodynamic and thermal boundary layers applied mathematically to vertical plates and Tubes
AAE016.14	Understand the physical mechanisms of phase change involving pool, nucleate and film boiling processes
AAE016.15	Understand Nusselt's theory of condensation for the application in film and dropwise condensation
AAE016.16	Correlate the empirical relations in terms of vertical and horizontal cylinders during film condensation
AAE016.17	Understand the concepts of black and gray body radiation heat transfer.
AAE016.18	Understand the concept of shape factor and evolve a mechanism for conducive radiation shields
AAE016.19	Understand the various classifications of heat exchangers based on arrangement and correlate the effects of fouling
AAE016.20	Understand the LMTD and NTU methods and apply the sAAE for solving real time problems in heat exchangers

Mapping of Semester End Examinations to Course Learning Outcomes:

SEE Question Number		Course Learning Outcomes		CO	Blooms Taxonomy Level
1	a	AAE016.04	Understand the thermal response of engineering systems for application of Heat Transfer mechanism in both steady and unsteady state problems.	CO 1	Understand
	b	AAE016.05	Understand heat transfer process and systems by applying conservation of mass and energy into a system.	CO 1	Understand
2	a	AAE016.01	Understand basic concepts of heat transfer modes, Fourier Law and First law of thermodynamics.	CO 1	Understand
	b	AAE016.03	Understand the physical system to convert into mathematical model depending upon the mode of Heat Transfer.	CO 1	Understand
3	a	AAE016.06	Understand the steady state condition and mathematically correlate different forms of heat transfer	CO 2	Remember
	b	AAE016.06	Understand the steady state condition and mathematically correlate different forms of heat transfer	CO 2	Remember
4	a	AAE016.07	Analyse finned surfaces, and assess how fins can enhance heat transfer	CO 2	Remember
	b	AAE016.05	Understand heat transfer process and systems by applying conservation of mass and energy into a system.	CO 2	Understand
5	a	AAE016.08	Remember dimensionless numbers which are used for forced and free convection phenomena.	CO 3	Remember
	b	AAE016.12	Calculate local and global convective heat fluxes using Nusselt's Theory.	CO 3	Remember

6	a	AAE016.11	Understand the various forms of free and forced convection and the application of the same in day to day problems	CO 3	Understand
	b	AAE016.10	Remember and use the methodology presented in tutorial to solve a convective heat transfer problems	CO 3	Remember
7	a	AAE016.14	Understand the physical mechanisms of phase change involving pool, nucleate and film boiling processes	CO 4	Understand
	b	AAE016.15	Understand Nusselt's theory of condensation for the application in film and drop wise condensation	CO 4	Understand
8	a	AAE016.16	Correlate the empirical relations in terms of vertical and horizontal cylinders during film condensation	CO 4	Remember
	b	AAE016.17	Understand the concepts of black and gray body radiation heat transfer.	CO 4	Understand
9	a	AAE016.19	Understand the various classifications of heat exchangers based on arrangement and correlate the effects of fouling	CO 5	Understand
	b	AAE016.19	Understand the various classifications of heat exchangers based on arrangement and correlate the effects of fouling	CO 5	Understand
10	a	AAE016.20	Understand the LMTD and NTU methods and apply the same for solving real time problems in heat exchangers	CO 5	Remember
	b	AAE016.20	Understand the LMTD and NTU methods and apply the same for solving real time problems in heat exchangers	CO 5	Remember

Prepared by:
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