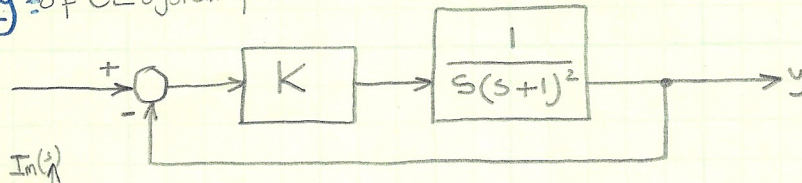<u>Issues</u>:

(0) How to determine stability of CL sys from Bode Plot of OL sys

(I) How to relate Bode plot of Open Loop system to Frequency Response specs of CL_{system} (i.e to M_p, w_p, BW) ?

(II) How to design compensators to meet specs?

<u>Stability</u> of CL system from Bode Plot of OL system

Consider

- All points on RL have the property

$1+kG=0$
$kG=-1$
$G=-\frac{1}{k}$

$$|K\,G(s)| = 1 \quad \& \quad \angle G(s) = 180°$$

- In particular, for $s = j w^*$ (corresponds to neutral stability)

$$|K\,G(j\overset{*}{w})| = 1 \qquad \angle G(j\overset{*}{w}) = 180°$$

- In agreement with RL system stable if
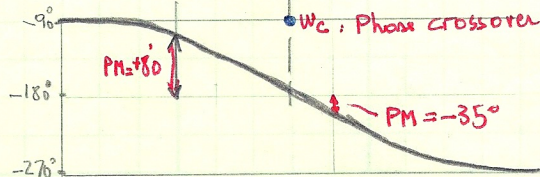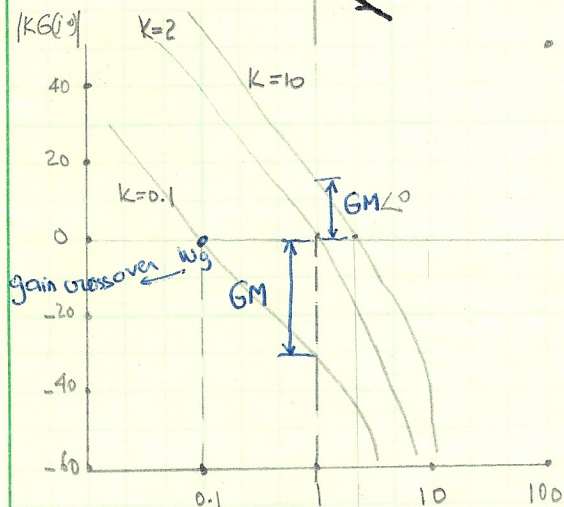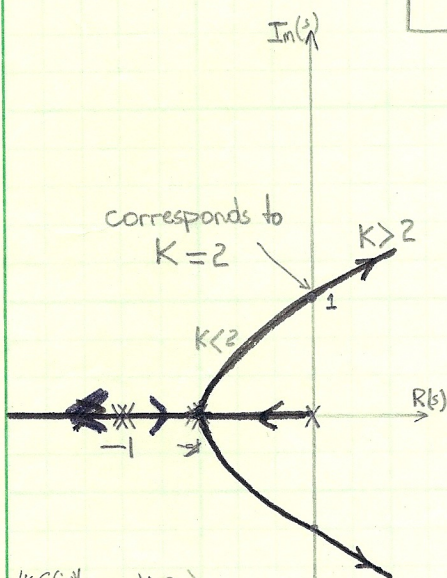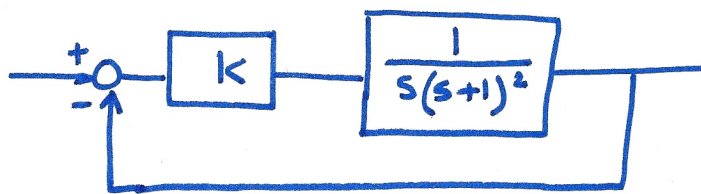
$$PM > 0$$

PM: Phase Margin

: the amount by which the phase of $G(jw)$ exceeds $-180°$ when $|K\,G(jw)| = 1$

- GM: Gain Margin
: measure of how much the gain can be raised before instability results.

$$\frac{+}{-} \rightarrow \boxed{k} \rightarrow \boxed{\frac{1}{s(s+1)^2}} \rightarrow$$

- $g = tf\left([0.1], [1\ 2\ 1\ 0]\right)$ ← corresponds to $k = 0.1$
- margin(g)

Bode Diagram
Gm = 26 dB (at 1 rad/sec) , Pm = 78.7 deg (at 0.099 rad/sec)
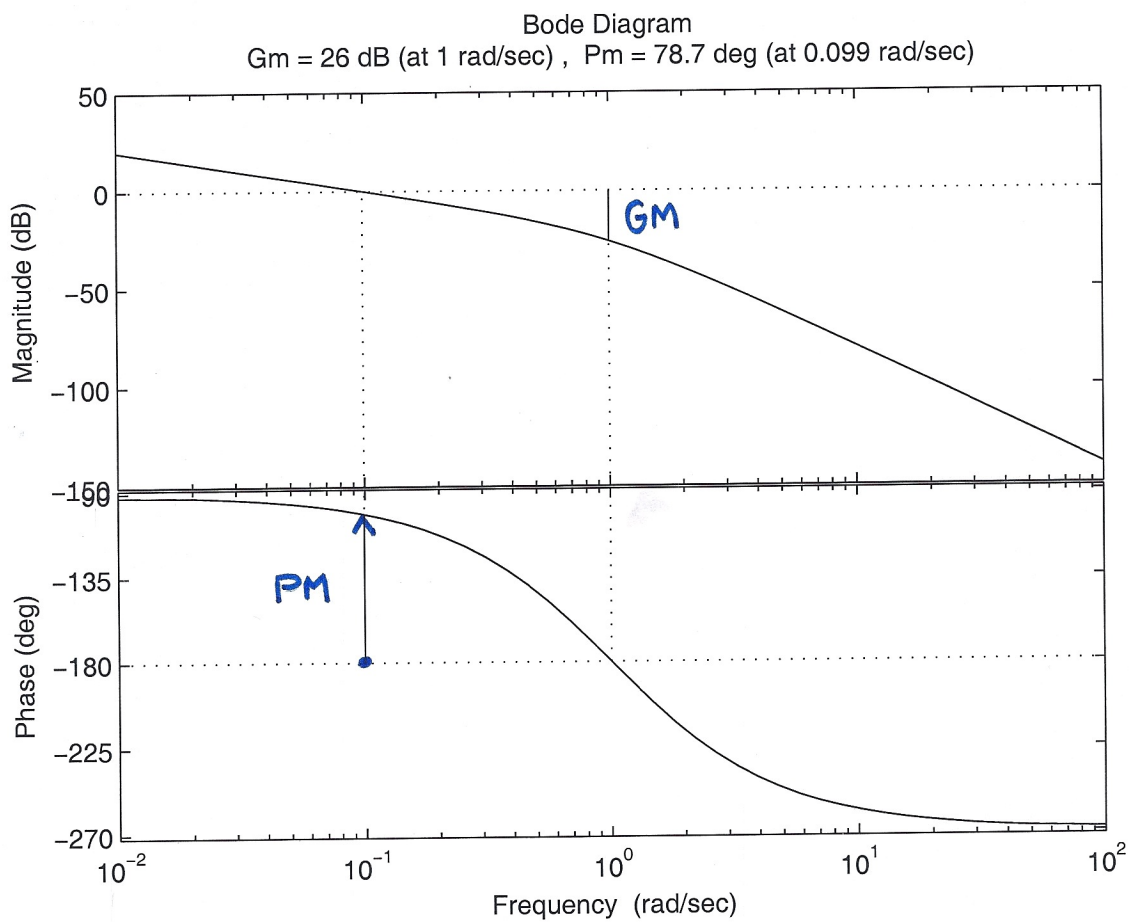
<u>Note</u>

Matlab command

• bode (g)

gives Bode Plot with no PM & GM information

Bode Diagram