編號： 73

國立成功大學 108 學年度碩士班招生考試試題

系　　所：機械工程學系

考試科目：自動控制

考試日期：0223，節次：1

※考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (25%)

The frequency response is defined as the steady-state response of a system to a sinusoidal input signal.

(1) (10%) For an absolute stable system with transfer function G(s) **prov**e that the frequency response of the system is just G(jω). Write down details of your derivation.

(2) (10%) If the system G(s) is not absolutely stable, design a method to obtain its frequency response.

(3) (5%) Sketch the Bode diagram of G(s) = (1+10s)/(s+s^2). First draw the asymptotes and located the corner frequencies then modification of the curves.

2. (25%)

The stability of a closed-loop system can be determined by the frequency response (function) of its loop transfer function.

(1) (5%) What is the Nyquist stability criterion?

(2) (5%) Explain why when the loop transfer function becomes -1 the closed-loop system becomes unstable?

(3) (15%) Given the loop transfer function GH(s) of a system as following, determine the stability of the closed-loop system using the Nyquist stability criterion.

$$\mathrm{GH}(s)=\frac{s+2}{s^2(s+4)}$$

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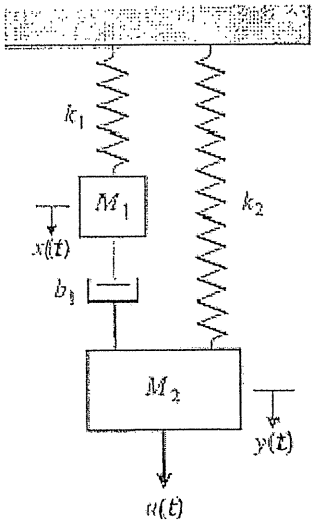
3. (25%)

A spring-mass-damper system is shown below. Where k_1 and k_2 represent the spring constant with unit *N/m*; M_1 and M_2 represent the mass with unit *Kg*; b_1 represents the damping constant with unit *N.s/m*; *x(t)* and *y(t)* represent the position with unit *m*; *u(t)* represents the input with unit *N*.

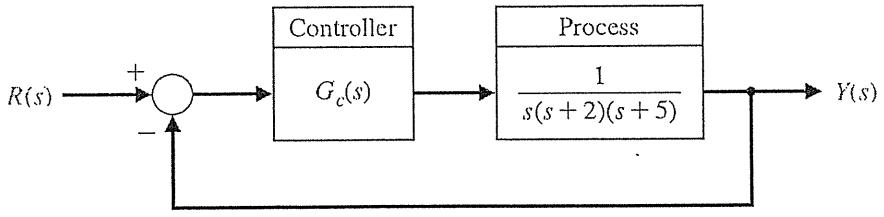
(1) (10%) Derive the differential equations first and then find the transfer functions from *u(t) to y(t)* (i.e. *Y(s)/U(s)*).

(2) (15%) It's known that when $k_1 = k_2 = M_1 = M_2 = b_1 = 1$, *Y(s)/U(s)* has two poles at (-1). Now, you plan to build a unit-feedback system with a proportional controller *K*, please draw the root locus diagram.

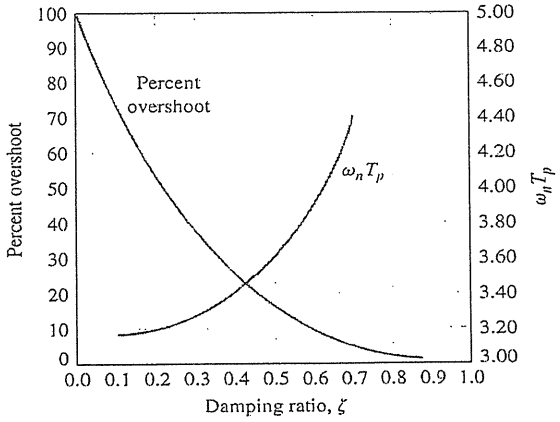


4. (25%)

A system is shown below. Please design a PD-controller $G_c(s)$ to make the step response has a percent overshoot *P.O.<=20%* and settling time $T_s<3$.



(reference data)



Damping ratio ζ	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
$\cos^{-1}\zeta$ (degree)	84	78	73	66	60	53	46	37