EE/GP140 - Homework Set No 2   **Handout 11**

Due: Friday, January 25
In class (A65 Mitchell) or in TA's office or box outside 305 Mitchell

1. A remote sensing radar system with a swath width of 50 km is launched into a polar orbit at 205 km altitude.

   (a) What is the orbital period?

   (b) What is the orbital velocity?

   (c) How long would it take this system to acquire full coverage at the equator if the instrument is used only on ascending passes?

   (d) Now, suppose the same satellite is launched into a $55°$ inclination orbit. How long would it now take to complete global coverage operating on ascending passes only? How about if the radar can operate on both ascending and descending passes?

   (e) Which of these orbits is most useful for studying ice motions in the Arctic Ocean?

2. Two satellites are launched into polar orbits, one at an altitude of 570 km and one at 277 km. If the swath width for the 570 km satellite is 160 km, what swath width must the 277 km satellite have in order to acquire the same rate of coverage?

   Suppose the pixel spacing and resolution is such that each satellite produces data at 30 m sampling on the Earth's surface, and that the pixels have the same dimensions in across- and along-track. Calculate the data rate for each satellite, assuming 8-bit samples and 3 different spectral channels for each.

3. The Thematic Mapper has spectral bands as in the table below:

Band	Wavelength range (μm)
1	0.45 - 0.52
2	0.52 - 0.60
3	0.63 - 0.69
4	0.76 - 0.90
5	1.55 - 1.75
6	10.4 - 12.5
7	2.08 - 2.35

(a) Which bands of TM might we use to create a measure similar to NDVI which we obtain from the AVHRR instrument?

(b) What would the TMVI (Thematic Mapper Vegetation Index) definition equation be? (There are several "correct" answers to this question) Justify your choices.

4. Why doesn't TM use the spectral region just longer and just shorter in wavelength than the band 5 region of 1.55 - 1.75 μm? What class of minerals would the instrument thus be less sensitive to?

5. A simple climate model: Suppose radiation from the sun is incident on Earth at 1000 W/m^2. Let 25% of this be reflected back into space from clouds, and let the transmission of the atmosphere in most of the Sun's blackbody spectrum be 100%. Finally, let the transmission τ of the atmosphere in the $\sim 10 \mu$m region of the spectrum be given by the following equation:

$$\tau = 1 - \frac{Q_{CO2} - 270}{20000} \tag{1}$$

where Q_{CO2} is the concentration of CO_2 in the atmosphere in parts per million.

(a) If the temperature of the Earth rises 0.25 K for every additional watt of net energy per square meter on the surface, how much would you expect the temperature to have risen since pre-industrial times?

(b) If the level of CO_2 rises at a rate such that it reaches twice today's level in 100 years, how much will the temperature rise over the next century?