EE 4382/5306 – Antenna Engineering
Test # 2 Oct. 30, 2017

Instructions:

a. **Please keep your cell phone stored in your bag or pocket. No cellphone access during the exam. If you are found using your cellphone, you will be asked to leave the room and will receive a grade of 0 in the test.**

b. **You cannot talk to your classmates during the exam. If you talk to your classmates during the exam, you will be asked to leave the room and will receive a grade of 0 in the test.**

c. **This is a closed book, closed notes, no computer exam. The formula sheet is one page, double-sided, written by you and will be handed at the end along with the test. DO NOT TEAR ANY PAGES FROM THE TEST.**

d. **Put the proper units and prefixes with your answers and use the appropriate sign conventions.**

e. **Show all work, including intermediate steps. Failure to do so will be penalized.**

f. **Write clearly the answer(s) to each question and highlight them or box them. Do all your work on the pages provided. No scrap paper is permitted. You may also use the back of the paper if you run out of space.**

g. **No bathroom breaks during the exam.**

By signing this exam, you agree that the work presented here represents only your effort.

Name: KEY **Signature:** KEY

UTEP ID: KEY

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1.– Line Wire, Loop, and Microstrip Antennas – Theory (4 points each)

Circle the correct answer for the following statements.

1. The maximum directivity (dimensionless) of an infinitesimal dipole is

   1.5 1.65 3

2. The radiation resistance of an small finite length dipole, with an idealized triangular current distribution, is__________ of an infinitesimal dipole with a uniform current distribution:

   equal twice one-fourth

3. The input impedance of a lambda/2 dipole, with an idealized sinusoidal current distribution, is:

   53 + j100 73 + j42 103 + j25

4. The normalized far field pattern of a small loop of constant current is the same as that of a :

   half-wave dipole infinitesimal dipole full-wave dipole

5. The maximum directivity (dimensionless) of a very small circular loop, with an idealized uniform current distribution, is:

   1.5 1.65 3

6. The reactance of a very small loop with many turns is primarily:

   Inductive Capacitive Resistive

7. The most popular microstrip patches are usually the:

   Rectangular and Circular Triangular and Elliptical Circular and Ring

8. A microstrip antenna is usually classified as:

   Broadband Narrowband Middleband

9. The analysis model for microstrip antennas that is the simplest is the

   Cavity Model Full-Wave Model Transmission-Line Model

10. The analysis model for microstrip antennas which is the most accurate is

Cavity Model   Full-Wave Model   Transmission-Line Model

11. In the transmission-line model, the number of radiating slots are:

2   3   4

12. In a microstrip antenna or line, the effective dielectric constant is used to take into account the:

impedance of the slots   geometry of the patch   fringing of the fields

2.– Linear Wire Antennas (26 points)

A lossless half-wave ($l = \frac{\lambda}{2}$) dipole operating at a 1GHz, with an ideal sinusoidal current distribution, is placed vertically at a height $h = 1.5\,\lambda$ above a flat, smooth, and infinite in extent perfect electric conductor.

Determine **ALL** the physical angles ($0 \leq \theta \leq 90^{\circ}$) where the pattern has nulls.

$\lambda/2$ dipole

$f = 1\,GHz$

$\lambda = 0.3\,m$

$h = 1.5\lambda$

$0 \leq \theta \leq 90°$

$0 \leq \theta \leq 1.5707$ rad

$kh = \frac{2\pi}{\lambda}\left(\frac{3\lambda}{2}\right) = 3\pi$

E-field AF $= \cos(kh\cos(\theta)) = 0$ for nulls

$\hookrightarrow kh\cos(\theta) = \cos^{-1}(0)$

$\hookrightarrow kh\cos(\theta) = \frac{n\pi}{2}$, $n = 1, 3, 5, \ldots$

$\hookrightarrow \cos(\theta) = \frac{n\pi}{2kh}$, $n = 1, 3, 5, \ldots$

$\hookrightarrow \cos(\theta) = \frac{n\pi}{2(3\pi)} = \frac{n}{6}$, $n = 1, 3, 5, \ldots$

$\hookrightarrow \theta = \cos^{-1}\left(\frac{n}{6}\right)$, $n = 1, 3, 5, \ldots$

$\theta_{n=1} = 80°$

$\theta_{n=3} = 60°$

$\theta_{n=5} = 33.56°$

$\theta_{n=7}$ = doesn't exist

3.– Small Loop Antennas (26 points)

A small circular loop of N-turns has a uniform current distribution and a circumference of $\frac{\lambda}{4}$ is fed by a lossless, balanced transmission line with a characteristic impedance of 300 Ω. **Neglecting proximity effects,** determine the closest integer number of turns so that the input impedance is nearly 300 Ω.

$C = \lambda/4 = 2\pi a \longrightarrow a = \lambda/8\pi$ it is a small loop ✓

$R_r = 20\pi^2 \left(\frac{C}{\lambda}\right)^4 N^2 = 20\pi^2 \left(\frac{1}{4}\right)^4 N^2 = 300\ \Omega$

$N = \sqrt{\frac{300}{0.771}} = 19.725$

$N \approx 20$ turns