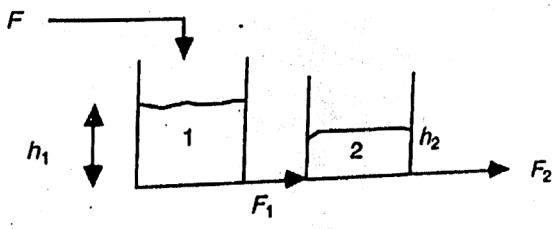
Ref. No. : Ex/PG/ChE//PC/T/121/2025

M. CHEMICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAMINATION 2025
SUBJECT: APPLIED MATHEMATICAL MODELLING IN CHEMICAL ENGINEERING
Time: Three hours Full Marks 100

No. of Questions		Marks
1.	Consider a constant volume batch reactor where a liquid phase 1st order exothermic reaction (A → B) is carried out. The temperature is controlled by manipulating the flow of cooling water in the jacket. Draw a schematic of the reactor. Write the model equations (mass balance, energy balance for jacket and reactor, species balance and controller equation). Draw an information Flow diagram	(10+5)
2.	Consider the batch distillation of Benzene, Toluene and Xylene in a vessel holding Mo kgmole and a heating rate Q Kcal/hr. At t=0 the compositions of XBo, XTo, XXo are given. Pressure is constant at Pt. Assume ideal solution, Raoult's law and Dalton's law hold. Write the model equations. Draw the Information Flow Diagram (IFD) and write the algorithm for simulating the moles, composition and temperature of the liquid in the vessel.	(7+8)
3	 Fig 1 Consider two interacting tanks in series. Derive the dynamic equation for the system in state space form.	(12)
	For the given values of the parameter (flow coefficients $\beta1=0.1$ $ft^{2.5}$/min and $\beta2=(0.12/\sqrt{6})$ $ft^{2.5}$/min and flow areas $A1=0.5m^2$, $A2=1m^2$ and input variables (F=0.15 m3/min) find out the steady state values of h1s and h2s. Check the stability of the steady state. What kind of phase plot do you expect?	(4+4)
4.	Consider an isothermal tubular reactor with axial mixing (TRAM) with irreversible 1st order chemical reaction ($r_A=-kC_A$). (i) Write the steady state species balance equation. Use Dankwert's boundary condition at the inlet. Non-dimensionalize the model equation and boundary conditions.	(10)
	(ii) Discuss about shooting method. Draw an IFD for solving the above problem using shooting method.	(5)

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Ref. No. : Ex/PG/ChE/PC/T/121/2025

M. CHEMICAL ENGINEERING FIRST YEAR SECOND SEMESTER EXAMINATION 2024
SUBJECT: MODELLING AND SIMULATION OF CHEMICAL PROCESSES

Time: Three hours Full Marks 100

No. of Questions		Marks
4.	Consider a batch polymerization reactor where the monomer is polymerized by free radical (chain growth) mechanism. Write the kinetic expression of initiation, propagation and termination through combination and disproportioanation. Write the model equations. Define the zeroth and first moment of polymer radical and dead polymer. Derive an expression for rate of monomer conversion considering QSSA for transient species. Use the common notations.	(15)
5. (a)	Consider a non-isothermal CSTR with jacket cooling where reactant A is converted to product by a first order reaction (A $\longrightarrow$ B). Assume constant volume system and constant density system. Write the dynamic model equations. Derive a single steady state energy balance equation G(Ts, μ) = 0 (by Qgen-Qr=0) where Ts is the state variable and μ is the vector of physical parameters that can be varied. Discuss about multiple steady state behavior and cusp catastrophe.	(6) (4)
(b)	Write the necessary condition of bifurcation. What do you mean by a stable limit cycle and Hopf bifurcation?	(2+8)