Επιταχυντές & Ανιχνευτές στην Πυρηνική και Σωματιδιακή Φυσική
8ο Εξάμηνο, Ακαδημαϊκό έτος 2017 – 2018

Ασκήσεις - Ομάδα 5: επιταχυντές Β

Άσκηση 5.1
Consider an electron storage ring with a **circumference** of **850m** and **energy** of **6GeV**. If the maximum **bending field** available is **0.854T**, what is the percentage of the circumference occupied by dipoles? With dipoles of **2.3m** long, find the integrated dipole strength, the bending angle and the number of dipoles.

Άσκηση 5.2

Trace the poles of a decapole and dodecapole magnet. What is the angle between the center of each pole in each case? Derive the angle between the poles of general **2n-**pole magnets?

Άσκηση 5.3

Use the expansion of the scalar potential in polar coordinates in order to show that the potential is symmetric by a rotation of $\boldsymbol{\pi}$. Prove that the first allowed multi-pole for a normal quadrupole magnet is a 12-pole ($\mathbf{b_6}$), the second a 20-pole ($\mathbf{b_{10}}$), etc. Is there a general rule for all multi-pole magnets?

Άσκηση 5.4

Prove that the transfer matrices of two symmetric cells and of one cell with mirror symmetry have their determinant equal to 1. Derive the transfer matrix of a particle moving in the opposite direction in the two above cases.

Άσκηση 5.5

Find the focal length of a thin focusing and defocusing quadrupole. To do so, consider an incoming parallel beam (in x or in y depending on the quad) and propagate it using the quad and a drift, and find the drift length in order to get **0** displacement. Do the same for both planes for a doublet formed by the two quads, with distance **L** between them.

Άσκηση 5.6

Write the transfer matrix of a FODO cell for which the integrated quad strength is $\mathbf{1/f = \pm\ 1/2f}$ and the drift has distance **l**. For this quad and considering the propagation of optics functions in a symmetric cell obtain an expression for the phase advance $\boldsymbol{\mu}$ and the beta function $\boldsymbol{\beta}$, at the focusing quad. Without matrix multiplication do the same for the defocusing quad. For numerical evaluation you will need that $\mathbf{B\rho = 26.68\ Tm}$, the quad length **0.509 m** the quadrupole gradient **12 T/m** and the distance between quads **6.545 m**.

Άσκηση 5.7

Write the **(α,β,γ,D,D')** functions propagation along a drift. Modify accordingly the formulas, assuming a symmetry point at the entrance of the drift. What is the beta function at the entrance of the drift in order to have a minimum value at the exit? For the numerical evaluation assume a **3m-**long drift.