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1. An electromagnetic wave is propagating along the positive z axis. The phasor that represents the electric field intensity is:

$$\vec{E} = (\hat{y} + j\hat{x})e^{-jkz}$$

   a) Calculate the equation of the instantaneous electric field in the plane z=λ.
   b) Plot the variation of the instantaneous electric field with respect to ωt.
   c) What is the polarization of the field? (linear, RHCP, LHCP, RHEP, or LHEP)
   d) Find the polarization loss factor (PLF) when the antenna receiving the wave has a polarization vector like the following: $\hat{\rho}_a = \frac{(\hat{x} - 0.5\hat{y})}{\sqrt{5/2}}$

a) From the relation between a phasor and its corresponding instantaneous variable:

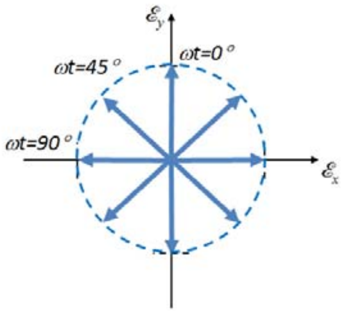
$$\vec{\mathscr{E}}(t) = \mathscr{Re}\left\{\vec{E}\, e^{j\omega t}\right\} = \mathscr{Re}\left\{(\hat{y} + j\hat{x})e^{-jkz}e^{j\omega t}\right\} = \hat{y}\cos(\omega t - kz) - \hat{x}\sin(\omega t - kz)$$

Considering that *z*=λ (and then *kz*=2π):

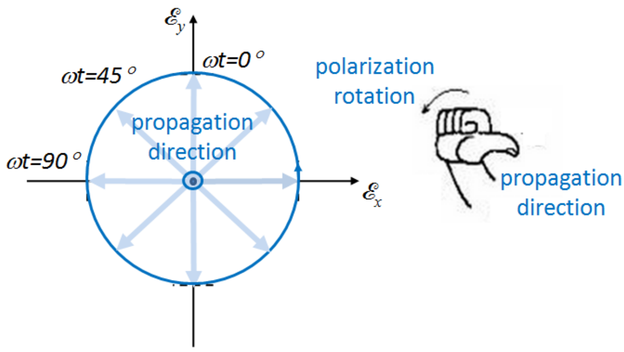
$$\vec{\mathscr{E}}(t) = \hat{y}\cos(\omega t) - \hat{x}\sin(\omega t)$$

b) Varying ωt from 0 to 2π

ωt	$\vec{\mathscr{E}}$
0°	$\hat{y}$
45°	$(\hat{y} - \hat{x})/\sqrt{2}$
90°	$-\hat{x}$
135°	$-(\hat{y} + \hat{x})/\sqrt{2}$
180°	$-\hat{y}$
225°	$-(\hat{y} - \hat{x})/\sqrt{2}$
270°	$\hat{x}$
315°	$(\hat{y} + \hat{x})/\sqrt{2}$



c) Attending to the plot of b) and considering that the wave is propagating along the positive z-axis, the wave is RHCP.



d) To calculate the polarization loss factor it is required the knowledge of the polarization unitary vectors of the incoming wave and the receiving antenna:

$$PLF = \left|\hat{\rho}_i \cdot \hat{\rho}_a\right|^2 = \left|\frac{(\hat{y} + j\hat{x})}{\sqrt{2}} \cdot \frac{(\hat{x} - 0.5\hat{y})}{\sqrt{5/2}}\right|^2 = \left|\frac{(j - 0.5)}{\sqrt{10/2}}\right|^2 = \frac{1}{2} \equiv -3\,\text{dB}$$

Name:

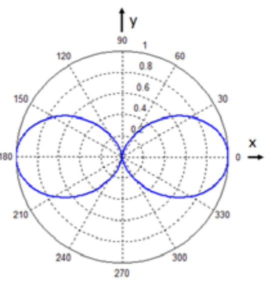
2. Mark the statements as true or false. Each incorrect mark cancels a correct one.:

	TRUE	FALSE
a) Increasing ohmic losses of an antenna reduces its radiation efficiency.		
b) Double the antenna effective area reduces its directivity by a factor of 2 its directivity.		
c) The Wheeler cap method is used to measure the antenna losses due to the polarization mismatch (PLF).		
d) A 25 cm height monopole is resonant at a frequency close to 300 MHz.		
e) The resonant frequency of an antenna is the frequency where return losses are lower.		
f) Antenna radiation patterns change with distance. For that reason the pattern measurement distance should be indicated in every antenna brochure.		
g) The magnitude of the electric field radiated by an antenna decays with the square of the increasing distance to the antenna.		
h) Antenna radiation patterns change with frequency. For that reason the measurement frequency should be indicated in the antenna brochure.		
i) H-plane radiation pattern is the cut of the radiation pattern by an horizontal plane.		
j) The radiation pattern of a dipole antenna is the same that the radiation pattern of a monopole antenna having half the length of the dipole.		

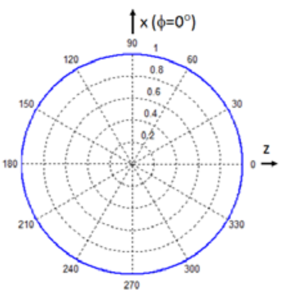
3. The electric field magnitude of a given antenna is given by the following formula. Which radiation pattern cut is not possible for this antenna?

$$\left|\vec{E}\right| = \frac{k\eta}{4\pi r}\left|I_0\right| l\sqrt{1-\sin^2\theta\ \sin^2\phi}$$

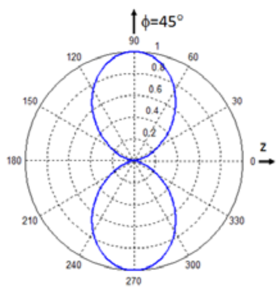
a)



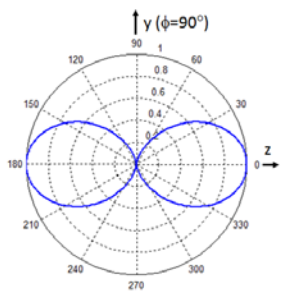
b)



c)

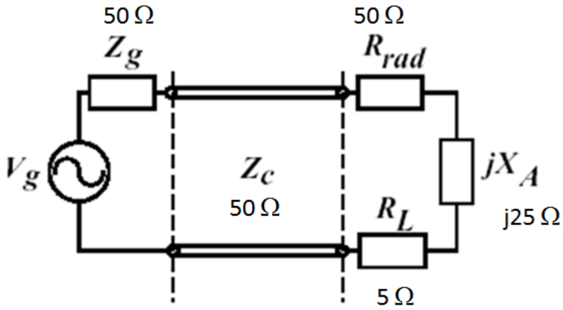


d)

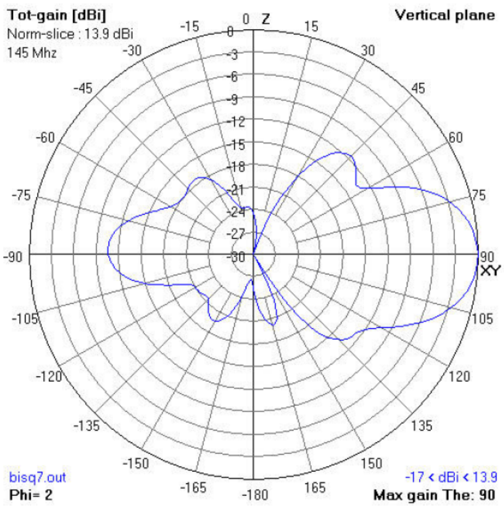


Name:

4. Compute the radiation efficiency of the antenna circuit shown in the figure below



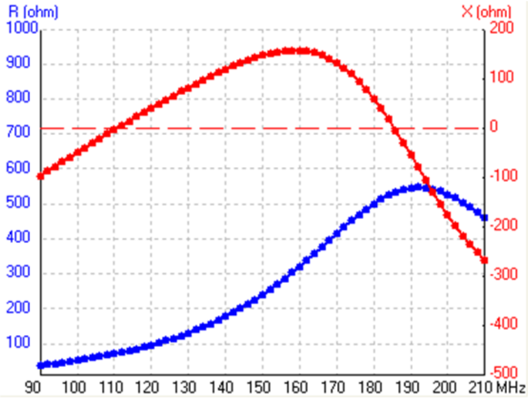
5. The vertical plane pattern of an antenna simulated with an electromagnetic CAD programme provides the following plot. Mark the incorrect figure:

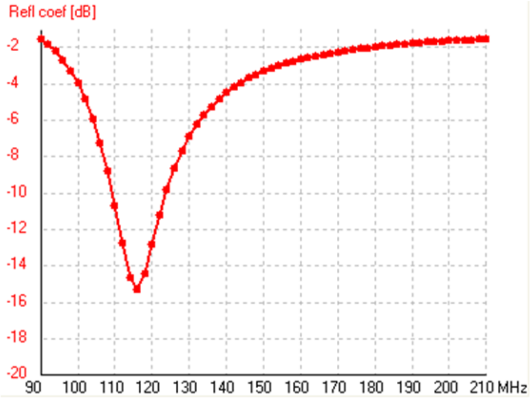


a) Null beamwidth is 180º
b) Front to back ratio (F/BR) is 10.5 dB
c) -3 dB beamwidth is 30º
d) Secondary lobe level (SLL) is -11.5 dB.

Name:

6. Given the antenna simulation results (impedance and return loss) shown at the figure, which is false?





a) Radiation efficiency is 50%.

b) Resonant frequency is 110 MHz.

c) At 160 MHz the source impedance for maximum transferred power is 325-j150 Ω.

d) -10 dB fractional bandwidth is approx. 13 %.

7. Identify the source impedance allowing the maximum transferred power to the previous antenna at 160 MHz.

a) -325 Ω b) j 150 Ω c) 150-j325 Ω d) 325-j150 Ω

8. If the antenna above is a λ/2 dipole, make an estimate of its physical length at matching.

a) 2.60 m b) 1.30 m c) 0.94 m d) 0.77 m

9. For the antenna above, which is the correct answer?

a) Matching efficiency (e_{ref}) is almost 50% at 120 MHz.

b) Radiation efficiency (e_{rad}) is almost 75%.

c) -10 dB bandwidth is 15 MHz.

d) -10 dB fractional bandwidth is 1.3 %.