# 國立臺北科技大學 104 學年度碩士班招生考試

## 系所組別：1302 車輛工程系碩士班

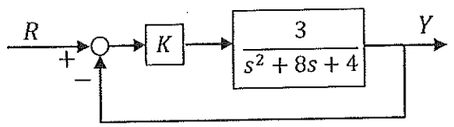
## 第三節　自動控制　試題（選考）



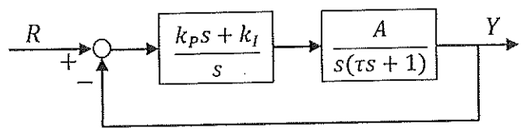
**注意事項：**

1. 本試題共五題，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、 In order to guarantee the stability of the system, please find the range of K such that all the closed-loop poles are located on the left side of s = –1. (15%)




二、 For the system with PI control, please find the system type and error constant with respect to the reference input $R$. (15%)




三、 The transfer function of a loudspeaker with circuit can be expressed as follows.

$$G(s)=\frac{X(s)}{V_a(s)}=\frac{Bl}{s\left[(Ms+b)(Ls+R)+(Bl)^2\right]}$$

where $v_a$ is the applied voltage; $x$ is the output cone displacement; $M$ and $b$ are the equivalent mass and viscous friction coefficient of the cone, respectively; $L$ is the inductance; $R$ is the resistance; $B$ is the magnetic field; and $l$ is the total effective length of the conductor. If we neglect the inductance, i.e. $L=0$, and assume that $M=0.25$, $b=0.25$, $R=4$, $B=0.5$ and $l=2$,

1. Please design a lead compensator $D_1(s)=K\frac{s+z}{s+p}$ for $G(s)$ such that the

overshoot ≤ 16 % and the rise time ≤ 0.45 sec. You are required to place the zero below the desired closed-loop complex pole, which is the intersection of the overshoot and rise-time boundaries. You are required to use the phase condition to find the pole location of the lead compensator. (25%)

2. After obtaining the lead compensator, you are required to design the lag compensator $D_2(s)=\frac{s+z}{s+p}$ such that the steady-state error with respect to the ramp input is less than 1%. You are required to place the pole of the lag compensator at –0.01. (10%)

四、For the third-order servo system

$$G(s)=\frac{50000}{s(s+10)(s+50)}$$

Design a lead compensator to achieve phase margin ≥ 50° and bandwidth ≥ 20 rad/sec using frequency design method descried below.

1. Calculate the phase of $G(s)$ at the desired bandwidth of 20 rad/sec. (10%)
2. Design $\alpha$ and $T$ of the lead compensator $D(s)=\frac{Ts+1}{\alpha Ts+1}$ to contribute additional phase such that the phase of $D(s)G(s)$ at the desired bandwidth of 20 rad/sec can meet the requirement of the phase margin. (10%)
3. Use $K$ to adjust the crossover frequency of $D(s)G(s)$ such that the crossover frequency of $KD(s)G(s)$ is equal to the desired bandwidth according to the design specification. (10%)

五、For a system with phase margin = 50° and bandwidth = 20 rad/sec, what is the minimum time delay to destabilize the system? (5%)