October, 2020

كهروو2
الفصل السادس

College of Electronics Technology/ Tripoli

Engineering Electromagnetics II

Final exam

Q.1) Calculate the line parameters *R, G, L,* and *C* for:

a) A lossless line with $\beta = 3$ *rad/m,* $Z_0 = 50\ \Omega$, $f = 10$ MHz

b) A distortionless line with $\gamma = 0.04 + j1.5$ */m*, $Z_0 = 80\ \Omega$, $f = 500$ *MHz* (20 points)

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Q.2) The electric field of an electromagnetic wave in free space is:

$E(z,t) = 50\cos(\omega t - \beta z)a_x$ *V/m*. Find the total power crossing a circular area of radius 2.5 *m* on plane *z* = constant. (10 points)

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Q.3) For a reflection of a plane wave at normal incident, show that:

$\frac{H_{t0}}{H_{i0}} = \tau\frac{\eta_1}{\eta_2} = \frac{2\eta_1}{\eta_1+\eta_2}$ and $-\frac{H_{r0}}{H_{i0}} = \Gamma = \frac{\eta_2-\eta_1}{\eta_2+\eta_1}$

where *i, r,* and *t* denote incident, reflected, and transmitted waves respectively. (15 points)

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Q.4) A uniform plane wave in a lossy nonmagnetic medium has:

$$E_s = (5a_x + 12a_y)e^{-\gamma z}\ ,\ \gamma = 0.2 + j3.4\ /\ m$$

(a) Compute the magnitude of the wave at $z = 4$ *m*, $t = T/8$.

(b) Find the loss in *dB* suffered by the wave in the interval $0 < z < 3$ *m*. (15 points)

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Useful formulas:

$$\alpha = \omega\sqrt{\frac{\mu\varepsilon}{2}\left[\sqrt{1+\left[\frac{\sigma}{\omega\varepsilon}\right]^2}-1\right]},\quad \beta = \omega\sqrt{\frac{\mu\varepsilon}{2}\left[\sqrt{1+\left[\frac{\sigma}{\omega\varepsilon}\right]^2}+1\right]},\quad |\eta| = \frac{\sqrt{\mu/\varepsilon}}{\left[1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2\right]^{1/4}}$$

Transmission line: general case:

$$\gamma = \alpha + j\beta = \sqrt{(R+j\omega L)(G+j\omega C)},\quad Z_0 = \sqrt{\frac{R+j\omega L}{G+j\omega C}}$$

$$Z_{in} = Z_0\left[\frac{Z_L + jZ_0\tan\beta l}{Z_0 + jZ_L\tan\beta l}\right],\quad \text{lossless transmission line.}$$

$$\varepsilon_o = \frac{10^{-9}}{36\pi},\quad \mu_o = 4\pi\times10^{-7}$$

.....

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March 3, 2020

College of Electronic Technology/ Tripoli

Engineering Electromagnetics II

تصرو 2
الفصل السادس

Final exam

Q.1) A lossless transmission line having $Z_o = 120\ \Omega$ is operating at $\omega = 5 \times 10^8$ rad/s. If the velocity on the line is 2.4×10^8 m/s, find: (a) L; (b) C. (c) let Z_L be represented by an inductance of 0.6 μH in series with 100 Ω resistance. Find Γ and SWR.

(points: 10)

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Q.2) If the H and E fields in air are given by $H = -0.3\sin(4\pi \times 10^6 t - \beta z) a_x\ A/m$, and $E = A\ \sin(4\pi \times 10^6 t - \beta z) a_E\ V/m$, find β, a_k, and A. (points: 4+2+4)

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Q.3) In travelling from free space into a certain material at normal incident, a uniform plane wave encounters a reflection of -0.125 and a velocity reduction of 50 percent. If the material is lossless, what are ε_r and μ_r? (points: 5+5)

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Q.4) The parameters of a certain transmission line operating at 6×10^8 rad/s are L = 0.4 μH/m, C = 40 pF/m, G = 80 mS/m, and R = 20 Ω/m. Find the following:

(a) γ, α, β, λ, and Z_o

(points: 10+5)

(b) If a voltage wave travels 20 m down the line, by what percentage is its amplitude reduced, and by how many degrees is its phase shifted? 10

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Q.5) a) Determine the dc resistance of a round copper wire ($\sigma = 5.8 \times 10^7$ mhos/m, $\mu_r = 1$, $\varepsilon_r = 1$) of radius 1.2 mm and length 600 m.

b) Find the ac resistance at 100 MHz.

(points: 5+5+5)

c) Calculate the approximate frequency where dc and ac resistance are equal.

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كود فيزيائية II

الإجابة النموذجية للإختبار النهائي

مارس/2020

Q.1) 10 [3+3+3+1]

Q.2) 10 [4+2+4]

Q.3) 10 [5+5]

Q.4) ~~15~~ (a) 10 [2+2+2+2+2]

(b) 5 [2.5+2.5]

Q.5) 15 [(a) 5 (b) +5 (c) +5] or ⇒ [(a) 7 (c) +8]

د. ايمان [illegible]

[illegible]

4/10/2020

Q.1) (a) L: with $Z_0 = \sqrt{\frac{L}{C}}$ and $u = \frac{1}{\sqrt{LC}}$, we find (1)

$$L = \frac{Z_0}{u} = \frac{120}{2.4 \times 10^8} = \boxed{0.50\ \mu H/m} \quad (3)$$

(b) C: use $Z_0 u = \sqrt{L/C}/\sqrt{LC} \Rightarrow C = \frac{1}{Z_0 u}$

$$= [120(2.4 \times 10^8)]^{-1} = \boxed{35\ PF/m} \quad (3)$$

(c) Let Z_L be represented by an inductance of $0.6\mu H$ in series with a 100Ω resistance. Find Γ and SWR.

The inductance impedance is $j\omega L = j(5 \times 10^8)(0.6 \times 10^{-6})$
$= j300 \Rightarrow$ so the impedance is:

$$Z_L = 100 + j300\ \Omega$$

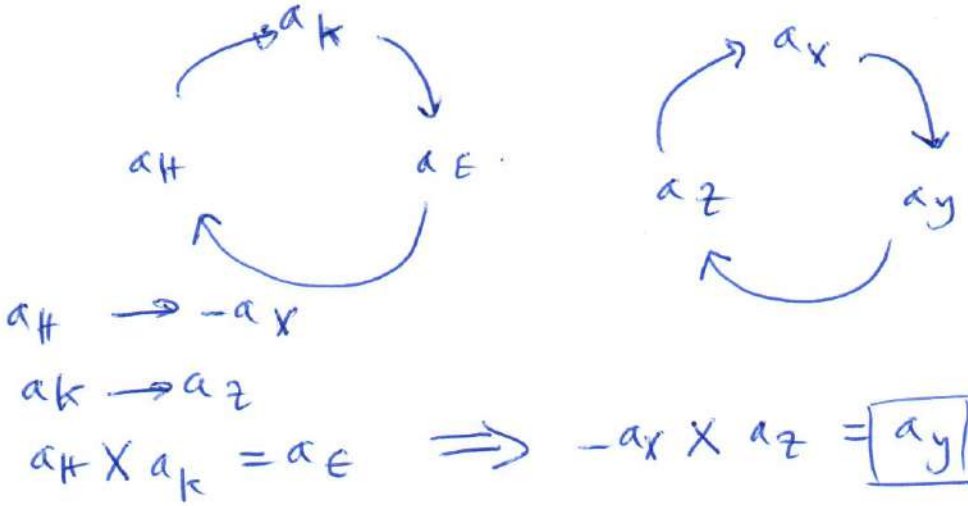
$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0} = \frac{100 + j300 - 120}{100 + j300 + 120}$$

$$= 0.62 + j0.52 = \boxed{0.808 \angle 40^\circ} \quad (3)$$

$$\therefore SWR = \frac{1 + |\Gamma|}{1 - |\Gamma|} = \frac{1 + 0.808}{1 - 0.808} = \boxed{9.4} \quad (1)$$

Q.2) $\beta = \omega\sqrt{\mu_0 \varepsilon_0} = \frac{\omega}{c} = \frac{4\pi \times 10^6}{3 \times 10^8}$

$$= \boxed{0.04188\ rad/m} \quad (4)$$



$a_H \rightarrow -a_x$

$a_k \rightarrow a_z$

$a_H \times a_k = a_\phi \Rightarrow -a_x \times a_z = \boxed{a_y}$ (2)

Q.4) (3)

(a) $\gamma = \sqrt{ZY} = \sqrt{(R+j\omega L)(G+j\omega C)}$

$= \sqrt{[20 + j(6\times10^8)(0.4\times10^{-6})][80\times10^{-3} + j(6\times10^8)(40\times10^{-12})]}$

$= 2.8 + j3.5\ m^{-1} = \alpha + j\beta$ (2)

Therefore, $\boxed{\alpha = 2.8\ Np/m}$, $\boxed{\beta = 3.5\ rad/m}$ (2)

(2)

$\lambda = \frac{2\pi}{\beta} = \boxed{1.8m}$ (2)

$Z_o = \sqrt{\frac{Z}{Y}} = \sqrt{\frac{R+j\omega L}{G+j\omega C}} = \sqrt{\frac{20 + j24\times10^{-2}}{(80*10^{-3} + j2.4\times10^{-2})}}$

$\boxed{= 44 + j30\ \Omega}$ (2)

Q.5) (a) $R_{dc} = \frac{l}{\sigma S} = \frac{l}{\sigma\pi a^2} = \frac{600}{(5.8\times10^7)(\pi)(1.2\times10^{-3})^2}$

$\boxed{R_{dc} = 2.2867\ \Omega}$ (5)

في حالة الضغط على الفأرة b تصبح
فقرة (a) ← 7
وفقرة (c) ← 8

(b) $R_{ac} = \frac{1}{\sigma 2\pi a\delta}$, at 100MHz, $\delta = 6.6\times10^{-3}$ mm

$R_{ac} = \frac{600}{(5.8\times10^7)(2\pi)(1.2)(6.6\times10^{-3})(10^{-3})(10^{-3})}$

$\boxed{R_{ac} = 207.88\ \Omega}$ (5)

(c) $\frac{R_{ac}}{R_{dc}} = \frac{a}{2\delta} = 1 \Rightarrow \delta = \frac{a}{2} = \frac{66.1\times10^{-3}}{\sqrt{F}}$

$\sqrt{F} = \frac{66.1\times 2\times10^{-3}}{a} = \frac{66.1\times2}{1.2} \Rightarrow \boxed{f = 12.127\ kHz}$ (5)

ملاحظة: فقرة (c) يمكن حلها لعدة طرق تم مراعاة ذلك عند تصحيح الأسئلة.

(1) (2) الطلبة الذين لم يتمكنوا من حل فقرة (b) يتم الغاء فقرة العقوبة وتوزيع الدرجات على (a) و (b)

(2)

$$\eta = \sqrt{\frac{\mu_0}{\varepsilon_0}} = 120\pi$$

$$A = E_0 = \eta_0 H_0$$

$$= 120\pi \times 0.3$$

$$= \boxed{113.09} \quad (4)$$

Q.3)

$\Gamma = -0.125$

ε_0, μ_0 Free space	Lossless ε, μ
$u = c$ →	$u = 0.5c$

$$\Gamma = \frac{\eta_2 - \eta_1}{\eta_2 + \eta_1}, \quad \eta_1 = \sqrt{\frac{\mu_0}{\varepsilon_0}} = 120\pi$$

$$\eta_2 - \eta_1 = \Gamma(\eta_2 + \eta_1) \Rightarrow \eta_2 = \frac{\eta_1(1+\Gamma)}{1-\Gamma}$$

$$\eta_2 = \frac{120\pi(1-0.125)}{1+0.125} \Rightarrow \boxed{\eta_2 = 293.21}$$

$$u = 0.5c \Rightarrow \boxed{u = 1.5 \times 10^8}$$

$$u = \frac{1}{\sqrt{\mu\varepsilon}}, \quad \eta_2 = \sqrt{\frac{\mu}{\varepsilon}}$$

$$\boxed{\frac{\eta_2}{u} = \mu} \qquad \eta_2 = \frac{\sqrt{\mu}}{\sqrt{\varepsilon}} \Rightarrow \boxed{\varepsilon = \frac{\mu}{\eta_2^2}}$$

$$\mu = \frac{\eta_2}{u} = \frac{293.21}{1.5 \times 10^8} = 1.95473 \times 10^{-6}$$

$$\mu_r \mu_0 = 1.95473 \times 10^{-6}$$

$$\boxed{\mu_r = 1.55} \quad (5) \qquad \varepsilon = \frac{\mu}{\eta_2^2} = \frac{1.95473 \times 10^{-6}}{(293.21)^2}$$

$$\varepsilon = 2.2736 \times 10^{-11} = \varepsilon_r \varepsilon_0$$

$$\boxed{\varepsilon_r = 2.567} \quad (5)$$

Q-4)(b)

$$\frac{V_{20}}{V_0} = e^{-\alpha L} = e^{-(2\cdot8)(20)}$$

$$= 4.8 \times 10^{-25}$$

$$= 4.8 \times 10^{-23}\ \%$$

2.5

(2.5 + 2.5) = (5)

The ~~Phase~~ Phase shift is given by: βL

$$\therefore \phi = \beta L \left(\frac{360}{2\pi}\right) = (3.5)(20)\left(\frac{360}{2\pi}\right)$$

$$= 4.0 \times 10^3 \text{ degree}$$

2.5

5 10 15 20 25 30 35 40 45 50 55 60