Performance Objectives – Module 1 – Electromagnetic Wave Propagation

1. HISTORY OF ELECTROMAGNETICS

a. Describe and explain the significance of the major milestones in the evolution of electromagnetics.

2. ELECTROMAGNETIC QUANTITIES

a. Give the units of, and explain the physical significance of the principal electromagnetic field quantities including electric field strength, magnetic field strength, magnetic flux density, electric current density and electric charge density.*

b. Give expressions for the three constitutive relations for linear isotropic media.*

c. Give the units and explain the physical significance of the permittivity, permeability and conductivity of a material or medium.*

d. Give expressions for, explain the significance of, and use the scalar electric potential and the magnetic vector potential to obtain the corresponding electric and magnetic fields, respectively.*

3. MAXWELL'S EQUATIONS

a. Explain the significance of Maxwell's equations in the history of electromagnetics, and identify Maxwell's unique contributions.*

b. Give Maxwell's equations in both point and integral form, and in both the general and free space cases.*

c. State the divergence and Stokes' theorem and explain their significance.*

d. Explain how the Helmholtz theorem helps to explain why Maxwell's equations take the form they do.

e. Give an expression for displacement current and explain its physical significance.*

f. List and explain the significance of the principal implications of Maxwell's equations.

4. WAVE PROPAGATION IN MATERIAL MEDIA

a. Show how assuming a time-harmonic field simplifies Maxwell's equations when they are expressed in point form.*

b. Given the field strength or power density of a plane wave travelling in a given direction, give the corresponding Helmholtz equations and find expressions for the field components of the wave.*

c. Give expressions for and explain the significance of the wave impedance and the Poynting vector associated with a plane wave.*

d. Given the permittivity, permeability and/or conductivity of free space, a perfect dielectric, partially conducting medium, and good conductor, find the velocity of propagation, wavelength, impedance, and/or complex propagation constant of a plane wave that is travelling through it.*

UBC Radio Science Lab

Title: **EECE 483 - Perf Obj – Mod 1 – EM Wave Propagation**		Notes:
Drawn by: David G Michelson	Date: 6 Sep 2013	* Review of material covered in previous courses
E-mail: davem@ece.ubc.ca	Approved by: DGM	

Performance Objectives – Module 1 – Electromagnetic Wave Propagation

e. Given a good conductor with specified permittivity, permeability and conductivity, calculate the skin depth and resistance at a specified frequency.

f. Given the field strength or power density of a spherical wave as observed at a given distance, give the corresponding Helmholtz equations and find expressions for the field components of the wave.

5. WAVE PROPAGATION AT BOUNDARIES

a. Give and derive the boundary conditions for static electric and magnetic fields at the boundaries between two media.*

b. Given a plane wave normally incident on the boundary between two media with specified properties, find expressions for the transmitted and reflected waves.*

c. Define and give expressions for Snell's *law of reflection* and *law of refraction*.*

d. Define and explain the significance of the *critical angle of incidence* observed when a wave propagates from a denser medium into a less dense medium.*

e. Define and give examples of perpendicularly or TE-polarized and parallel or TM-polarized plane waves.*

f. Given a TE- or TM-polarized plane wave obliquely incident on the boundary between two media with specified properties, find the direction and derive expressions for the transmitted and reflected waves.*

6. DIFFRACTION BY A KNIFE-EDGE

a. Define Huygens' principle and explain how it can be used to predict the effects of diffraction.

b. Given transmitting and receiving antennas located at specified distances from and below opposite sides of a knife edge obstruction, calculate the excess attenuation due to the knife edge.

c. Given transmitting and receiving antennas located on opposite sides and at specified distances from a knife edge obstruction, determine the minimum path clearance required to incur negligible excess attenuation.