Accelerator Fundamentals Problem Set Tuesday Week 2

1. Wiedemann problem 5.2
2. Wiedemann problem 7.8
3. A 1 GeV beam is injected into a **proton** synchrotron and accelerated to 10 GeV. Assume the circumference is 1km, and that **2/3** of the circumference is made of bending magnets:
    a) what is the bending radius and the mean radius?
    b) What is the revolution frequency at injection and top energy?
    c) If the ring has a mean **dispersion** of **9m** what are the transition energy, and the momentum compaction (phase slippage factor) at injection and top energy

4. For a symmetric FODO cell (with weak bends) with half-cell length L=7m, phase advance per cell = 105 degrees, and bending angle $\theta = (2\pi)/100$,

a) Calculate the values of both the dispersion and beta functions in the centers of the quadrupoles
b) For an rms beam emittance of 1 mm-mrad in both horizontal and vertical planes, and an rms momentum spread of dp/p=0.001, calculate the maximum horizontal and vertical rms beamsizes.
c) If a storage ring is constructed from 50 such FODO cells, what are the horizontal and vertical tunes, and the horizontal and vertical natural chromaticities
d) **Extra credit:** Imagine placing a thin sextupole magnet at each thin quadrupole location to cancel the natural chromaticity, that is, to make the chromaticities in each plane equal zero. Assume each sextupole at every QH has the same strength $m_1 l_1$ and each sextupole at every QV has the same strength $m_2 l_2$. What are the required strengths?