[This question paper contains 4 printed pages.]

Your Roll No...............

Sr. No. of Question Paper : 5711 **J**

Unique Paper Code : 2513012006

Name of the Paper : Network Synthesis

Name of the Course : **B.Sc. (Hons.) Electronic Science**

Semester : IV (Under NEP UGCF Mode)

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. There are **seven** questions in all, out of which you have to attempt any **five** questions. Q. No. **1** is compulsory.
3. **All** questions carry equal marks.

1. (a) Define the terms 'pole' and 'zero' of a network function. What is their significance in circuit analysis? (3)

(b) What is a Hurwitz polynomial? Give an example of a second-order Hurwitz polynomial. (3)

(c) State two important properties of driving-point immittance functions of an LC network. (3)

(d) Briefly explain the concept of an ideal low-pass filter. What are its characteristics in the frequency domain? (3)

(e) Write the expressions for the hybrid (h) parameters of a two-port network in terms of the port voltages and currents. (3)

(f) Define a Positive Real (PR) function. Give one necessary condition for a function to be positive real. (3)

2. (a) State and prove the Initial Value Theorem as applied in Laplace transform-based circuit analysis. (6)

   (b) Define the Transmission (ABCD) parameters of a two-port network. Express the output voltage and current in terms of the input voltage and current using these parameters. (6)

   (c) What is time constant, τ for R-C and R-L networks and describe its significance in determining the transient response of the circuit. A series R-C circuit has a resistor $R=10\Omega$ and a capacitor $C=0.1$ F. The input voltage Vin(t) is a unit step function, u(t) applied at t=0.

      (i) Find the system function H(s) for the circuit.

      (ii) Calculate the time constant τ for the circuit. (6)

3. (a) Explain the concepts of causality and stability for a linear time-invariant (LTI) system. How are these related to the location of poles in the s-plane? (6)

   (b) State Sturm's Theorem. How can it be used in the context of network synthesis? (6)

   (c) Consider a continuous-time linear time-invariant (LTI) system with the impulse response :

$$h(t) = e^{-2t}u(t),$$

   where u(t)u(t) is the unit step function.

      (i) Determine whether the given system is causal.

      (ii) Verify if the system is stable. (6)

4. (a) What are the properties of driving-point impedance functions of an RC network? State any three important properties. (6)

(b) A driving-point immittance function is given as :

$$Z(s)=\frac{s^2+4s+3}{s(s+2)}.$$

(i) Verify if this function is realizable as an L-C driving-point impedance.

(ii) If realizable, derive the network synthesis for the given Z(s)Z(s) using L and C elements. (6)

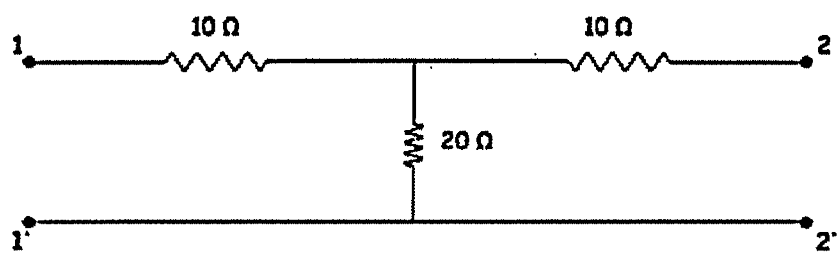
(c) Discuss the synthesis of driving-point immittance functions using all three elements (R, L, C). Outline the advantages of combining all three elements in network synthesis. (6)

5\. (a) State two important properties of transfer functions for passive networks. (6)

(b) Briefly explain the synthesis of an LC ladder network with a 1-ohm resistive termination. What is the goal of this type of synthesis? (6)

(c) What are constant-resistance networks? Give one example of a constant-resistance network topology (draw the circuit diagram). (6)

6\. (a) What are two port networks. How is Z-parameter related to Y-parameter. For the two-port network shown below, find the Impedance (Z) parameters. Draw its equivalent circuit diagram. (9)



(b) State the definition and properties of Hurwitz polynomials, highlighting their importance in stability analysis. Verify if the polynomial is a Hurwitz polynomial using its properties. Show that all roots of P(s)P(s) lie in the left half of the ss-plane.

$$P(s) = s^4 + 4s^3 + 6s^2 + 4s + 1 \qquad (9)$$

7. (a) Compare R-C and R-L Driving-Point properties and practical implications in network design. A driving-point impedance is given as :

$$Z(s) = \frac{s^2 + 3s + 2}{s(s+2)}.$$

Verify if Z(s) satisfies the conditions for positive real functions (PRFs). If Z(s) is a PRF, synthesize the impedance function using L and C elements in Foster Form. (9)

(b) Briefly explain the Butterworth approximation used in low-pass filter design. What are the key characteristics of a Butterworth filter's frequency response? Compare the Butterworth and Chebyshev approximations used in filter design with respect to their passband and stopband characteristics. (9)