# PHYS 942 homework assignment #04

Department of Physics
University of New Hampshire
Prof. J. Raeder, J.Raeder@unh.edu

PHYS 942
October 14, 2016

Names ($\leq$3, write clearly): _____

Due: Wednesday, October 26, at the lecture. **Show all your steps!**

1. (*10 points*) A FM radio station emits 100 kW through a vertical dipole antenna at 90 MHz. What is the peak-to-peak electric field of the emitted waves 30 km away?

2. (*20 points*) Jackson, problem 8.4, only for the TM mode. The following relations will come in handy:

$$\int_0^a J_n(x_{lm}\rho/a)J_n(x_{ln}\rho/a)\rho d\rho = \frac{1}{2}a^2 J_{l+1}(x_{mn})^2,$$

where $x_{mn}$ is the $n^{th}$ root of $J_m$, and:

$$J_{m+1}(z) = \frac{m}{z}J_m(z) - J'_m(z),$$

which implies:

$$J_{m+1}(x_{mn}) = -J'_m(x_{mn}).$$

3. (*30 points*) Jackson, problem 8.8. You can use the results from Jackson chapter 8.9 on Schumann resonances. Note that "low order in $h/a$" means long wavelength, so that $u(r)/r \approx \text{const.} = H_0$ and $r \approx a$. That implies:

$$E_r \approx -\frac{i}{\epsilon_0\omega_l a}l(l+1)H_0 P_l(\cos\vartheta), \quad H_\varphi \approx H_0 P_l^1(\cos\vartheta)$$

from which $U$ and $P_{\text{loss}}$ can be calculated using the normalizations of the Legendre polynomials.

4. (*20 points*) Jackson, problem 9.1.

5. (*20 points*) Jackson, problem 9.16.