P6317 Assignment I

Due, Wednesday, February 1, 2017

1) [5] Prove that sound free to radiate in a three dimensional domain will decay in intensity in proportion to $1/R^2$ while sound constrained to two dimensions will decay in proportion to $1/R$.
2) [5] A point radiates 1000 W of acoustic power at 1000 Hz in a 7000 m deep ocean. Plot a graph of the rms pressure as a function of range from 1 to 10000 m. (Use log-log axes). Repeat the calculation if the sound source is in the arctic where the water is only 50 m deep (ignore any energy loss with bottom and surface interactions). Repeat both calculations assuming a 50000 Hz source. In each case, what would the sound level be in dB (re 1 μPa) at a range of 10,000 m.
3) [5] For the CTD profile provided on the ftp site, brigus.physics.mun.ca in directory, /pub/zedel/p6317 in file, ctdprofile.dat, plot profiles of temperature, salinity, and sound speed as a function of depth. (the columns in ctdprofile.dat are; depth (m), temperature (celsius), salinity (psu), and I don't know what the other columns are.) To estimate sound speed use the relation:

$$C = 1449.2 + 4.6T - 0.055T^2 - 0.000291T^3 + (1.34 - 0.01T)(S - 35) + 0.016Z. \quad (1)$$

Explain the shape of the sound speed profile in relation to the temperature and salinity profiles; what factors are important at what depth intervals.

4) [5] Explain what operating frequency sonar you would choose for the following applications. Explain how your choice is constrained by the application and by the physical limitations of sound in the ocean. (Realise that this question has no "exact" answers but you must justify your choices.)

i) Echosounder for fish finding in 500 m depth.
ii) Echosounder for plankton survey in 100 m depth.
iii) Sidescan sonar for operation in 100 m water depth looking for sunken galleon (and, of course, treasure hidden within).
iv) System for communicating over 500 km range.
v) System for communicating over 500 m range.

5) [5] If you consider that $u = u(x - Ct)$, show that:

$$\frac{\partial u}{\partial t} = -C\frac{\partial u}{\partial x}$$