KATHMANDU UNIVERSITY

SCHOOL OF ENGINEERING

DHULIKHEL

PCEG-308

Lab -02

Department of Electrical and Electronics Engineering

By:

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To:

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Date:

27th June, 2024

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-1.1.1.

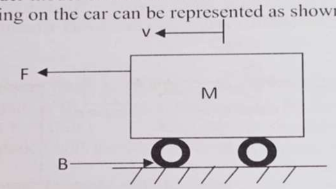


Figure-1.1.1

The differential equation representing the system is

$$M\frac{dv}{dt} = F - bv$$

Assume that:
F = 400N, M = 1000 kg and b = 40 N*sec/m

This system will be modeled in Simulink by using the system equation as above.
Or,

$$\frac{dv}{dt} = \frac{F - bv}{M} = \frac{F - 40v}{1000}$$

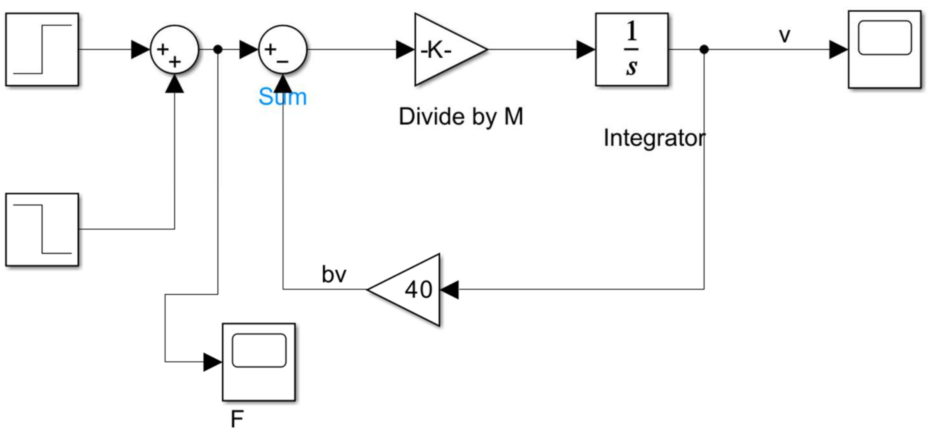


Figure 1: Simulink Block

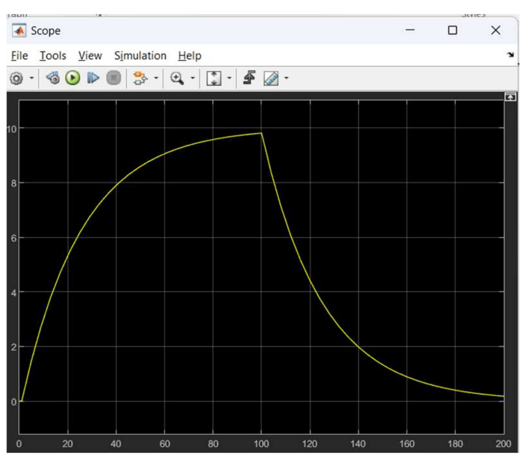


Figure 2: Output Response

System Response to Ramp Input

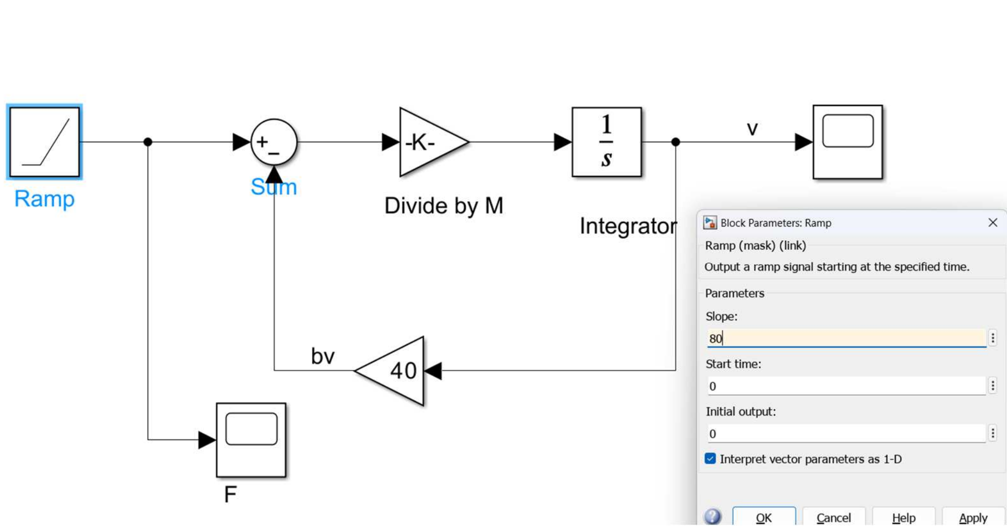


Figure 3: Simulink Block with ramp response

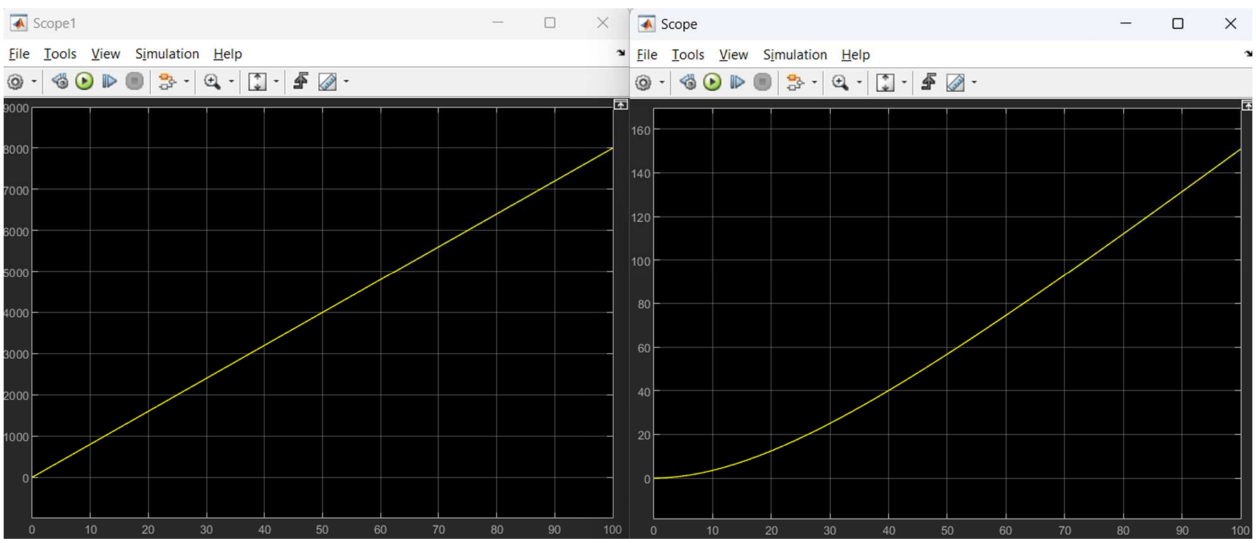


Figure 4: Input Response (left) and Output Response (right)

Ramp Input with Saturation

A ramp input should be applied to the system as before, with the following changes: The engine force, F, will not be allowed to exceed 2000 N. Thus, the system's input will appear as a ramp until its value reaches 2000 N. From that time forward, the saturated input will be maintained at 2000 N. This situation is similar to the car's driver, with the vehicle starting from rest, the gas pedal being steadily pushed down until it reaches the floor (i.e., the maximum force that the engine can provide), and then the pedal being held there for an indefinite time.

The Saturation block allows us to set an upper and lower limit for its input signal. If the signal to the block is between the minimum and maximum values we have set, the Saturation block passes it through unaltered. If the input signal is greater than the maximum, however, it outputs the set maximum value.

Similarly, if the input signal is less than the minimum, the Saturation block simply outputs this user-defined minimum value.

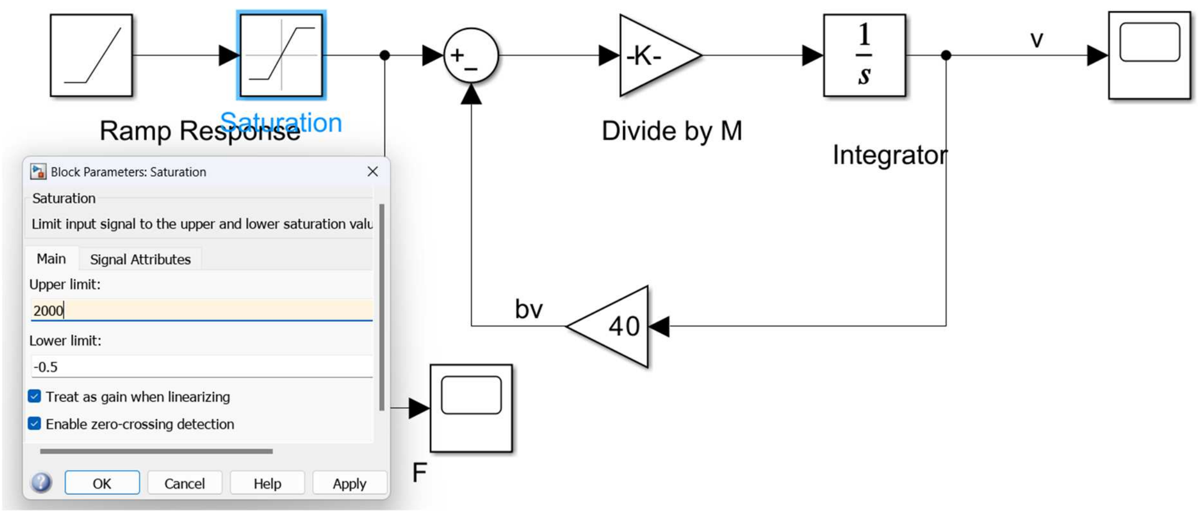


Figure 5: Ramp Input with Saturation

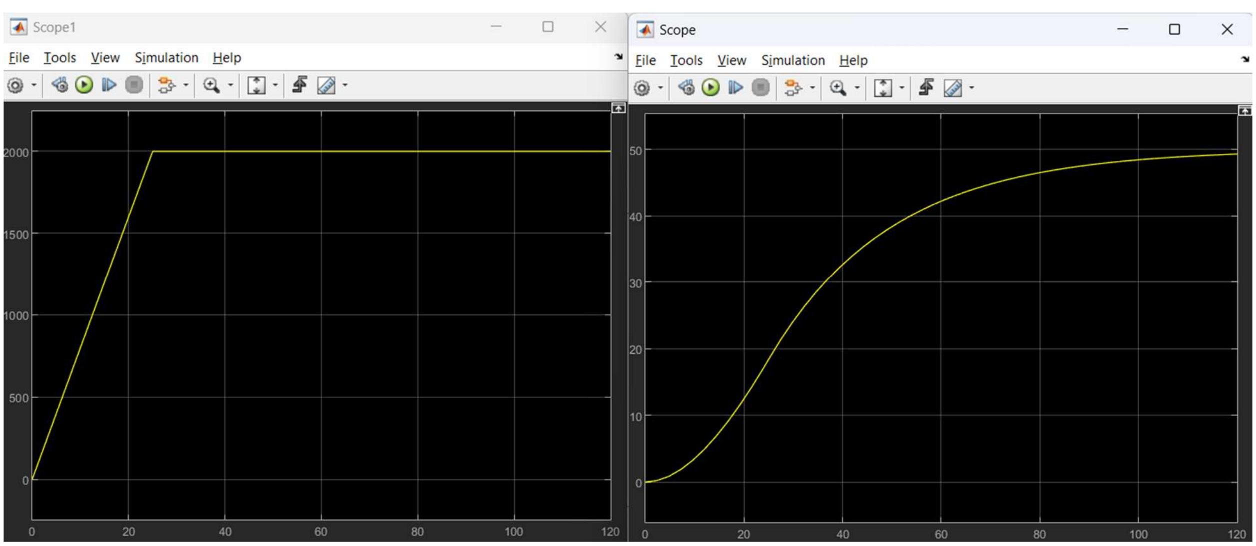
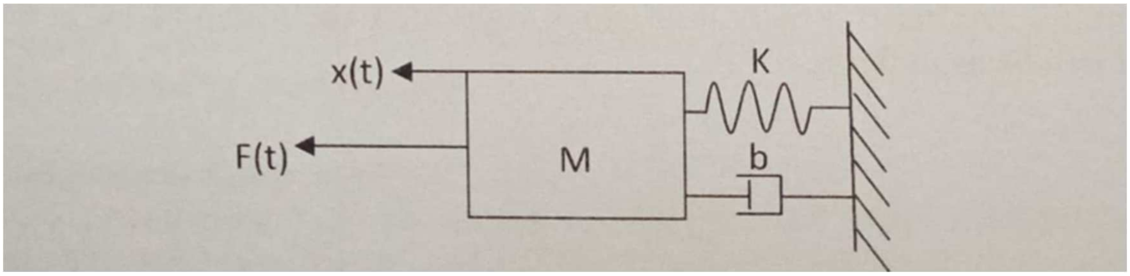


Figure 6: Input Response (left) and Output Response (right)

Second Order System

Consider the second order system as shown in the figure below.



The force equation of the system is

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

Let $x_1 = x$ and $x_2 = \frac{dx}{dt}$, then

$$\frac{dx_1}{dt} = x_2$$

$$\frac{dx_2}{dt} = \frac{1}{M}[f(t) - Bx_2 - Kx_1]$$

The Simulink model for this system is presented below.

We have considered mass (M) = 1kg, K = 500, b = 10. Also for step input, step time = 0, Initial value = 0 and final value = 1.

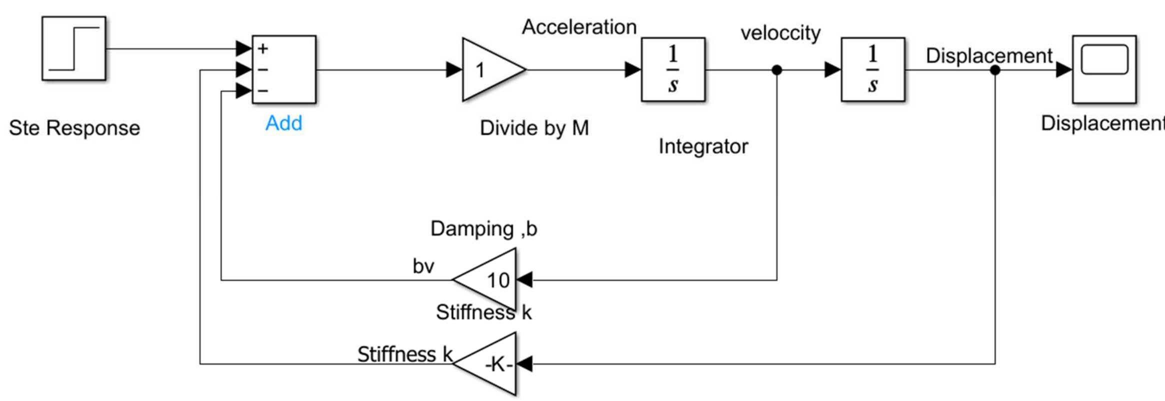


Figure 7: Simulink Model

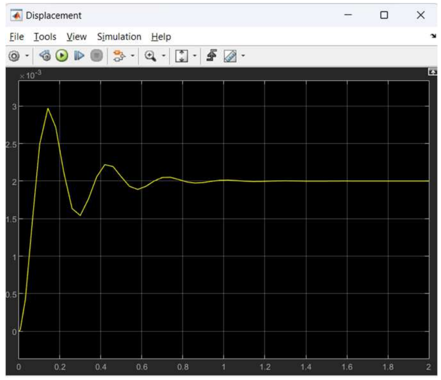


Figure 8: Output response

This output response is an underdamped case.

Let b = 44.7. In this case, the output response will be critically damped as seen in the figure below.

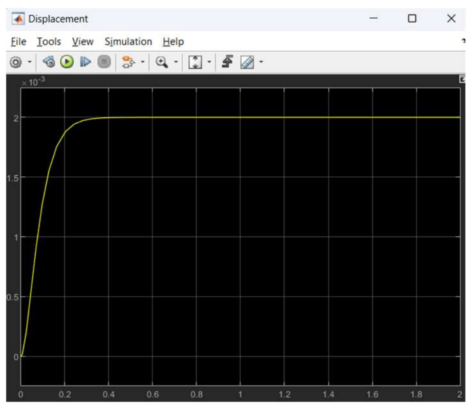
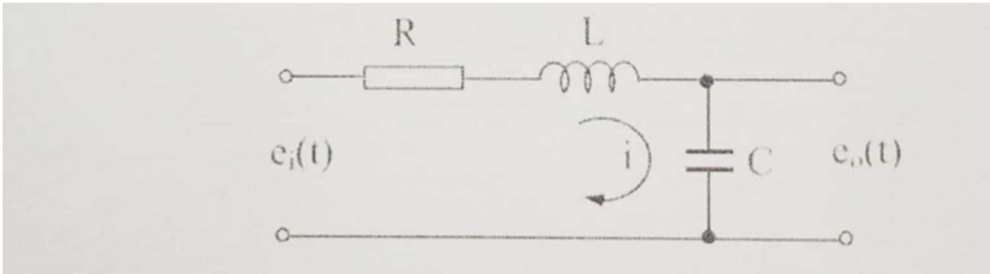


Figure 9: Critically damped output response

Let b = 100. In this case, the output response will be overdamped as seen in the figure below.

Figure 10: Over-damped output response

Q1) For the following RLC network, make a Simulink model to simulate the network. Use these numerical values: R = 100 ohm, L = 0.2H and C = 2000 micro Farad, e(t) = 5V.



To the system, connect the ramp input with the saturation block and analyze the output response of the second order system. Compare that with the step input as before and comment on the differences.

Solution:

Let's consider step input. The Simulink block is shown below.

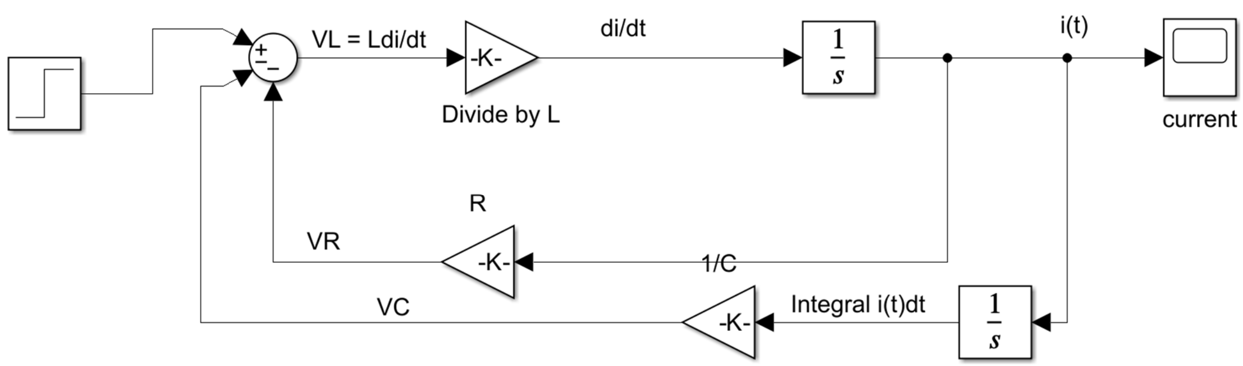


Figure 11: Simulink block with Step Input

The output response is shown in the figure next page.

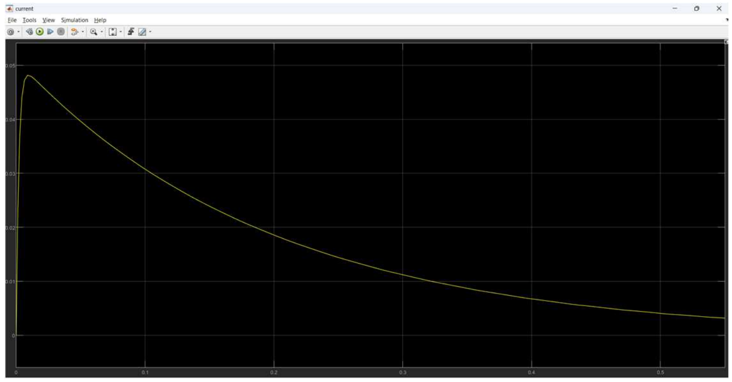


Figure 12: Output Response for Step Input

Let’s take ramp response. The Simulink block is shown below.

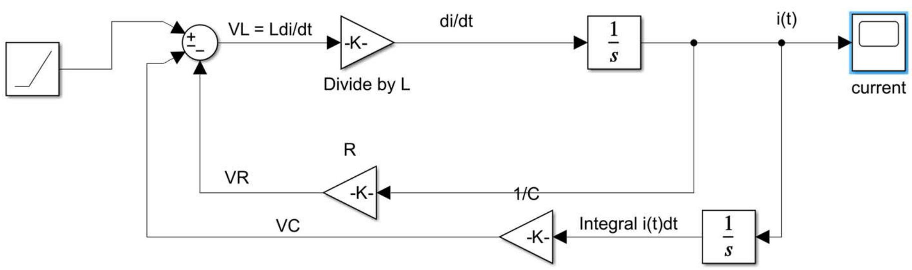


Figure 13:Simulink block with ramp input

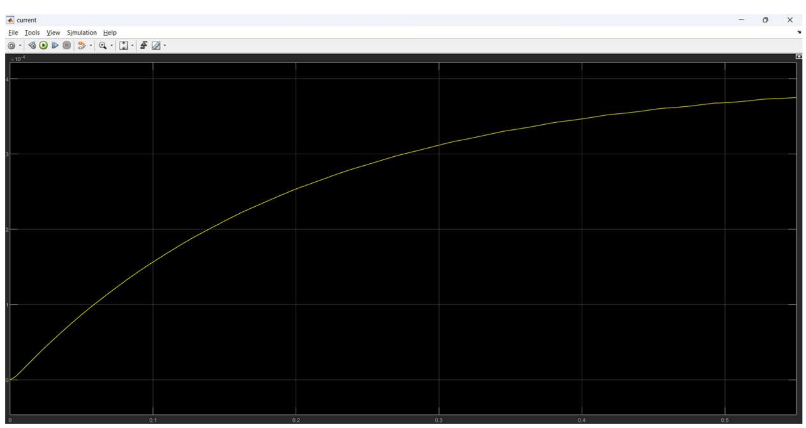


Figure 14: Output Response with Ramp input