U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

July 2023 Semester End Main Examinations

Program: B.E. **Semester: VI**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 19CH6DCPMS **Max Marks: 100**
Course: Process Modelling and Simulation **Date: 17.07.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT – I	**CO**	**PO**	**Marks**
1	a)	Enlist four applications of mathematical models.	*CO1*	*PO2*	**04**
	b)	Write the detailed classification of mathematical models.	*CO1*	*PO2*	**04**
	c)	Component A reacts irreversibly and at a specific reaction rate k to form product, component B. Write the component balance equations when the reaction (first order) takes place in i) CSTR and ii) PFR. Make necessary assumptions wherever.	*CO1*	*PO2*	**12**
		UNIT – II			
2	a)	An irreversible exothermic reaction is carried out in a single perfectly mixed non isothermal CSTR. The reaction is as follows: $A \rightarrow B$ The reaction is nth order in reactant A and has heat of reaction λ (energy units/mole of A reacted). Negligible heat losses and constant densities are assumed. To remove the heat of reaction, a cooling jacket surrounds the reactor. Cooling water is added to the jacket at a constant volumetric flow rate. Develop a mathematical model for the system assuming that the CSTR has i) perfectly mixed cooling jacket and ii) Plug flow cooling jacket. State all the assumptions made and explain the notations scheme used clearly.	*CO3*	*PO4*	**10**
	b)	Develop a model for gas- liquid bubble reactor in which mass-transfer limited reaction takes place. Make all the necessary assumptions. Give the nomenclature used in modeling the given system.	*CO3*	*PO4*	**10**
		OR			
3	a)	A first order irreversible exothermic reaction $A \rightarrow B$ occurs in a series of three perfectly mixed CSTRs. Feed enters the first reactor and product leaves the third reactor. Derive the mass balance and	*CO3*	*PO4*	**06**

			component continuity equations considering isothermal and constant holdups. Assume constant density for the system, which is a binary mixture of A and B.			
		b)	Develop a mathematical model for the batch reactor in which the first order consecutive reactions takes place to get the desired product B. $A \xrightarrow{k_1} B \xrightarrow{k_2} C$ The reaction is exothermic.	*CO3*	*PO4*	**14**
			UNIT – III			
	4	a)	Consider a section of flat wall of thickness L, whose height and length are large compared to L. If the temperature distribution is uniform throughout the wall at $t = 0$ and heat is supplied at a fixed rate per unit area to one surface, develop a mathematical model for temperature distribution as a function of position and time in the differential form.	*CO3*	*PO4*	**14**
		b)	The temperature distribution across a large concrete 50 cm thick slab heated from one side, as measured by thermocouples, approximates to the following relation: $T = 60 - 50x + 12x^2 + 20x^3 - 15x^4$ where, T is in degree Celsius and x is in metres. Considering an area of 5 m^2, compute the following: (a) the heat entering and leaving the slab in unit time, (b) the heat energy stored in unit time, (c) the rate of temperature change at both sides of the slab, and (d) the point at which the rate of heating or cooling is maximum. Take the following data: Thermal conductivity k = 1.2 W/m ºC and thermal diffusivity $\alpha = 1.77 \times 10^{-3} m^2/s$.	*CO3*	*PO4*	**06**
			UNIT – IV			
	5	a)	Liquefied petroleum gas (LPG) is fed into a pressurized tank to hold the liquid level in the tank and assume that LPG is pure propane. Heat is added at a rate Q to hold the desired pressure in the tank by vaporizing the liquid at a rate W_v. Gas is drawn off the top of the tank at a volumetric flow rate F_v. Model the vaporizer system considering F_v as the forcing function for i) Liquid dynamics model and ii) vapor dynamic model.	*CO2*	*PO3*	**15**
		b)	Discuss the various fluid packages available in Unisim Software.	*CO2*	*PO3*	**05**
			OR			
	6	a)	Write the equations describing a batch distillation column with hold up used to separate multicomponent mixture. List the assumptions and nomenclature used clearly.	*CO2*	*PO3*	**10**

		b)	Write the equations of total continuity and component continuity for i) Condenser and reflux drum ii) Feed tray iii) Reboiler and column base for an ideal binary distillation column, state the assumptions clearly.	*CO2*	*PO3*	**10**
			UNIT – V			
	7	a)	Differentiate between the simulation and modeling. Explain various simulation tools used in Chemical Engineering with their advantages and limitations.	*CO6*	*PO12*	**10**
		b)	Explain the dynamic simulation and process optimization with examples.	*CO6*	*PO12*	**10**

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