Ref. No. : Ex/ET/T/212/2018

Name of the Examinations: B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING SECOND YEAR FIRST SEMESTER - 2018

Subject : NETWORK SYNTHESIS Time : 3 Hours **Full Marks : 100**

Instructions : Answer any *five* questions ; All questions carry equal marks

1(a) State conditions (a) and (b) of a PR function.

02

1(b) Using condition (a) and (b) prove that if $Z_1(s)$ and $Z_2(s)$ are PR functions then

(i) $Z_1(s) + Z_2(s)$ is PR
(ii) $Z_1(Z_2(s))$ is PR
(iii) $\frac{K}{S}$ is PR

02+03+03

1(c) Let the one port shown in Fig 1(a) is an RC active network. A proof is available that the input impedance function of this one port is PR. If each capacitor C_i of the circuit is replaced by an RC series network as shown in Fig 1(b) prove that the input impedance of the resulting configuration is also PR. You are allowed to use only the results included in part (a) and (b).

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1 (d) Repeat 1 (c) with each capacitor C_i being replaced by the configuration shown in Fig 1(c)

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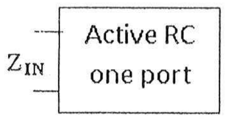

Fig 1(a)

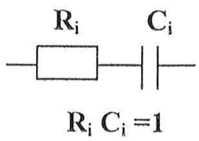

Fig 1(b)

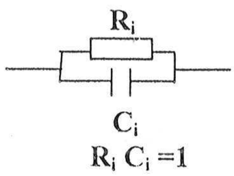

Fig 1(c)

2 Let n different types of one ports be available. Let the driving point impedance function for the i^{th} type be denoted by $Z_i(S)$. It is given that for all i, $Z_i(s)$ is PR. Prove that the input impedance function of any circuit implemented using these one ports is PR. You can only assume the Tellegen's Theorem and condition (a) and (b) for the PR function.

20

3(a) Let an RC driving point impedance function be given by.

$$Z_{RC}(S) = \frac{S^3 + 8S^2 + 15S + 4}{S^3 + 6S^2 + 8S}$$

It is known that the function has a pole at S = -4. Realize the impedance by the following sequential steps

(i) Remove the pole at S= -4
(ii) Realize the remaining function by Cauer I synthesis procedure.

10

3(b) Let an RC driving point admittance function be given by

$$Y_{RC} = \frac{2S^3 + 5S^2 + 2S}{S^3 + 4S^2 + 4S + 1}$$

It is also given that the function has a pole at S=-1. Realize a ladder network to implement this function by sequentially removing the poles at S=-1.

4(a) 10

Let $P(S) = \prod_{i=1}^{n}(S + a_i)$ such that all a_i's are real positive and distinct. Let $P'(S) = \frac{dP(S)}{dS}$.

Show that

(i) $\frac{P'(S)}{P(S)}$ is PR

(ii) The admittance function $\frac{SP'(S)}{P(S)}$ is PR and RC realizable.

4(b) 5+7

Let $P(S) = \prod_{i=-n}^{n}(S + ja_i)$ such that all a_i's are real and $a_i = -a_{-i}$. Show that the impedance function $\frac{P'(S)}{P(S)}$ is PR and LC realizable.

5 Describe a constant K low pass filter. What are the disadvantages of this configuration? Describe how m-derived filters may be used to overcome these disadvantages. Hence describe the composite filter structure suitable for practical applications. 08

6 Assume that the reactance T structures shown in Fig 2 and Fig 3 are terminated to their characteristic impedances. Using qualitative reactance piot determine the qualitative filter characteristics for both the networks. 5+5+5+5

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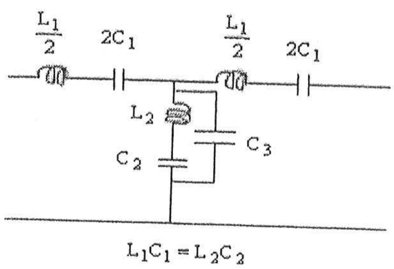

Fig 2

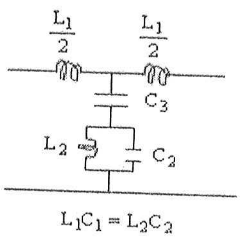

Fig 3

7(a) Find the expression for the $V_1(S)/V_i(S)$ and $V_2(S)/V_i(S)$ for the circuit shown in Fig 4(a)

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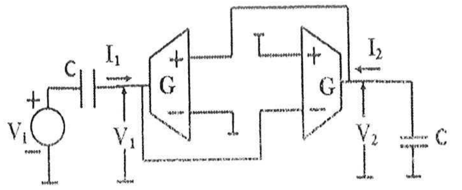


Fig 4(a)

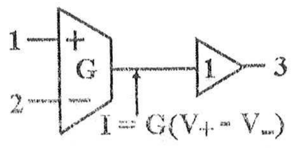
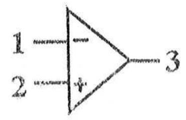


Fig 4(b)



4(c)

7(b) Justify the claim that the circuit shown in Fig 4(a) implements an op amp as shown in Fig 4(b).

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7(c) Hence find the voltage transfer function for the circuit shown in Fig 4(c). Find α such that the resulting configuration behaves as an all pass filter.

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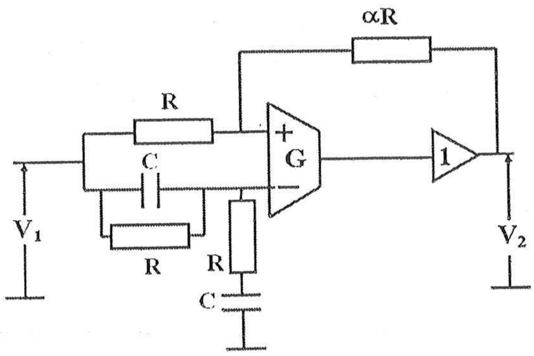

Fig 4(c)

8(a) Let $P(S) = M(S) + N(S)$ be a Hurwitz polynomial, where N(S) and M(S) are odd and even parts respectively. Show that $\phi(S) = \dfrac{M(S)}{N(S)}$ is a PR function.

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8(b) Let P(s) be a Hurwitz Polynomial with degree N. Prove that

(i) $P(S) + P'(S)$ is a Hurwitz Polynomial,

(ii) $[P(S)]^2 + [P'(S)]^2$ is a Hurwitz Polynomial

(iii) $P'(S)$ is a Hurwitz Polynomial

(iv) $[P^{n-1}(S)]^2 + [P^n(S)]^2$ is a Hurwitz polynomial, where, $P^r(S) = \dfrac{d^r P(S)}{dS^r}$ and $n \geq 1$

You can assume condition (a), (b) , (a'), (b') and (c') for PR a function and the fact that . if P(S) is a Hurwitz polynomial then $\dfrac{P(S)}{P'(S)}$ is a PR function.

12