1. Suppose $y(s) = [(3s+5)/(s^2+2s+5)]r(s)$ and $r(s) = 1/s$, please determine $y(t)$, the peak time (t_p), and the maximumn overshoot (M_p), where $\dot{y}(t = t_p) = 0$ and $M_p = y(t_p) - 1$. (20%)
2. For the system shown in Figure 1, where $G(s) = (s+1)/(s^2(s+3))$ and $G_1(s) = (s+1)/(s+2)$. Please determine the system type. (10%)
3. The magnitude asymptote of a Bode plot of $G(s)$ is shown in Figure 2. Please determine $G(s)$ in terms of ω_1 and ω_2, where all zeros and poles of $G(s)$ are in left half plane and are real. (10%)
4. Assume an open loop $G(s) = \omega_n^2/(s(s+2\zeta\omega_n))$ with unity feedback. Please show that the phase margin $PM = tan^{-1}(2\zeta/\sqrt{\sqrt{1+4\zeta^4} - 2\zeta^2})$. (10%)
5. Please determine the Z-transform of the transfer function of the zero-order hold and explain its physical meaning. (12%)
6. The first-order hold can be realized by

   $$e_n(t) = e(nT) + e'(nT)(t - nT), \quad n = 0, 1, 2, \ldots$$

   where $nT \le t < (n+1)T$ and $e'(nT) = \{e(nT) - e[(n-1)T]\}/T$. If the input of the first-order hold is $e(t) = 1$, as $t = 0$; and $e(t) = 0$, as $t \neq 0$. Please determine and plot the output $e_{out}(t)$ of the first-order hold. (12%)
7. Let $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$, please find $sin(At)$. (10%)
8. Consider a system, $\dot{X} = AX + BU$ and $Y = CX + DU$. Let $\bar{X} = PX$, where P is a nosingular matrix. Please determine the equivalent system, $\dot{\bar{X}} = \bar{A}\bar{X} + \bar{B}U$ and $Y = \bar{C}\bar{X} + \bar{D}U$. Please prove that the transfer function matrices of these two systems are the same. (16%)

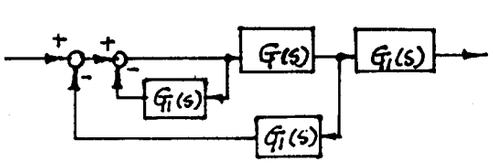

Figure 1

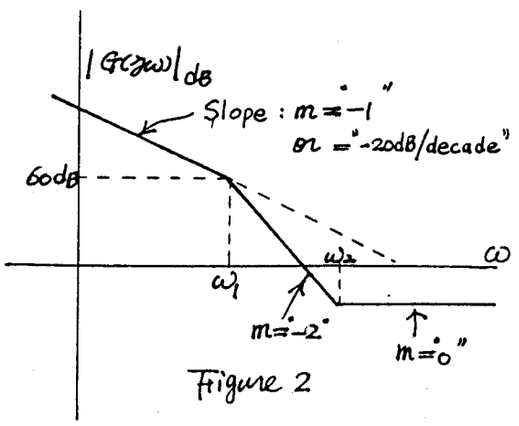

Figure 2