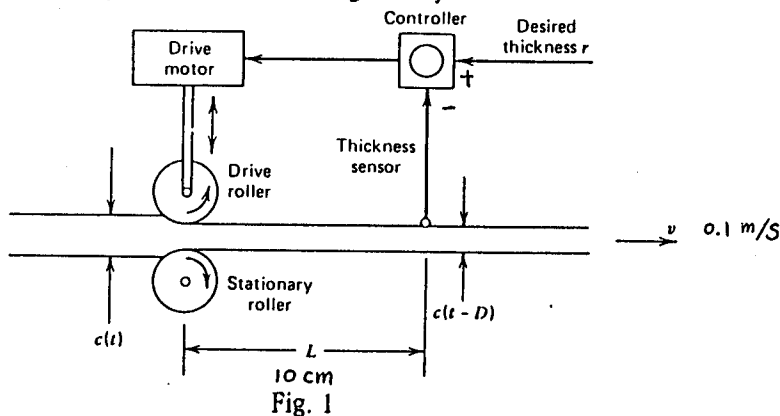


**Problem 1. (15%)** One of the advantages of feedback control is the low sensitivity of system performance to the variations of the system parameters. Pick up a plant and explain this phenomenon by comparing the closed-loop and the open loop control of that plant. (Draw block diagrams and make necessary calculations to support your results.)

**Problem 2. (15%)** The three basic feedback control actions are: the proportional, the integral and the derivative control actions. What are the effects of each action and what are the differences between these actions? Explain this using the control of a second-order system under step command inputs. (Draw block diagrams and make necessary calculations)

**Problem 3. (20%)** Propose a testing plan for evaluating the time-domain behavior of a copy machine.

**Problem 4. (15%)** Consider a thickness control system as shown in Fig. 1. The system consists of driving motor and roller, controller, thickness sensor, and material transportation subsystems. If the driving motor and roller is modeled as an integrator with appropriate gain, the controller is in proportional type, the dynamics of thickness sensor can be neglected, the material transportation is a pure time-delay process, plot the root-locus and determine the stability conditions for the given system.



**Problem 5. (15%)** Consider a feedback control system as shown in Fig. 2.1. The dynamic characteristics of the plant are tested under sinusoidal input signal with varying frequency and obtained as shown in Fig. 2.2. When

$G_c(s) = 1$ , determine and explain whether the closed-loop system is stable or not. If the system is to be operated in a noisy environment and  $G_c(s)$  is a P, D, or PD-type controller, design a controller to meet the specifications: Gain Margin = 8 db and Phase Margin =  $21^\circ$

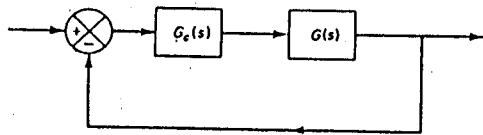


Fig. 2.1

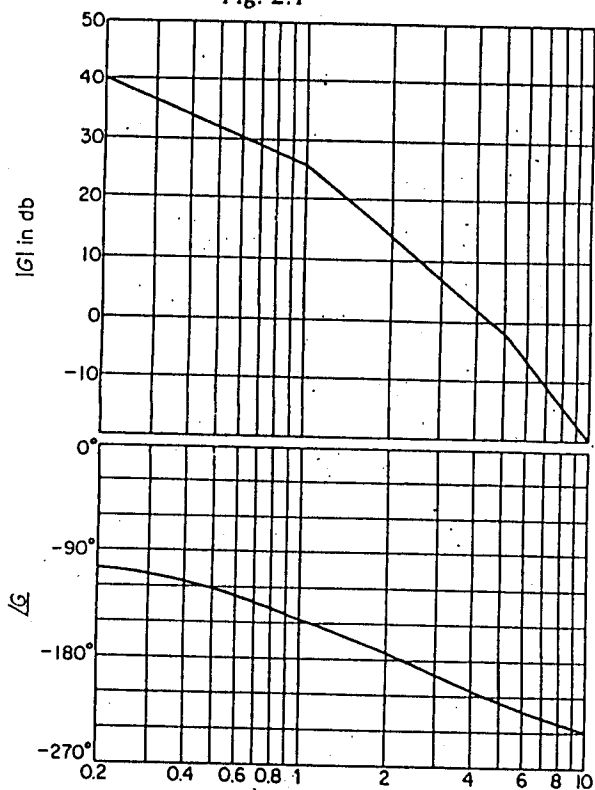


Fig. 2.2

**Problem.6 (20%)** Determine the stability of the followed control system from the Nyquist diagram of the system. What is the gain margin of this system? If there is a time delay between the controller block and the plant, what would be the change in the gain margin?

