Total number of printed pages: **03** **Programme: Diploma**

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2022

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)	Differentiate between reversible process and irreversible process with examples. Define extensive variable with example.	3+1=4
	b)	Mention the transfer mechanism in open system, closed system, and isolated system with diagram.	4
	c)	Mention two thermodynamic states and path functions with their symbols.	2+2=4
	d)	Define adiabatic, isothermal, and isobaric and isochoric processes with mathematical expression.	4
	e)	Define adiabatic wall and diathermal wall. Explain Zeroth law of thermodynamics with mathematical expression.	2+2=4
2.	a)	Give the mathematical expression of work done by the system and work done on the system by considering first law of thermodynamics.	4
	b)	What is the unit of specific heat in SI system? Establish the relationship between two heat capacities.	1+3 = 4
	c)	Calculate the work done on or by a system that absorbs $240x10^3$ J of heat experiences a change in internal energy of $140x10^3$J. Does the system undergo expansion or contraction? Justify your answer.	4
	d)	3000J of heat is added to a system while 2000J of work is done on the system. Calculate the change in internal energy.	3
	e)	State the Second Law of Thermodynamics. Give only the diagram of Carnot Cycle. Is it irreversible cycle?	2+2+1=5
3.	a)	Explain enthalpy and entropy with their mathematical expressions.	2+2=4
	b)	Explain vapour compression refrigeration cycle with diagram.	4
	c)	Define tons of refrigeration. Give the example of most effective and ecofriendly refrigerant with chemical formula.	2+2=4

	d)	Define and explain the efficiency of heat engines. Define and explain the coefficient of performance (COP) of the refrigerator.	2+2=4
	e)	An engine operates between 600K and 400K. The engine's heat input is 1000 Joule. What is the efficiency of the engine? If the work done by the engine is W then what is the heat output?	4
4.	a)	State and explain Fourier's Law of heat transfer. Define heat flux.	3+1
	b)	Give the mathematical expression of mean heat transfer area of a solid whose cross sectional area of heat transfer is proportional to the radius.	4
	c)	Give the mathematical expression of thermal resistance and thermal conductance.	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.	8
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=6
	c)	Define absorptivity, reflectivity and transmittivity with suitable diagram. How they are interrelated?	3+1=4
	d)	Express mathematically LMTD.	4
6.	a)	What is Nusselt No? Is it dimensionless quantity?	2+1=3
	b)	Define convective heat transfer coefficient with mathematical equations.	3
	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.	8
7.	a)	A cold storage is to be maintained at -8^0C while the surrounding is at 30^0C. The heat leakage from surroundings into the cold storage is estimated to be 30kw. The actual COP of the refrigeration plant is one third of an ideal plant working between the same temperatures. Find the power required to drive the plant.	6
	b)	Explain one ideal indirect contact freezing system with diagram. What is cryogenic 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^2K. 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