EAS 426 / ENGR 301: Environmental Remote Sensing and Image Analysis
Homework Set 1: Remote Sensing Foundations

Due Feb 18, 2022 before class.

Show all your work

Upload your solution set to Blackboard

LATE ASSIGNMENTS WILL NOT BE ACCEPTED

(1) Consider the electromagnetic wave described by:

$E_x = 0$
$E_y = E_0 \cos(\omega t - kx)$
$E_z = 0$

$B_x = 0$
$B_y = 0$
$B_z = (E_0/c) \cos(\omega t - kx)$

where E_0 = 1 kV/m = 1000 volts/m

(a) Show that the wave satisfies Maxwell's Equations.

(b) What is the direction of propagation of the wave in (x,y,z) space?

(c) Find the flux density of the wave

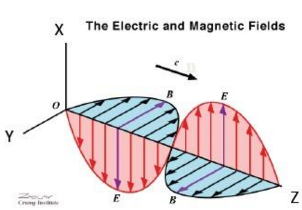
Hint: consider that the field quantities (E and B) are vectors (similar the those diagrammed in our lecture) and that the 'Del' operator is a differential vector operator in (x,y,z) space:

$$\nabla = \left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z} \right)$$

Maxwell's equations in free space

$$\nabla \cdot \vec{E} = 0$$
$$\nabla \cdot \vec{B} = 0$$
$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$
$$\nabla \times \vec{B} = \varepsilon_0 \mu_0 \frac{\partial \vec{E}}{\partial t}$$

E* & *B are the electric and magnetic field vectors



$E_x = E_0 \cos(\omega t - kz)$
$E_x = 0$
$E_z = 0$

$B_x = 0$
$B_y = \frac{E_0}{c} \cos(\omega t - kz)$
$B_z = 0$

(2) Plot the spectral emittance the five bodies in our solar system Listed here:

Sun (6000 K)
Venus (600 K)
Earth (300 K)
Mars (200 K)
Titan (120 K)

What is the wavelength at which emittance is a maximum for each body?

Hint: Consider the Plank formula as defined by:

$$S(\lambda)\frac{2\pi hc^2}{\lambda^5}\frac{1}{e^{ch/\lambda kT}-1}$$

(3) Assume that the sun emittance spectrum follows exactly Plank's formula:

$$S(\lambda)\frac{2\pi hc^2}{\lambda^5}\frac{1}{e^{ch/\lambda kT}-1}$$

with T = 6000°K. Calculate the percent of solar energy in the following spectral regions:

(a) Channel 1: 400 - 515 nm
(b) Channel 2: 525 - 605 nm
(c) Channel 3: 630 – 690 nm
(d) Channel 4: 750 – 900 nm
(e) Channel 5: 1550 – 1750 nm
(f) Channel 6: 10400 – 12500 nm
(g) Channel 7: 2090 – 2350 nm
(h) Panchromatic: 520 – 900 nm

Note that these correspond to Landsat 7 spectral channels, so these represent the solar energy incident on Earth's atmosphere associated with each of these bands.

Hint: This is an exercise in numerical integration. I will accept a numerical approach (Matlab, etc).
This can also be done numerically in Excel.

For full credit, turn in your programming code (e.g. matlab code, excel spreadsheet, etc.) with your solution.