KATHMANDU UNIVERSITY

SCHOOL OF ENGINEERING

DHULIKHEL

PCEG-308

Lab -01

Department of Electrical and Electronics Engineering

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To:

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Date:

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In the circuit shown in figure 1.2.1, determine the node voltages V_1 and V_2 and the power delivered by each source.

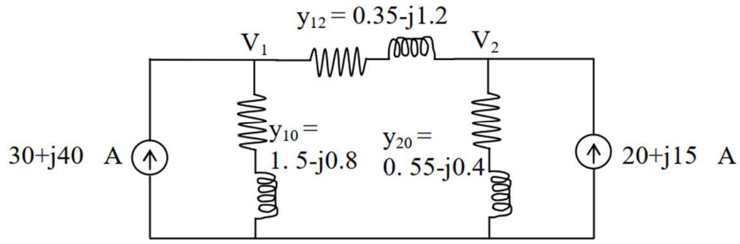


Figure-1.2.1

Krichhoff's current law results in the following matrix node equation.

$$\begin{bmatrix} 1.5 - j2.0 & -0.35 + j1.2 \\ -0.35 + j1.2 & 0.9 - j1.6 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 30 + j40 \\ 20 + j15 \end{bmatrix}$$

And the complex power of each source is given by $S = VI^*$. The following program, is written to yield solutions to V_1, V_2 and S.

Matlab Code:

```
j=sqrt(-1); >> I=[30+j*40; 20+j*15];
>> Y=[1.5-j*2 -0.35+j*1.2; -0.35+j*1.2 0.9-j*1.6]; >> V=inv(Y)*I
V =
3.5902 +35.0928i
6.0155 +36.2212i
>> S=V.*conj(I)
S = 1.0e+003 *
1.5114 + 0.9092i
0.6636 + 0.6342i
```

Transfer Function:

```
>> num=[1 4];
>> den=[1 2 10];
>> sys=tf(num,den)
sys =
              s + 4
          --------------
          s^2 + 2 s + 10
```

Transfer Function to Poles and Zeros

```
>> num=[1 11 30 0];
>> den=[1 9 45 87 50];
>> [z,p,k]=tf2zp(num,den)

z =
        0
  -6.0000
  -5.0000

p =
  -3.0000 + 4.0000i
  -3.0000 - 4.0000i
  -2.0000
  -1.0000

k =
     1
```

State Space Representation

```
>> num=[1 7 2]; den=[1 9 26 24];
>> [A B C D]=tf2ss(num,den)

A =
   -9  -26  -24
    1    0    0
    0    1    0

B =
    1
    0
    0

C =
    1    7    2

D =
    0
```

A system is described by the following state-space equations

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 1 & 1 \\ -1 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix} u$$

$$y = [1 \quad 0 \quad 0]x$$

Find the transfer function $G(s) = \frac{Y(s)}{X(s)}$.

```
>> A=[0 1 0; 0 0 1; -1 -2 -3];
>> B=[10; 0; 0];
>> C=[1 0 0]; D=[0];
>> [num,den]=ss2tf(A,B,C,D);
>> sys=tf(num,den)

Transfer function:
 10 s^2 + 30 s + 20
---------------------
s^3 + 3 s^2 + 2 s + 1
```

Q).Consider the simple mechanical system as shown in the figure-2.1.1 below. Three forces influence the motion of the mass, namely, the applied force, the frictional force, and the spring force.

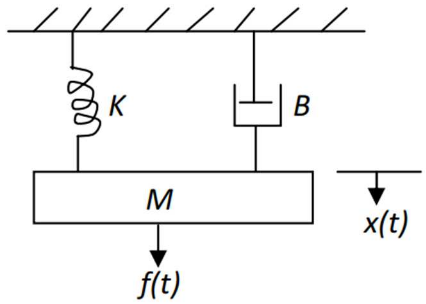


Figure-2.1.1

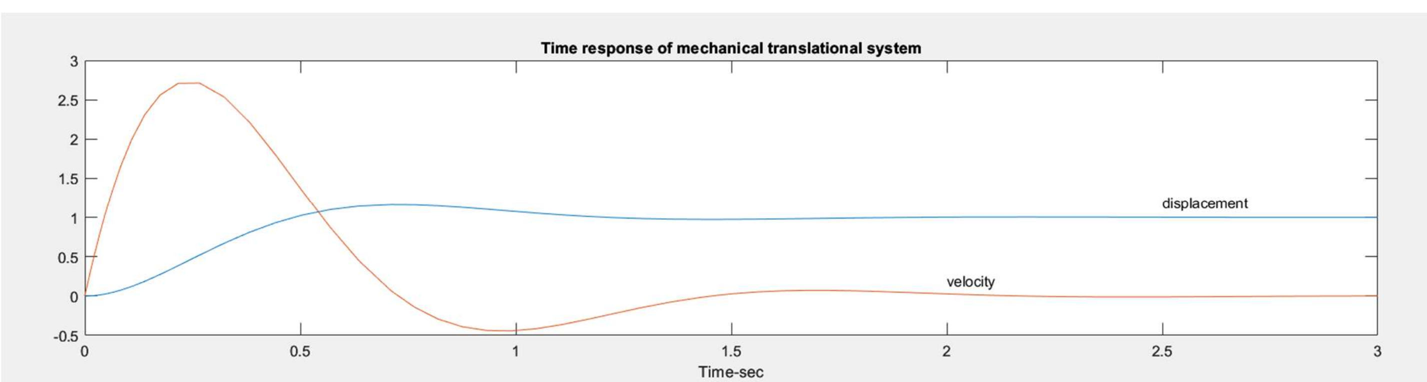
With the system initially at rest, a force of 25 Newton is applied at time t = 0. Assume that the mass M = 1 Kg, frictional coefficient B = 5 N/m/sec., and the spring constant K = 25 N/m

Mechsys.m file

```
function xdot=mechsys(t,x);
F=25;
M=1; B=5; K=25;
xdot=[x(2);1/M*(F-B*x(2)-K*x(1))];
```

Saving the above instructions as **mechsys.m** and executing the following instructions:

```
>> tspan=[0,3];
>> x0=[0,0];
 >> [t,x]=ode23('mechsys',tspan,x0);
 >> subplot(2,1,1),plot(t,x)
>> title('Time response of mechanical translational system')
>> xlabel('Time-sec')
>> text(2.5,1.2,'displacement') >> text(2,.2,'velocity')
```



Q) The circuit elements in the figure 2.1.3 are R = 1.4Ω, L = 2H, and C = 0.32F, the initial inductor current is zero, and the initial capacitor voltage is 0.5 volts. A step voltage of 1 volt is applied at time t = 0. Determine i(t) and v_c(t) over the range 0 < t < 15 sec. Also, obtain a plot of current versus capacitor voltage.

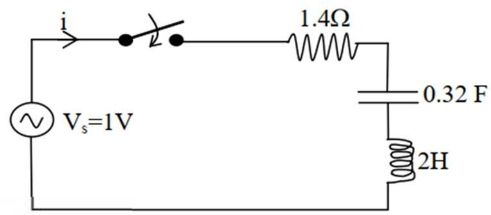


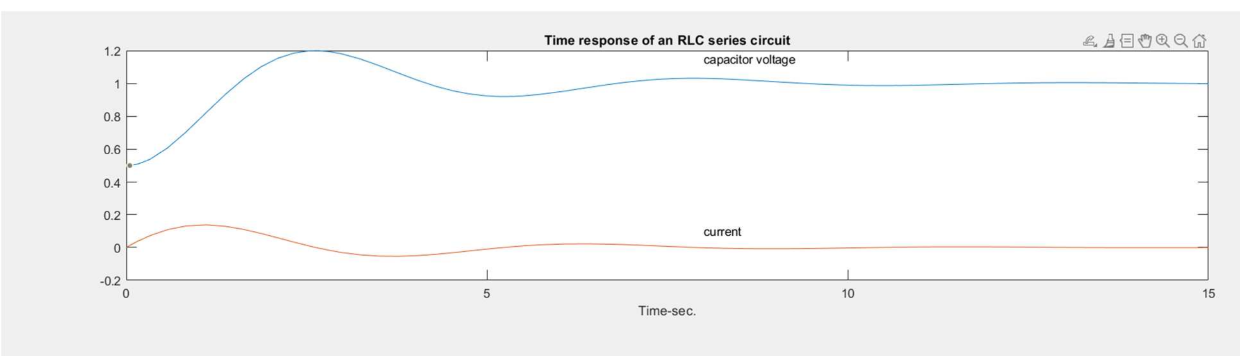
Figure-2.1.3

Electsys.m file

```
function xdot=electsys(t,x);
V=1;
R=1.4; L=2; C=0.32;
xdot=[x(2)/C;1/L*(V-x(1)-R*x(2))];
```

Saving the above instructions and executing the following instrucitons,

```
x0=[0.5,0];

tspan=[0,15];

[t,x]=ode23('electsys',tspan,x0);

subplot(2,1,1)

plot(t,x)

title('Time response of an RLC series circuit') xlabel('Time-sec.')

text(8,1.15,'capacitor voltage') text(8,.1,'current')
```



Consider the first-order model of the motion of a car. Assume the car to be travelling on a flat road. The horizontal forces acting on the car can be represented as shown in the figure 2.2.1.
Assume that:
M = 1000 kg and b = 40 N*sec/m

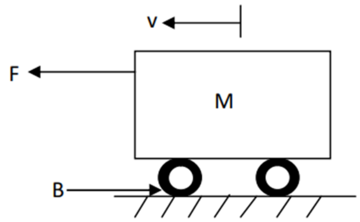
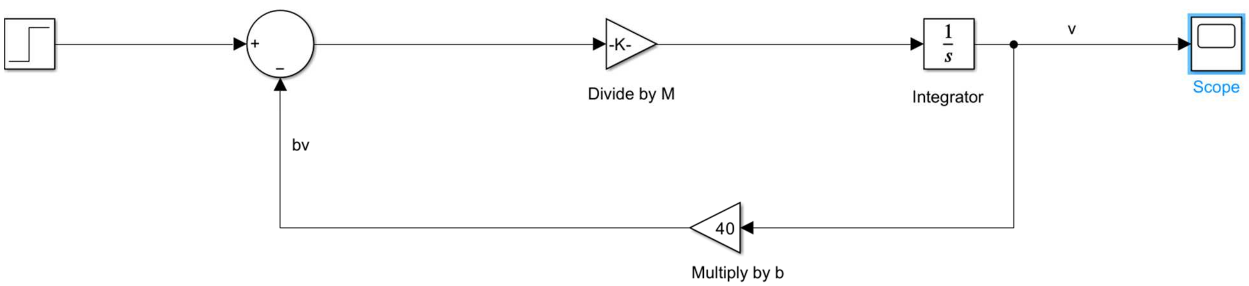


Figure-2.2.1

Modeling on Simulink



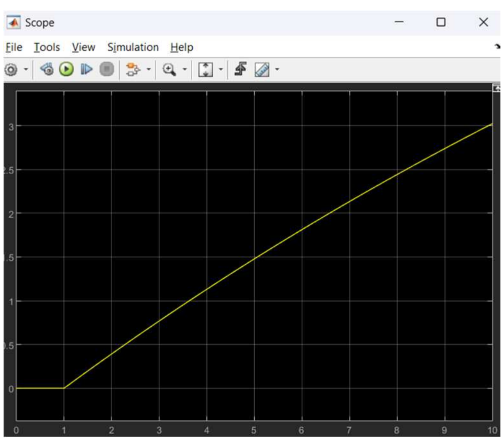


Figure 2: Response for t=10sec

Figure 1: Response for t = 150sec

From this graph, we observe that the system has a steady-state velocity of about 10 m/s, and a time constant of about 25 seconds.

Steady Space Analysis

Using the following state space model in Simulink.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -5 & -4 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 5 \end{bmatrix} u(t)$$

And $$y = [1 \quad 0 \quad 0]x$$

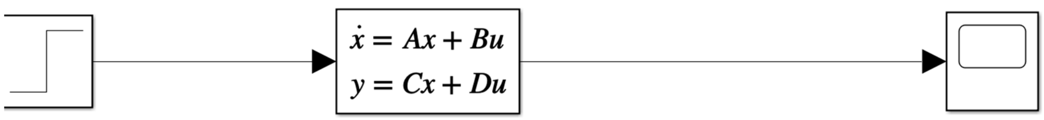


Figure 3: Simulink model

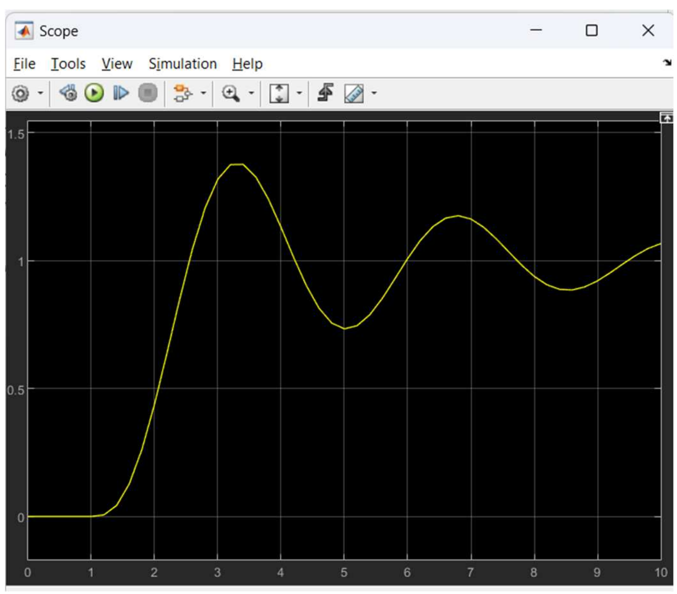
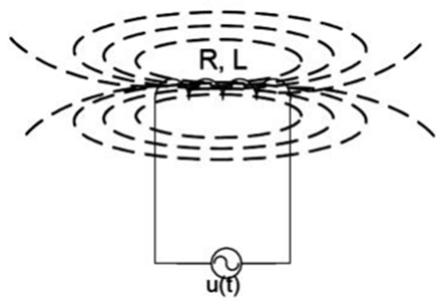


Figure 4: Output Response

Q) For the systems shown below draw the block diagram using SIMULINK see the output in the scope with respect to input. Consider u(t) a unit step input and i(t) the output; assume L = 0.01 and R = 0.01 and zero initial conditions.



Solution:

Here, the given circuit is series RL circuit.

The differential equation for the RL circuit is:

Ldi(t)/dt + Ri(t)=u(t)

Taking the Laplace transform and assuming zero initial conditions:

$$LsI(s) + RI(s) = U(s)$$

$$I(s)\,(Ls + R) = U(s)$$

The transfer function $\frac{I(s)}{U(s)}$ is:

$$\frac{I(s)}{U(s)} = \frac{1}{Ls+R}$$

$$\frac{I(s)}{U(s)} = \frac{1}{0.01s+0.01} = \frac{1}{0.01(s+1)} = \frac{100}{s+1}$$

Modeling on Simulink

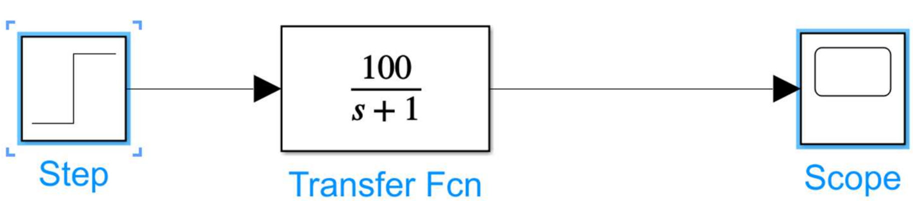


Figure 5: Simulink block diagram

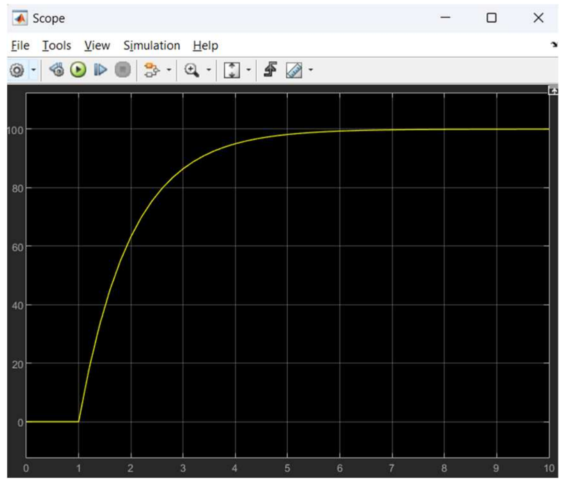
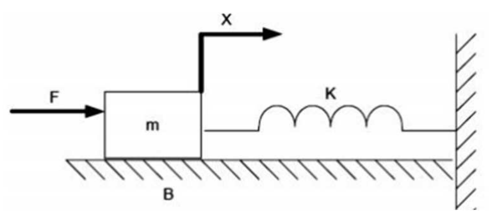


Figure 6: Response of Current

Q2)



Consider F(t) a step input and x(t) the output; assume m = 2Kg, K= 32 and B = 2 N-s/m and zero initial conditions.

The differential equation for the mass-spring-damper system is:

$$m\frac{d^2x(t)}{dt^2} + B\frac{dx(t)}{dt} + Kx(t) = F(t)$$

Now, creating the Simulink block diagram with this transfer function.

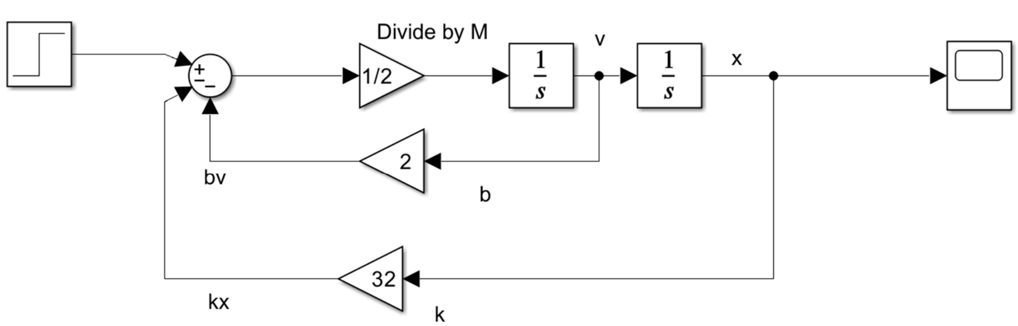


Figure 7: Simulation model block

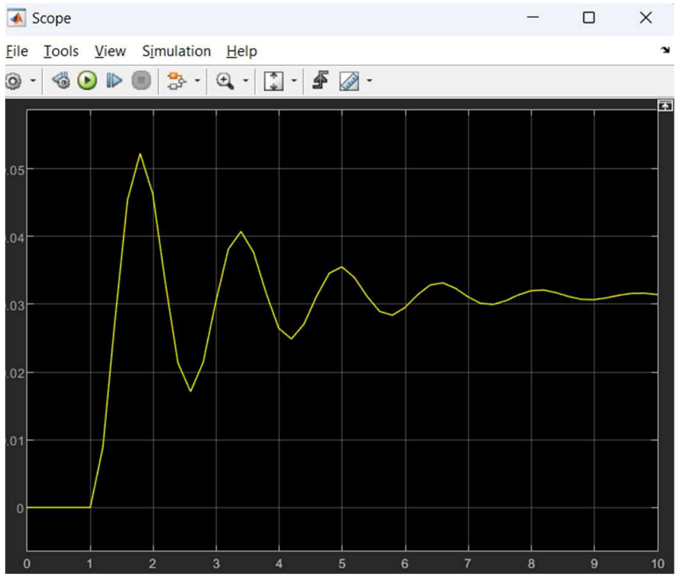


Figure 8: Output Response

2. For the system defined by the equation

$$2\frac{d^3y}{dt^3} + 4\frac{d^2y}{dt^2} + 8\frac{dy}{dt} + 10y = 10u(t)$$

Draw the SIMULINK block diagram and plot the output response y(t) with respect to u(t).

Using the state variables , we get the matrix form as

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -5 & -4 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 5 \end{bmatrix} u(t)$$

And $\quad y = [1 \quad 0 \quad 0]x$

Now in Simulink block,

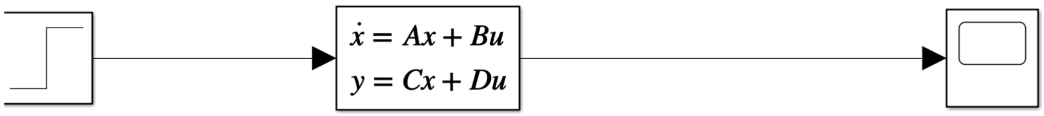


Figure 9: Simulink Block

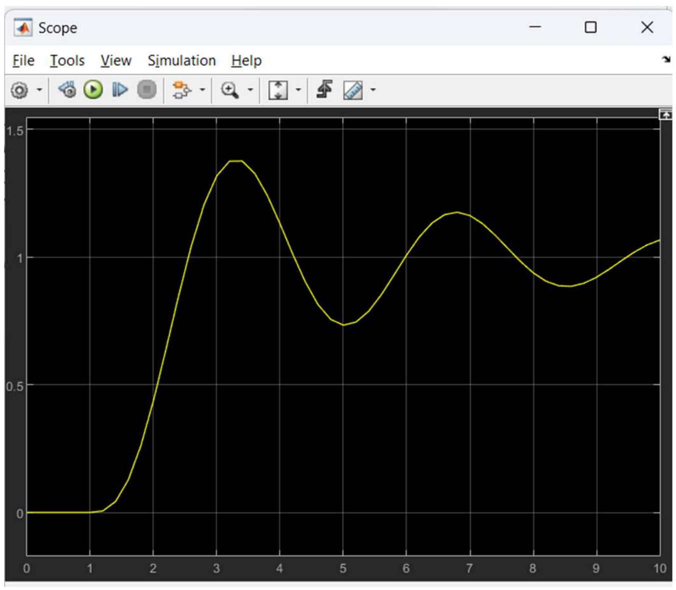


Figure 10: Output Response