M. TECH. –II (CHEMICAL ENGINEERING) (CBCS – 2015 COURSE) : **WINTER - 2017**

SUBJECT : MODELING & SIMULATION OF CHEMICAL PROCESSES

Day : **Monday** Time : **11.00 AM TO 02.00 PM**

Date : **27/11/2017** **W-2017-2825** Max. Marks : 60

N.B.

1) All questions are **COMPULSORY.**
2) Figures to the right indicate **FULL** marks.
3) Answers to both the sections should be written in **SEPARATE** answer book.

SECTION – I

Q.1 **a)** Differentiate between the following: **(05)**

i) Lumped parameter Vs Distributed parameter model.

ii) Simple Vs rigorous model.

b) Discuss the principles of formulation of mathematical model. **(05)**

OR

a) Discuss the following fundamental laws used in the formulation of models : **(05)**

i) Continuity equation

ii) Component continuity equation.

b) Consider a CSTR where consecutive reactions occur. Here reactant A goes to reactant B at a specific reaction rat k_1 but B can react at a specific reaction rate k_2 to form a third component C. **(05)**

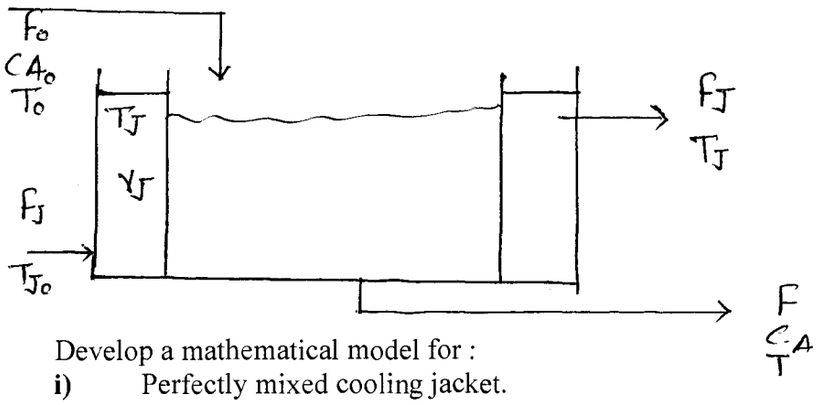
$A \xrightarrow{k_1} B \qquad B \xrightarrow{k_2} C$

Assuming first order reactions, develop the component continuity equation for component A, B and C.

Q.2 An irreversible, exothermic reactions is carried out in a single perfectly mixed non isothermal CSTR. **(10)**

$A \xrightarrow{k} B$

The reaction is n^{th} order in reactant A and has heat of reaction λ. To remove the heat of reaction, a cooling jacket surrounds the reactor.



Develop a mathematical model for :

i) Perfectly mixed cooling jacket.

ii) Plug flow cooling jacket.

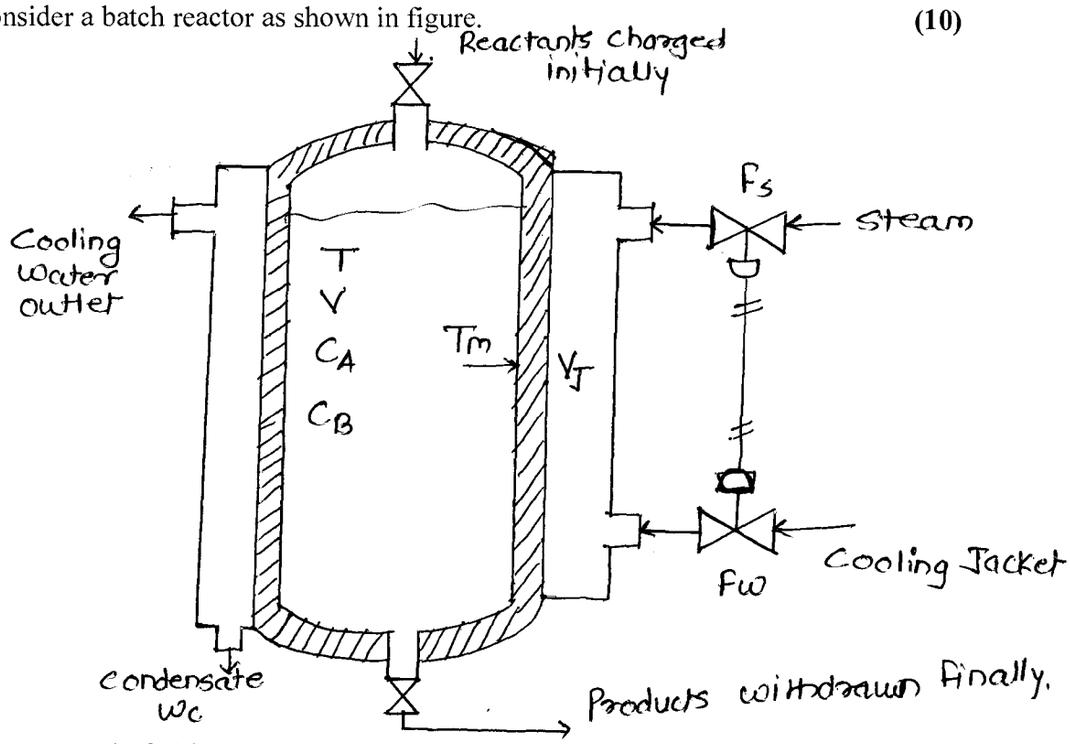
iii) Lumped jacket model.

OR

Develop a mathematical model for simple and variable hydraulic tank. **(10)**

P.T.O.

Q.3 Consider a batch reactor as shown in figure. **(10)**



Here steam is fed into the jacket to bring the reaction mass up to a desired temperature. Then cooling water must be added to the jacket to remove the exothermic heat of reaction and to make the reactor temperature follow the prescribed temperature time curve. First order consecutive reaction takes place in the reactor as time proceeds.

$A \xrightarrow{k_1} B \xrightarrow{k_2} C$

Develop a mathematical model describing.

i) Total continuity equation.
ii) Comp. continuity equation of A and B.
iii) Energy equation of process and metal wall.

OR

Develop a mathematical model for ideal binary distillation column. Draw neat sketch and clearly mention the assumptions made. Also examine the degrees of freedom. **(10)**

SECTION – II

Q.4 What is simulation? Explain the importance of simulation in process optimization. **(10)**

OR

Explain typical steps involved in developing a simulation model. **(10)**

Q.5 **a)** Which are the important steps in simulation for parameter optimization? Explain in detail. **(05)**

b) What is sensitivity analysis? Explain its importance. **(05)**

OR

a) Explain the solution strategies for lumped parameter model in detail. **(05)**

b) Explain the solution methods for initial value and boundary value problem. **(05)**

Q.6 **a)** What are deterministic and stochastic approaches of simulation? Differentiate them with an example. **(05)**

b) What is simulated annealing? Explain its application in simulation. **(05)**

OR

a) What is reliability theory? Explain its application in simulation. **(05)**

b) What is principle component analysis? What is its importance in simulation? **(05)**

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