Assignment - 2

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**Question-1**

(a) **First principles model:**

Assuming,

1. The reactor is perfectly mixed.
2. Heat of reaction is constant.

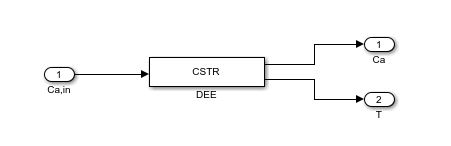
Component balance gives us-

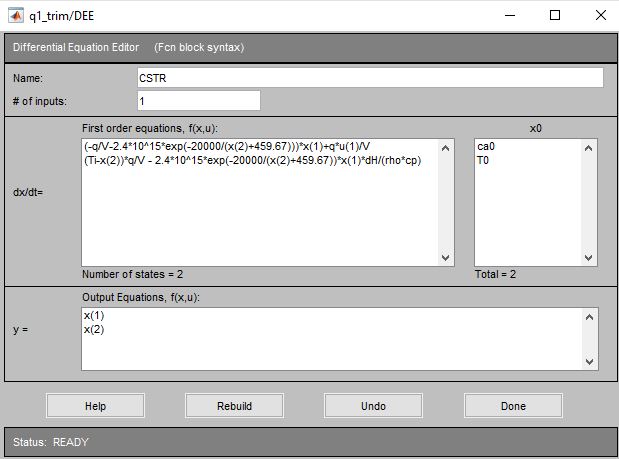
The energy balance gives us-

Therefore, the model is-

Where,

(b) **Simulink diagram and steady state:**

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* Following code is used:

[xs,us,ys] = trim('q1\_trim',[1;1],0.8,[1;1],[],1,[])

* We get the steady state temperature

(c) **Finding transfer function:**

* Following code is used:

[xs,us,ys] = trim('q1\_trim',[1;1],0.8,[1;1],[],1,[]) %Finding steady-state

[A,B,C,D]=linmod('q1\_trim',xs,0.8) %Linearzing the model

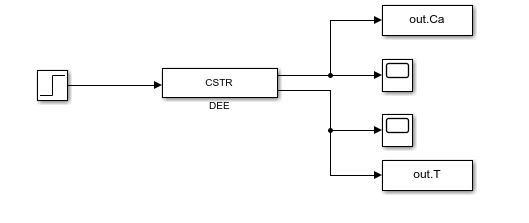
[num,den]=ss2tf(A,B,C,D) %Finding the coefficients of Num and Den of two transfer functions

Gs=tf(num(2,:),den) %Transfer function relating T and Ca,in

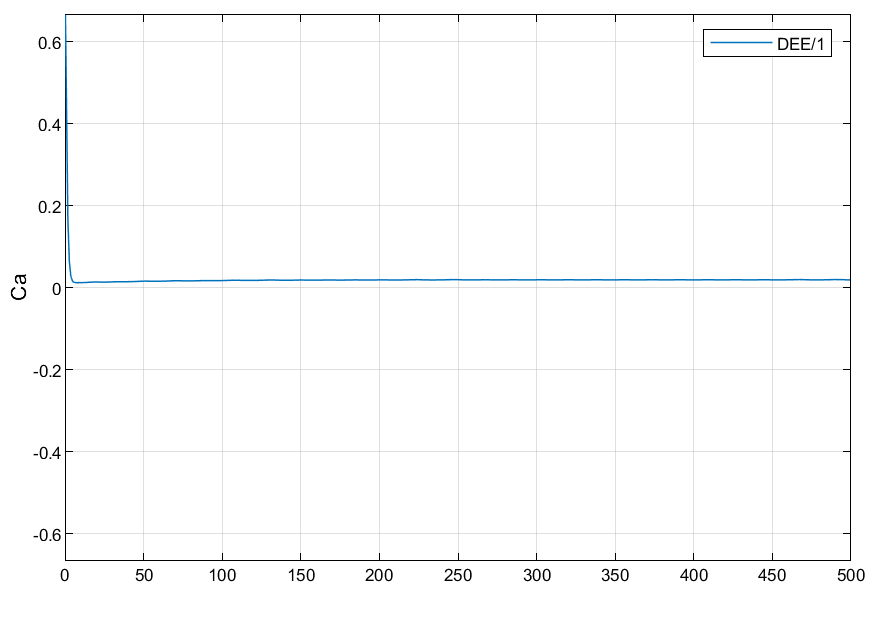
* Evaluated transfer function is-

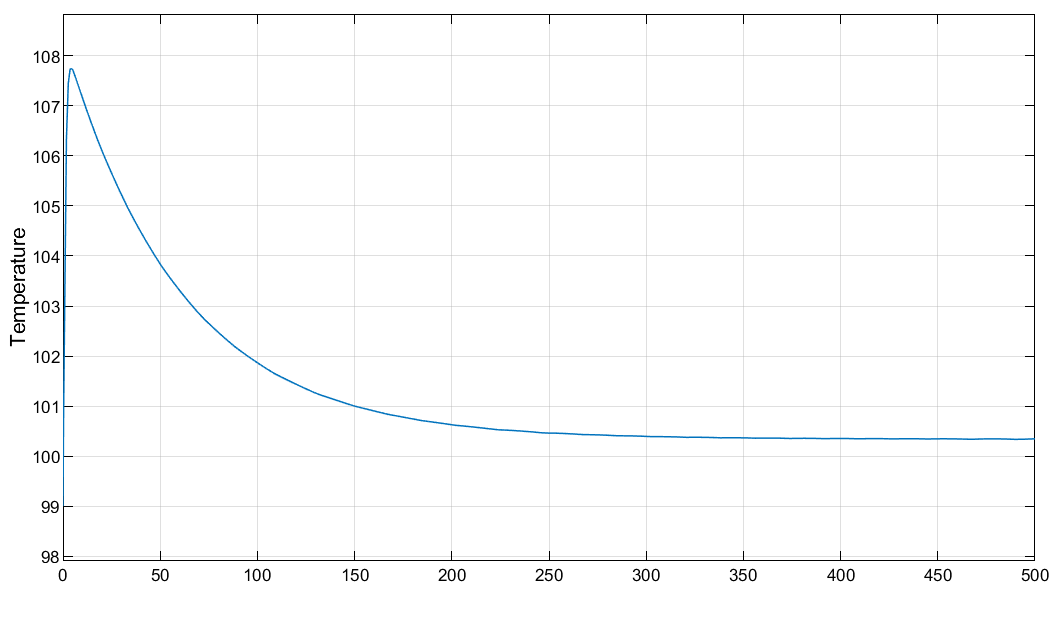
(d) **Step-Responses:**

* Non-linear Simulink model-

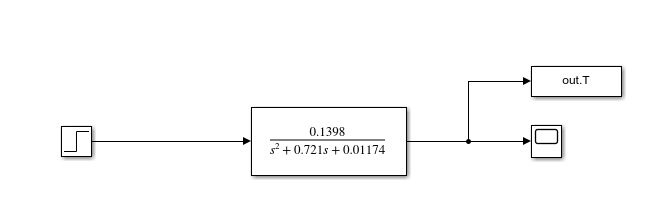


* Step responses for a 10% step in CA,in-

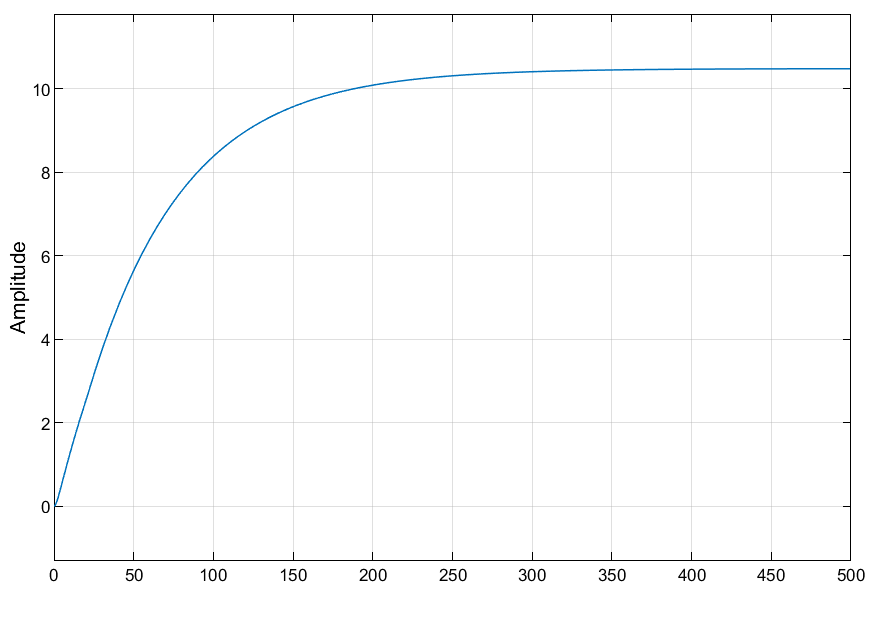




* Linearized Simulink Model in Laplace Domain (between T and CA,in)-



* Step response-



**Question-2**

(a)-(i) **Finding SS description using partial fraction expansion method:**

* Now, the state equations are:
* Corresponding state-space representation is:

(a)-(ii) **Finding SS description using state-transition method:**

We write state equations as-

State-space model can be written as-

State-transition diagram is-



(b) **SS model for the SITO system:**

Now,

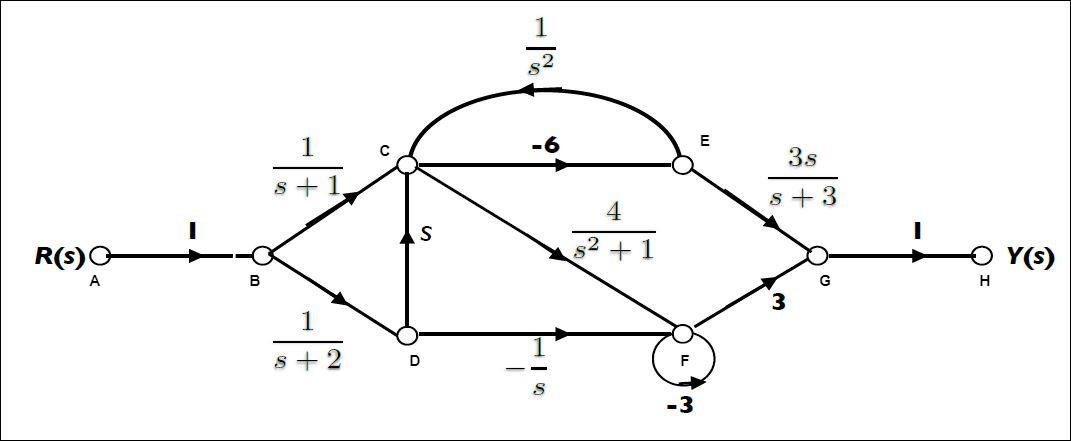
Similarly,

From these, state equations can be written as-

And,

State-space model can be written as-

**Question-3**



(a) **Block diagram of the given process:**



(b) **For finding transfer function**

* There are five paths connecting Y(S) and R(S). The transmittance of these are given by-
* There are two loops in the given diagram. Transmittance of these are given by-
* Determinant of the graph is given by-
* Co-factor of each path is given as as-
* With the help of all the above equations, we can get the transfer function-