Indian Institute of Technology Delhi
Major Examination 2008-09
EEL 338: Antennas and Propagation

Date: May 6, 2009 Duration: 2 Hours
Total Marks: 30

Q. 1: A thin slot with the length L=0.7λ and the width w=0.2λ is cut in an infinite ground plane. Assume a coordinate system such that the conducting plane lies on the xy-plane with the larger dimension of the slot parallel to y-axis and assume that the width of the slot is small compared to the wavelength. The field distribution is constant over the slot and is given by:

$$\vec{E}_a = -E_0 \hat{a}_x$$

Draw the geometry indicating the electric field (***1 mark***). Find the equivalent source (***1 mark***). Sketch the six approximate principal plane patterns in the xz-plane, the yz-plane and the xy-plane (***6 marks***).
The radiated fields are given by:

$$E_\theta = C\cos\phi \frac{\sin X}{X}\frac{\sin Y}{Y} \qquad E_\phi = C\cos\theta\sin\phi \frac{\sin X}{X}\frac{\sin Y}{Y}$$

$$X = \frac{kw}{2}\sin\theta\cos\phi \qquad Y = \frac{kL}{2}\sin\theta\sin\phi$$

Q. 2: Using the equivalence principle and cavity model, explain why some sides of a microstrip patch antenna are called 'radiating edges' and some other sides are called 'non-radiating edges' (***7 marks***).
Assume that the dominant mode within the cavity is TM^x_{010} for which the fields are given as:

$$E_x = E_0 \cos\left(\frac{\pi}{L}y'\right)$$

$$H_z = H_0 \sin\left(\frac{\pi}{L}y'\right)$$

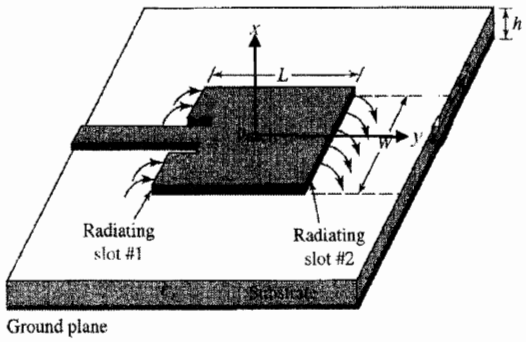
$$E_y = E_z = H_x = H_y = 0$$

Q. 3: Explain the differences between broadside arrays with uniform, binomial and Dolph-Tschebyscheff excitations in terms of their directivities and HPBW. (***3 marks***)?

Q. 4: Design an E-plane horn such that the maximum phase difference between two points at the aperture (one at the center and the other at the edge) is 120°. Assuming that the maximum length along its wall ρ_e (measured from the aperture to its apex), is 10λ. The waveguide feeding the horn has dimensions of a=0.5λ and b=0.25λ. Find

a. The maximum total flare angle of the horn, (***2 marks***)
b. The largest dimension of the horn at the aperture, (***2 marks***)
c. The directivity of the horn (dimensionless and in dB) (***4 marks***).

Q. 5: Consider a patch antenna with the coordinate system as shown in the figure below. How would you position a dipole with the center on the x-axis in the far field for maximum reception? (***4 marks***)



Useful Formulae:

Directivity of an E-plane sectoral horn:

$$D_E = \frac{64a\rho_1}{\pi\lambda b_1}\left[C^2\left(\frac{b_1}{\sqrt{2\lambda\rho_1}}\right) + S^2\left(\frac{b_1}{\sqrt{2\lambda\rho_1}}\right)\right]$$