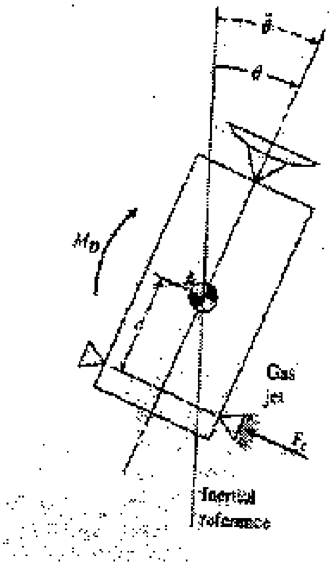
1. **簡答題 (25%):** 回答請略爲說明原因，否則視爲猜答，不給分

a. 請問右圖人造衛星爲幾階(order)的系統?(2%)

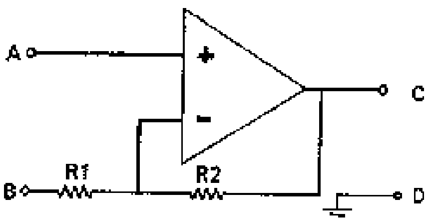
b. 請問右圖人造衛星 Type 爲多少?(2%)




c. 人造衛星以固定的軌跡，固定的公轉速度（與地球自轉速度一樣）繞地球，爲維持能夠讓人造衛星的天線正對著地球，請問我們應該作定位，定速或定加速控制人造衛星?(2%)

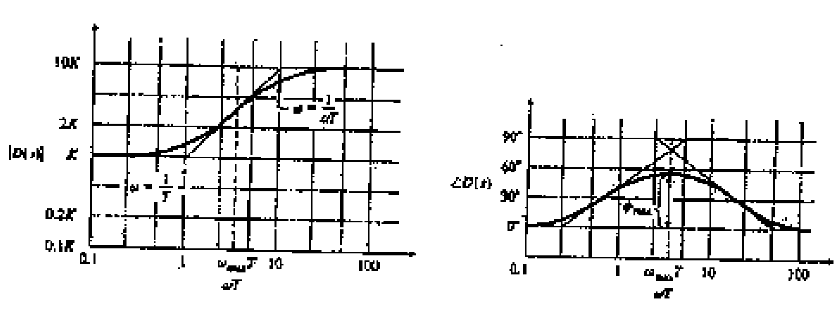
d. 上述的控制，若以單位回饋（unity Feedback）作控制時，其穩態(steady state)的控制誤差爲何?(2%)

e. 在作單位負反回饋時，會用到如下圖操作放大器電路，請問感測器的訊號線要接到 A,B,C 那一個端點?(1%) 功率方大器的輸入線要接到 A,B,C 那一個端點?(1%) 另外還剩一個端點應該接那?(1%) 假設 R2 電阻爲 10KΩ，請問 R1 應選用多少的電阻才能達到單位負反饋的效果?(2%)




f. 有一系統其衝擊響應圖如右，請問其系統是否穩定?(2%)請問這系統在那些個像限有根(poles)?(2%)請問這系統的階數是否大於 1 階?(2%)

g. 下圖爲那一種補償器(Compensation)的頻率響應?(2%) 我們使用這種補償器的那個特點?(能夠提高什麼 2%)原則上在設計時，我們會把 Φmax 所發生的頻率放在原系統的那一個位置?(2%)



**2. Root Locus (30%):** The DC motor has the armature driven by the electric circuit shown in the following Fig. 2. It is standard to relate the torque $T$ developed in the rotor in terms of the armature current $i_a$ and a torque constant $K_t$, and to express the voltage generated as a result of rotation in terms of the shaft's rotational velocity $\dot{\theta}_m$ and an electric or electromotive force constant $K_e$. Thus

$$T = k_t i_a \;\;\&\;\; e = k_e \dot{\theta}_m .$$

Now, assume the rotor has inertia $J_m$, friction coefficient $b$, and disturbance $w = 0$.

(a) Find a transfer function of the DC motor relating the output shaft's rotation $\theta_m$ to the input voltage $v_a$? (10%)

(b) If, a normalized function of above transfer function is

$$\frac{\theta_m(s)}{v_a(s)} = K_G G(s) = \frac{1}{s(s+c)},$$

then sketch a root locus with respect to the proportional feedback control with $c = 2$. (10%)

(c) If the control system is a unity feedback loop, find the root locus versus $c$. (10%)

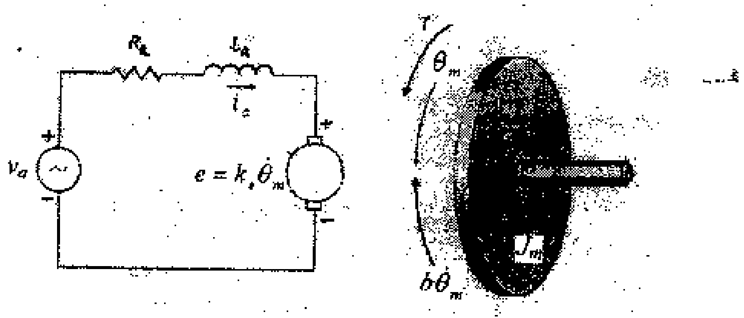



Fig. 2

**3. Frequency Response (20%):** The open loop system with the transfer function is

$$G(s) = \frac{1}{(s+1)(s+10)}$$

If the sinusoidal input signal $u(t) = 2\cos(3t) + 4\cos(15t)$ over the interval $0 \le t \le 5$ sec., assuming zero initial conditions.

(a) Find the sinusoidal steady-state response $y_{ss}(t)$. (7%)

(b) Draw $u(t)$ & $y_{ss}(t)$ in a single plot, and comment on their relationships to one another. (6%)

(c) Draw the Bode plot if the control system is a unity feedback loop. (7%)

**4. Nyquist Stability (25%):** Consider the system in Fig. 3.

(a) Find the closed-loop transfer function, T(s). (5%)

(b) Rewrite the characteristic equation of T(s) as 1+K1*G(s). Find G(s). (5%)

(c) When K2=2, draw the Nyquist diagram for G(s). (10%)

(d) From the Nyquist diagram, find out the region of K1 to stabilize the closed-loop system (T(s)) for K2=2. (5%)

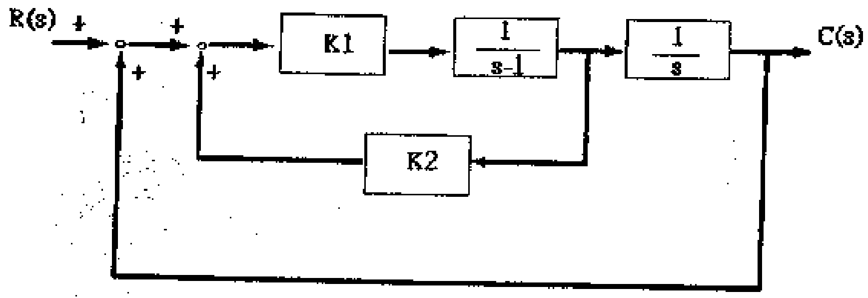



Fig. 3