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53 (IE 503) CNSY-1

2019

CONTROL SYSTEM–1

Paper : IE 503

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. *(a)* Develop a block diagram representation of an Antenna Azimuth position control system, so as to have the azimuth angle output of the antenna $\theta_0(t)$, follow the input angle of the potentiometer $\theta_i(t)$.

Contd.

Identify the functional role of the individual blocks, the output/input type of signal, the individual block hardware envisaged. (Refer *Fig.* 1) 3+3+4=10

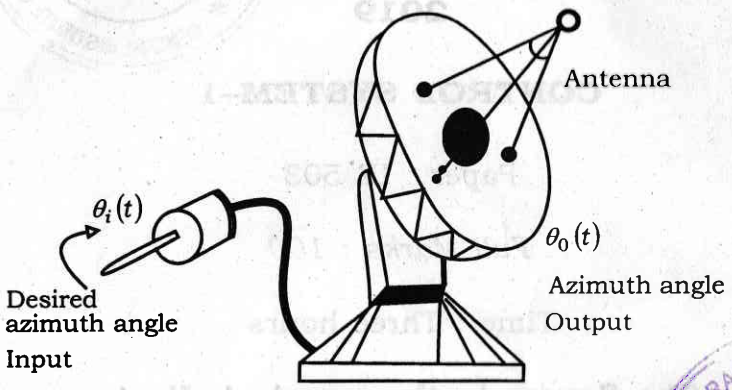


Fig. 1

(b) Write a brief description on open loop control system and close loop control system. 5

(c) Explain the following terms used in Control Systems *(i)* Transient State *(ii)* Steady State responses *(iii)* Correlate these terms with Linear Time Invariant System equation highlighting the concept of natural and forced response. 2+3=5

2. *(a)* 4+4+2=10

(i) Two R-C first order networks are connected in cascade, derive the transfer function of these two networks. (Refer *Fig.* 2)

(ii) If the same two networks are connected with an isolation/buffer circuit, what difference will it make to the above transfer function ?

(iii) Comment on the Input and Output impedance of such cascade blocks when designing a feedback control system.

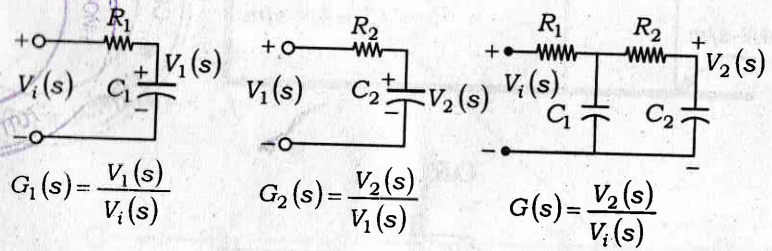


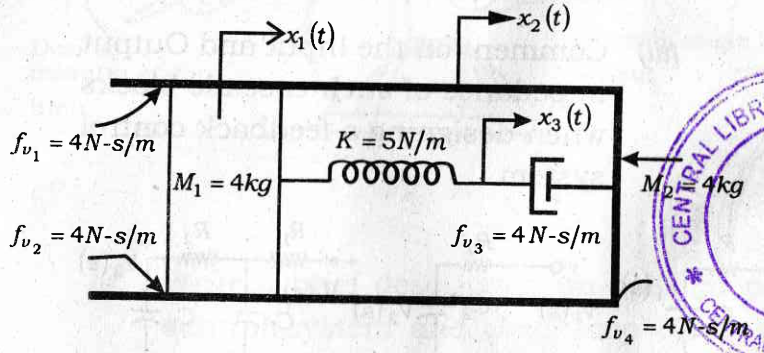
Fig. 2

(b) Discuss the merits of feedback control system. 10

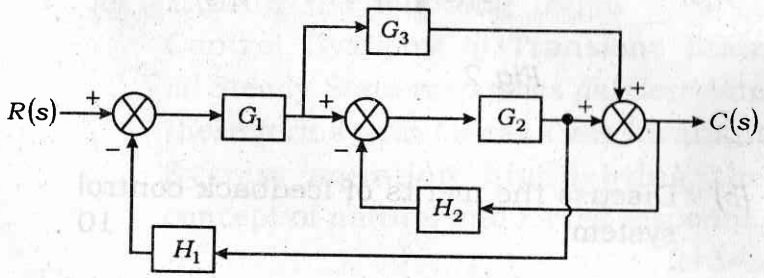
OR

Discuss the various functional elements of Translational elements and tabulate the force-voltage, force current relationships and their Impedances. 6+2+2=10

3. *(a)* Find the transfer function, $X_3(s)/F(s)$, for each system. 10



OR



Determine the overall transfer function $C(s)/R(s)$ for the system whose block diagram is shown using Block reduction technique. If $G_1 = G_2 = G_3 = H_1 = 1$, $H_2 = 1$ find C/R. 8+2=10

(b) Find the Transfer functions for the system whose signal flow graph is shown in *Fig.* 3. 5+5=10

(i) $y_{6(s)}/y_{1(s)}$

(ii) $y_{2(s)}/y_{1(s)}$

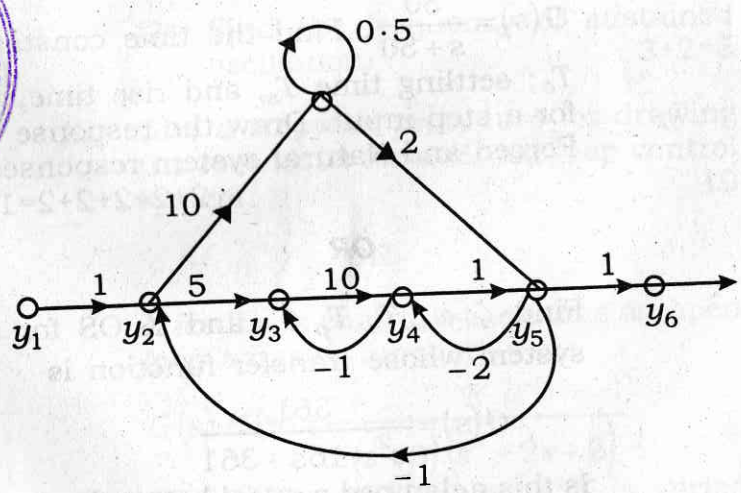


Fig. 3

4. *(a)* Derive the output response of a second order system subjected to a step input given that $\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$. 10

OR

Determine the values of gain '*K*' and velocity feedback constant '*b*' so that the maximum overshoot for the unit step input is 20% and peak time is 10 second. Obtain the rise time and settling time. 5+5=10

(b) A system has a transfer function $G(s) = \frac{50}{s+50}$. Find the time constant T_c; settling time T_s, and rise time, T_r for a step input. Draw the response of Forced and Natural system responses. 2+2+2+2+2=10

OR

Find $\zeta, \omega_n, T_s, T_p, T_r$ and % OS for a system whose transfer function is

$$G(s) = \frac{361}{s^2 + 16s + 361}$$

Is this a damped sinusoid or undamped system ? 10

5. *(a)* Determine the stability of the system represented by the characteristic equation

$s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$

by means of Routh criterion. Determine the number of roots of the characteristic equation lying in the right half of *s*-plane. 4+1=5

OR

The characteristic equation of the system is given by

$$s^4 + 20s^3 + 15s^2 + 2s + K = 0$$

(1) Determine range of *K* for system stability.

(2) Find the frequency of sustained oscillation. 3+2=5

(b) Give a stepwise procedure for drawing the root locus for a closed loop control system. 10

OR

A feedback control system has an open loop transfer function

$$G(s)H(s) = \frac{K}{s(s+3)(s^2 + 2s + 2)}$$

Sketch the root locus as *K* is varied from 0 to ∞. 6+4=10

(c) Sketch the Polar plot for the transfer function having two first order poles

$$G(s)=\frac{10}{(s+1)(s+3)}$$ 3+2=5

6. (a) Draw the Bode plot for

$$G(s)=\frac{10(1+0\cdot5s)}{s(1+0\cdot1s)(1+0\cdot2s)}$$

Also find phase and gain margin. 8+2=10

(b) An open loop transfer function of a system is given by

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

Draw Nyquist Plot. 6+4=10

7. Write short notes on : ***(any two)*** 10+10=20

(a) Steady State Errors for Type 0, 1, 2 systems for STEP, RAMP, PARABOLIC Inputs.

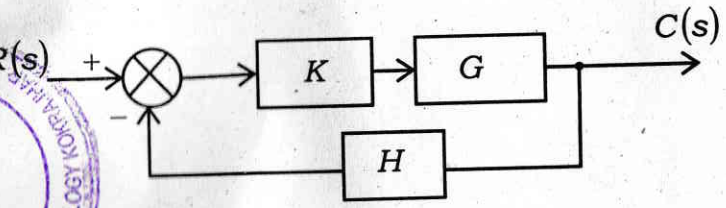
(b) Test SIGNALS (STEP, RAMP PARABOLIC, IMPULSE, SINE) — Their Specification and Application.

(c) DC-Armature Control Servomotor.

(d) Design Methodology for Modelling systems.

8. Determine the sensitivity of the overall transfer function for the system shown in figure with respect to change in parameter

(a) K, (b) H where $G=\frac{\omega_n^2}{s^2+2\zeta\omega_n s}$. 10+10=20



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