國立臺北科技大學九十五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

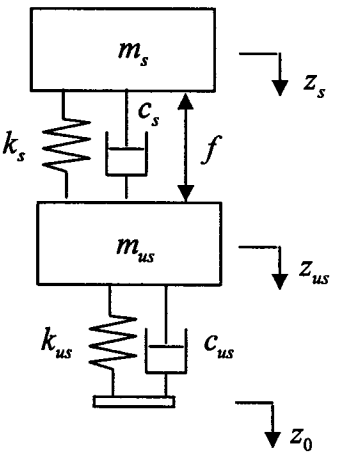
第一節 自動控制 試題

填 准 考 證 號 碼

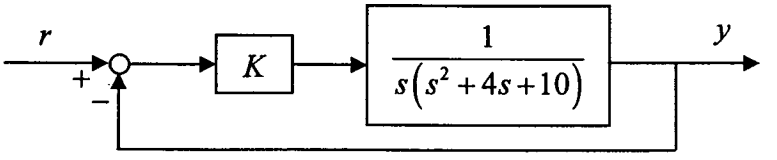
注意事項：

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 is the mass, k is the spring stiffness, c is the damper coefficient, and z is the vertical displacement. The subscripts s and us denote for the sprung mass (vehicle body) and unsprung mass (wheel), respectively. z_0 is the road unevenness. If f is the active force generated by a hydraulic cylinder, 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 input $u = f$ and the state vector $\boldsymbol{x} = \begin{bmatrix} z_{us} - z_0 & \dot{z}_{us} & z_s - z_{us} & \dot{z}_s \end{bmatrix}^T$. Please use the road velocity input for the disturbance input, i.e. $w = \dot{z}_0$. (20%)



二、A closed-loop control system is shown below. Engineering analysis shows that all the poles have to be away from the Imaginary axis ($\mathrm{Re}(s) < -1$). Please find the range of K to achieve this requirement. (20%)



三、A servomechanism has the plant transfer function

$$G(s)=\frac{1}{s(s+2)(s+8)}$$

You are 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 15% 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. (Hint: Due to the noise constrain, the pole should be located no less then –40. Select the desired poles to be $s_0=-4\pm jN$, where N is the integer that will satisfy the s-plane constrain. You are only required to design the compensator using the selected N.) (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、From the following Bode plot, reconstruct the transfer function (10%). What is the phase margin? (5%). Please calculate how much time delay is enough to de-stabilize the system (5%)