Indian Institute of Technology Delhi
Department of Electrical Engineering

ELL225 **Control Engineering I** **2017-18/II**

Total Time: 1 hour. Maximum marks: 21; Q1:5, Q2:5, Q3:5, Q4: 6.

- Write clearly each step of your calculation.

Q1. A signal flow graph as shown in Figure-1.

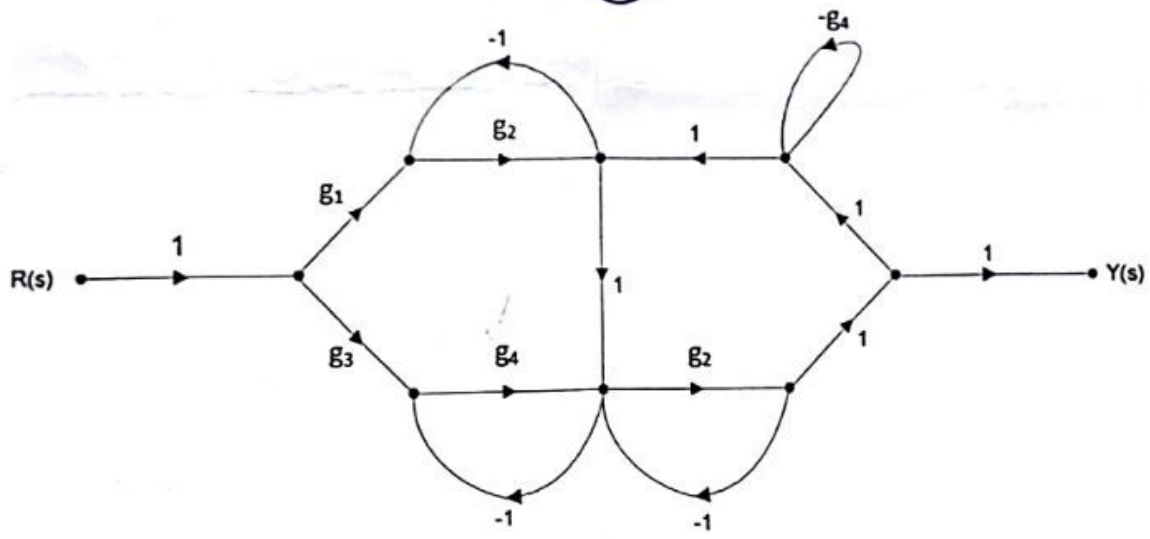

Figure-1

(a) Determine all the loop gains and forward path gains?
(b) Using Mason's rule, find the ratio of Y(s)/R(s)?

Q2. The block diagram of a feedback system is shown in fig. 2. The closed loop transfer function is written as $\frac{Y(s)}{R(s)} = M(s,k) = |M|\exp(j\phi)$ where both magnitude $|M|$ and phase ϕ depend on a real parameter k. Suppose the sensitivity of M with respect to k is written as

$$S_k^M = S_k^{|M|} + jx S_k^{\phi}.$$

(a) Determine x?

(b) Suppose in fig. 2, $G(s,k) = \frac{2}{s(1+ks)}$ with nominal value of $k = 1$. Find S_k^M at the frequency $\omega = 1$ rad/sec.?

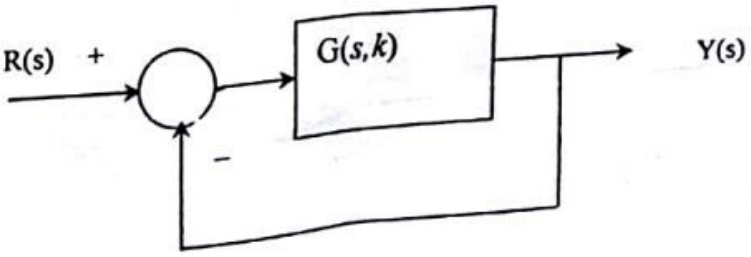

Figure-2

P.T.O

Q3. Find the transfer function of the system as shown in figure 3 where y is the output and r is the input. (Resistance R in Ohm and capacitance C is in Farad).

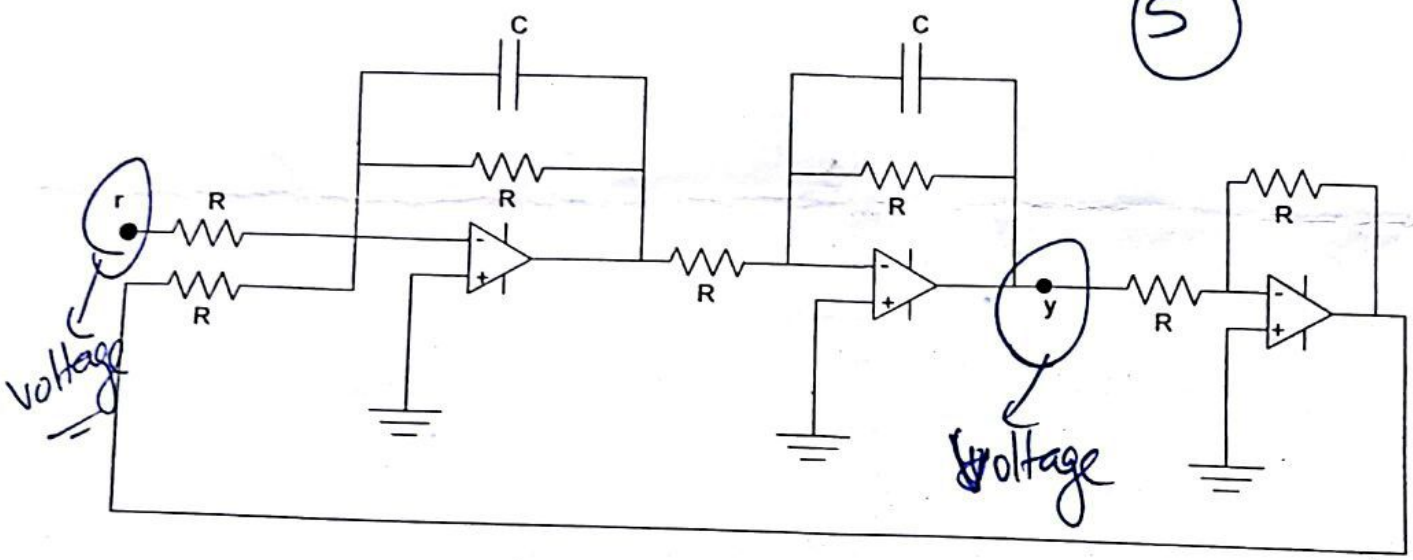

Figure-3

Q4. Q3. A transfer function of a real system is given by

$$\frac{Y(s)}{R(s)} = G(s) = \frac{K}{s^3 + 4s^2 + 6s + 4} = \frac{K}{(s+2)(s+1+j1)(s+1-j1)}$$

where Y(s) is the output, R(s) is the input.

(a) Write the '**relative degree**" and '**Type**' of the transfer function G(s)?

(b) Using final value theorem, determine the steady state value of the output for a **unit step** input?

(c) Derive a state variable model (A,B,C.D) for this system.