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The University of Jordan, Summer 2013 **Electromagnetics II, EE351**

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Question 1 (4 pts)

A 50 Ohm T.L. is terminated in a load with impedance (100 + j 50) Ohm. Find reflection coefficient and VSWR

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$Z_0 = 50\,\Omega$ $Z_L = 100 + j50$ $Z_n = \frac{100 + j50}{50} = 2 + j1$

$\Gamma = \frac{Z_n - 1}{Z_n + 1} = \frac{2 + j1 - 1}{2 + j1 + 1} = \frac{1 + j1}{3 + j1} = 0.447 \angle 26.565$

$S = \frac{1 + |\Gamma|}{1 - |\Gamma|} = \frac{1 + 0.447}{1 - 0.447} = 2.616$

Question 2 (4 pts)

A slotted line with 50 Ohm characteristic impedance is terminated with an unknown load. It was found that VSWR = 3, distance between the two minimas = 30 cm, and first minima at 12 cm from load. Compute load impedance

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$Z_0 = 50$ $S = 3$ $d = 30$ $d_{min} = 12\,cm$

$S = \frac{|\Gamma| + 1}{1 - |\Gamma|}$ $S - |\Gamma| S = |\Gamma| + 1$ $|\Gamma| = \frac{S - 1}{S + 1} = \frac{2}{4} = 0.5$

$\frac{\lambda}{2} = 30\,cm$ $\lambda = 60\,cm$

$\theta_r = 2\beta d_{min} - \pi(2n + 1)$ First minima $n = 0$

$\theta_r = 2 \times \frac{2\pi}{60 \times 10^{-2}} \times 12 \times 10^{-2} - \pi = -36$

$\Gamma = 0.5 \angle -36$

$\Gamma = \frac{Z_n - 1}{Z_n + 1}$ $\Gamma(Z_n + 1) = Z_n - 1$ $Z_n \Gamma + \Gamma = Z_n - 1$

$Z_n = \frac{1 + \Gamma}{\Gamma - 1}$

$Z_n = \frac{1 + \Gamma}{1 - \Gamma} = \frac{1 + 0.5 \angle -36}{1 - 0.5 \angle -36} = 2.16 \angle -38$

$Z_L = Z_n Z_0 = 2.16 \angle -38 \times 50 = 85 - j66.6$

$Z_L = 85 - j66.6$

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Question 3 (6 pts)

Given Γ = 0.5 exp(j 60), and λ = 24 cm. find the location of first minima and maxima

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$F = 0.5\, e^{j60}$ $|F| = 0.5$ $\theta r = 60$ $\lambda = 24$

@ n=0 $d_{min} = \frac{\theta r \lambda}{4\pi} + \frac{(2n+1)\lambda}{4} = \frac{\frac{\pi}{3} \times 24\times10^{-2}}{4\pi} + \frac{24\times10^{-2}}{4} = 8\,cm$

@ n=0 $d_{max} = \frac{\theta r \lambda}{4\pi} + \frac{n\lambda}{2} = \frac{\frac{\pi}{3} \times 24\times10^{-2}}{4\pi} + 0 = 2\,cm$

Question 4 (4 pts)

Plot the voltage and current on an open circuit T.L. and a short circuit T.L.

ملاحظة مهمة → الحل خلف الورقة

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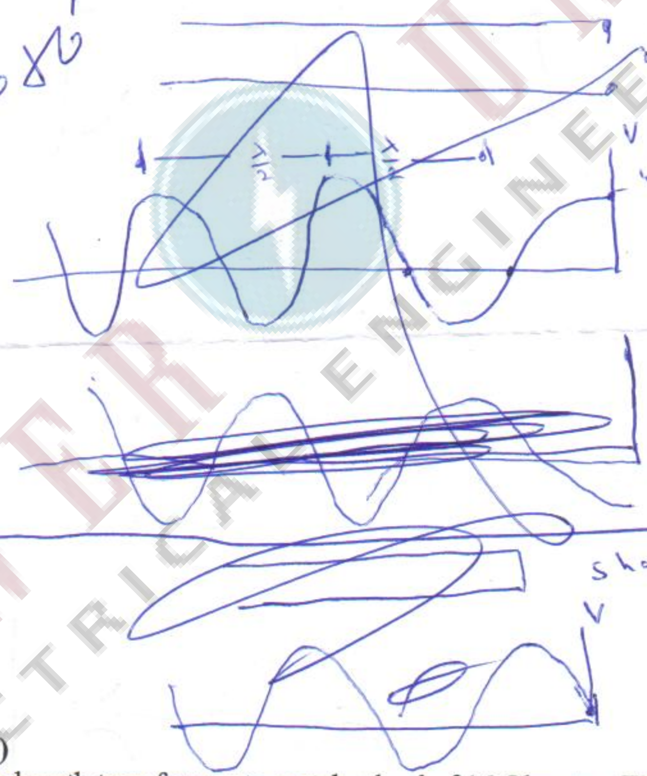
open ملاحظة

الحل خلف الورقة



الحل خلف الورقة

Question 5 (4 pts)

Use a quarter wavelength transformer to match a load of 16 Ohm to a T.L. of 100 Ohm

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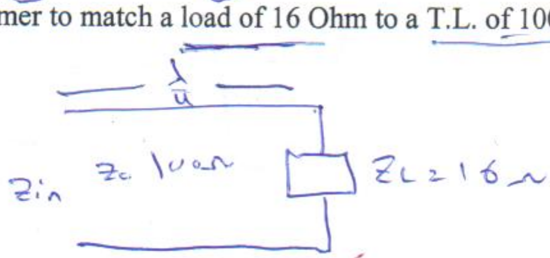

$Z_{in} = Z_o \left(\frac{Z_L + j Z_o \tan(\beta l)}{Z_o + j Z_L \tan(\beta l)} \right) = \frac{Z_o^2}{Z_L}$

$Z_o = \sqrt{Z_{in} Z_L}$ → $Z_{in} = \frac{(100)^2}{16} = 625\,\Omega$

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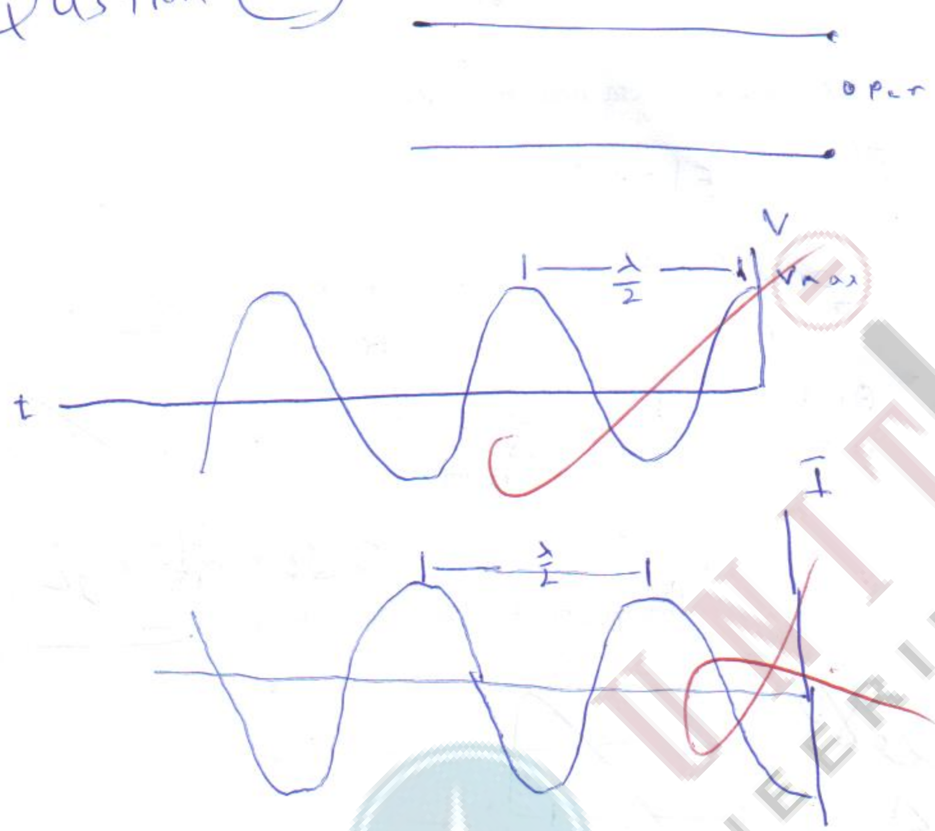
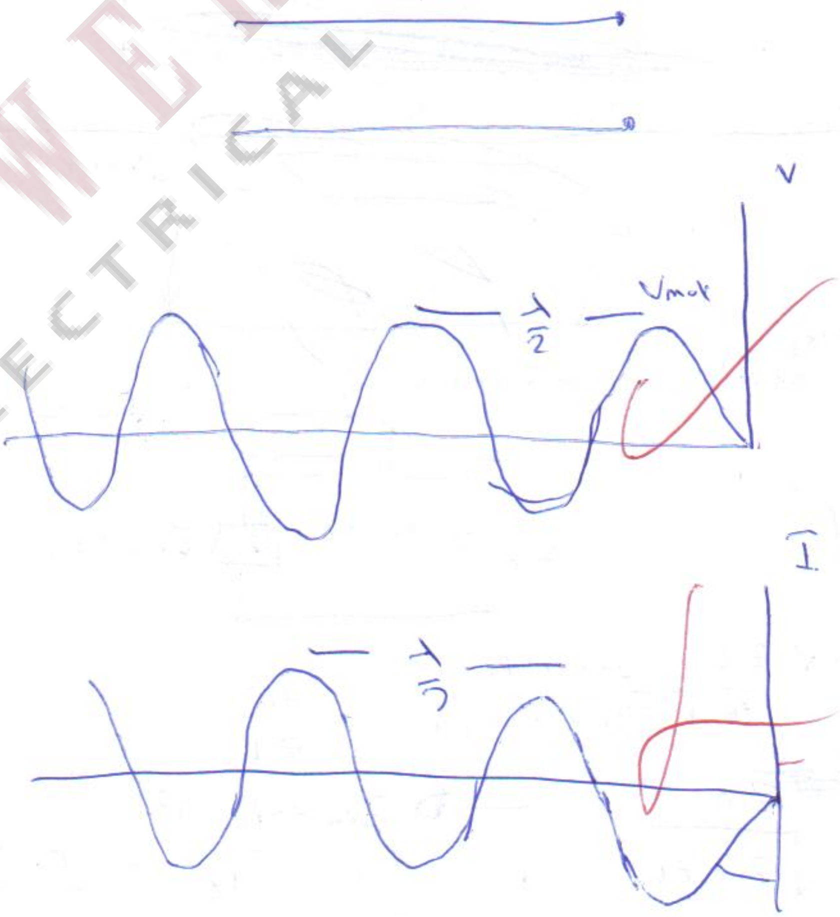
to happen marching the value of Zin must be equal 625

Qustion (4)



short



Question 6 (10 pts)
A load of impedance (25 – j 50) Ohm is connected to a 50 Ohm T.L. Use a short circuit stub to perform matching using the Smith Chart.

Z_R = ① we find $Z_n = \frac{25 - j50}{50} = \boxed{0.5 - j1}$

② $y_n = \frac{1}{z_n} = \frac{1}{0.5 - j1} = \boxed{0.4 + j0.8}$

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③ we perform y_n @ smith chart

④ we move to $1 + jx$ to find Value of x

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Now we find l_A, l_B

$l_A = 0.063\lambda$

$l_B = 0.207\lambda$

we choose $\boxed{l_A = 0.063\lambda \text{ Less cost}}$

Now we find d??

d = stub impedance $= \pm j1.58$

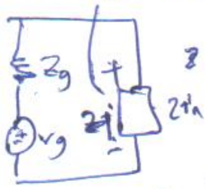
$d_A = 0.089\lambda$

$d_B = 0.409\lambda$

Question 7 (2 pts)

A 1.05 GHz generator with $v_g(t)=10\sin(wt+30)$, with impedance of 10 Ohm is connected by a T.L. with 50 Ohm impedance and terminated in a load of (100 + j 50) Ohm. The phase velocity is 0.7 c. Find v(z,t) and i(z,t) on line

$0.7c = f\lambda \rightarrow \lambda = \frac{0.7\times3\times10^8}{1.05\times10^9} = 0.2$ $\quad \lambda = 0.2$



$\beta L = \frac{2\pi}{\lambda} = \frac{2\pi}{0.2} = 1800$ $\quad \beta L =$

$Z_{in} = Z_0\left(\frac{Z_L + jZ_L\tan(\beta L)}{Z_0 + jZ_L\tan(\beta L)}\right) = Z_L = (100 + j50)$

$V_g(t) = 10\sin(\omega t + 30) = 10\cos(\omega t - 60)$ $\quad V_g = 10\angle -60$

voltage divition — $V_{in} = \frac{Z_{in}\times 10\angle -60}{Z_{in}+Z_g} = 9.256\, e^{-j57.87}$

$V^+ = V_{in}\left(e^{j\beta L} + \Gamma e^{-j\beta L}\right) = 9.256\angle -57.87\left(e^{j1800} + \Gamma e^{-j1800}\right)$

$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = 0.862\angle 4.61$

$V^+ = 9.256\angle -57.87\,(1+\Gamma) = 17\angle -55.75$

$V(z,t) = V^+\left(e^{\beta z} + \Gamma e^{-\beta z}\right) = 17\angle -55.75\left(e^{\beta z} + 0.852\, e^{j4.61}e^{-\beta z}\right)$

$= 17\cos(\omega t + \beta z - 55.75) + 14.482\cos(2.1\pi\times10^9 t - \beta z - 51.6)$

$2\pi f = 2.1\pi G$

$I(z,t) = 1.7\cos(\omega t + \beta z - 55.75) - 1.448\cos(2.1\pi\times10^9 t - \beta z - 51.6)$

Question 8 (2 pts)

Use the incident voltage and current waves on a T.L. to find an expression for the incident power on the T.L.

~~$P_i = \frac{1}{2}\,\mathrm{Real}(V(z)\,I^*)$~~

$P_i = \frac{1}{2}\,\mathrm{Real}(V_i \times I_i^*)$

$V_i(z) = V^+ e^{-\gamma z}$

$I_i(z) = \frac{V^+}{Z_0} e^{-\gamma z}$

$P_i = \frac{1}{2}\,\mathrm{Real}\left(\frac{V^{+2}}{Z_0} e^{-\gamma z} e^{\gamma z}\right) = \frac{V^{+2}}{2Z_0}$

Power for incident

The Complete Smith Chart

Black Magic Design