EE 894J - Spring Quarter 1999

Final Exam

June 9th, 1999

Write your name below and sign the honor pledge “No aid given, received, or observed” if it applies.

There are 2 problems on this exam. Exam is open book and notes.

Please box or underline your final answers, and remember to include units.

Be sure to show all work clearly if you wish to obtain any partial credit.

Use the pages at the back of the exam for your work. Be sure to clearly indicate which problem is being worked on each page.

Name: _____

“The Pledge”: No aid given, received, or observed.

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Problem 1 (5 parts, 50 points)

For each of the problems below, specify which theory would be most applicable: independent scattering theory, radiative transfer theory, continuous random medium theory, small perturbation method, or physical optics surface scattering. Explain why this particular theory should be applicable, what further information other than a description of system parameters (incidence and scattering angles, polarizations, antenna patterns, and range to target) would be required, and any potential limitations of the theory.

(a) Analysis of a tropospheric communications link at 1 GHz under clear atmosphere conditions.

(b) 5 GHz scattering from a PEC rough surface described as a Gaussian random process with an isotropic, Gaussian correlation function, height variance 12 cm, and correlation length 2 m.

(c) Prediction of scattering from rain at 1 GHz. Particle fractional volumes of less than 0.1% are expected.

(d) 10 GHz scattering from a PEC rough surface described as a Gaussian random process with an isotropic, Gaussian correlation function, height variance 1 mm, and correlation length 1 cm.

(e) Prediction of scattering from a layered random medium at 2 GHz. Particle fractional volumes of up to 2% are expected.

Problem 2 (3 parts, 50 points).

(a) 1 GHz backscattering is measured from a single layer random medium, with thickness 100 m. The random medium is free space containing a 1% fractional volume of spheres with radius 0.5 mm and relative permittivity $3 + i0.1$. Find the backscattering coefficient per unit area $\sigma_{vv}(\theta_i)$ for this medium at observation angle θ_i from the first order iterative solution of radiative transfer theory. It is not necessary to re-derive this solution, but a function involving only numbers and functions of θ_i should be given as your answer.

(b) 1 GHz backscattering is measured from a PEC randomly rough surface with power spectral density $W(p, q)$. Find the backscattering coefficient per unit area $\sigma_{vv}(\theta_i)$ for this surface at observation angle θ_i from the first order SPM solution. It is not necessary to re-derive this solution, but a function involving only numbers, functions of θ_i, and W should be given as your answer.

(c) If W is known to be Gaussian and isotropic, i.e. $W(p, q) = \frac{h^2 l^2}{\pi} e^{-(p^2 + q^2)\frac{l^2}{4}}$, find values of the surface height variance and correlation lengths which make your part (a) and (b) answers equal at 45 degrees. Try to find values if possible which satisfy the limitations of first order SPM.