國立台灣科技大學九十五學年度碩士班招生試題

系所組別： 自動化及控制研究所碩士班丙組

科　　目： 控制系統

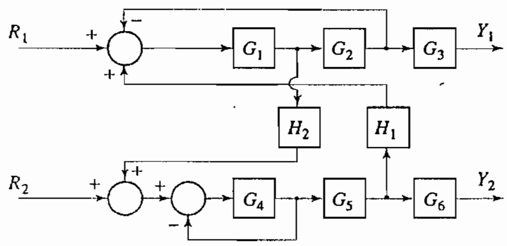
總分100分

1. The block diagram of a feedback control system is shown below. The input-output relation is of the form (15%)

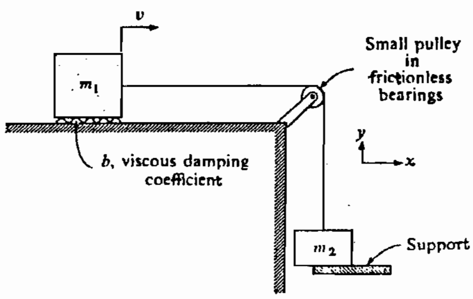
$$Y(s) = G(s)R(s)$$

where $Y(s)=\begin{bmatrix} Y_1(s) \\ Y_2(s) \end{bmatrix}$; $R(s)=\begin{bmatrix} R_1(s) \\ R_2(s) \end{bmatrix}$

Find the transfer function matrix G(s).



2. A system consisting of two masses, m_1 and m_2, connected by a flexible but inelastic cable (i.e., cable stiffness is very large) is originally held in equilibrium by having a support under the mass m_2 as shown in the figure below. (15%)



Draw a simple lumped parameter model of this system involving translational elements which move in the x direction only. Include an input to this system which is equivalent to removing the support in the real system. Then, find **v** as a function of time after the support is removed. Make a clearly labeled sketch of this system response, showing all its salient features.

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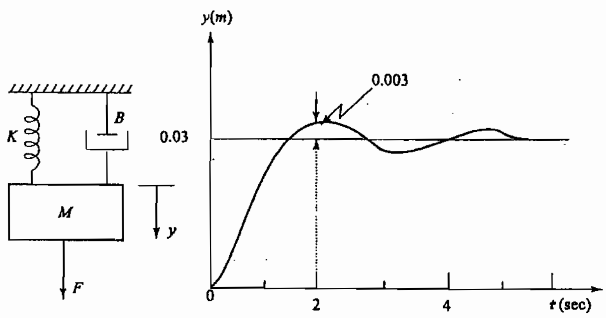
3. The differential equations of a fluid system consisting of two tanks connected through a long frictionless pipe, having a flow input Q_{in} are: (15%)

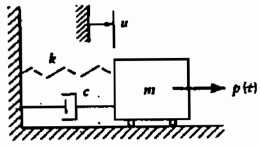
$$C_1\dot{P}_1 = Q_{in} - Q_P$$
$$C_2\dot{P}_2 = Q_P$$
$$I\dot{Q}_P = P_1 - P_2$$

Identify the state variables, and find the transfer function $\frac{Q_P(s)}{Q_{in}(s)}$.

4. The figure below shows a mechanical vibrating system. If the system is at rest and let the displacement of the mass measured relative to static equilibrium position. When 9 Newton of force is applied to the system, the mass oscillates as shown. Determine the parameters M, B and K of the system from the response. (10%)



5. The system shown has k=40 lb/in, the damping ratio $\zeta = 0.2$, and the mass weighs 38.6 lb. If the system is at rest, that is, $u(0) = 0$, $\dot{u}(0) = 0$, when an excitation $p(t) = 10\cos(10t)$ commences, determine an expression for the resulting motion. (15%)



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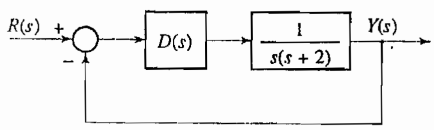
6. Consider the type-1 system as shown. We would like to design the compensator D(s) to meet the following specifications:
(i) Damping ratio $\zeta = 0.707$
(ii) Settling time $\leq 2\,\text{sec}$



(a)Show that the proportional control is not adequate. (5%)
(b) If the proportional plus derivative control can work, find the proportional and derivative constants. (10%)

7. A sketch of a laboratory experiment in a fluid (water) flow is shown in the figure below.
Assume that the flow through the equal-sized holes A, B and C is described by

$$Q = K\sqrt{P_{in} - P_{out}}\,.$$

(a) With holes at A and C and no hole at B, write the equations of motion for this system in terms of h_1 and h_2. Assume that h_3 is 20 cm and h_2 is less than 20 cm. When h_2 is 10 cm, the outflow is 200 cm^3/min. Compute the constant K and include it in your equations. (10%)
(b) Repeat the previous step for hole A closed and B open. (5%)