Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER II (New) EXAMINATION – SUMMER - 2016

Subject Code: 2723011 **Date: 27/05/2016**

Subject Name: Process Modelling & Simulation

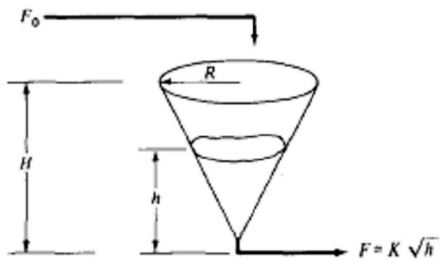
Time: 10:30 AM To 01:00 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Write the component continuity equations for a perfectly mixed batch reactor (no inflow or outflow) with first-order isothermal reactions: **07**
(i) Consecutive, (ii) Simultaneous, (iii) Reversible

(b) A fluid of constant density ρ is pumped into a cone-shaped tank of total volume H´ R^2/3. The flow out of the bottom of the tank is proportional to the square root of the height h of liquid in the tank. Derive the equations describing the system. **07**



Q.2 **(a)** Differentiate between deterministic and stochastic processes. **07**

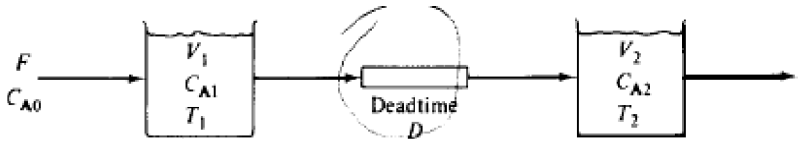
(b) Describe the black-box model based modeling approach. **07**

OR

(b) Explain the classification of chemical process models. **07**

Q.3 **(a)** Consider the system that has two stirred chemical reactors separated by a plug-flow dead time of D seconds. Assume constant holdups (V_1 and V_2), constant throughput (F), constant density, isothermal operation at temperatures T_1 and T_2, and first order kinetics with simultaneous reactions: **07**

AŸ B rate constant k1
AŸ C rate constant k2



No reaction occurs in the plug-flow section. Write the equations describing the system.

	(b)	Benzene is nitrated in an isothermal CSTR in three sequential irreversible reactions: Benzene + HNO_3 → Nitrobenzene + H_2O rate constant k1 Nitrobenzene + HNO_3 → Dinitrobenzene + H_2O rate constant k2 Dinitrobenzene + HNO_3 →Trinitrobenzene + H_2O rate constant k3 Assuming each reaction is linearly dependent on the concentrations of each reactant, derive a dynamic mathematical model of the system. There are two feed streams, one pure benzene and one concentrated nitric acid (98 wt%). Assume constant densities and complete miscibility.	**07**
		OR	
Q.3	**(a)**	Write material and energy balance equation for non-isothermal CSTR with perfectly mixed cooling jacket.	**07**
	(b)	Explain equation of continuity with example.	**07**
Q.4	**(a)**	Write the modeling equations for Ideal Binary Distillation Column with neat sketch.	**07**
	(b)	Enlist total (2NC+7) modelling equations for steady state model of multi-component flash drum. Where NC=Number of component.	**07**
		OR	
Q.4	**(a)**	Write a short note on degree of freedom analysis of ideal binary distillation column.	**07**
	(b)	Sketch single component vaporizer, and write the modelling equations for liquid phase dynamic model.	**07**
Q.5	**(a)**	Enlist at least three chemical process flowsheet simulators. Explain features, capability, limitations of any one chemical process flowsheet simulators.	**07**
	(b)	Write a short note on usefulness and limitation of process simulation	**07**
		OR	
Q.5	**(a)**	Explain solution strategies using tearing of stream with plug flow recycle reactor model.	**07**
	(b)	Differentiate between modular approaches & equation solving approaches for flowsheet solutions.	**07**

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