UNIVERSITY OF NAIROBI

SECOND SEMESTER EXAMINATIONS 2007/2008

THIRD YEAR EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING

FEE 322: ELECTRICAL CIRCUIT THEORY II B

DATE: 22ND JULY, 2008 TIME: 11.15 A.M. – 01.15 P.M.

INSTRUCTIONS
1. Attempt **ONE** question from **EACH** of the **THREE** sections
2. All questions carry equal marks
3. Smith Charts are provided

SECTION A: TWO-PORT NETWORKS

QUESTION ONE: (20 MARKS)

(a) (i) Give the defining equations for the transmission (ABCD) parameters.
(ii) For two networks connected in cascade, derive the expression for the overall ABCD parameters in terms of the ABCD parameters of the individual networks.
(iii) Obtain the ABCD parameters for the circuit of Fig.Q1(a)
(iv) Determine the open circuit voltage gain of the circuit

[8 marks]

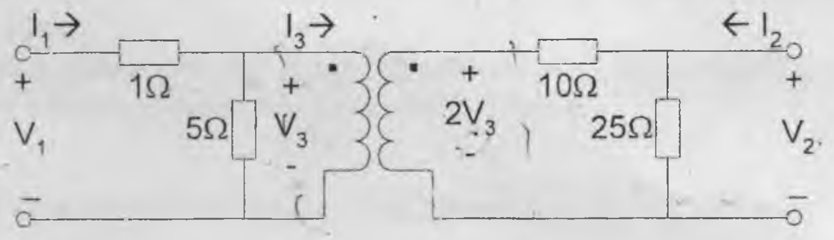


Fig. Q1(a)

(b) (i) Explain what is meant by '*image impedance*' as applies to two-port networks.
(ii) Determine the values of the image impedances of the network in Fig.Q1(a). $Z_{i1} = \sqrt{\frac{AB}{CD}}$, $Z_{i2} = \sqrt{\frac{BD}{AC}}$
(iii) Determine the propagation function of the network in Fig.Q1(a)

$\theta = \frac{1}{2}\ln\left(\frac{\sqrt{AD}+\sqrt{BC}}{\sqrt{AD}-\sqrt{BC}}\right)$

[6 marks]

(c) (i) Give the defining equations for the ***z-parameters*** of a two port network.
(ii) Obtain the expressions for the z-parameters in terms of the ABCD parameters
(iii) Using the result in (ii) obtain the equivalent *T-network* for the network in Fig.Q1(a)

[6 marks]

QUESTION TWO: (20 MARKS)

(a) (i) Derive the expressions for the ***z-parameters*** in terms of the ***h-parameters***.
(ii) Convert the network of Fig.Q2(a) into the equivalent *T-network*.
(iii) Determine the ***z-parameters*** of the network.
(iv) Determine the characteristic impedance of the network. $Z_0 = \sqrt{Z_{11}^2 - Z_{12}^2}$

[8 marks]

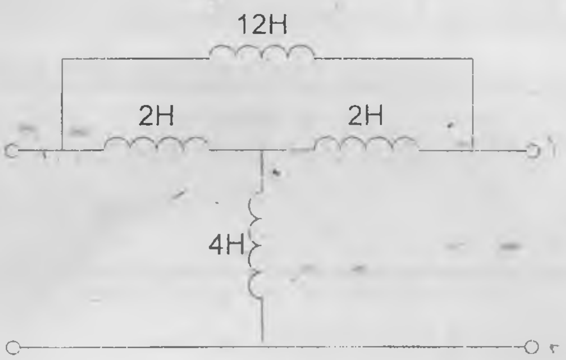


Fig. Q2(a)

(b) (i) With the help of diagrams, show how termination on *image basis* differs from termination on *iterative basis* for a two-port network.
(ii) Show that the characteristic impedance of a symmetrical lattice network is given by $\sqrt{Z_A Z_B}$, where Z_A and Z_B are the series and diagonal arm impedances respectively
(iii) By converting the network of Fig. Q2(b) into a lattice network determine its characteristic impedance at ω = 0.4 radians.

[8 marks]

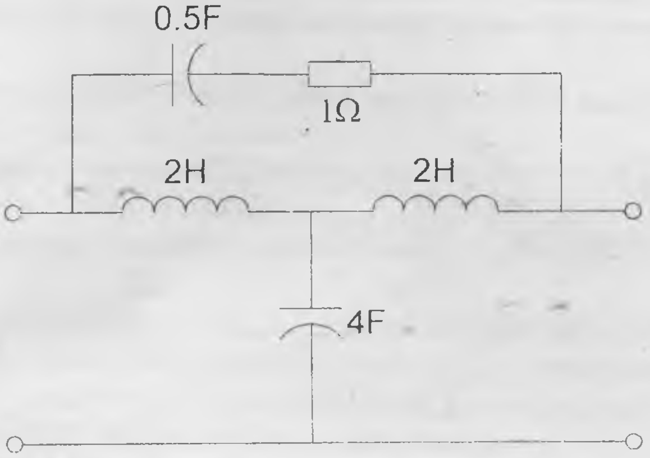


Fig. Q2(b)

(c) Using a purely resistive symmetrical lattice network, design a ***symmetrical π-type attenuator*** having a characteristic impedance of 100Ω and an attenuation of 20 nepers.

[4 marks]

SECTION B: ONE-PORT NETWORK SYNTHESIS

QUESTION THREE: (20 MARKS)

(a) (i) Give the four properties that must be true for the driving point immitance functions for any non-dissipative network that is physically realizable.

(ii) Indicate which of the four are true for even dissipative networks.

(iii) State the separation property of reactive networks and explain its significance

[4 marks]

(b) For the circuit of Fig.Q3(b) determine

(i) the driving point impedance of the network as a quotient of polynomials

(ii) a sketch of the reactance function $X(j\omega)$

(iii) the second Cauer form of the equivalent network, indicating all the component values

[8 marks]

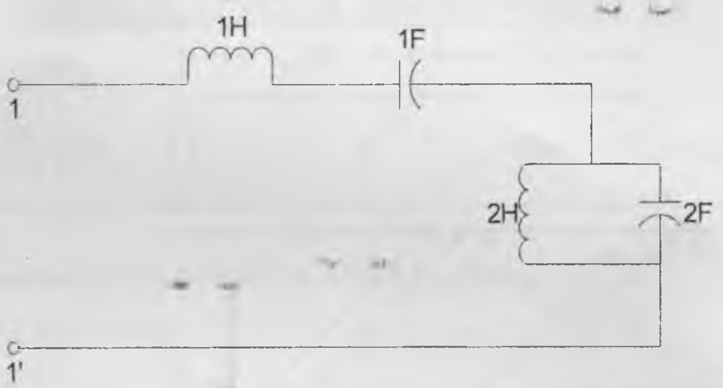


Fig. Q3(b)

(c) A certain network's driving point admittance function has poles at s = -2 and -6 and zeros at s = 0, -4 and -8. At s = -3, the admittance is 1mho. Determine

(i) the quotient expression in s for the admittance function

(ii) the second Foster network, indicating all component values

(iii) the first Cauer network, indicating all the component values

[8 marks]

QUESTION FOUR: (20 MARKS)

(a) (i) Give the factored form of the general driving point impedance expression in s for R-C networks.

(ii) Show a general pole-zero plot for the networks in (i), indicating any assumptions.

(iii) Give a sketch of a **complete** first Foster R-C network

[4 marks]

(b) For the driving point impedance function $Z_D(s) = \dfrac{2s^2 + 8s + 6}{3s^2 + 18s + 24}$ determine

(i) the first Foster network, indicating all component values

(ii) the second Cauer network, indicating all the component values

[8 marks]

(c) For the driving point impedance $Z_D(s) = \dfrac{10s^4 + 12s^2 + 1}{2s^3 + 2s}$ determine

(i) all the external and internal poles and zeros

(ii) the frequency pattern (pole-zero plot)

(iii) the second Foster form of the network, indicating all the component values

[8 marks]

SECTION C: TRANSMISSION LINES

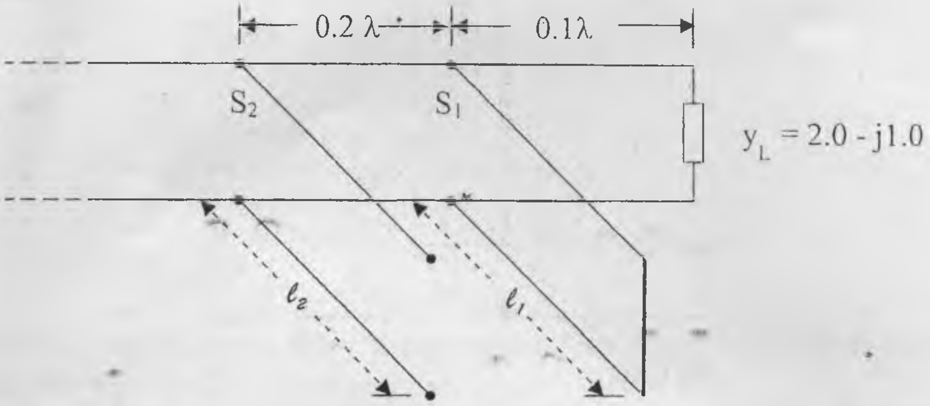
QUESTION FIVE: (20 MARKS)

(a) (i) Explain the advantage of double stub matching over single stub matching.
(ii) Show that the impedance of a short circuit stub of a lossless line is pure reactance.
(iii) Determine the range of the shortest lengths of an open circuit stub that result in inductive reactance.

[5 marks]

(b) The layout for a double-stub tuner is shown in Figure Q4 below. Determine
(i) the required length ℓ_1 of the short circuit stub S1
(ii) the required length ℓ_2 of the open circuit stub S2
(iii) the VSWR **on each** of the three sections of the main line
(iv) the percentage of the power incident at the junction of stub S1 that gets transmitted
(v) the percentage of the power incident at the load that gets reflected

[15 marks]



$\sqrt{Z_{sc} \cdot Z_{oc}}$

Figure Q4

QUESTION SIX: (20 MARKS)

(a) Starting from the general expression for Z_ℓ, the transmission line impedance at a point a distance ℓ from the load Z_L, show that $Z_{sc}Z_{oc} = Z_0^2$ and $Z_{sc}/Z_{oc} = \tanh^2\gamma\ell$

[4 marks]

(b) A 50m long transmission line operating at 1MHz has open-circuit and short-circuit impedance of $-j39.4\Omega$ and $j142.8\Omega$ respectively. Calculate
(i) the characteristic impedance of the line
(ii) the propagation coefficient of the line
(iii) the line input impedance when terminated with a load of $18.75 - j112.5\Omega$

[7 marks]

(c) Given a high frequency line with $Z_O=150\Omega$, terminated in $Z_L=70+j0\Omega$. The line is 18.68λ long. Neglecting losses, use the Smith Chart on an admittance basis to determine
(i) the reactance in ohms which, if connected across the sending end of the line, will make the input impedance of the combination a pure resistance
(ii) the input impedance of the line under the conditions in (i).

[3 marks]

(d) Two transmission lines are connected in parallel at their sending ends. One line is 0.625λ long and has $Z_O=400\Omega$ with a termination $Z_L=800\Omega$. The other is 0.375λ long and has $Z_O=400\Omega$ and is terminated in an impedance of $400+j400\Omega$. Using **ONLY** the Smith Chart on an admittance basis, determine the input impedance of the parallel combination of the two lines.

[6 marks]

For π Network
$\cancel{R_1} = R_0\left(\frac{N^2-1}{2N}\right)$
$R_2 = \frac{R_0}{2}\left(\frac{N+1}{N-1}\right)$

For T Network
$R_1 = 2R_0\left(\frac{N-1}{N+1}\right)$
$R_2 = 2R_0\left(\frac{2N}{N^2-1}\right)$

$R_A = R_0\left(\frac{N-1}{N+1}\right)$
$R_B = R_0\left(\frac{N+1}{N-1}\right)$