Kem-90.148 Process modeling and simulation I; basics (2 cr)
Examination 4.5.2005

NB! Write down when you have taken the course and the computer examination

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1.
A) Phenomenological process models. Their significance, applicability and benefits in industrial use.

B) Give a short description of the basic principles ("laws") for constructing physical - chemical dynamic process models.

2.
Describe the following:
A) Numerical integration methods of ordinary differential equations (ODEs)
-Euler
-Runge-Kutta (4^{th} order)

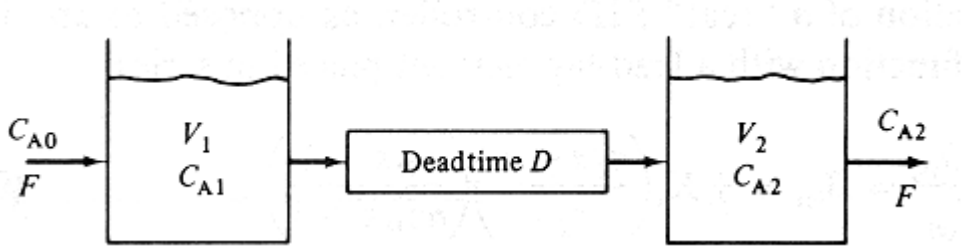
B) Iterative convergence methods
-Interval halving method
-Newton-Raphson method

Describe what kinds of problems are solved with these methods, how do they work and what are the strengths and weaknesses of the methods.

3.
Two isothermal CSTRs are connected by a long pipe that acts like a pure deadtime of D minutes at the steadystate flow rates. Assume constant throughputs and holdups and a first-order irreversible reaction: $A \xrightarrow{k} B$ in each tank.

A) Derive the transfer function of the system (input: C_{A0} and output: C_{A2})

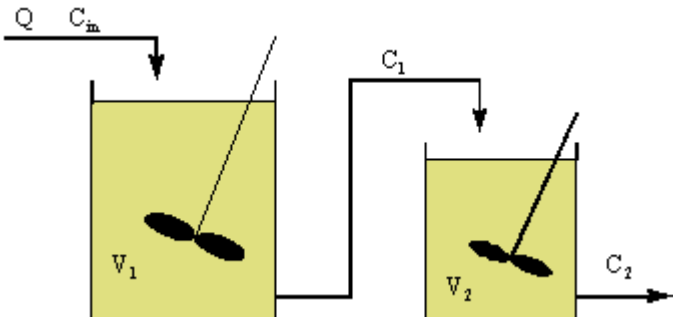
B) Find the unit step response of the system.



4.

A)

Two ideal mixers are in series. Volumes V_1 and V_2 are constant, V_1=0.5 m^3 and V_2=0.3 m^3. Also inflow Q in constant (Q=1.5 m^3/s). Concentrations $C_{in}(t)$, $C_1(t)$ and $C_2(t)$ are vaiables. Input of the process is C_{in} output C_2.



Form:

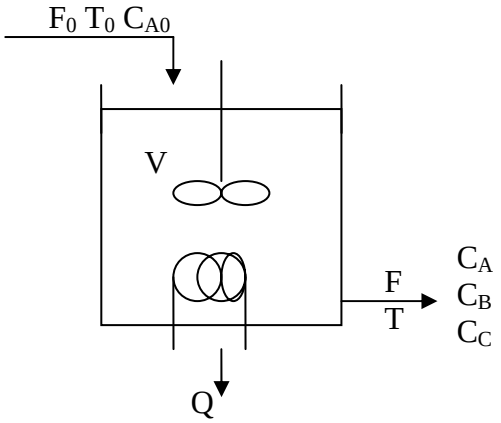
a) Differential equations describing the process.
b) State-space presentation of the system.
c) Transfer function (input is C_{in} and output C_2).

B)

In a chemical mixing reaction occurs a reaction of first order

$$A \xrightarrow{k} B + C,$$

where k is the reaction speed constant. Heat λ (KJ/mol) is freed in the reaction.



f_0 = inflow
f = outflow
T_0 = the temperature of the inflow
T = the temperature of the outflow
V = reactors volume
Q = cooling capacity
C_A, C_B, C_C = the concentrations of in the outflow

i) Write mass- and energy balances for this reaction.
ii) Present a formula describing the conversion in the reactor
iii) How does one seek the operation point of the reactor?