XMUT220 Signals and Systems

Homework 3: Time and Frequency Characteristics

Due Date: Sunday, 29th November 2026 (online submission to VUW XMUT220 website)

1. A first-order continuous-time LTI system is represented with a differential equation as follows:

$$\frac{dy(t)}{dt} + 5y(t) = x(t)$$

For the above system, perform the tasks given below:

a. Determine the systems' time constant (τ), rise time (T_r), and settling time (T_s) at 1% or 2% standard. [10 marks]

b. Sketch and simulate in MATLAB the transient response (time domain) plot of the system. [10 marks]

c. Determine the equations for the magnitude and phase of the frequency response. Sketch and simulate in MATLAB the frequency response (magnitude and phase plots) of the system. [10 marks]

d. Briefly describe the frequency response characteristics of the system at low frequency, cut-off frequency, and high frequency. [6 marks]

e. Determine the equation of the system in the time domain when the system is subjected to a step input and prove the correctness of your result with simulation in MATLAB. [10 marks]

2. Briefly describe magnitude and phase of the frequency response of the following first- and second-order continuous-time LTI systems. Then, sketch and simulate in MATLAB their frequency responses (e.g. magnitude and phase plots).

a. System 1. [10 marks]

$$G(j\omega) = 5 + \frac{j\omega}{2}$$

b. System 2. [10 marks]

$$G(j\omega) = \frac{1}{8 + j\omega}$$

c. System 3. [10 marks]

$$G(j\omega) = \frac{1}{(j\omega)^2 + 3j\omega + 9}$$

3. Suppose that there are two continuous-time LTI systems represented as follows:

i. System 1.

$$G(j\omega) = \frac{1 + (j\omega/2)}{1 + 2j\omega}$$

ii. System 2.

$$G(j\omega) = \frac{1 + 2j\omega}{1 + (j\omega/2)}$$

For the two systems given above, attempt and answer the following:

a. Briefly describe the magnitude and phase of the system's frequency response. Sketch manually and simulate in MATLAB their Bode plots. [16 marks]

b. Which system has the phase lead, and which one has the phase lag? Describe briefly the reason for your answer. [4 marks]

c. Which system amplifies signals, and which one attenuates and at what frequency range? [4 marks]

Marking Schedule

Student Name : _____

Student ID : _____

No	Description	Mark	Your Mark	Remarks
1a	The systems' time constant (τ), rise time (T_r), and settling time (T_s) at 1% and 2% standards.	10		
1b	Sketch and simulation in MATLAB of the transient response (time domain) plot of the system.	10		
1c	The equations for magnitude and phase of the frequency response. Sketch and simulation in MATLAB of the frequency response (magnitude and phase plots) of the system.	10		
1d	Description of the frequency response characteristics of the system at low frequency, cut-off frequency, and high frequency.	6		
1e	The equation of the system in the time domain for a step response and prove the correctness of the result with simulation in MATLAB.	10		
2a	Brief description of the magnitude and phase of the frequency response at cut-off frequency and low and high frequencies. Sketch and simulation in MATLAB the frequency response of system 1.	10		
2b	Brief description of the magnitude and phase of the frequency response at cut-off frequency and low and high frequencies. Sketch and simulation in MATLAB the frequency response of system 2.	10		

2c	Brief description of the magnitude and phase of the frequency response at cut-off frequency and low and high frequencies. Sketch and simulation in MATLAB the frequency response of system 3.	10		
3a	Brief descriptions of the magnitude and phase of the system's frequency response. Sketch and simulation in MATLAB of the Bode plots of the systems.	16		
3b	System that has the phase lead and which one has the phase lag? Brief reason of the answer.	4		
3c	The system that amplifies signals and attenuates and at what frequency range?	4		
	Total	100		

Comments: