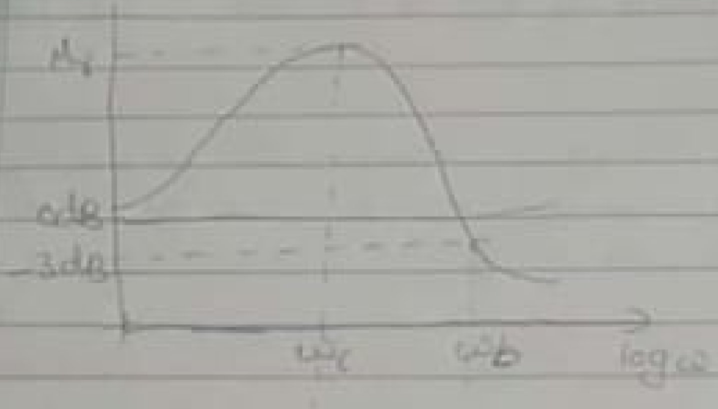
Frequency Response specifications



(1) Bandwidth:- It is defined as range of frequencies over which the s/m will respond satisfactorily
⇒
For closed loop system
⇒ Bandwidth is range of frequencies over the magnitude of closed loop response ie $\left|\frac{C(j\omega)}{R(j\omega)}\right|$ does not drop by more than 3dB from its zero response

(2) cutoff frequency:- The frequency at which the magnitude of closed loop response is 3dB down from its zero frequency value is called cutoff frequency (ω_b)

3) cutoff rate:- The slope of the resultant curve near the cutoff frequency

(4) Resonant Peak (M_r):- It is the maximum value of magnitude of the closed loop frequency response

(5) Resonant frequency (ω_r):- The frequency at which

the resonant peak M_r occurs in closed loop frequency response

(6) Gain crossover frequency (ω_{gc}) :- The frequency at which magnitude of $G(\omega)H(\omega)$ is unity is called Gain crossover frequency

7) Phase crossover frequency (ω_{pc}) :- The frequency at which phase of $G(j\omega)H(j\omega)$ is $-180°$ is called Phase crossover frequency

(8) Gain Margin :- is defined as the margin in gain allowable by which gain can be increased till s/m reaches on the verge of Instability

Positive Gain Margin :- increase in K is possible before the s/m becomes unstable, hence s/m is stable

negative Gain Margin :- K is greater than K_{max} and s/m is unstable

Mathematically :-

$$G.M = \frac{1}{|G(j\omega)H(j\omega)|_{\omega=\omega_{pc}}}$$

$$= \frac{1}{20\log|G(j\omega)H(j\omega)|_{\omega=\omega_{pc}}}$$

$$= -20\log|G(j\omega)H(j\omega)|_{\omega=\omega_{pc}}$$

(9) Phase Margin:- It is possible to introduce phase lag in the system i.e negative angles without affecting magnitude plot of $G(j\omega)H(j\omega)$

The ~~ad~~ amount of additional phase lag which can be introduced in the s/m till the system reaches on the verge of instability is called Phase Margin

Positive phase Margin: negative angle introduction is possible before s/m becomes unstable. Such s/ms are stable

negative phase Margin:- Present negative phase lag should be changed by adding positive angle. Hence s/m is unstable

Mathematically

$$P.M = [\angle G(j\omega)H(j\omega)|_{\omega=\omega_{gc}} - (-180)$$

$$= 180^\circ + \angle G(j\omega)H(j\omega)|_{\omega=\omega_{gc}}$$

possible when ...
systems.

For G.M. and P.M. positive i.e. stable system, $\omega_{gc} < \omega_{pc}$. While for G.M. ... negative i.e. unstable system, $\omega_{gc} > \omega_{pc}$.

In some absolutely stable systems G.M. may be obtained as $+\infty$ while for unstable systems G.M. may be obtained as $-\infty$.

All such G.M. and P.M. conditions are shown in figures below.

Stability Conditions :

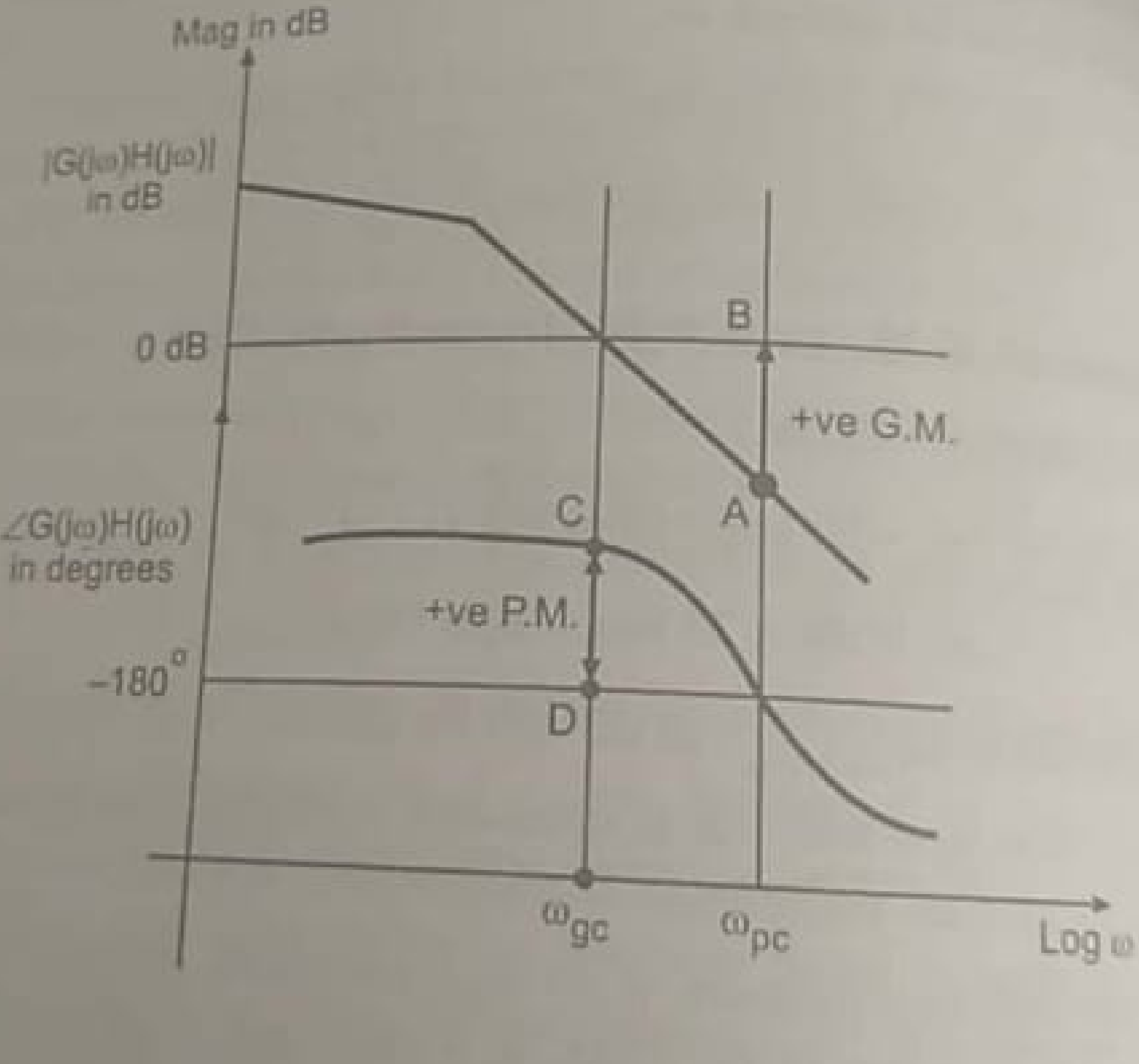


Fig. 11.21 $\omega_{gc} < \omega_{pc}$ **G.M. and P.M. positive, stable system**

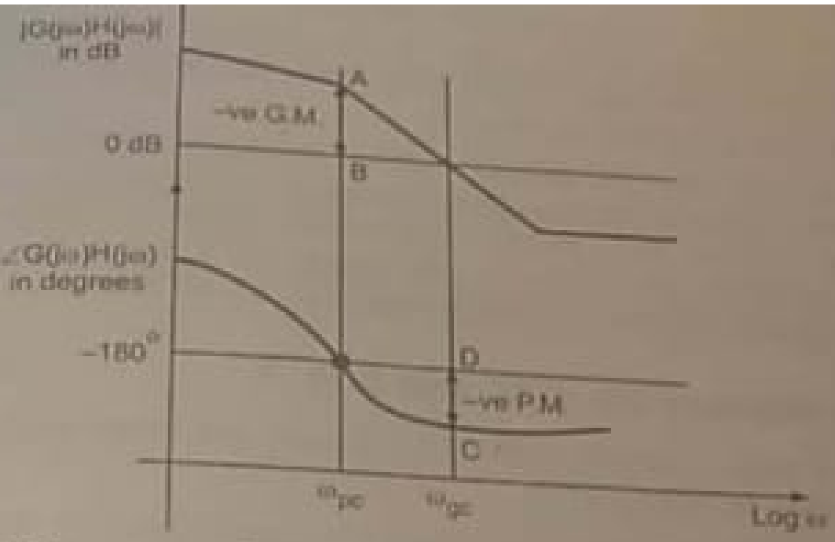


Fig. 11.22 $\omega_{gc} > \omega_{pc}$ G.M. and P.M. negative, unstable system

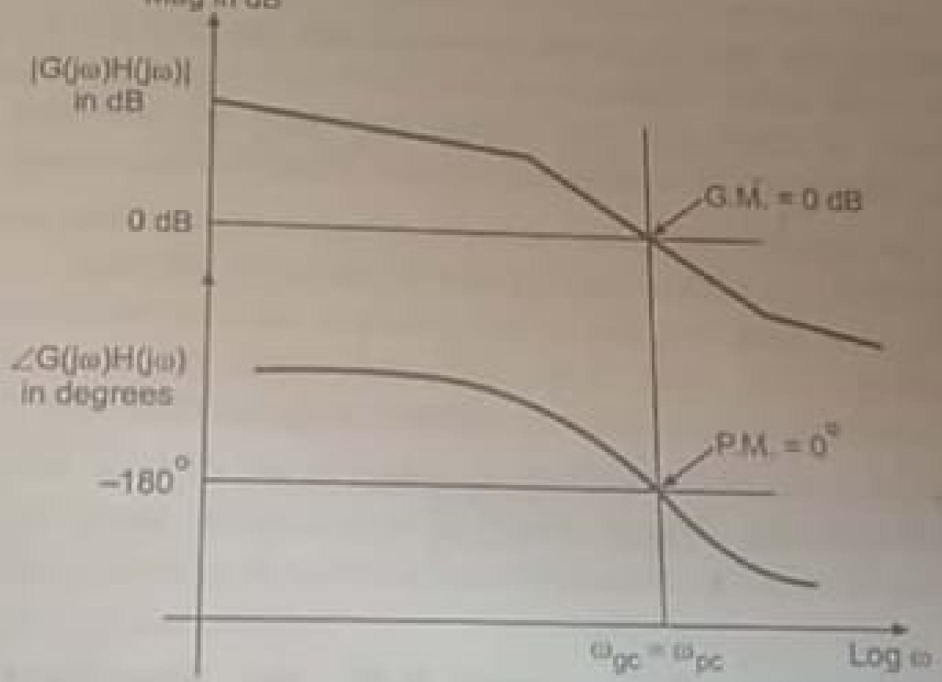


Fig. 11.23 $\omega_{gc} = \omega_{pc}$ G.M. and P.M. zero, marginally stable system

11.8 What should be Values of G.M. and P.M. of a Good System

It is obvious that a system should have gain which is lower than critical valu the system is far removed from unstable conditions.

This is necessary because for most of the systems the transfer function of co and systems changes with variation in temperature and pressures of su environment. Moreover the gains are also dependent on supply frequency, supp loading conditions, variations in control energy sources such as pneumatic air p neumatic systems).