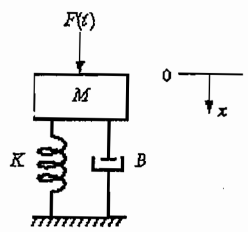
國立台灣科技大學九十五學年度碩士班招生試題

系所組別：高分子工程系碩士班丙組

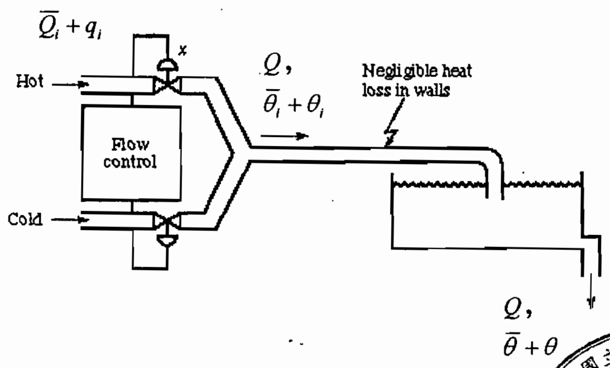
科　　目：控制系統

1. 共五大題，總分 100 分。 2. 請於答案卷內依序作答。

一、Following figure shows a machine of mass M mounted on a foundation using a spring of stiffness K with a damper of coefficient B in parallel. The machine generates a disturbing force $F(t) = A\sin\omega t$. Find the force transmitted to the foundation at steady-state. (15%)



二、The scheme of following figure produces a steady stream flow of fluid with controlled temperature θ. A stream of hot fluid at constant temperature θ_H is continuously mixed with a stream of cold fluid at constant temperature θ_C, in a mixing valve. The valve characteristic is such that the total flow rate $Q\,(m^3/\text{sec})$ through it is maintained constant but the inflow $q_i(t)\,(m^3/\text{sec})$ of hot fluid may be linearly varied by controlling valve stem position $x\ (q_i = K_v x)$. The valve stem position x thus controls the temperature $\theta_i(°C)$ of the outflow from the mixing valve. Due to the distance between the valve and the point of discharge into the tank of volume $V(m^3)$, there is a time delay of τ_D sec between the change in θ_i and the discharge of the flow with the changed temperature into the tank. Derive a transfer function model $\theta(s)/\theta_i(s)$, and a linear relationship between θ_i and x for small perturbations about the equilibrium operating point $\overline{Q_i}$, $\overline{\theta_i}$, $\overline{\theta}$. Given: $\frac{Q}{V}=1,\ \ \tau_D = 1.5,\ \ K_v = 0.5$ (15%)



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三、Consider a second-order model (30%)

$$\frac{Y(s)}{R(s)} = G(s) = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}; 0 < \zeta < 1$$

Find the response y(t) to the input

(a) $r(t) = \mu(t)$, a unit step function

(b) $r(t) = t\mu(t)$, a unit ramp function

Find the steady-state component y_{ss} of y(t) in each case.

Will the final value theorem give the correct value of y_{ss} in each case? Why?

四、A closed-loop control system is to be designed for an underdamped response to a step input. The specifications for the system are as follows:

Percent overshoot $\leq$ 1.5%

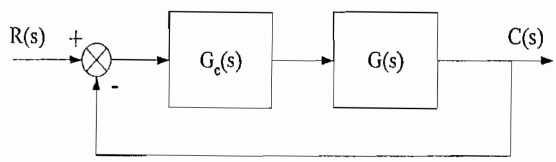
Settling time $\leq$ 2.5 seconds (Use a 2% settling criterion)

(a) Sketch the region in the s-plane in which the dominant poles of the system should be located. (8%)

(b) The control system has the plant (12%)

$$G(s) = \frac{4}{s^2 + 6s + 4}$$

Design a PID controller $G_c(s)$ so that the closed-loop system has a real pole at -10, the settling time of 2.5 seconds and the percent overshoot of 1.5%.



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五、A unity feedback system has a process

$$G(s) = \frac{K(s+\alpha)}{s(s+1)(s+10)}$$

(a) Find the value of α so that the system will have a settling time of 4 seconds for large values of K. (Use a 2% settling criterion) (5%)

(b) Sketch the root locus for $0 < \alpha < \infty$, with $K = 4$. Also find all the critical points, such as breakaway points, asymptotes, $j\omega$-axis crossing, and so on. (15%)