DE2.3 Electronics 2 for Design Engineers

Tutorial Sheet 6 – Feedback Control

(Lectures 16 - 19)

* indicates level of difficulty

1.* Reduce the figure given in Figure Q1 (a) to the standard feedback configuration illustrated in Figure Q1 (b). Express the transfer functions G and H in terms of G_1, G_2, H_1 and H_2

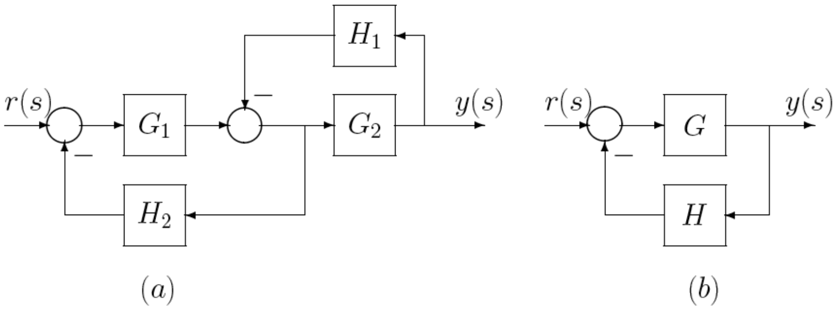

Figure Q1

2. A closed-loop system is used to track the sun to obtain maximum power from a photovoltaic panel. The tracking system is represented by the system shown in Figure Q2, where

$$G(s) = \frac{100}{\tau s + 1}.$$

Assume that τ = 3 seconds nominally, calculate the time constant of the close-loop system response.

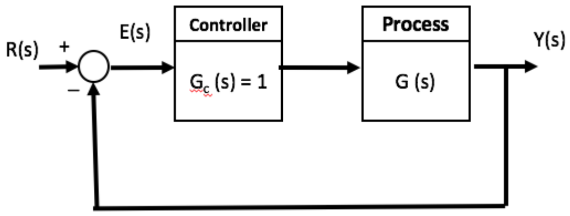

Figure Q2

3.** Figure Q3 shows a first order system with a PI controller. The transfer functions of the plant P(s) and the controller C(s) are:

$$P(s) = \frac{b}{s+a} \quad and \quad C(s) = k_p + \frac{k_i}{s}$$

(i) Derive loop transfer function of the system L(s).
(ii) Hence or otherwise, derive the transfer function of the closed loop system from reference *r(t)* to output *y(t)*.
(iii) By rearranging the denominator of the transfer function in the form:

$$s^2 + 2\zeta\omega_0 s + \omega_0{}^2,$$

derive expressions for k_p and k_i in terms of ζ, the damping factor, and ω_0, the natural or resonant frequency.

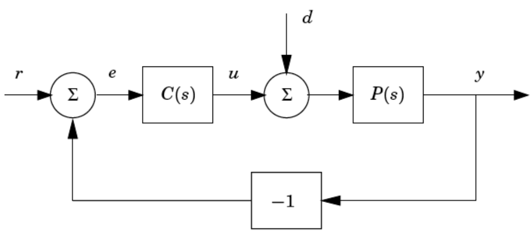

Figure Q3

4.** Figure Q4 (a) shows an operational amplifier circuit - the amplifier gain is $A(v_+ - v^-)$. The input impedance is effectively infinite. The disturbance input v_n represents electrical noise. Determine the gains G_1 and G_2 from v_i to v_0 (i.e. gain for input signal) and v_n to v_0 (i.e. gain for disturbance), respectively. Show that the system is represented by block diagram Q2 (b).

The nominal values of the parameters are: $R_1 = 10\ k\Omega$, $R_2 = 100\Omega$ and $A = 10^4$.

(i) Calculate G1 and G2 for these parameters. What conclusion can you make?

(ii) Calculate separately the effects on G_1 of a 10% change in R_1, R_2 and A.

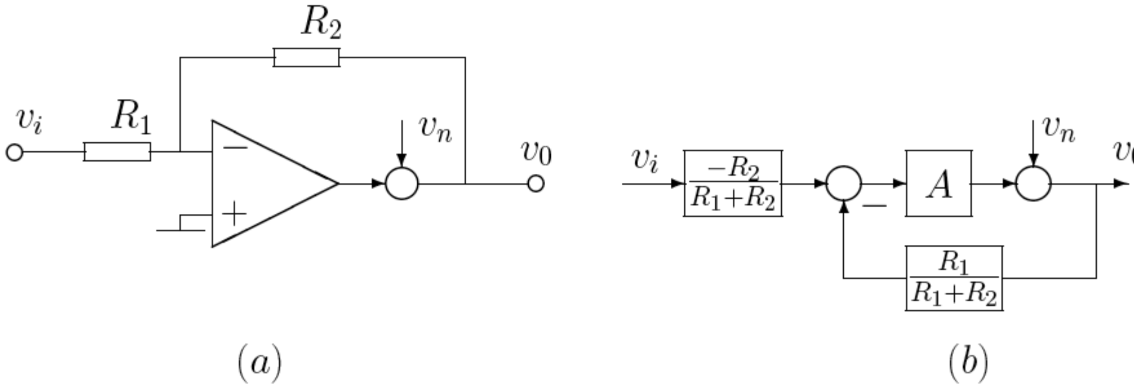

Figure Q4