EE 434 Electromagnetic Waves, Spring 2009
Practice exam, 2009/5/4

(1) What is a broadside antenna array? What is a end-fire antenna array?
(2) An antenna (or antenna array) has the directional gain

$$D(\theta, \phi) = \sin^2\left(\frac{\theta}{2}\right)\cos^2\left(\frac{\phi}{2}\right)$$

Plot the gain in the $\phi = 0$ and $\theta = 90^\circ$ planes respectively.
(3) For the same direction gain as in question 2, write an expression for a vector wave electric field which is consistent with this directional gain.
(4) For an array of two antennas, what spacing, d, and phase difference, ψ will result in an end-fire array with a power maximum in the positive direction and minimum in the negative direction.
(5) Sketch the magnetic field of a TM_{21} mode in a rectangular waveguide. And then the electric field of a TE_{21} mode.
(6) What is the cutoff frequency for the TM_{21} mode in a waveguide with dimension $a = 5\,\mathrm{cm}$ and $b = 3\,\mathrm{cm}$.
(7) For the same waveguide, what is the wavelength of a wave at the cutoff frequency? What is the wavelength of a wave at twice the cutoff frequency?
(8) Still for the same waveguide and at twice the critical frequency, if the waveguide is empty, and the amplitude of E_x is $1\,\mathrm{V/m}$, what is the amplitude of H_y?
(9) Consider two dielectric regions with $\epsilon_{1r} = 1$, $\epsilon_{2r} = 2$, and $\mu_1 = \mu_2 = \mu_0$ and an incident plane wave with electric field amplitude $E_1 = 1\,\mathrm{V/m}$. What is the amplitude of the reflected electric field? What is the amplitude of the reflected magnetic field?
(10) What is the incident power? What is the reflected power?
(11) What is Snell's law? What is the brewster angle? What does total internal reflection mean? Derive an expression for the angle of total internal reflection.