

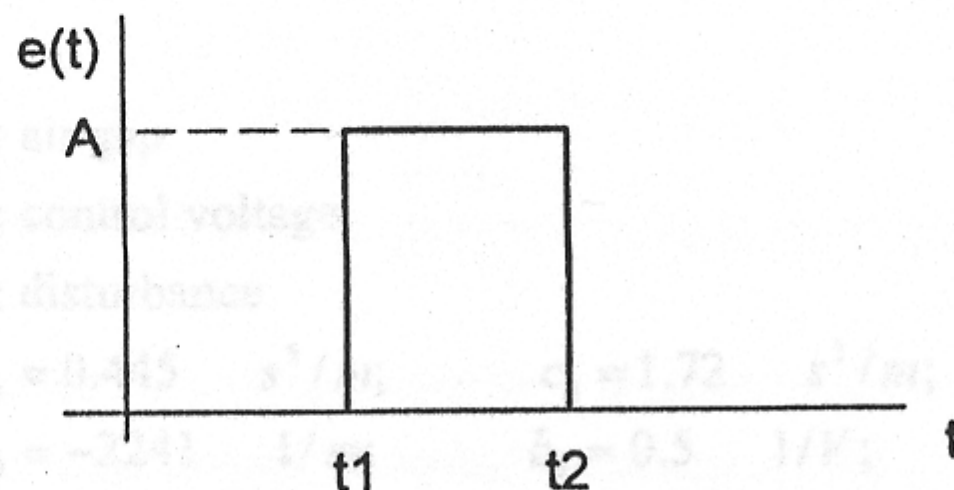
國立臺灣科技大學
八十八學年度碩士班招生考試試題

系所別：工程技術研究所碩士班
自動化及控制學程

組別：丙組

科目：控制系統

1. (a) Find the Laplace transform of the signal $e(t)$. (5%)



- (b) f_p is a periodic function with period T

$$f_p(t) = f_p(t+T)$$

and f_p is defined as

$$f(t) = \begin{cases} f_p(t) & 0 < t < T \\ 0 & T < t \end{cases}$$

Please use the Laplace transform of $f(t)$ to describe the Laplace transform of $f_p(t)$ (6%)

- (c) Given

$$G(s) = \frac{1-e^{-s}}{s(1-e^{-4s})}, \quad \text{Re}(s) > 0$$

Find the inverse Laplace transform (7%)

and plot $g(t)$ (2%)



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2. A train suspended by magnetism shown in the following Fig. can be described by the differential equation

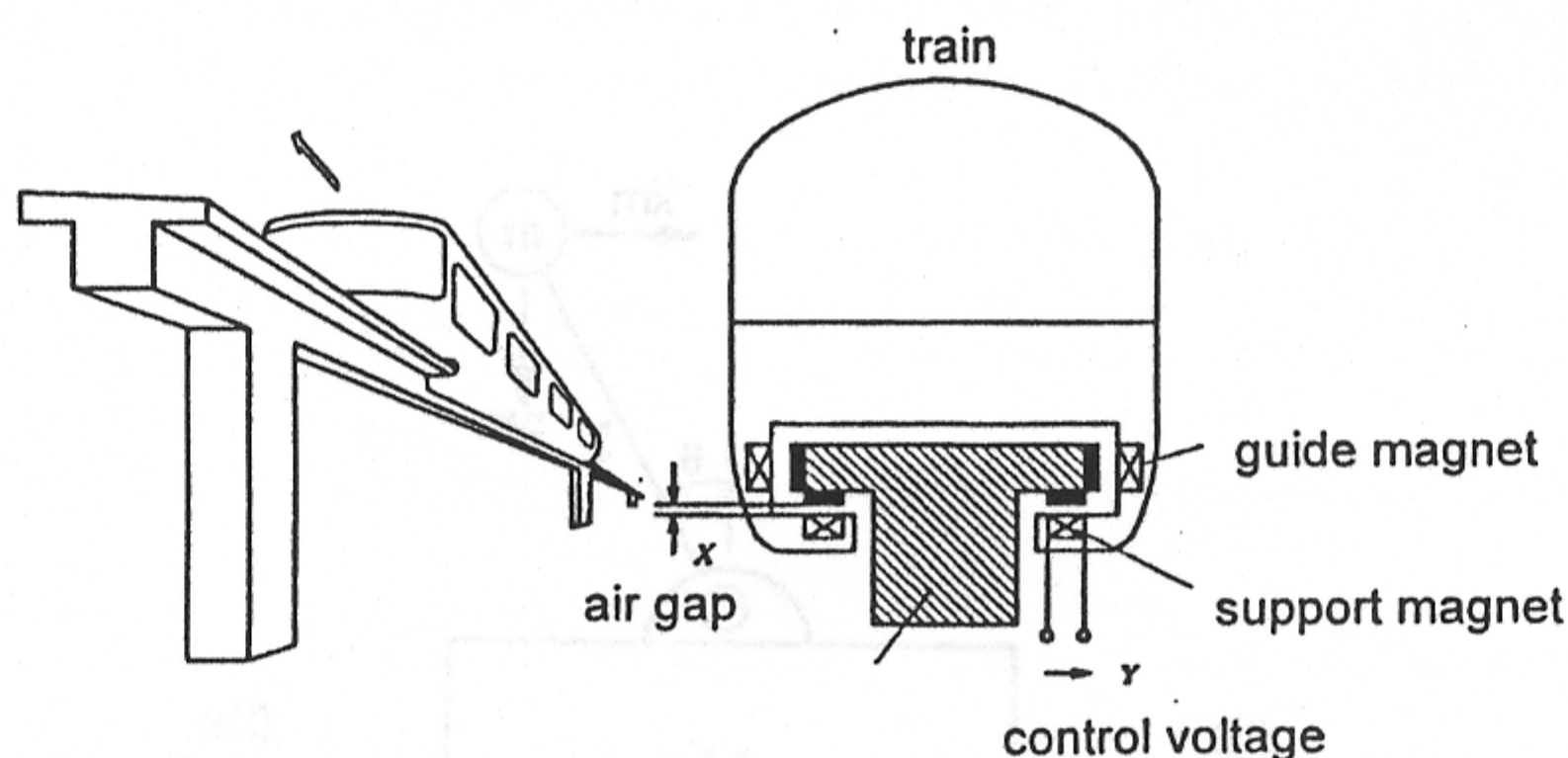
$$c_3 \ddot{x} + c_2 \dot{x} + c_1 x + c_0 = b_0 y - k_z z$$

where

 x : air gap y : control voltage z : disturbance

$$c_3 = 0.445 \text{ s}^3/m; \quad c_2 = 1.72 \text{ s}^2/m; \quad c_1 = -288.3 \text{ s}/m$$

$$c_0 = -2241 \text{ 1}/m; \quad b_0 = 0.5 \text{ 1}/V;$$



- (a) Investigate the system without control (i.e. $y=0$) stable, or not? (7%)
 (b) If a PD-controller $[K_R(1 + T_V \cdot s)]$ is used, calculate the stable range of the parameters K_R and T_V with the help of Hurwitz criterion (8%)
 (c) To improve the control error, a PID-controller

$$K_R(1 + \frac{1}{T_M} \frac{1}{s} + T_V \cdot s)$$

with the parameters

$$K_R = 5500 \text{ V}/m; \quad T_V = 0.2 \text{ s}; \quad T_n = 0.8 \text{ s} \text{ are used.}$$

Determine with the help of the Routh criterion, if the control system is stable? (10%)



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3. An inverted pendulum is mounted on a wagon shown in the following figure.

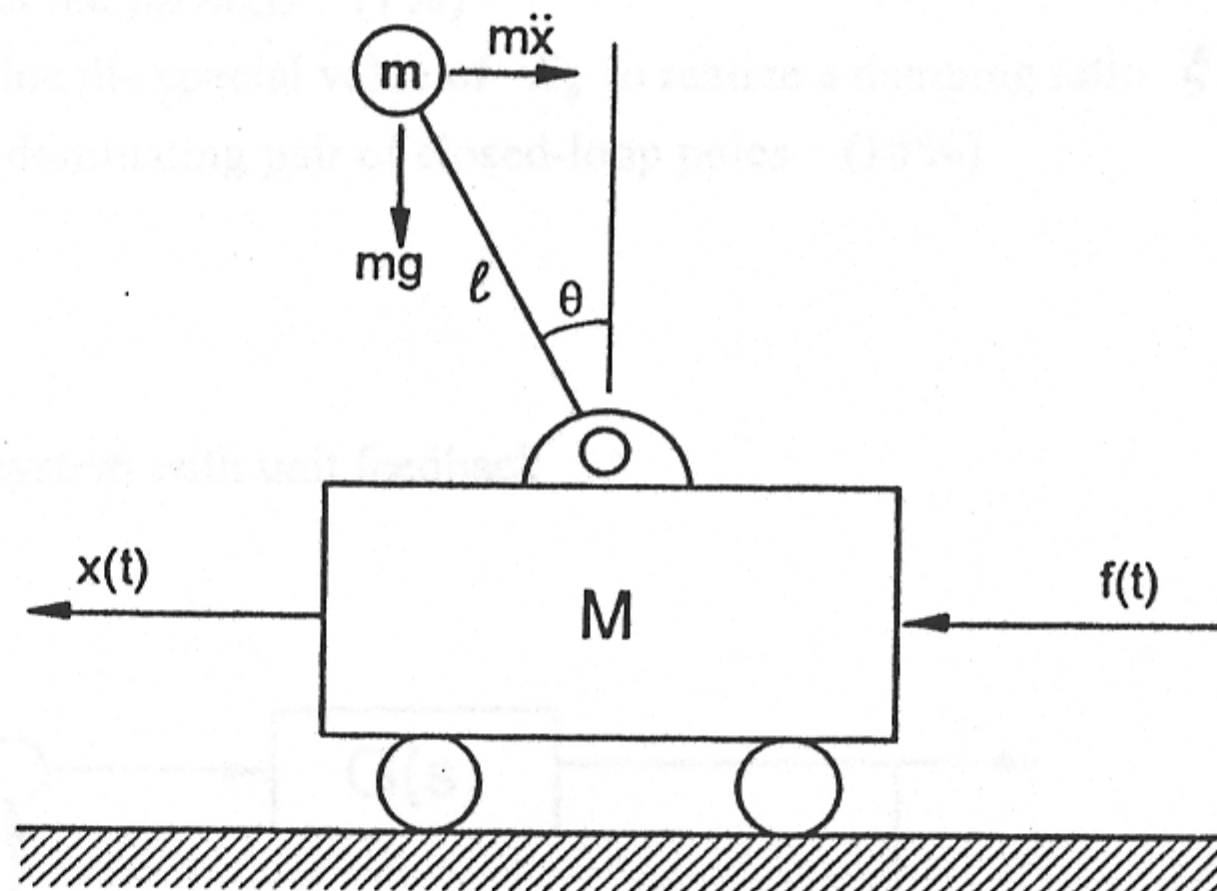
Assume the rod between pendulum and wagon is rigid. The car has to be moved to keep the mass m at the middle position. Such a system can be described by

$$M\ddot{x} + ml\ddot{\theta} - f(t) = 0$$

$$ml\ddot{x} + ml\ddot{\theta} - mgl\theta = 0$$

Assume $M \gg m$ and θ is quite small, $f(t)$ is the external force on the wagon.

- describe the system with state space representation. (8%)
- prove the system is stable or unstable. (7%)



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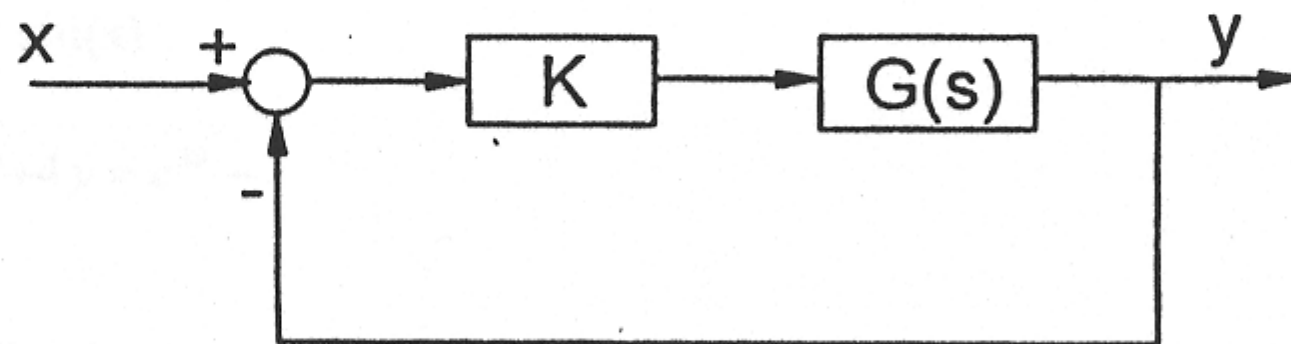
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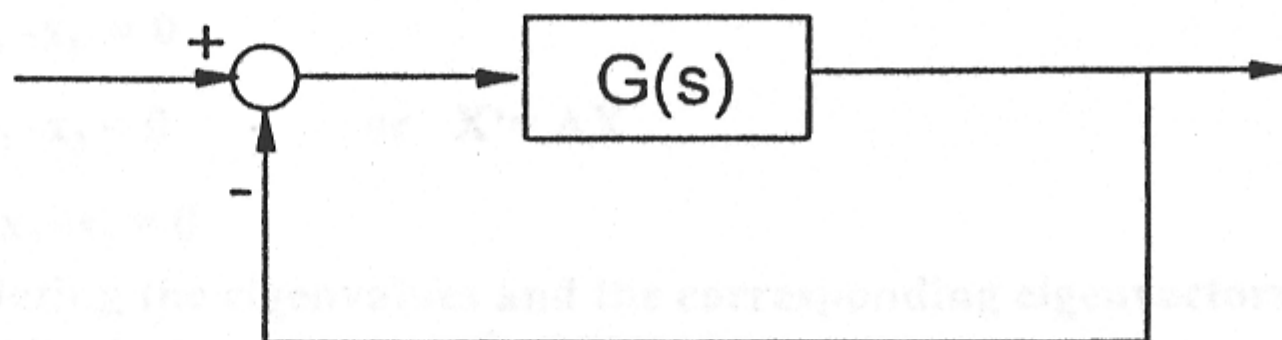
4. Consider the feedback system

where K is a constant proportional controller

$$G(s) = \frac{1}{s(s+2)(s+4)}$$

- sketch the loci of the closed-loop pole for varying K (8%)
- describe the system stability from K , and the point where the branches intersect the $j\omega$ -axis (7%)
- determine the special value of K_0 to realize a damping ratio $\xi = 1/\sqrt{2}$ for the dominating pair of closed-loop poles (10%)

5. Consider a system with unit feedback



$$\text{where } G(s) = \frac{2}{s-1}$$

- sketch the Nyquist plot (9%)
- determine the phase margin and gain margin (6%)

