

B.TECH SEM - IV (2007 COURSE) (CHEMICAL ENGG.) :

SUMMER - 2018

SUBJECT: HEAT TRANSFER - I

Day : **Saturday**
Date : **09/06/2018**

S-2018-2603

Time : **10.00 AM TO 01.00 PM**
Max. Marks: 80

N. B. :

- 1) **Q. No. 1 and Q. No. 5 are COMPULSORY.** Out of the remaining questions, attempt **ANY TWO** questions from each section.
- 2) Figures to the right indicate **FULL** marks.
- 3) Both the sections should be written in the **SEPARATE** answer books.
- 4) Use of non programmable **CALCULATOR** is allowed.
- 5) Assume Suitable data, if necessary.

SECTION I

- Q.1** a) Write a short note on importance of dimensional analysis in experimental design and data reduction. **(05)**
- b) Derive the equation for critical radius of insulation for cylinder. **(05)**
- c) What is Newton's law of cooling? **(04)**
- Q.2** a) Explain in detail following dimensionless numbers with significance used in heat transfer. **(08)**
- i) Nusselt Number
 - ii) Biot Number
 - iii) Peclet Number
 - iv) Prandtl Number
- b) What is the difference between conduction and convection? **(05)**
- Q.3** A furnace wall consists of 200 mm of refractory fireclay brick, 100 mm of Kaolin brick and 6 mm of steel Plate. The fire side of the refractory is at 1150°C and the outside of steel is at 30°C. An accurate heat balance over the furnace shows the heat loss from the wall to be 300 W/m². It is known that there may be thin layers of air between the layers of brick and steel. To how many millimeters of Kaolin are these air layers equivalents? **(13)**

Material	Thermal Conductivity Btu/hr.ft ² (°F/ft)
Kaolin Brick	0.05
Fireclay Brick	0.58
Steel Plate	49

- Q.4** Write a short note on: **(13)**
- i) The Colburn analogy
 - ii) Thermal boundary layer
 - iii) Reynolds analogy
 - iv) Fouling factor

SECTION II

- Q.5** a) Explain Stefan-Boltzman's law. **(05)**
- b) What are characteristics of an efficient furnace? **(05)**
- c) Write a short note on heat transfer in a agitated vessels. **(04)**

P.T.O.

- Q.6** Explain following laws related to radiation in detail. (13)
- Kirchoff's law
 - Wein's displacement law
 - Plank's law
 - Laws of shape factor

- Q.7** Write down the stepwise procedure of following methods related to furnace. (13)
- Wohlenberg simplified method
 - Orrock-Hudson method
 - Lobo and Evans method

- Q.8** A heat exchanger consists of 56 tubes of external diameter 16.4 mm and length 0.5 m, mounted in a rectangular duct of height of 0.2504 m and width 0.5m. The tubes are mounted in a staggered array with 60° triangular pitch, with seven successive rows each consisting of eight tubes with a pitch of 3.13 mm. Corbels are attached to the walls to reduce bypass flow. The tubes contain hot water that maintain their surface temperature at 70°C and air flows across them at a rate of 0.914 kg/s. If the air enters the duct at 15°C , what is its exit temperature?

Fluid Properties:

Density	1217 kg/m ³
Viscosity	1.8×10^{-5} N.s/m ²
Specific heat	1007 J/kg.K
Conductivity	253 W/m.K
Number of tubes	8.5
a	0.273
F ₁	1
F ₂	0.97
K _a	1
K _f	0.35

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