國立臺北科技大學九十八學年度碩士班招生考試

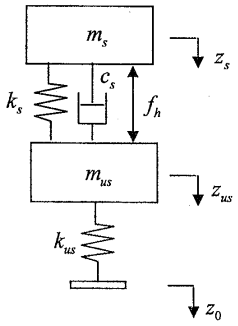
系所組別：1320 車輛工程系碩士班乙組

第一節　自動控制　試題

注意事項：

1. 本試題共四題，配分共 100 分。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

一、Quarter-car model is often used for active suspension design analysis. m_s is the sprung mass; m_{us} is the unsprung mass; k_s and c_s are the spring constant and damping coefficient of the suspension; k_{us} is the spring constant of the tire; z_s and z_{us} are the vertical displacements of m_s and m_{us}, respectively. The subscripts s and us denote for the sprung mass (vehicle body) and unsprung mass (wheel), respectively. z_0 is the road unevenness. f_h is the active force generated by a hydraulic actuator. The actuator dynamics can be modeled as $\tau \dot{f}_h + f_h = f_{in}$, where f_{in} is the force command. Please write the equation of motion in the **state-variable** form, i.e. $\dot{\boldsymbol{x}} = \mathbf{A}\boldsymbol{x} + \mathbf{B}u + \mathbf{G}w$, using the control input $u = f_{in}$, the disturbance input $w = \dot{z}_0$, and the state vector $\boldsymbol{x} = \left[z_{us} - z_0 \quad \dot{z}_{us} \quad z_s - z_{us} \quad \dot{z}_s \quad f_h\right]^T$. (20%)



二、Suppose that unity feedback is to be applied around the following open-loop system $KG(s)$. Is it possible to have all the closed-loop poles located on the left-hand side of $s = -1$? If yes, what is the allowed arrange of gain K? (20%)

$$KG(s) = K\frac{1}{s\left(s^2 + 4s + 16\right)}$$

三、A servomechanism has the plant transfer function

$$G(s) = \frac{1}{s(s+2)(s+5)}$$

You are asked to design a series compensation transfer function $D(s)$ in the unity feedback configuration to meet the following closed-loop specifications:

- The response to a reference step input is to have no more than 10% overshoot.
- The response to a reference step input is to have a rise time of no more than 0.4 sec.
- The steady-state error to a **unit ramp** at the reference input must be less than 0.01.

1. Design a lead compensator $D(s) = K\frac{s+z}{s+p}$ that will cause the system to meet the dynamic response specifications. (30%)
2. Design a lag compensator to be used in series with the lead compensator you have designed to make the system to meet the steady-state error specification. (10%)

四、For the plant P(s) = $\dfrac{s+5}{(s+0.5)(s-2)}$

1. Obtain a rough sketch of the Nyquist plot with K=1 (15%). You need to show the point where the Nyquist locus intersects with the real axis.
2. What is the range of K for a stable closed-loop system? (5%)