1. For the sampled-data system of Fig. 1, obtain the output mid between sampling instants.

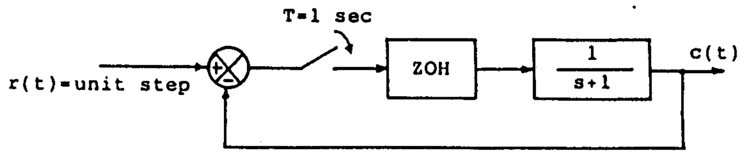

Fig. 1.

2. A discrete-time system is described by the difference equation

$$y(k+2)+5y(k+1)+6y(k)=u(k),\quad y(0)=y(1)=0;\ T=1\text{ sec}$$

Determine a state model in canonical form. Find the state transition matrix. For input $u(k)=1$ for $k \geq 0$, find the output $y(k)$.

3. The block diagram of a multiple-input multiple-output system is shown in Fig. 2. Determine the transfer matrix $P_a(s)$ such that the closed-loop transfer matrix is

$$P(s) = \begin{bmatrix} \frac{1}{s+1} & 0 \\ 0 & \frac{1}{5s+1} \end{bmatrix}$$

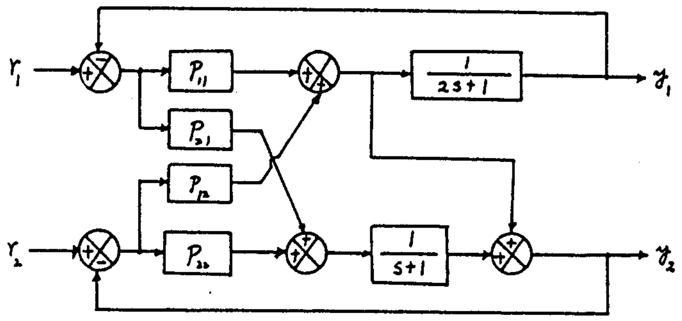

Fig. 2.

4. The closed-loop transfer function of the system is

$$\frac{C(s)}{R(s)} = \frac{1}{s^2+s+1}$$

For a unit-impulse input find $\int_0^\infty c^2(t)dt$.

5. A speed control for a gasoline engine is shown in Fig. 3.

(a) Determine the necessary gain K if the steady-state speed error is required to be less than 7% of the speed reference setting.

(b) With the gain determined from (a), utilize the Nyquist criterion to investigate the stability of the system.

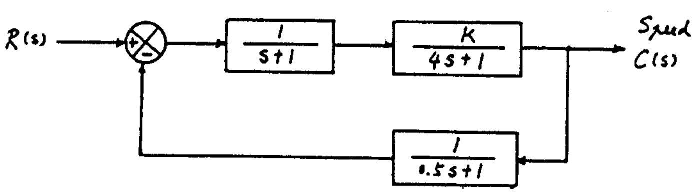

Fig. 3.