Accelerator Physics Homework #6

1. A proton beam of 1 GeV kinetic energy is injected into a synchrotron storage ring. It's found that all protons with a normalized emittance (total) greater than 10 microns are lost. This is interpreted as being due to a resonance caused by a sextupole imperfection, and correctors are installed to compensate for it. Just worrying about the horizontal plane for now, the phase advance in each FODO cell is 95°, the tune is 7.7, and the maximum beta is 25m.
    a. (5 points) I install one sextupole corrector in the high beta region of one cell. How many cells away (minimum) would I install a second corrector to most effectively cancel an arbitrary sextupole imperfection in the lattice?
    b. (15 points) If the sextupole correctors are 20 cm long, what is the lowest maximum sextupole field B'' each must be capable of to be sure of canceling the effect of the imperfection?
2. (15 points) Calculate the power lost to synchrotron radiation and the vertical synchrotron damping times for the following machines. Show the equations you use, but definitely use a spreadsheet to simplify the calculations. (You can just show the calculation once and then use a spreadsheet to calculate the other cases)

Machine	Particle type	Circumference	Bend radius of magnets	Beam Current	Energy (per beam)
LEP	Electrons	27 km	3.5 km	5 mA	45 GeV
					104 GeV[1]
LHC	Protons	27 km	3 km	600 mA	7 TeV
HE-LHC[2]	Protons	27 km	3 km	600 mA	16.5 TeV

[1] Highest energy reached during LEP II run.
[2] This would be an accelerator base on Nb3Sn dipoles, being considered for 2030 or later.