NBU-003-027601 Seat No. _______

M. Sc. (ECI) (Sem. VI) (CBCS) Examination

April / May - 2017

Paper - 21 : Advanced Concept of Control Systems

Faculty Code : 003
Subject Code : 027601

Time : $2\frac{1}{2}$ Hours] [Total Marks : 70

1. Answer the following in brief in brief (any 7 out of 10, each carry 2 marks). (14)

1. What is conditionally stable system? Explain it briefly.
2. Explain correlation between time and frequency response in brief.
3. Give an example of system with transportation lag and derive its transfer function.
4. Write an equation of asymptotes regarding root locus and explain each of them in brief.
5. If characteristic equation of system is given as $s^3 + 5s^2 + 4s + K = 0$, find the point at which root locus branches cross imaginary axis. Also find the gain K for the imaginary roots.
6. What is the advantage of bode plot over root locus? Explain in brief.
7. When system has two open loop poles and one open loop zero, which shape does root locus branches take? Explain it briefly.
8. Define relation between resonant frequency and damped natural frequency with proper equation.
9. At which angle real axis break in or break away occurs? Explain brief.
10. Draw the polar plot for the integral or derivative factor $(j\omega)^{\pm r}$.

2. Answer the following in brief (any 2 out of 3, each carry 7 marks). (14)

1. Closed loop transfer function of the system is given as
$$C(s) = \frac{K}{1 + s(s+2)(s+4) + K}$$
Check whether following points lie on root locus. If point is found on root locus, identify value of gain K for which characteristic equation would have those roots.
   i. S=-1
   ii. S=-3
   iii. S=±j2.8
2. For the quadratic factor $(1 + j2\zeta u - u^2)^{\pm r}$, write the step to draw bode plot. Explains the effect of corner frequency and its relation with ζ.
3. Consider the following second order transfer function:
$$G(s) = \frac{1}{s(Ts+1)}$$
Sketch the polar plot and explains why the shape of the polar plot differs substantially from general second order system?

3. Answer the following in brief (each carry 7 marks) **(14)**

1. Prove that polar plot of first order pole $1 + j\omega T$, the polar plot is circle for $-\infty \leq \omega \leq \infty$, centered at (0,0) having radius of 0.5.
2. Consider the system with transportation lag of 1 second whose open loop transfer function is given as

$$G(s)H(s) = \frac{K_1}{s(\tau_m s + 1)} \quad where\ \tau_m = 0.5\ second$$

Plot the root locus.

OR

3. Answer the following (each carry 7 marks) **(14)**

1. For the factor "poles or zeros on real axis $(1 + j\omega T)^{\pm r}$. write the step to draw bode plot. Also explain how we can compensate error at corner frequency.
2. What is non-minimum phase system? If transfer function is given as

$$G(s) = \frac{K_a(1-T_a s)}{s(Ts+1)}, (T_a > 0), H(s) = 1$$

Explain the concept of non-minimum phase system with root locus. How can we make the system stable, choose the range of the gain properly?

4. Answer the following (each carry 7 marks) **(14)**

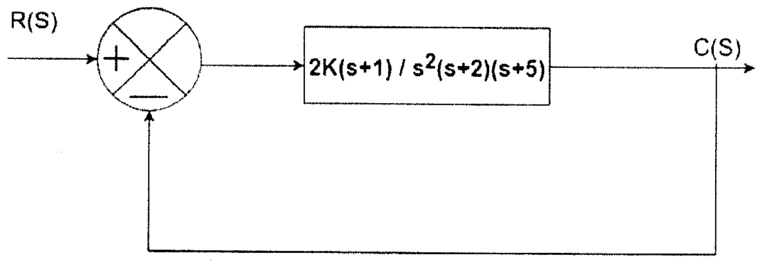
1. Write the general rules to plot root locus for negative and positive feedback system in brief.
2. For a sinusoidal transfer function $G(j\omega) = \frac{j\omega T}{1+j\omega T}$, prove that the polar plot is semicircle. Find the radius and center. Write each step of plotting.

5. Answer the following (any 2 out of 4, each carry 7 marks) **(14)**

1. Draw the bode diagram for the following open loop transfer function and also explain each step for drawing:

$$G(j\omega) = \frac{10(j\omega + 3)}{(j\omega)(j\omega + 2)[(j\omega)^2 + j\omega + 2]}$$

2. Derive the formula for the centroid for the negative feedback, single loop system. Also explain that why the asymptotic line is considering as a straight.
3. Plot the root locus for the following control system and choose the range of K such that system remains stable.



4. For the following multi-loop system, Plot the root locus as K_a varies from 0 to ∞ so as K.