Total number of printed pages: 03

Diploma/3rd Semester/DFET302

2023

SUBJECT NAME: ELEMENTS OF FOOD ENGINEERING-I

Full Marks: 100

Time: Three hours

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

*Answer **any five** questions.*

1.	a)	Give one example each of thermodynamic state and path functions with their symbols. Give one example each of extensive and intensive variables with their symbols.	2+2
	b)	Define open system and closed system with diagram.	4
	c)	Define specific heat and mention it's unit in SI system. Give only the mathematical expression of the interrelationship between C_p and C_v.	3+1
	d)	Define adiabatic, isothermal, isobaric and isochoric processes with mathematical expression.	4
	e)	Explain Zeroth law of thermodynamics with mathematical expression.	4
2.	a)	State and express mathematically the 1st law of thermodynamics. How can you derive work done from it?	4
	b)	Calculate the work done on or by a system that absorbs 240KJ of heat experiences a change in internal energy of 140KJ. Does the system undergo expansion or contraction? Justify your answer.	4
	c)	3000J of heat is added to a system while 2000J of work is done on the system. Calculate the change in internal energy.	3
	d)	State the Second Law of Thermodynamics. Give only the diagram of Carnot Cycle. Is it irreversible cycle?	2+2+1
3.	a)	Give only the mathematical expression of enthalpy and entropy.	2+2
	b)	Define tons of refrigeration. Give the example of most effective and ecofreindly refrigerant with chemical formula.	2+2
	c)	Explain with mathematical expression the efficiency of heat engine. Explain with mathematical expression the coefficient of performance (COP) of the refrigerator.	3+3
	d)	An engine operates between 727°C and 127°C. The engine's heat input is	6

6000 Joule. What is the efficiency of the engine and work done by the engine in each cycle?

4. a) State and explain Fourier's Law of heat transfer. Define heat flux. 3+1

b) The walls of a drying chamber are built up by a layer of brick (thermal conductivity is 0.7w/mk) of thickness 250mm and a layer of felt (thermal conductivity is 0.046w/mk) of thickness 20mm. The temperature of the outside surface of the red brick layer is 110^0C and that of the felt layer is 25^0C. Calculate the heat loss per m^2 area of the wall. 6

c) Give the mathematical expression of thermal resistance and thermal conductance with significance of each symbol. 4

d) A pipeline, 150/160mm diameter, carries steam. The temperature of the inside surface is 120^0C and that of the outside surface is 119.8^0C.The thermal conductivity of the tube material is 50w/mk. Find the rate of heat loss from a length of 1m of the pipe line. 6

5. a) Determine the rate of heat loss Q through a wall of red brick (K=0.70w/mk) 6m in length,5m in height and 0.3m in thickness, if the wall of surface is maintained at 120^0C and 40^0C respectively. 6

b) State and explain Stefan-Boltzmann's law of radiation. What is a emissivity of a body? 4+2

c) Define absorptivity, reflectivity and transmittivity with suitable diagram. How they are interrelated? 3+1

d) Express mathematically LMTD with the significance of each term. 4

6. a) What is Nusselt No? How it is related to film thickness? 2+2

b) Give the mathematical expression of individual and overall heat transfer coefficient related to convective heat transfer. 2+2

c) Graphically represent and explain the Parallel flow and counter-current flow heat exchanger with (T-X) diagrams. 3+3=6

d) A fluid of temperature 15^0C is flowing over a flat surface maintained at 152^0C. If the cross-sectional area of the flat surface is $0.20m^2$ and the rate of heat transfer from the flat surface to the fluid is 800W, Calculate the convective heat transfer coefficient. 6

7. a) Differentiate between refrigeration and freezing. Explain the functions of different components of vapour compression refrigeration cycle (VCRC) with a schematic diagram. Give an example of ideal refrigerant. 2+4+1

b) Explain plate freezing system with diagram. What is immersion freezing? 4+2=6

c) In an air blast freezer operating at -30^0C, blocks of fish is -2.2^0C and the moisture content of fish is 82%. The thickness of the fish block is 0.0508m and the convective heat transfer coefficient (h) is 20w/m^{2}K. Calculate the freezing time in hour required to freeze the fish blocks. Assume density of unfrozen fish as 1050kg/m^3, thermal conductivity of the frozen fish (k) as 1.025w/mK, latent heat of water to ice as 335KJ/kg and shape factors for infinite slab, P=1/2 and R=1/8. 8

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