Code No: RT32035 **R13** SET - 1

III B. Tech II Semester Regular/Supplementary Examinations, April - 2017

HEAT TRANSFER

(Mechanical Engineering)

Time: 3 hours Maximum Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1	a)	Explain briefly the terms thermal capacity and thermal diffusivity of a material.	[4M]
	b)	What are the assumptions for lumped capacity analysis?	[4M]
	c)	Explain the term dimensional homogeneity?	[3M]
	d)	Define momentum thickness and energy thickness.	[4M]
	e)	Explain briefly the condensation mechanism.	[4M]
	f)	What is 'Intensity of radiation'?	[3M]

PART -B

2	a)	State and explain Fourier's law of conduction and also write its assumptions and features.	[6M]
	b)	Derive the general heat conduction equation for spherical coordinate system and simplify to one-dimensional steady state with heat generation and constant thermal conductivity in radial direction.	[10M]
3	a)	What is meant by transient heat conduction? Explain the significance of Heisler's charts in solving transient conduction problems.	[8M]
	b)	The initial uniform temperature of a large mass of material (α = 0.42m2/hour) is120^{0}C. The surface is suddenly exposed to and held permanently at 6^{0}C. Calculate the time required for the temperature gradient at the surface to reach 400^{0}C/m.	[8M]
4	a)	What are the advantages and limitations of 'Dimensional Analysis'?	[8M]
	b)	Discuss the physical significance of dimensionless numbers Re, Nu, Pr, st, Gr	[8M]
5	a)	Derive an energy equation for thermal boundary layer over a flat plate.	[8M]
	b)	Atmosphere air at 300^{0}C flows over a flat plate of (3x1) m^2 maintained at 700^{0}C with a velocity of 10m/s. Calculate the distance from the leading edge at which transition occurs. Find the thickness of the hydrodynamic boundary layer and thermal boundary layer at 0.5m from the edge.	[8M]
6	a)	Write about classification of heat exchangers.	[6M]
	b)	A heat exchanger is required to cool 55,000 kg/hr of alcohol from 66^0 C to 40^{0}C using 40,000 kg/hr of water entering at 5^0 C. Calculate the surface area required for i) Parallel flow mode ii) Counter flow mode. Take U (over all heat transfer coefficient) = 580 W/m^{2}k, Cp for alcohol = 3760J/kg.K, Cp for water = 4180 J/kg.K.	[10M]
7	a)	Explain the terms absorptivity, reflectivity and transmittivity.	[6M]
	b)	Two large parallel plates of emissivities 0.9 and 0.6 are at temperatures 427^0 C and 27^0 C respectively. A radiation shield of aluminium sheet of emissivity 0.4 is placed between two plates. Determine the shield temperature and the heat transfer rate per unit area. With the presence of the shield.	[10M]

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Code No: RT32035 **R13** SET - 2

III B. Tech II Semester Regular/Supplementary Examinations, April - 2017

HEAT TRANSFER

(Mechanical Engineering)

Time: 3 hours Maximum Marks: 70

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2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1	a)	What is the difference between thermodynamics and heat transfer?	[3M]
	b)	Explain the significance of Heisler charts.	[4M]
	c)	What are the uses of dimensional analysis?	[4M]
	d)	What is turbulent intensity?	[3M]
	e)	Define 'Heat exchanger effectiveness'.	[4M]
	f)	What is a 'black body'? How does it differ from a gray body?	[4M]

PART –B

2	a)	Define thermal conductivity and explain the various factors on which it depends.	[6M]
	b)	A 250 mm outer diameter steam pipe maintained at temperature 150^0 C is exposed to an ambient at 25^0 C with a convection heat transfer coefficient of 50 W/m^{2}K. Calculate the thickness of the asbestos insulation (of thermal conductivity 0.1 W/m K) required to reduce the heat loss from the pipe by 50%.	[10M]
3	a)	What are Fourier and Biot numbers? Explain their physical significance.	[4M]
	b)	Write short notes on efficiency and effectiveness of the fin.	[4M]
	c)	In a quenching process, a copper plate of 3 mm thick is heated up to 350^0C and then suddenly it is dipped a water bath and cooled to 25^0C. Calculate the time required for the plate to reach the temperature of 500^0C. The heat transfer coefficient on the surface of the plate is 28 W/m^2 K. The plate dimensions may be taken as length 40 cm and width 30 cm. Take properties of copper as c = 380 J/kg K, ρ = 8800 kg/m^3 k = 385W/m °K.	[8M]
4	a)	Describe the Rayleigh's method for dimensional analysis.	[8M]
	b)	Show by dimensional analysis for free convection, Nu= f(Pr,Gr).	[8M]
5	a)	Explain boundary layer thickness and momentum thickness.	[6M]
	b)	A plate of length 500 mm and width 250 mm has been placed longitudinally in a stream of crude oil which flows with a velocity of 6m/sec. If the oil has specific gravity of 0.9 and kinematic viscosity 1 stoke, calculate. i) Boundary layer thickness at the middle of plate. ii) Shear stress at the middle of plate. iii) Friction drag on one side of the plate.	[10M]
6	a)	Under what conditions is the effectiveness NTU method preferred over LMTD method in the analysis of a heat exchanger?	[8M]
	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.	[8M]
7	a)	State Planck's law. Define Lambert's law of radiation.	[6M]
	b)	Explain the meaning of the term geometric factor in relation to heat exchange by radiation. Derive an expression for the geometric factor F_{1-1} for the inside surface of a black hemispherical cavity of radius R with respect to itself.	[10M]

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Code No: RT32035 **R13** SET - 3

III B. Tech II Semester Regular/Supplementary Examinations, April - 2017

HEAT TRANSFER

(Mechanical Engineering)

Time: 3 hours Maximum Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1	a)	Name and explain briefly the various modes of heat transfer?	[4M]
	b)	What is the physical significance of Fourier and Biot numbers?	[4M]
	c)	Write the advantages of dimensional analysis?	[3M]
	d)	Explain Reynolds analogy.	[4M]
	e)	What is burnout point?	[3M]
	f)	Define Lambert's law of radiation.	[4M]

PART -B

2	a)	Derive an equation to find critical thickness of insulation for sphere.	[8M]
	b)	A steam pipe having 20mm outer diameter is to be covered with two layers of insulation each having a thickness of 10mm. The average thermal conductivity of one material is five times that of the other. Assuming that the inner and outer surface temperatures of the composite insulation are fixed, show that the heat transfer will be reduced by 29.9 percent when a better insulating material is next to the pipe than when it is away from the pipe.	[8M]
3	a)	What is mean by transient heat conduction?	[4M]
	b)	An average convective heat transfer coefficient for flow of 100^0 C air over flat plate is measured by observing the temperature-time history of a 30 mm thick copper slab (Density=9000 kg/m^3, C_p=0.38 kJ/kg k, K= 370 W/mK) exposed to 100^0 C air. In one test run, the initial temperature of the plate was 210^0 C and in 5 minutes, the temperature decreased by 40^0 C. Find the heat transfer coefficient for this case. Neglect internal thermal resistance.	[12M]
4	a)	Show by dimensional analysis for forced convection Nu = f (Re, Pr).	[8M]
	b)	Describe Buckingham's method to formulate a dimensionally homogeneous equation between the various physical quantities affecting a certain phenomenon.	[8M]
5	a)	Explain displacement thickness and energy thickness.	[6M]
	b)	Determine the heat transfer rate by free convection from a 0.3m x 0.3m plate whose one surface is insulated and other surface is maintained at 1000 C and exposed to atmosphere at 300^0 C when i) The plate is vertical. ii) The plate is horizontal with the heated surface facing down.	[10M]
6	a)	State some method to promote drop wise condensation.	[8M]
	b)	Saturated steam at 1 atm is exposed to a vertical plate 1m high and 0.5m wide having a uniform surface temperature of 80^0 C. Estimate the heat transfer rate to the plate and the steam condensation.	[8M]
7	a)	State and explain the 'Total radiation: Stefan-Boltzmann law', relating to thermal radiation and temperature of a radiating body.	[8M]
	b)	A square room 4m by 4 m has the floor heated to 320K, the ceiling to 300K and the walls are assumed to be perfectly insulated. The height of the room is 3 m. The emissivity of all surfaces is 0.8. Using the network method, find the net interchange between the floor and the ceiling and the wall temperature.	[8M]

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Code No: RT32035 **R13** SET - 4

III B. Tech II Semester Regular/Supplementary Examinations, April - 2017

HEAT TRANSFER

(Mechanical Engineering)

Time: 3 hours Maximum Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**

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PART –A

1	a)	What is the significance of heat transfer?	[4M]
	b)	What is meant by transient heat conduction?	[3M]
	c)	Write the limitations of dimensional analysis?	[4M]
	d)	Explain wall shear stress in laminar flow over a flat plate.	[4M]
	e)	Define the terms boiling and fouling.	[3M]
	f)	State and explain Wien's displacement law.	[4M]

PART -B

2	a)	Explain clearly the mechanism of conduction, convection and radiation. Write formulae to calculate the thermal resistance of conduction, convection and radiation.	[8M]
	b)	A composite wall consists of an iron plate of thickness 4cm and thermal conductivity 62 W/mK, and asbestos layer of thickness 3.5cm with thermal conductivity of 0.07 W/mK. Determine the rate of heat transfer and the interface temperature if the left side of the composite wall is at 430^0 C and the right side is at 30^0 C.	[8M]
3	a)	Derive expression for temperature distribution and heat dissipation in a straight fin of rectangular profile for infinitely long fin.	[8M]
	b)	One end of a very long metal rod is connected to a wall at 150 ^{0}C while the other end protrudes into a room whose air temperature is 20 ^{0}C. The rod is 3mm in diameter and the heat transfer coefficient is 280 W/m^{2}K.Estimate the total heat dissipated by the rod taking its thermal conductivity as 200W/mK.	[8M]
4	a)	What is dimensional analysis? What are the uses of dimensional analysis?	[6M]
	b)	Explain the circumstances under which natural convection occurs. Use the principle of dimensional analysis to establish a relation between Nusselt number, Grashoff number and Prandtl number.	[10M]
5	a)	Derive momentum equation for hydrodynamic layer over a flat plate.	[8M]
	b)	A horizontal steam pipe of 0.1m diameter is placed horizontally in a room at 20^0 C. the outside surface temperature is 80^0 C and the emissivity of the pipe material is 0.93.Estimate the total heat loss from the pipe per meter length due to free convection and radiation.	[8M]
6	a)	Explain briefly the various regimes of saturated pool boiling.	[8M]
	b)	A wire of 1mm diameter and 150 mm length is submerged horizontally in water at 7 bar. The wire carries a current of 131 A with an applied voltage of 2.15V. If the surface of the wire is maintained at 180^0 C, Calculate i) The heat flux ii) The boiling heat transfer coefficient	[8M]
7	a)	State Stefan-Boltzmann law. State and prove Kirchoff's law of radiation.	[8M]
	b)	The effective temperature of a body having an area of 1.02 m^2 is 527^0C. Calculate the total rate of energy emission, the intensity of normal radiation and the wavelength of maximum monochromatic emissive power.	[8M]

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