

共四題，滿分為一百分，請依序作答

1. (50%) Consider a PID control system shown in Figure P1,

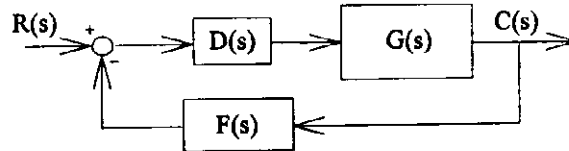


Figure P1. PID control of a system.

where

$$G(s) = \frac{k}{(1 + \tau_1 s)(1 + \tau_2 s)}, \quad D(s) = 1 + \frac{k_I}{s}, \quad \text{and} \quad F(s) = (1 + k_D s),$$
$$\tau_1 = 1, \quad \tau_2 = 0.1, \quad k_D = 0.01, \quad \text{and} \quad k_I = 0.1.$$

- (10%) Find the closed-loop transfer function ?
- (10%) Find the steady-state errors for unit step input and unit ramp input ?
- (10%) Sketch the Root Locus for $k > 0$
- (10%) Sketch the Nyquist Plot for $k = 10$.
- (10%) Plot the open-loop Bode Diagram, and find the gain margin and phase margin for $k = 10$.

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組 別： 控制組

科 目： 控制工程

2. Compute the inverse Laplace transform of the following: (10%)

$$\frac{s+1}{(s-1)^3(s+2)}$$

3. (a) If we apply $u(t) = \sin \pi t$ to a device, called a half-wave rectifier, then the output consists of the part of $u(t)$ with $u(t) > 0$, that is

$$y(t) = \begin{cases} \sin \pi t & \text{for } 2k \leq t < 2k + 1 \\ 0 & \text{for } 2k + 1 \leq t < 2(k + 1) \end{cases}$$

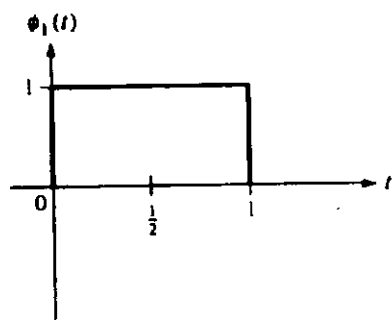
- for $k = 0, \pm 1, \pm 2, \dots$. Find the Fourier series of $y(t)$. (10%)
 (b) What are the average powers of $u(t)$ and $y(t)$? (5%)
 (c) What percentage of the input power is transmitted to the output? (5%)

4. Find a set of α_i , $i = 1, 2, 3, 4$, so that the function

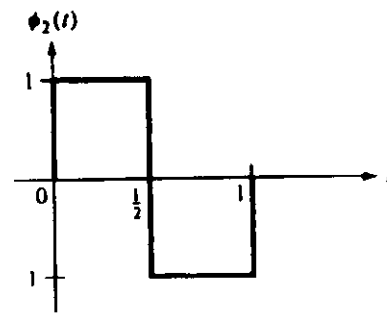
$$\bar{f}(t) = \alpha_1 \phi_1(t) + \alpha_2 \phi_2(t) + \alpha_3 \phi_3(t) + \alpha_4 \phi_4(t)$$

where $\phi_i(t)$ are as defined in Figure P4, minimizes

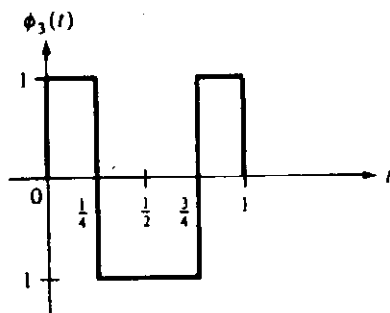
$$\int_0^1 [\sin t - \bar{f}(t)]^2 dt \quad (20\%)$$



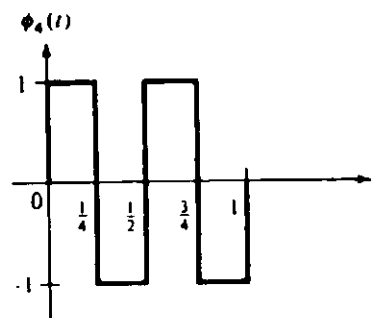
(a)



(b)



(c)



(d)

Figure P4