XMUT315 Control Systems Engineering

Assignment 4: Analysis with Root Locus and Nyquist Diagram

Due Date: Monday, 29th June 2026 (online submission to XMUT315 wiki website at VUW)

A. Root Locus Analysis

1. Sketch root locus diagram of the following open-loop control system given below. [10 marks]

$$G(s) = \frac{(s+5)}{(s-0.2)(s^2+2s+32)(s^2-125)}$$

2. Consider the following control systems having the transfer function equations:

   i. System 1:

$$G_1(s) = \frac{s^2+4s+5}{(s+2)(s+3)(s+4)}$$

   ii. System 2:

$$G_2(s) = \frac{100(s+6)}{s(s+1)(s+2)(s+3)(s+4)}$$

   iii. System 3:

$$G_3(s) = \frac{(s+1)^2}{(s+1)(s+6)}$$

   iv. System 4:

$$G_4(s) = \frac{(s+1)^2}{(s-1)(s+6)}$$

   v. System 5:

$$G_5(s) = \frac{(s+3)}{(s+1)(s-1)(s+4)}$$

   vi. System 6:

$$G_6(s) = \frac{(s+4)}{(s+1)(s-1)(s+3)}$$

a. Sketch the root locus diagram for each of the systems. You need not calculate break in/out points, crossing points of the imaginary axis or angle of departure/arrival. However, you should indicate the real axis intercept of any asymptotes and their angles. [30 marks]

b. With the aid of appropriate sketches, describe the closed loop step response of each system (but skip $G_2(s)$ for now) as well as its behaviour for very large K. [25 marks]

c. For the system described by $G_2(s)$, describe how the behaviour of the system changes as the compensator gain is varied over the complete range from zero to infinity. [10 marks]

B. Nyquist Diagram Analysis

3. For a control system given by the following transfer function equation:

$$G(s) = \frac{20}{s^3 + 5s^2 + 6s}$$

a. Sketch the Nyquist diagram of the system above. [15 marks]

b. Referring to the Nyquist diagram, describe the stability of the system. [5 marks]

c. Perform Nichols chart simulation of the system in MATLAB. Does the simulation result confirm the outcome of part (b)? [5 marks]

Marking Schedule

Student ID : _____

Student Name : _____

No	Description	Mark	Your Mark	Remarks
A	**Root Locus Analysis**			
1	Sketch of the root locus diagram of the system.	10		
2a	Sketch of root locus diagrams of the systems.	30		
2b	Description of closed-loop step response of the systems and its behaviour for very large K.	25		
2c	Description of behaviour of the system as the compensator gain is varied from zero to infinity.	10		
B	**Nyquist Diagram Analysis**			
3a	Sketch of Nyquist diagram of the system.	15		
3b	Description of stability of the system.	5		
3c	Result of Nichols chart simulation of the system in MATLAB and its comparison with the result of part (b).	5		
	Total	100		

Comment: