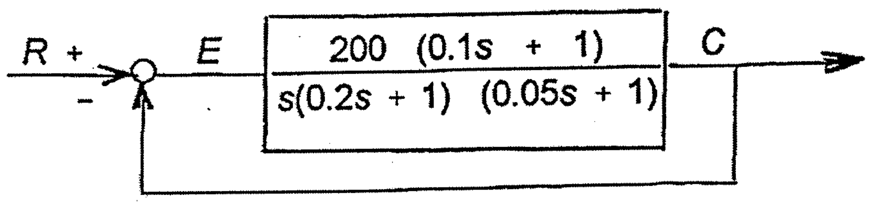
Question 1

Given:



a) Draw the Bode diagram.

b) Is the system stable?

Question 2

Given:

$$G(s) = \frac{K\,(s^2 + 0.5s + 100)}{s\,(s + 1)\,(s + 2)}$$

a) Sketch the root Locus.

b) If the Loci cross the imaginary axis, determine values of w at the axis intersections.

c) If we want complex roots with $\zeta = 0.707$, what must be the value of K?

Question 3

a) The characteristic equation for a feedback control system is:

$$(s + 2)\;(s^2 + 4s + 8) + K = 0$$

Determine the range of values of K for which the system is stable.

b) Use the Laplace transform method to solve the following differential equations.

- $$\frac{dy}{dt} + y = 2 \sin t$$
- $$\frac{dy}{dt} + y = 2 \cos t$$

All the initial conditions are zero.

Question 4

a) $s^3 + 5s^2 + 6s = 0$

b) $s^3 + 2s^2 + 4s + 8 = 0$

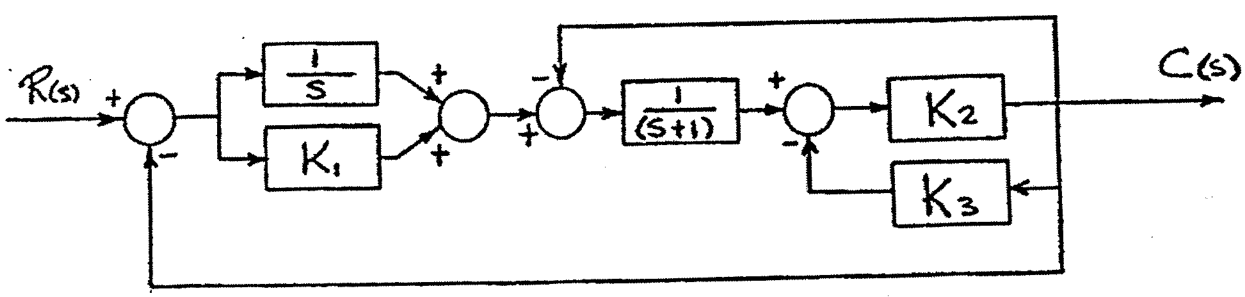
c) $s^4 + 5s^3 + 5s^2 - 5s - 6 = 0$

Question 5

a) Reduce the block diagram shown below and find the closed loop transfer function $\frac{C(s)}{R(s)}$.

b) What is the system order number?

c) What type of steady state error would result if R(t) is a unit ramp input? Verify your answer by application of the final value theorem.



K1, K2, AND K3 ARE CONSTANTS.

TABLE 6-1

Laplace Transform Pairs

Functions of Time: $f(t)$ for $0 \le t$	Laplace Transforms: $\mathcal{L}[f(t)]$
1. $f(t)$	$\int_0^\infty f(t)e^{-st}\,dt = F(s)$
2. $x(t) + y(t)$	$X(s) + Y(s)$
3. $Kf(t)$	$KF(s)$
4. $\frac{df(t)}{dt}$	$sF(s) - f(0)$
5. $\frac{d^2f(t)}{dt^2}$	$s^2F(s) - sf(0) - \frac{df(0)}{dt}$
6. $\frac{d^nf(t)}{dt^n}$	$s^nF(s) - \sum_{l=1}^{n} s^{n-l}\frac{d^{l-1}f(0)}{dt^{l-1}}$
7. $\int_0^t f(t)dt$	$\frac{1}{s}F(s)$
8. 1 or $u(t)$	$\frac{1}{s}$
9. t	$\frac{1}{s^2}$
10. t^n for $n > -1$	$\frac{n!}{s^{n+1}}$
11. e^{-at}	$\frac{1}{s+a}$
12. te^{-at}	$\frac{1}{(s+a)^2}$
13. t^ne^{-at}	$\frac{n!}{(s+a)^{n+1}}$
14. $1 - e^{-at}$	$\frac{a}{s(s+a)}$
15. $e^{-at} - e^{-bt}$	$\frac{b-a}{(s+a)(s+b)}$
16. $ae^{-at} - be^{-bt}$	$\frac{(a-b)s}{(s+a)(s+b)}$
17. $\sin \alpha t$	$\frac{\alpha}{s^2+\alpha^2}$
18. $\cos \alpha t$	$\frac{s}{s^2+\alpha^2}$

TABLE 6-1 (*Continued*)

Functions of Time: $f(t)$ for $0 \le t$	Laplace Transforms: $\mathcal{L}[f(t)]$
19. $t \sin \alpha t$	$\frac{2\alpha s}{(s^2+\alpha^2)^2}$
20. $t \cos \alpha t$	$\frac{s^2-\alpha^2}{(s^2+\alpha^2)^2}$
21. $e^{-at}\sin \alpha t$	$\frac{\alpha}{(s+a)^2+\alpha^2}$
22. $e^{-at}\cos \alpha t$	$\frac{s+a}{(s+a)^2+\alpha^2}$
23. $e^{-\zeta\omega_n t}\sin \omega_n(1-\zeta^2)^{1/2}t$ for $\zeta < 1$	$\frac{\omega_n(1-\zeta^2)^{1/2}}{s^2+2\zeta\omega_n s+\omega_n^2}$
24. $e^{-\zeta\omega_n t}\sinh \omega_n(\zeta^2-1)^{1/2}t$ for $\zeta > 1$	$\frac{\omega_n(\zeta^2-1)^{1/2}}{s^2+2\zeta\omega_n s+\omega_n^2}$
25. $1 - \frac{e^{-\zeta\omega_n t}}{\sqrt{1-\zeta^2}}\sin(\omega_n\sqrt{1-\zeta^2}\,t + \phi)$ $\phi = \tan^{-1}\frac{\sqrt{1-\zeta^2}}{\zeta}$ for $\zeta < 1$	$\frac{\omega_n^2}{s(s^2+2\zeta\omega_n s+\omega_n^2)}$
26. $\begin{Bmatrix} f(t-a) & \text{where } t > a \\ 0 & \text{where } t < a \end{Bmatrix}$	$e^{-as}F(s)$