2024

ELECTRONICS — HONOURS

Paper : DSE-A-1 and DSE-A-2

The figures in the margin indicate full marks.

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

Paper : DSE-A-1

(Numerical Techniques)

Full Marks : 50

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

1. Answer ***any ten*** questions from below : 1×10

(a) What is meant by a polynomial function?

(b) Name two iterative methods of solving a linear algebraic equation.

(c) What are significant digits?

(d) What is a floating point error?

(e) What is the use of the Regula Falsi method?

(f) When does Newton Raphson method fail to converge to a root?

(g) What is meant by pivoting?

(h) What is a divided difference table?

(i) What is initial value problem?

(j) What is the use of the Power method in numerical analysis?

(k) What is Heun's method?

(l) Write down the formula for Taylor series of a function.

2. Define absolute and relative errors. What is error-propagation? Find the relative error in the number $c = a - b$ where $a = 0.5234 \times 10^4$ and $b = 0.5232 \times 10^4$ are two numbers stored in the computer system with a 4-digit mantissa. 3+2+5

3. Write the algorithm for either Newton's Raphson method or Bisection method. Use either of the two methods to solve for any one of the roots of the function $f(x) = x^2 - 3x + 2$. 5+5

4. What is meant by curve fitting? What is the difference between curve fitting and interpolation? What is linear regression? Find the equation of the straight line that best fits the following data-set :

x	1	2	3	4	5
y	2	4	7	10	12

2+1+2+5

5. What is meant by interpolation? Use Lagrange's interpolation to fit the following data to a polynomial :

x	0	1	2	3
$e^x - 1$	0	1.72	6.39	19.09

Obtain the value of $e^{1.5}$ from the fitted polynomial. 2+5+3

6. Evaluate the integral $\int_0^1 \left(x^3 + 1\right) dx$ using Trapezoidal formula for numerical integration. Also find the corresponding truncation error. Name two more methods of numerical integration. 5+3+2

7. (a) Name a few numerical methods to solve an ordinary differential equation.

   (b) Use the Euler method to solve the following equation :

   $\frac{dy}{dx} = 4x^3 + 2$ and find $y(2)$.

   Given $y(1) = 3$ and the step size $h = 0.5$.

   (c) Write the forward and backward divided difference formulas for numerical differentiation.

   2+5+3

8. (a) Solve the following system of equations using basic Gauss elimination :

$$10x_1 + 2x_2 - x_3 = 27$$
$$-3x_1 - 6x_2 + 2x_3 = -61.5$$
$$x_1 + x_2 + 5x_3 = -21.5.$$

   (b) What is partial pivoting? Name a few methods of solving a system of linear algebraic equations other than Gauss elimination. 5+(2+3)

Paper : DSE-A-2

(Control System)

Full Marks : 50

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

1. Answer ***any ten*** questions : 1×10

(a) In Force-voltage analogy, Mass (M) is analogous to

(i) Resistance (ii) Capacitance

(iii) Inductance (iv) Flux.

(b) A _____ starts from an input node and ends at an output node along which no node is traversed more than once.

(i) path (ii) loop

(iii) forward path (iv) None of these.

(c) The Laplace transform of an impulse function is

(i) 0 (ii) 1

(iii) S^{-1} (iv) None of these.

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

(i) Second (ii) Watt

(iii) Hertz (iv) No dimension.

(e) An open-loop transfer function is given as $G(H)\,H(S) = \dfrac{K(S+2)}{S(S+3)(S+4)}$, its centroid is located at S = ?

(i) –2.5 (ii) 0

(iii) –4.5 (iv) –4.

(f) If the actuating signal depends on the integral of the error, the controller is known as

(i) P-controller (ii) P-I controller

(iii) PID controller (iv) None of these.

(g) The presence of an all zero row in Routh-Hurwitz array indicates

(i) Highly stable system (ii) Highly unstable system

(iii) Presence of negative roots only (iv) Presence of symmetrical roots.

(h) An open-loop transfer function has 4 poles and 1 zero. The number of branches of root locus is

(i) 3 (ii) 2

(iii) 1 (iv) 4.

(i) For a pole factor $P=\frac{1}{(S+5)}$, the corner frequency is

(i) $\frac{1}{5}$ (ii) 5

(iii) -5 (iv) $-\frac{1}{5}$.

(j) Root locus technique is used to calculate

(i) Marginal stability (ii) Absolute stability

(iii) Conditional stability (iv) Relative stability.

(k) If the gain of the open-loop system is doubled, the gain margin

(i) is not affected (ii) gets doubled

(iii) becomes half (iv) becomes one-fourth.

(l) The order of a control system is defined as

(i) number of poles at origin. (ii) number of zeros at origin.

(iii) order of the differential equation. (iv) total number of poles of equation.

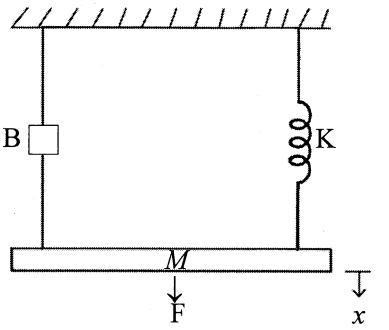
(m) Which mechanism in control engineering implies an ability to measure state?

(i) Controllability (ii) Observability

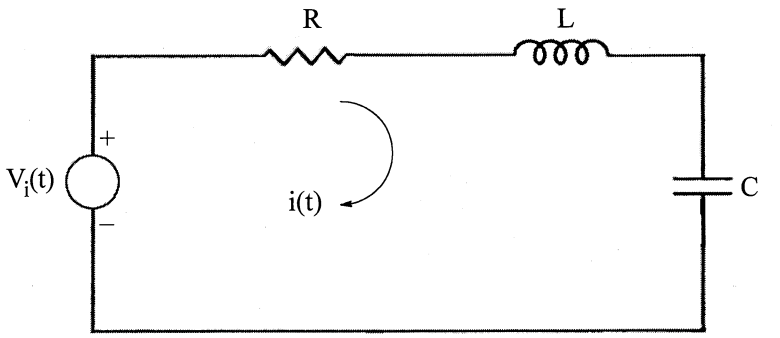
(iii) Differentiability (iv) Adaptability.

2. (a) What is a mathematical model?

(b) Write the mathematical model of the given Mass-Spring-dashpot system.



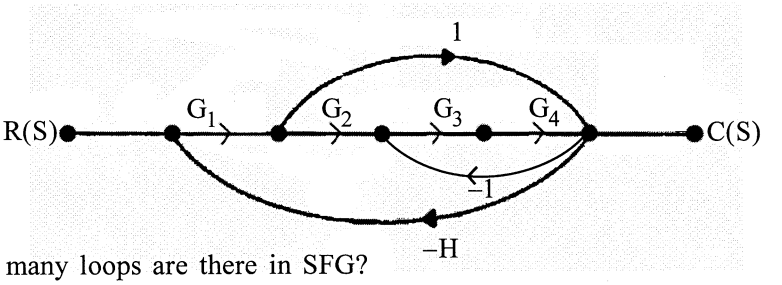
(c) Obtain the transfer function of the electrical system as shown in figure :



(d) With respect to frequency response of a control system, explain what is meant by phase margin. 1+3+3+3

3. (a) State Mason's gain formula.

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



(i) How many loops are there in SFG?

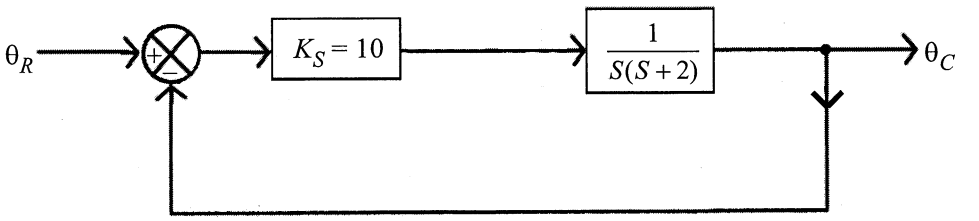
(ii) Calculate the gain of the SFG using Mason's gain formula.

(c) Hence determine the output if unit step is provided at the input. 2+(1+4)+3

4. (a) What are type-0 and type-1 systems?

(b) For an open-loop transfer function $G(S)\,H(S) = \dfrac{10}{(S+2)(S+3)}$, Find out steady state error for a unit step input.

(c) Consider a system as shown in below figure :



Determine the—

(i) damping factor and

(ii) natural frequency of the system. 2+4+4

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5. (a) State the Routh-Stability Criterion.

(b) A characteristic polynomial is given as

$s^5 + 6s^4 + 15s^3 + 30s^2 + 44s + 24 = 0$.

Answer the following questions :

(i) Form the Routh table as applicable.

(ii) Comment on the stability of the system.

(c) What are dominating poles and zeros?

(d) Draw the pole-zero plot for the given system :

$$T(S) = \frac{(S-2)(S+3)}{(S+2)(S+4)}.$$

2+(3+1)+2+2

6. (a) What is a Bode plot?

(b) Define Gain margin and Phase margin.

(c) In Bode plot, show that for a first-order system, the magnitude plot will drop at the rate of 20dB per decade from the corner frequency.

(d) State the advantages of Nyquist plot. 2+3+4+1

7. (a) What is the controllability test?

(b) A linear time invariant system is characterised by the state variable model. Comment on the controllability of the system

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U$$

$$Y(t) = [1 \quad 2] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}.$$

(c) Write down the difference between Lead and Lag compensators.

(d) Write down the differences between P, PD and PID controllers. (1+4)+2+3

8. The open-loop transfer function is given as

$$G(S)H(S) = \frac{K}{S(S+4)(S^2+4S+20)}.$$

Determine the following :

(a) Number of asymptotes

(b) Centroid

(c) Breakaway points. 3+3+4
