DEPARTMENT OF ELECTRICAL ENGINEERING
EEL-207 ENGINEERING ELCTROMAGNETICS
MAJOR TEST (30th November 2006)

1. Answer the following:

   (a) If a small single turn loop antenna has a radiation resistance of 0.04 ohm, how many turns are needed to produce a radiation resistance of 1 ohm?
   (b) A receiving antenna has a maximum dimension of 3 m and operates at 100 MHz. Is this in the far field of another antenna transmitting from ½ km away?
   (c) A receiving antenna is located 100m away from the transmitting antenna. If the effective area of the receiving antenna is 500cm^2 and the power density at the receiving location is 2mW/m^2, what is the total power received?
   (d) An antenna receives a power of 2mW from a radio station. Calculate the effective area if the antenna is located in the far zone of the station where E= 50mV/m.
   (e) Give the time-space representation of the following time harmonic electric field and mention what type of polarization is associated with it: $\mathbf{E}(r) = (\hat{x} + 2j\hat{y})e^{-j\beta z}$
   (f) Find the total current flowing in moist soil having $\sigma = 10^{-3} S/m, \varepsilon_r = 2.5$ for an electric field of $6.0\text{x}10^{-6}\sin(9.0\text{X}10^{9}\text{t})$ V/m.
   (g) Determine the current at the interface of two regions having $\mu_{r1} = 2$ and $\mu_{r2} = 5$ and the fields are $\mathbf{B}_1 = 2\hat{x} + 10\hat{z}$ tesla and $\mathbf{B}_2 = 25\hat{x} - 15\hat{y} + 10\hat{z}$ tesla, respectively.

   (1+1+1+2+2+2+2) marks

2. (a) A uniform 4-Hertzian dipole element array, with dipoles aligned perpendicular to the axis of the array, each has a progressive phase shift of 45^0 and inter element spacing of 0.4λ. Using the principal of pattern multiplication, sketch the radiation pattern of the array, both in the x-y and y-z plane for $\theta = 90^0$.
   (b) Plot the array factor, mark the location of the nulls and determine the 3-dB beamwidth of the array.
   (4+5)marks

3. Show for that for a terminated lossless transmission line: $[Z(z)]_{max}=Z_o$ X (VSWR)
(4 marks)

4. What is the dominant mode of the microstrip line? Draw the E- and H- field lines for the dominant mode for the microstrip line.
(3 marks)

5. Enumerate the advantages of optical fiber as a transmission line. Why graded index fiber is better than a step index fiber? Give the illustrative values of the diameters and index value used for a single mode step and graded index glass fibers.
(4 marks)

6. (i) A 10 W microwave transmitter is connected by an air filled lossless waveguide of cross section 2.5 cm **X** 1 cm to a lossless half wave dipole antenna. (a) For transmission at 10 GHz, find the ratio of phase and the group velocity of the waveguide. (b) If the antenna is excited by the dominate mode of the waveguide, determine the power delivered to the antenna and the VSWR on the waveguide.
(ii)What is the power received by a distant $\lambda/4$ monopole standing on the ground at a distance of 1 km from the transmitting $\lambda/2$ dipole?
(5+4) marks

$\mu_0 = 4\pi x10^{-7} H/m$, $\varepsilon_0 = 8.854x10^{-12} F/m$, 1GHz=$10^9$Hz