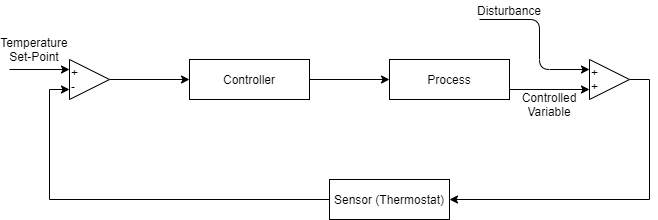
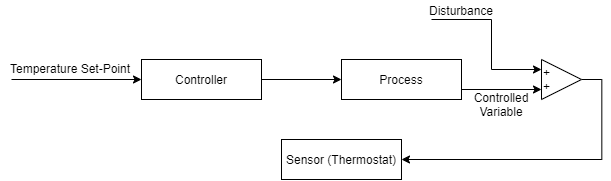
Assignment - 1

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Question-1

* 1. Controlled Variable: Temperature of the room.
  2. Manipulated Variable: Switch Position (On/Off).
  3. Disturbance Variable: Ambient Air temperature

1. Feedback control diagram:  
     
   
2. Feedforward control diagram:  
     
   

**Question – 2**

The process given in this problem is a continuous process.

1. Controlled variable: Flow rate of the blood.
2. Manipulated Variable: Temperature of the unit, concentration of waste substances in blood.
3. Disturbance Variable: Changes in waste concentration due to metabolic activities in the body.

**Question – 3**

**For finding steady state values-**  
At steady state

Solving these two equations, we get:

L = 80 gmol/min; V = 100 gmol/min; M = 20 gmol/min; a = 0.5; zf = 0.1 gmol solute/gmol vapour

From these, we get,

**For linearizing the system of ODEs:**

The model has two states, w and z.

And two outputs, again w and z.

We define-

State vector:

Output vector:

Input vector:

Given system of equations:

Linearized system is written as:

Where,

Putting all the input, steady state and parameter values to get-

**Eigen-Values & direction of slowest and fastest change:**

Eigen values of the matrix A are -3.33 and -9.66.

The eigen value -9.66 corresponds to that eigen vector which is the direction of fastest change at the initial steady state.

is the direction of fastest change, and is the direction of smallest change.

**SIMULINK Modelling, steady state using ‘trim’, and linearized model using ‘linmod’:**

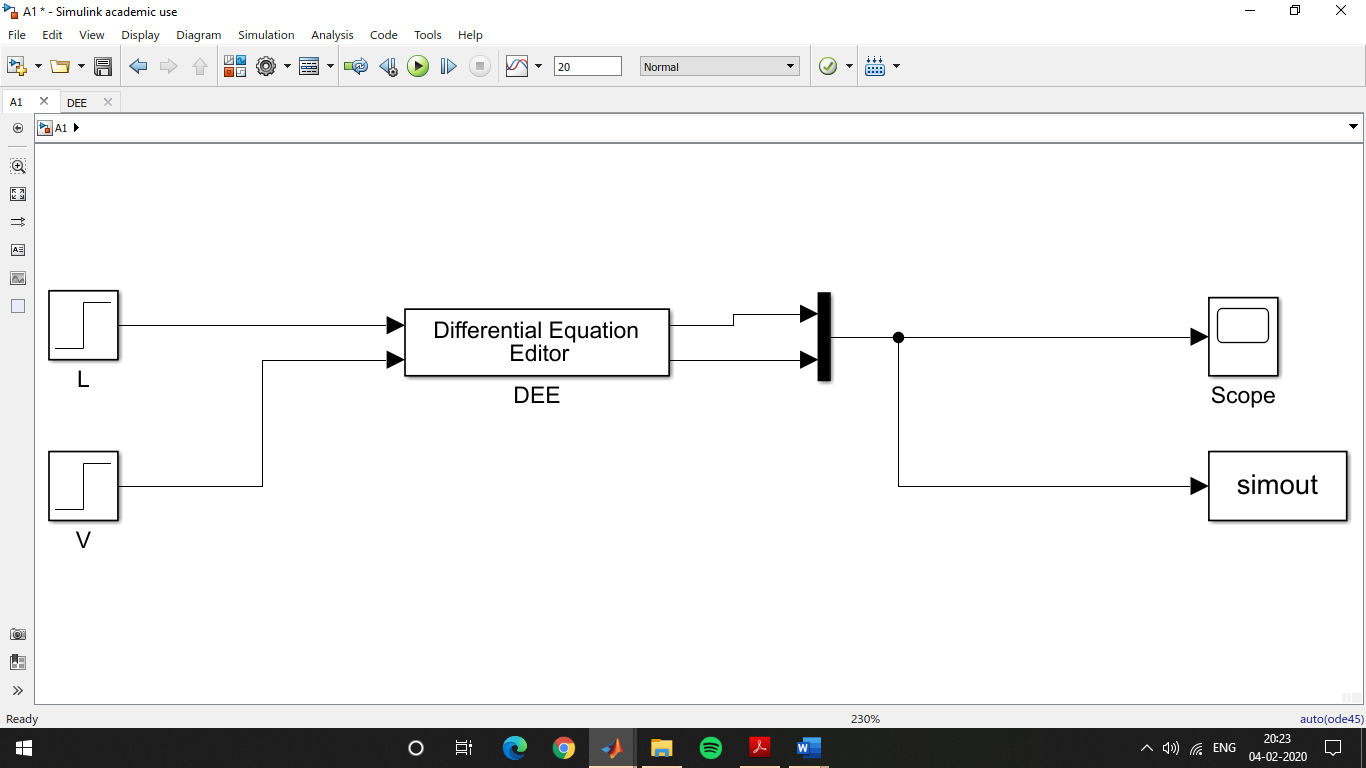


Figure: Block diagram of non-linear system of ODEs

Figure: Output of step input (in L) response

Using ‘trim’ we get, .

Using ‘linmod’ we get the linearized model with

The following code is used:

x0 = [0;0]

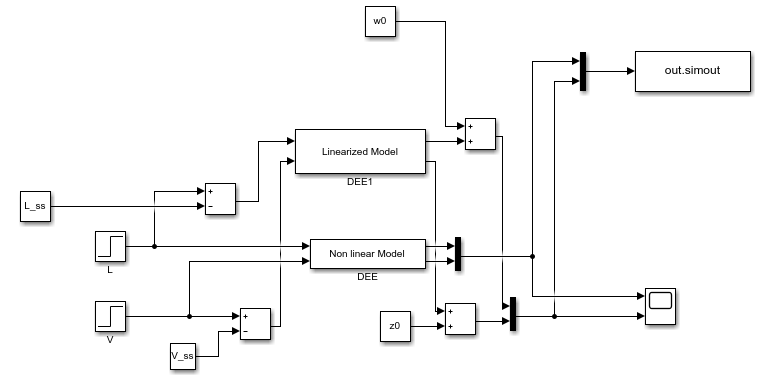
y0 = [0;0]

u0 = [80;100]

[X,U,Y] = trim('A1trim', x0, u0)

[A,B,C,D] = linmod('A1trim',X,u0)

**Responses to step input changes in linear and non-linear models:**



The plots obtained by a 5% and 15% increase in L are as shown below.

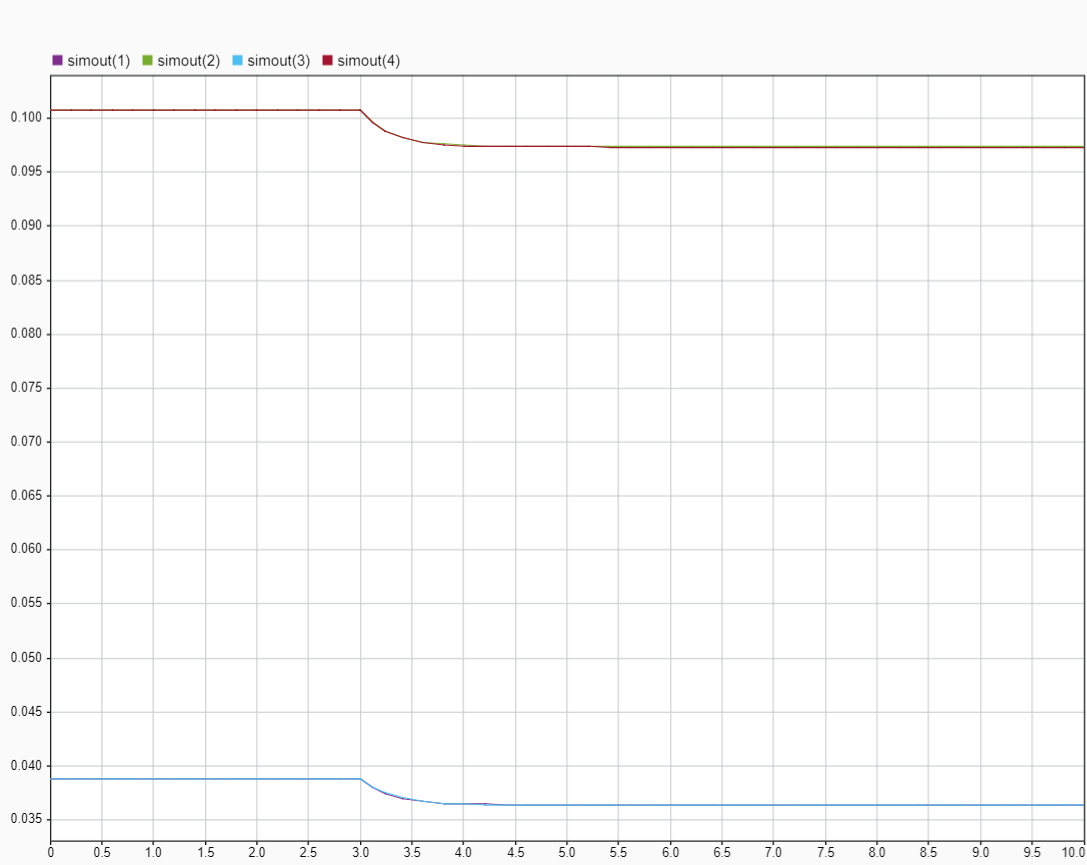
For 5% change in flow rate L:

Simout(1) – w as calculated by non linear model

Simout(1) – z as calculated by non linear model

Simout(3) – w as calculated by linear model

Simout(4) – z as calculated by linear model



Plot showing the response in w and z as calculated by the linear and non-linear models for a 5% change in L.

The linear model is sufficiently capable of capturing the transience and the final steady state in this case.

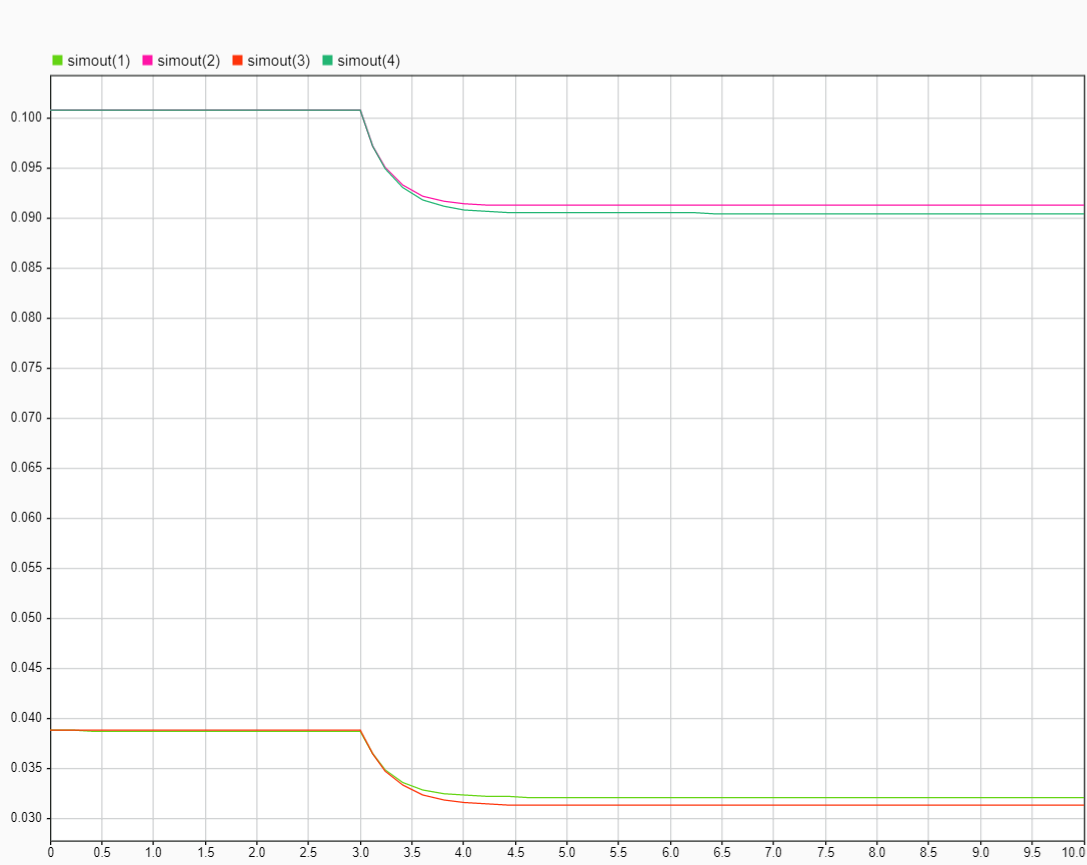
For 15% change in flow rate L:

Simout(1) – w as calculated by non-linear model

Simout(1) – z as calculated by non-linear model

Simout(3) – w as calculated by linear model

Simout(4) – z as calculated by linear model



Plot showing the response in w and z as calculated by the linear and non-linear models for a 15% change in L.

In this case the linear model is not sufficient in estimating the steady state but however is capable of modelling the transience to a fair degree as seen from the plots.

**Question-4**

**(a) Laplace transform of function:**

**(b) Inverse Laplace:**

We break up the expression into the constitutive partial fractions.

Rewriting the denominator in terms of a square, we can write:

Manipulating the second term:

For the case where we have:

For the case where we have:

For the case where we have: