System Description

The system presented in this section (Phillips, Chakraborty and Nagel, n.d.) is a second-order position control system (servomotor). As shown in Fig. 2-2., the system is digitally controlled by the Texas Instruments TI9900 microprocessor system. The terminal shown in the same figure is used for system initialization, parameters filtering if needed and system operation testing and it was chosen to be a Texas Instruments Microterminal. The system hardware configuration is given in Fig. 2-3.

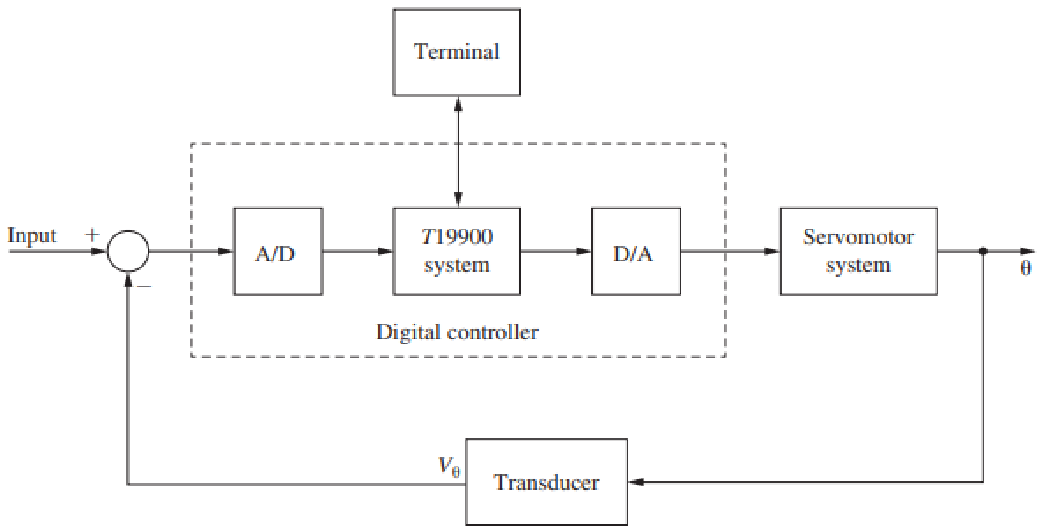

Figure 2-2 System block diagram.

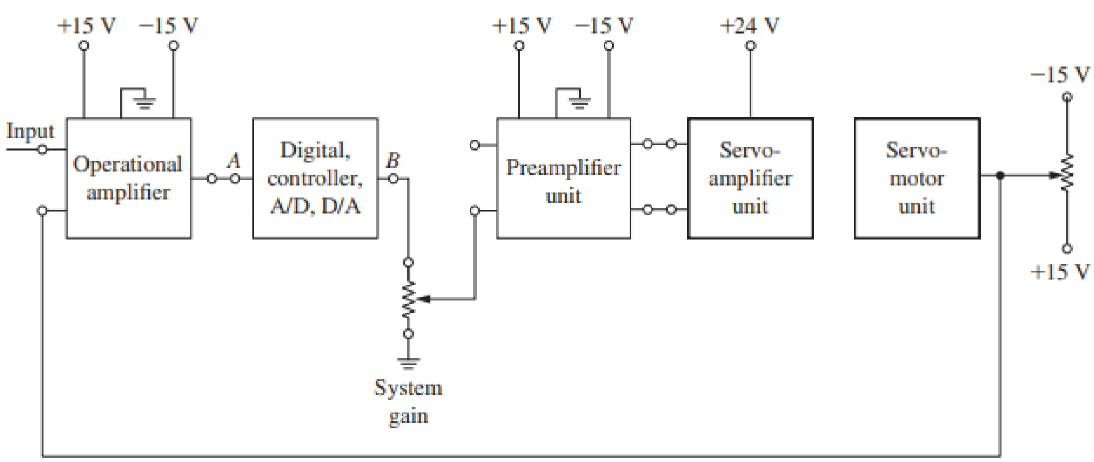

Figure 2-3 System block diagram.

System Modeling

The system model is obtained experimentally by removing the digital controller, the A/D, and the D/A shown in Fig. 2-3. Thus, in this figure, points A and B were connected. Since the servomotor is dc and armature-controlled, the system was assumed to be a second-order system, hence the plant transfer function was assumed to be

$$G_p(s) = \frac{\omega_n^2}{s(s + 2\delta\omega_n)} \tag{2-1}$$

The closed loop transfer function is

$$T(s) = \frac{G_p(s)}{1 + G_p(s)} = \frac{\omega_n^2}{s^2 + 2\delta\omega_n s + \omega_n^2} \tag{2-2}$$

Thus the system frequency response is given by

$$T(j\omega) = \frac{\omega_n^2}{(\omega_n^2 - \omega^2) + j2\delta\omega_n\omega} \tag{2-3}$$

To obtain the natural frequency of the system **(ωn)** experimentally, a sinusoidal input was applied to the system and its frequency varied till the output lagged the input by 90° in phase. **ωn** was found to be equal to 6, the damping ratio **δ** was calculated then using the amplitude T(**$j\omega n$**) = **$-j/2\delta$** and found to be equal 0.3. This method of identifying the natural frequency of a system is called a **sine sweep**.

Thus the closed loop transfer function can be written as

$$T(s) = \frac{36}{s^2 + 3.6s + 36} \tag{2-4}$$