Ahmedabad University

Mid Semester Examination, Winter Term 2026

Subject: CHE 404 Catalytic and Biochemical Reaction Engineering

Attempt any four questions. All questions carry equal marks. Use of scientific calculators is permitted.

Date: 24th February 2026 **Timing: 11:00 AM to 01:00 PM** **Full Marks 20**

Qu 1a Catalytic reaction A → C is carried out where surface reaction is rate controlling step. Develop rate equation using the Hougen Watson model. Can the rate under some conditions show a zero-order dependence with respect to A? Explain.

Qu 1b A simple tube contains 10 g of a porous NH_3 synthesis catalyst. Hg is admitted at 1 atm, and the volume required to bathe the bed of catalyst is 4 mL, the unpacked volume being 10 mL. The Hg is removed and He gas is admitted to the evacuated bed. The volume of He admitted at NTP is 8.2 mL. Compute the void fraction of the bed, the pore volume per g of the catalyst, the catalyst pellet density and the true density of the iron crystalline structure of the catalyst.

Qu 2a Drive a criterion to ascertain negligible pore diffusion resistance inside a catalyst pellet,

Qu 2b Given the following data for physical adsorption of N_2 on an alumina catalyst at 77K, compute the BET surface area.

p/p_o	0	0.01	0.08	0.15	0.3	0.45
V, mL at NTP	0	75	100	120	140	160

Qu 3a An isothermal bed of porous spherical catalyst pellets of 3 mm diameter exhibits a conversion commensurate with a first order rate constant of 0.3 s^{-1}. Intrapellet diffusivity is 3×10^{-2} cm^2/s. If a 2 – m depth of the present catalyst is required to realize design conversion, what depth will be needed if because of reduced pressure drop catalyst of 6 mm diameter is to be utilized.

Qu 3b A new catalyst proposed for commercial use is evaluated in the laboratory at 370 ^{0}C. A conversion of 71% is achieved with a 100 g sample. At the same conditions 40 g of the present commercially employed but far more expansive catalyst gives same conversion. If the activation energy of the proposed catalyst is 30 kCal/ mol, by how many degrees must the reactor temperature be increased to match the performance of the present commercial catalyst?

Qu 4 What are the major seats of resistance for heat and mass transfers for a gas phase catalytic reaction? Explain. Develop equations for maximum possible rise inside a catalyst pellet and across the gas film.

Qu 5 What do you mean by pore diffusion affected zero order reaction? Explain and derive an equation of the Effectiveness factor for strong pore diffusion resistance.

Qu 6a How does a catalyst lose its activity? Explain.

Qu 6b A first order reaction is being carried out on a catalyst which is poisoned by a side-by-side reaction. Both the reactions are extremely fast. We observe that with only a small fraction of catalyst pore poisoned, there is a significant drop in catalyst activity. Explain this observation and derive an equation to substantiate the observation.