U.S.N.										

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

Autonomous Institute Affiliated to VTU

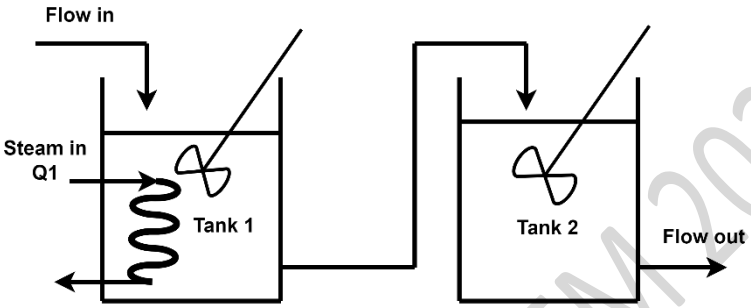
June 2025 Semester End Main Examinations

Programme: B.E. **Semester: VI**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 22CH6PCPMS **Max Marks: 100**
Course: Process Modelling and Simulation

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.

				CO	*PO*	Marks
			UNIT – I			
1	a)		Elucidate the importance of degrees of freedom analysis with a suitable example.	*CO1*	*PO2*	**05**
	b)		Explain the different fundamental laws applied in process modeling with relevant equations.	*CO1*	*PO2*	**05**
	c)		Consider the Continuous Stirred-Tank Reactor (CSTR) where component 'A' reacts irreversibly and at a specific reaction rate *k* to form product, component 'B'. The reaction is exothermal in nature hence a cooling coil is attached to the CSTR to remove the heat. Apply suitable fundamental laws to develop a mathematical equation for the process.	*CO2*	*PO3*	**10**
			OR			
2	a		Classify & enlist four applications of process models.	*CO1*	*PO2*	**10**
	b		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.	*CO2*	*PO3*	**10**
			UNIT – II			
3	a)		Formulate a relation to estimate the differential change in the liquid level of the tank with time for interacting and non-interacting tanks systems. List the assumptions made.	*CO 2*	*PO3*	**10**
	b)		Consider an enzymatic reaction occurring in a perfectly mixed stirred tank reactor. Consider the rate of cell growth (R_1) and rate of substrate consumption (R_2). Formulate a relation to estimate the differential change in substrate concentration with time.	*CO 2*	*PO3*	**10**
			OR			

	4	a)	An irreversible, exothermic reaction is carried out in a single perfectly mixed CSTR. The temperature changes with time in the CSTR system. The reaction is n^{th} order in reactant 'A' and has a heat of reaction λ (J/kg mol of A reacted). To remove the heat of reaction, a cooling jacket surrounds the reactor. Cooling water is added to the jacket and the fluid in jacket is assumed to be perfectly mixed. Formulate a mathematical model for the given case using suitable fundamental laws.	*CO 2*	*PO3*	**10**
		b)	A Newtonian fluid pass through a two perfectly mixed tanks and shown in the figure below. The volume of both the tanks are different and constant. Develop a relationship to estimate the change in temperature in both the tanks. List the assumptions made.  	*CO 2*	*PO3*	**10**
			UNIT - III			
	5	a)	Two concentric cylindrical metallic shells are separated by a solid material. If the two metal surfaces are maintained at different temperatures. Find the steady state temperature distribution within the separating material.	*CO3*	*PO4*	**08**
		b)	Derive an equation to find the effectiveness of heat transfer through an extended surface of finite length.	*CO3*	*PO4*	**12**
			OR			
	6	a)	A steam pipe with inner radius 25 mm and outer radius 50 mm is made of a material with thermal conductivity of 45 W/m·K. If the inner and outer surface temperatures are 300°C and 100°C respectively, calculate the rate of heat loss per meter length of pipe.	*CO 3*	*PO4*	**08**
		b)	A well-stirred tank contains 500 liters of a liquid initially at 25°C. Steam is passed through a jacket around the tank, maintaining the wall temperature at 95°C. Assuming the tank is perfectly insulated, and the liquid is well-mixed. Formulate the expression for the temperature of the liquid as a function of time.	*CO 3*	*PO4*	**12**
			UNIT – IV			
	7	a)	Elucidate the importance features of equation of state models with relevant equations.	*CO 3*	*PO4*	**08**
		b)	Formulate a mathematical model to predict the behavior of multicomponent flash drum. List the assumption made during the derivation.	*CO 3*	*PO4*	**12**

			OR			
	8	a)	Explain the importance of NRTL and Wilson model with relevant equations.	*CO3*	*PO4*	**08**
		b)	Develop a mathematical model to solve an ideal binary distillation column. List all the assumption made and estimate the degrees of freedom for the developed model.	*CO3*	*PO4*	**12**
			UNIT – V			
	9	a)	Explain the advantages and limitations of different simulation tools used commercially for chemical engineering applications.	*CO 6*	*PO12*	**10**
		b)	Differentiate between modular approach and equation solving approach in simulation.	*CO6*	*PO12*	**10**
			OR			
	10	a)	Describe the two approaches of simulation in detail.	*CO6*	*PO12*	**10**
		b)	Explain the dynamic simulation and process optimization with Examples.	*CO6*	*PO12*	**10**

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