National University of Sciences and Technology (NUST)
School of Electrical Engineering and Computer Science

Department of Electrical Engineering and Computer Science

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Dated: 4/12/2022

Semester: 5th

Section: BEE 12C

EE-232: Signals and Systems

Lab 10: Linearity in Simulink MATLAB

Group Members

		PLO4 – CLO3	PLO5 - CLO3	PLO8 - CLO4	PLO9 - CLO4
Name	Reg. No	**Viva / Quiz / Lab Performance**	**Analysis of data in Lab Report**	**Modern Tool Usage**	**Ethics and Safety**
		5 Marks	**5 Marks**	**5 Marks**	**5 Marks**
Danial Ahmad	331388				
Muhammad Umer	345834				
Syeda Fatima Zahra	334379				

1 Table of Contents

2 MATLAB Simulink

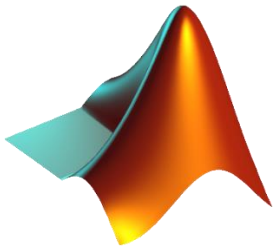
2.1 Objectives

This Lab experiment has been designed to familiarize students with MATLAB Simulink; students are required to prove linearity of a system using Simulink.

2.2 Equipment

Software

- *MATLAB*



2.3 Lab Instructions

All questions should be answered precisely to get maximum credit. Lab report must ensure following items:

- Lab objectives
- MATLAB codes
- Results (Graphs/Tables) duly commented and discussed
- Conclusion

3 Lab Tasks

3.1 Testing Linearity

To test the linearity of the gain block, build the system in the following Figure 1.

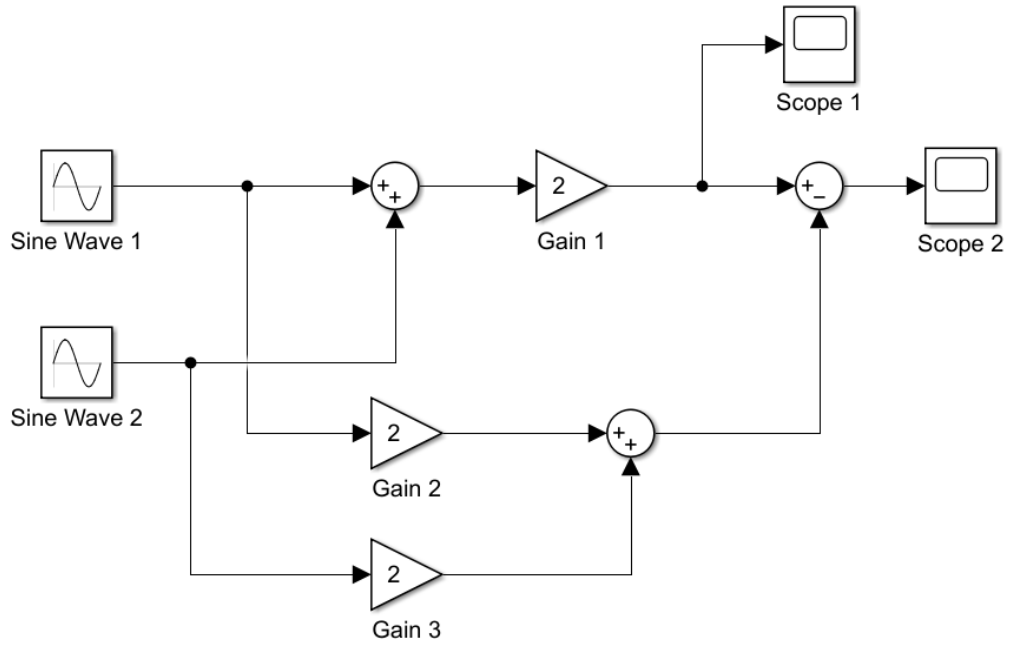
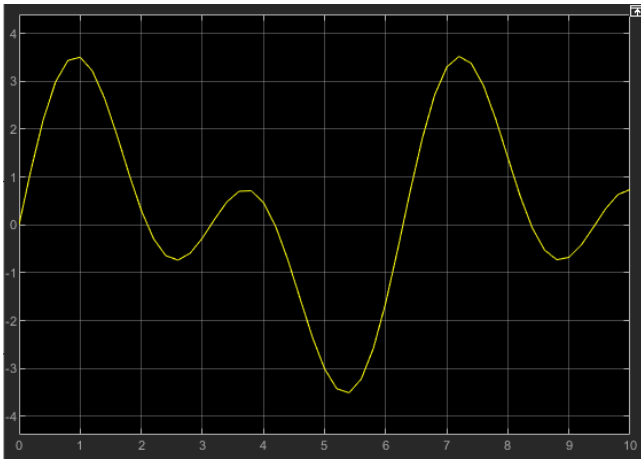
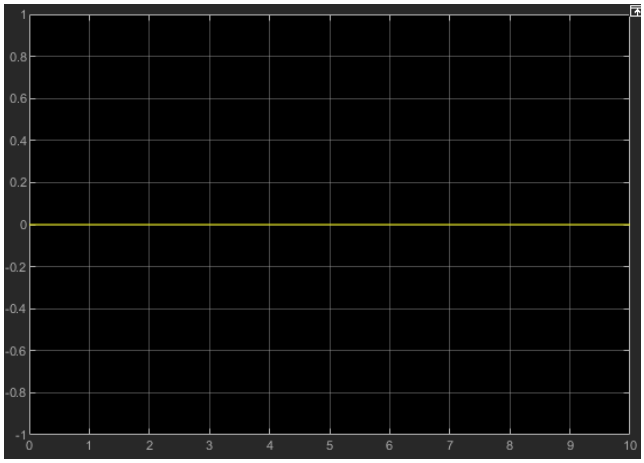


Figure 1



Scope 1: (Sine Wave 1 + Sine Wave 2) × 2



Scope 2: ((Sine Wave 1 + Sine Wave 2) × 2) − (2 × Sine Wave 1) + (2 × Sine Wave 2)

As scope 2 displays: $((Sine\ Wave\ 1 + Sine\ Wave\ 2) \times 2) - (2 \times Sine\ Wave\ 1) + (2 \times Sine\ Wave\ 2)$, we can deduce that the system is indeed linear, due to a constant zero output.

3.2 Exercise

3.2.1 Task 1

Use Simulink to design a non-linear system and show that the system is non-linear by showing that the principle of superposition does not hold.

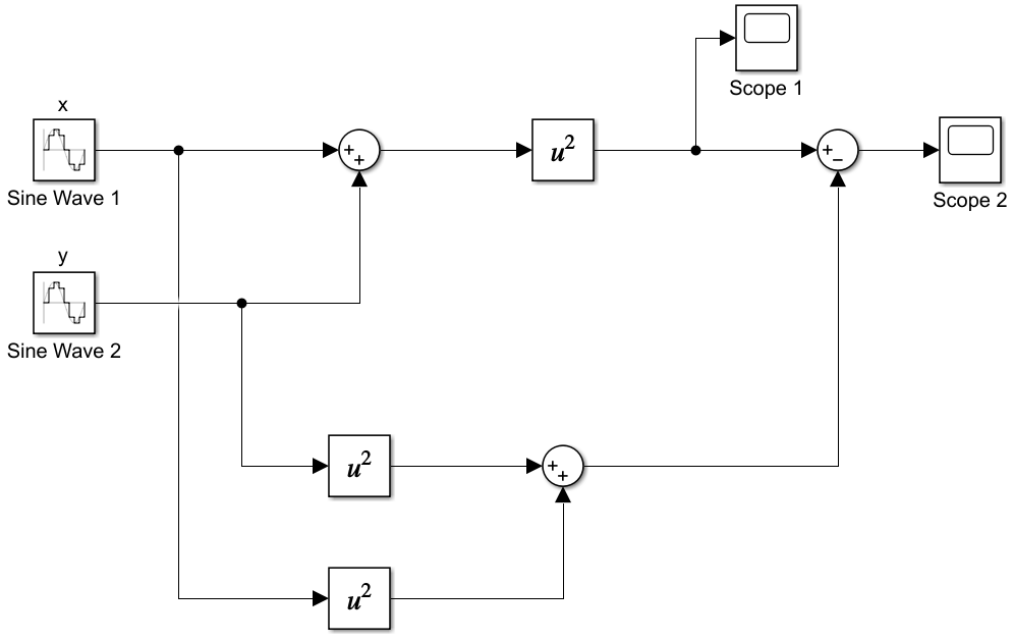
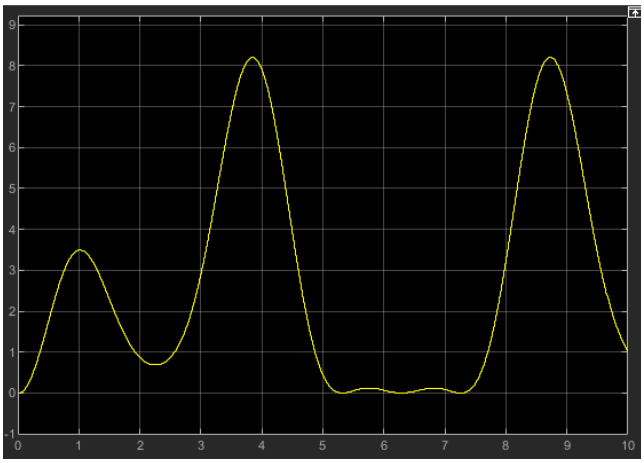
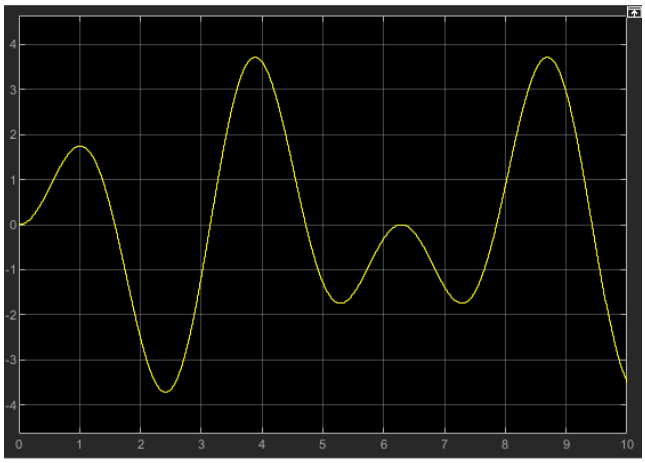


Figure 2



Scope 1: (x + y) ^ 2



Scope 2: (x + y) ^ 2 − ((x) ^ 2 + (y) ^ 2)

As scope 2 displays: $(x + y)^2 - ((x)^2 + (y)^2)$, we can deduce that the system is not linear, due to a non-zero constant output.

3.2.2 Task 2

Use the symbolic toolbox to show that the squaring operation is not linear. That is, use the symbolic toolbox to show that:

$$(\alpha x + \beta y)^2 \neq \alpha x^2 + \beta y^2$$

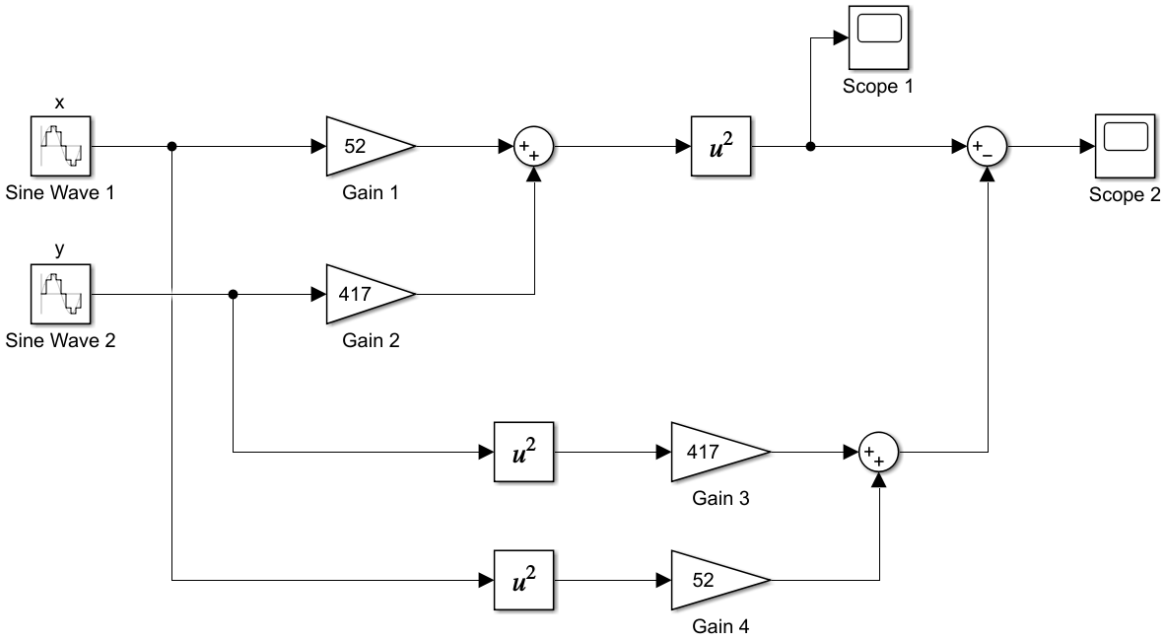
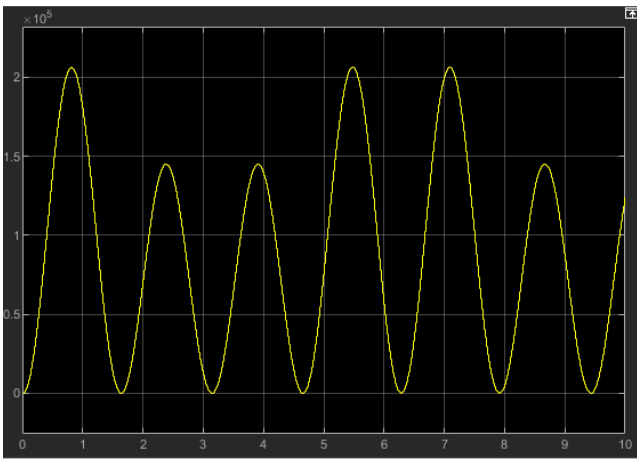
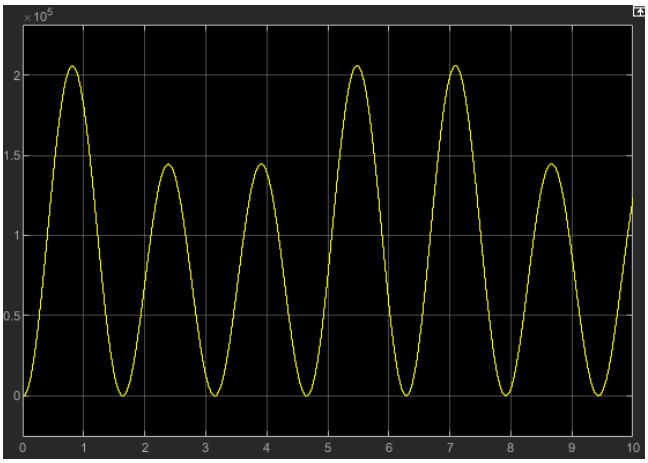


Figure 3

In Figure 3, x and y are sine waves of different frequencies. α is a gain of 52 and β is a gain of 417.



Scope 1: (52x + 417y) ^ 2



Scope 2: (52x + 417y) ^ 2 – ((52x) ^ 2 + (417y) ^ 2)

As scope 2 displays: $(52x + 417y)^2 - ((52x)^2 + (417y)^2)$, we can deduce that the system is not linear, due to a non-zero constant output.

4 Conclusion

In this lab, MATLAB® Simulink was used to show the linearity and non-linearity of different systems, mainly the squaring operation. We deduce that Simulink is a useful and versatile MATLAB "add-on" used as a graphical programming environment for modelling systems.