2020

ELECTRONICS — HONOURS

Paper : DSE-A-2

[Control Systems]

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***question no.*** **1** and ***any four*** questions from the rest.

1. Answer the following questions (Multiple Choice Questions) : 1×10

(a) In the expression $M = \frac{G}{1+GH}$, G represents the open-loop gain of the system in consideration, H represents :

(i) Stability (ii) Sensitivity

(iii) Bandwidth (iv) Feedback factor.

(b) The sensitivity of a system with feedback is expressed as

(i) $G / (1 + GH)$ (ii) $1 / (1 + GH)$

(iii) $G/(1+GH)^{\frac{1}{2}}$; (iv) $H / (1 - GH)$.

(where the symbols have their usual meanings.)

(c) The Laplace transform of $\frac{d}{dt} f(t)$ is

(i) $sF(s) - f(0)$ (ii) $s^2F(s) - sF(s) + f(0)$

(iii) $sF(s)^2 - f(0) + f'(0)$ (iv) $F(s)/s$.

(d) The Laplace transform of $e^{\beta t} f(t)$ is

(i) $F(s + \beta^2)$ (ii) $F(s - \beta)$

(iii) $F(s^2 + \beta^2)$ (iv) $F(s + \beta)$.

(e) Non-touching loops

(i) have only common nodes in a signal flow graph

(ii) have unity gain

(iii) do not have any common nodes in a signal flow graph

(iv) have at least one node in common.

(f) In Mason's gain formula, the denominator Δ has the dimension of

(i) no dimension (ii) hertz (iii) watt (iv) second.

(g) Zero-state response of a control system is due to

(i) initial conditions only

(ii) input only

(iii) when the output of the system is zero

(iv) when all the inputs are zero.

(h) The Routh-Hurwitz criterion represents a method of determining the location of _____ of a polynomial with constant coefficients.

(i) poles and zeroes (ii) poles

(iii) zeroes (iv) None of these.

(i) The Ramp function has the ability to test how a system would respond to a signal that varies

(i) parabolically with time (ii) exponentially with time

(iii) linearly with time (iv) None of these.

(j) The equation $u(t) = K_1 e(t) + K_2 \frac{d}{dt} e(t)$ represents a

(i) PD controller process (ii) P controller process

(iii) PID controller process (iv) All of these.

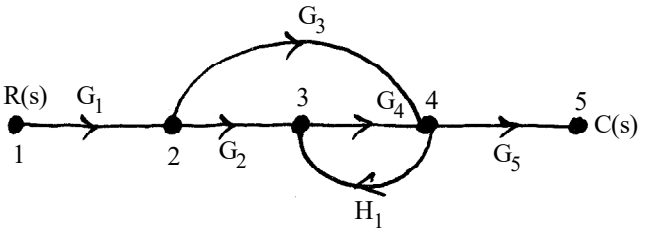
2. (a) What is meant by the sensitivity of a control system?

(b) On which factors does it depend?

(c) Derive the expression of sensitivity of a control system. 3+2+5

3. (a) What is an SFG?

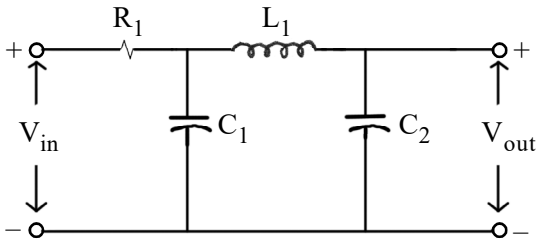
(b) With respect to the representation below, answer the following :



(i) How many loops are there in the SFG?

(ii) Calculate the gain of the SFG. 3+(2+5)

4. Consider the circuit below and answer the following questions :



(a) Represent the circuit as an SFG.

(b) Hence, calculate the gain formulation. 5+5

5. Consider the following polynomial :

$$2s^4 + s^3 + 3s^2 + 5s + 10 = 0$$

(a) Prepare the Routh's array.

(b) Calculate the roots.

(c) Comment on the stability of the system represented by the equation. 2+3+5

6. (a) Define a control system with feedback.

(b) Explain the operation of OP-AMP as Schmitt's trigger circuit.

(c) Can the output of this configuration be controlled? Justify your answer. 2+5+3

7. With reference to unit-step response of a linear time invariant control system, define the following. 2×5

(a) Maximum overshoot

(b) Delay time

(c) Rise time

(d) Settling time

(e) Steady-state error.

8. (a) Write the differences between P, PD and PID controllers.

(b) Write the general mathematical expressions for each of the above controllers.

(c) Draw the simple OP-AMP circuit of a PD controller. 5+3+2

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