Total No. of printed pages = 5

FPT-302/EFE-I/3rd Sem/B/2013/M

ELEMENTS OF FOOD ENGINEERING – I

Full Marks – 70

Pass Marks – 28

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer question No.1 and any *five* from the rest.

1. (a) Fill in the blanks : 1×4=4

(i) The real or imaginary surface that separates the system from its surroundings is called the ———.

(ii) 375 K (Kelvin) is equal to ——— °C.

(iii) The radiation emitted by black body is called ———.

(iv) The S.I unit of heat flux is ———.

[Turn over

(b) Distinguish any *two* of the following : 3×2=6

(i) Mechanical equilibrium and chemical equilibrium

(ii) Source and sink of a thermal reservoir

(iii) Isothermal and isobaric processes.

2. (a) What do you mean by a pure substance ? Define saturated liquid and saturated temperature. 6

(b) State first law of thermodynamics. 2

(c) Heat is transferred to a heat engine from a furnace at a rate of 150 MW. If the rate of waste heat rejection to a nearby river is 80 MW, determine the net power output and the thermal efficiency for this heat engine. 4

3. (a) What do you mean by heat flux ? 2

(b) A stainless steel plate 5 cm thick is maintained at a temperature of 600°C at one face and 100°C on the other. If the thermal conductivity of stainless steel is 20 W/m.k, calculate heat flux through the material. 5

(c) Determine the thermal resistance of the composite wall as shown in figure-1, if the thermal conductivities of walls A, B, C and D are 50, 11, 7 and 30 W/m.k respectively. Given data :

The area of the slabs A, B, C and D are $1m^2$, $0{\cdot}5m^2$, $0{\cdot}5m^2$ and $1m^2$ respectively.

The thickness of slabs A, B, C and D are 5 cm, 10 cm and 5 cm respectively. 5

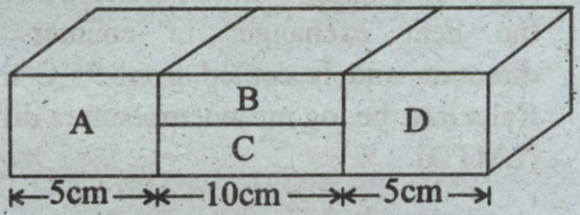

Figure 1

4. (a) What is the driving force of heat transfer ? How will you define convection heat transfer ? 1+2=3

(b) A fluid of temperature $15^{\circ}C$ is flowing over a flat surface maintained at $152^{\circ}C$. If the cross-sectional area of the flat surface is $0{\cdot}020m^2$ and the rate of heat transfer from the flat surface to the fluid is 800 W, calculate the convective heat transfer coefficient. 5

(c) What are the force and natural convections ? 4

5. (a) What is a heat exchanger ? Mention any three types of heat exchanger. 2+3=5

(b) Draw the temperature profiles (T–x) diagrams of parallel and counter flow heat exchanger. 2

(c) A dilute pineapple juice is heated in a double pipe heat exchanger from 28°C to 75°C by heat exchanging with hot water which enters the heat exchanger in counter current direction and is cooled from 95°C to 85°C. Calculate the log mean temperature difference (LMTD). 5

6. (a) What are the main components of a shell-and-tube heat exchanger ? Draw a shell-and-tube heat exchanger. 3+2=5

(b) Define effectiveness of a heat exchanger. 2

(c) Hot water at 70°C is flowing over the upper surface of 3m long flat plate whose surface temperature is 25°C. If the Nusselt number is 521 and coefficient of thermal conductivity, K is 0·685 W/m°C, calculate the convective heat transfer coefficient and also heat flux. 5

7. (a) State Clausius's statement of second law of thermodynamics. 2

(b) Define a refrigeration cycle and refrigerant. What are the main objectives of refrigerator and heat pump ? 4+2=6

(c) The food compartment of a refrigerator is maintained at 3°C by removing heat from it at a rate of 7 KW. If the required power input to the refrigerator is 2 KW, determine

(i) The coefficient of performance of the refrigerator.

(ii) The rate of heat rejection to the room that houses the refrigerator. 4

8. (a) Explain the following food freezing methods with diagram :

(i) Freezing by indirect contact of refrigerant

(ii) Food freezing by air blust. 4+4=8

(b) Write short notes on fire-tube-boiler. 4