

4. (25%) Given a unit feedback system as shown in figure 3, where  $r$  is the reference,  $y$  is the output, and  $e$  is the error.

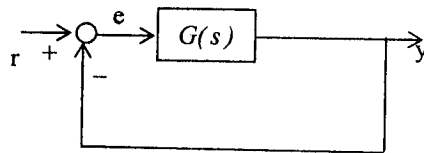


Figure 3.

The transfer function  $G(s)$  is given as:

$$G(s) = \frac{300}{s(s+5)(s+20)}$$

The Bode plot of  $G(s)$  is given below:

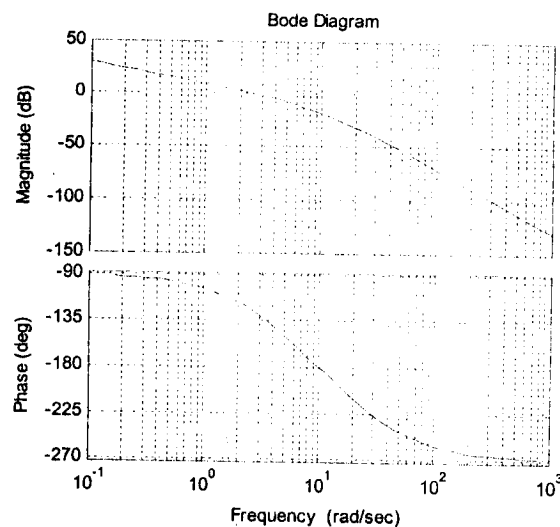


Figure 4

- (10%) Please find the approximate gain margin (GM), phase margin (PM) and cross-over frequency using the Bode diagram in figure 4.
- (5%) Use the information in (a), find the approximate settling time, rise time, and damping ratio for the closed loop system.
- (5%) Calculate the steady state errors for a *unit step* input and a *ramp* input using the transfer function  $G(s)$ ?
- (5%) Can you identify the steady state errors for a unit step input and a ramp input using the Bode plot?

5. (20%) For a linear time-invariant system,
- (5%) Explain what the asymptotic stability is;
  - (5%) Explain what the bounded-input-bounded-output (BIBO) stability is;
  - (10%) Explain why the asymptotic stability is equivalent to the BIBO stability.