AMERICAN UINVERSITY OF BEIRUT
FACULTY OF ENGINEERING AND ARCHITECTURE
EECE 460 Control Systems
Fall 2004-2005
Quiz II
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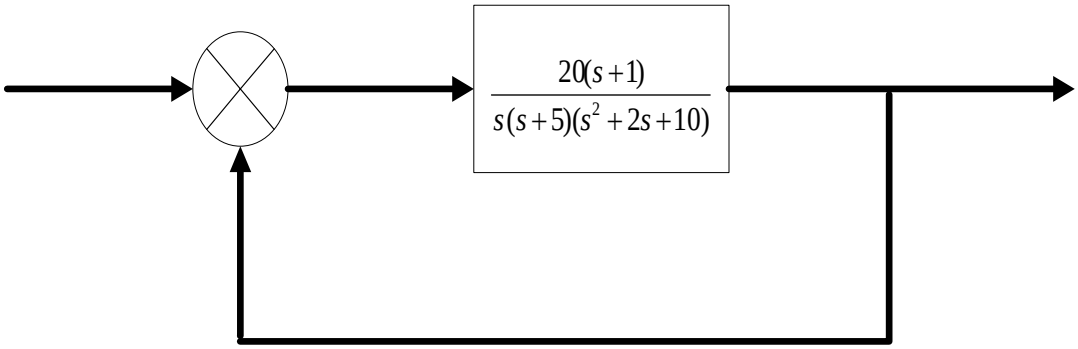
1.5 Hours, January 7, 2005
Total of 100 points; Open Book Exam, 3 pages
YOU MUST RETURN THIS EXAM WITH YOUR ANSWER BOOKLET

Problem 1 (30 points):

Consider the system shown in the Figure below.

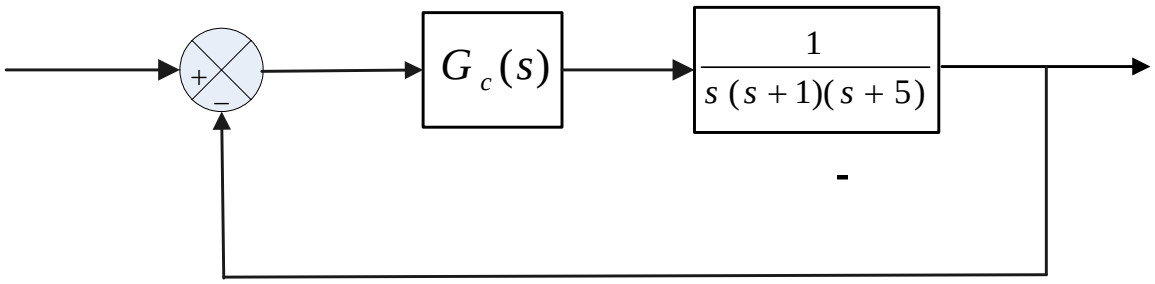


Control system with unity feedback

a) Approximate on a semi-log paper the Bode diagram of the **open-loop** transfer function $G(s)$.
b) Based on part (a), approximate graphically the phase margin and gain margin
c) Using the results of part (b), is the **Closed-loop** transfer function stable? Justify.

Problem 2 (30 points):

Consider the system shown in the Figure below.

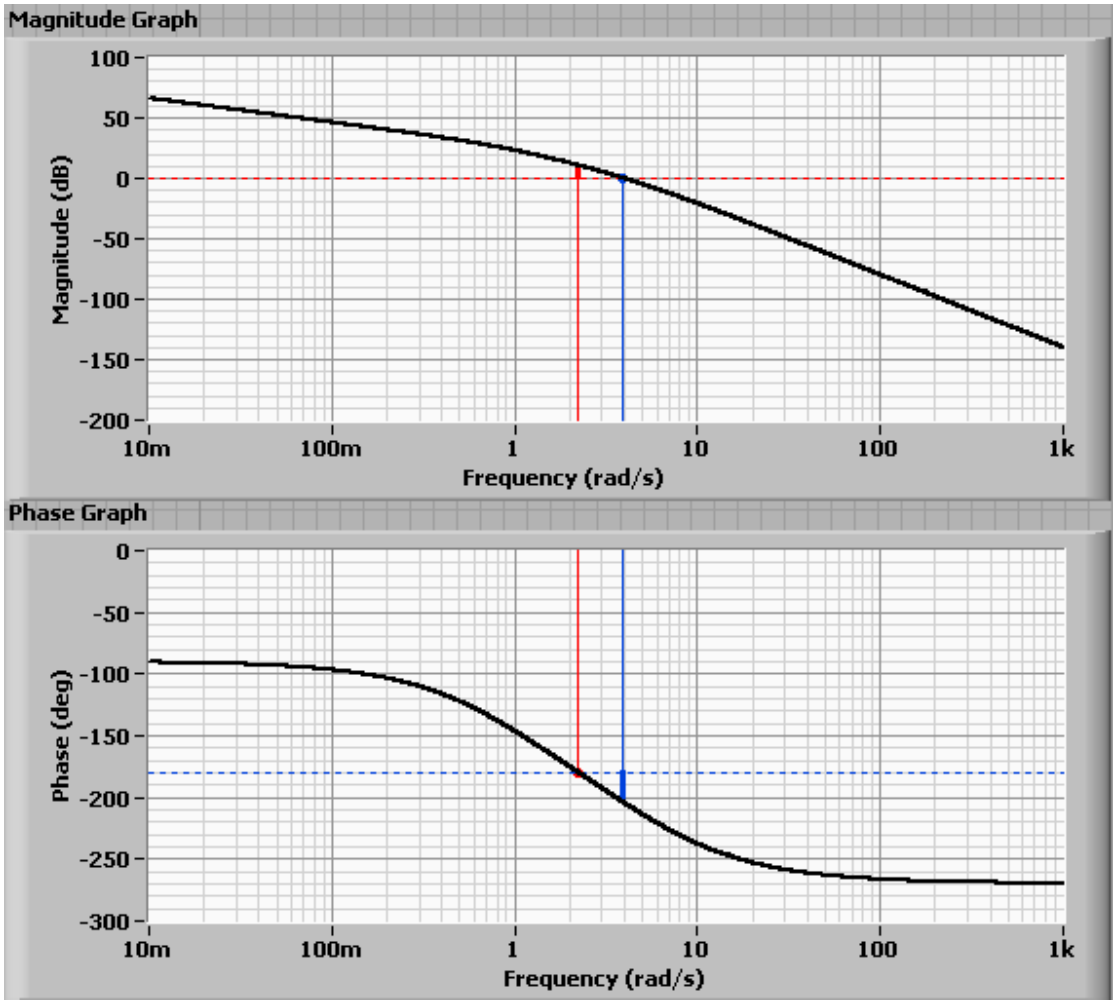


Control System with series controller

Let us assume that the compensator $G_c(s)$ is a lag-lead and has the following form:

$$G_c(s) = K_c \frac{(s+\frac{1}{T_1})(s+\frac{1}{T_2})}{(s+\frac{\beta}{T_1})(s+\frac{1}{\beta T_2})}$$

The uncontrolled open loop system bode plots with K_c = 100 corresponding to the static velocity error constant K_v is 20 sec^{-1} are



a) Design the compensator (if needed) such that phase margin is at least 60^o, and gain margin is not less than 8 dB.

b) Verify the effectiveness of the controller in meeting the desired specs.

Problem 3(40 points):

Consider the servo system described by a state model LTI. Matrices A, B, and C are given as:

$$A=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -5 & -6\end{bmatrix} \qquad B=\begin{bmatrix}0\\ 0\\ 1\end{bmatrix} \qquad C = [1\ 0\ \ 0]$$

The nonzero output reference is r(t).

a) Is the system fully controllable? Verify.

b) Determine **if possible** the feedback gain constant vector of a Pole Placement Controller using state feedback [k1, k2, k3] such that the desired closed loop poles are:

   S1 = -2 + j4 S2 = -2 – j4 S3 = -10
   we assume that all 3 states are available for feedback

c) Is the system fully observable? Verify.

d) Realistically only the output y(t) is available for feedback. Design an observer (**if possible**) to estimate on-line the internal states using only system output y(t) and input u(t).