請勿答題在試題紙上

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1. (25%) The transfer function G(s) of a control system in Fig. 1(a) has the frequency-response asymptotes shown in Fig. 1(b). Over what range of values of K will the system be stable?

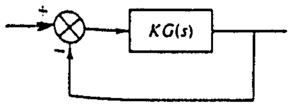

FIG. 1(a)

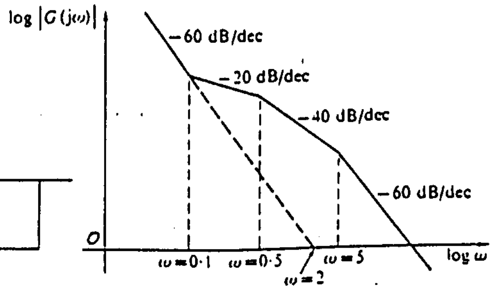

FIG. 1(b)

2. (25%) Figure 2(a) is a control system in which the transfer function G(s) is

$$G(s) = \frac{1}{s(s+1)}$$

Consider the following four controllers

a. $KH = \frac{1}{2}$

b. $K_1H_1 = 10(1+0.3s)$

c. $K_2H_2 = \frac{(1+25s)}{50s}$

d $K_3H_3 = \frac{(1+0.3s)(1+25s)}{5s}$

The Nyquist diagram of the open-loop frequency response for each of the four controllers is shown in Fig. 2(b). Fill in the curve number to the corresponding open-loop transfer function listed in the following.

( ) $K_1H_1G(s)$ ( ) $K_2H_2G(s)$ ( ) $K_3H_3G(s)$

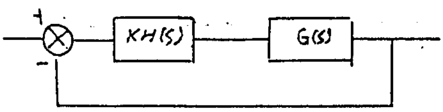

Fig. 2(a)

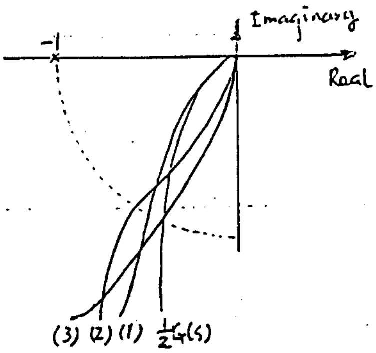

Fig. 2(b)

3. For the two classical control system design methods, namely the root-locus method of Evans and the frequency-response method of Bode. Explain which of these methods is best described by the following statements. If you feel more than one method fits a given statement equally well, say so and explain why. (15%)
   (a) This method is readily used when the plant description must be obtained from experimental data.
   (b) This method permit most direct control over dynamic response characteristics such as rise time, percent overshoot and settling time.
   (c) This method permit most direct control over the steady state error constants.
   (d) This method can be used without modification for plants that include transportation lag terms such as

$$G(s) = \frac{e^{-2s}}{(s+3)^2}$$

4. In design by the method of Bode we use lead and lag networks. For a type I system indicate the effects of these compensation networks on each of the design performance specifications listed below. Indicate the effects as *an increase*, *substantially unchanged* or *a decrease* and use the second-order plant $G(s) = \frac{K}{s(s+1)}$ to illustrate your conclusion. (15%)
   (a) Steady state error constant to step input
   (b) Phase margin
   (c) Closed-loop bandwidth
   (d) Percent overshoot

5. A standard control problem is sketched in the figure below with three alternative solutions. The signal w is the plant noise and may be analyzed as if it were a step; the signal v is the sensior noise and may be analyzed as if it contained power to very high frequencies. (20%)
   (a) Compute the values of the parameters K_1, a, K_2, K_T, K_3, d and K_D so that

$$\frac{y}{r} = \frac{16}{s^2+4s+16}$$

   in each case. Note that in the inner loop of system III a pole is to be placed at $s = -4$.
   (b) Complete the accompanied table. Express the last entries as A/s^k to show how fast noise from v is attenuated at high frequencies.

System	K_v	$\frac{y}{w}\Big\vert_{s=0}$	$\frac{y}{v}\Big\vert_{s=\infty}$
I			
II			
III			

Note that K_v stands for the steady state error constant to a step input.