

Homework Problems III Accelerator Physics

1. Show that for any smooth scalar field, ϕ :

$$\underline{\nabla} \times \nabla \phi = 0$$

2. Show that:

$$\langle \cos \mu \sin^m \mu \rangle = 0 \quad ,$$

$$\langle \sin^m \mu \rangle = \frac{m-1}{m} \langle \sin^{m-2} \mu \rangle = \begin{cases} 0 & \text{m odd} \\ \frac{m-1!!}{m!!} & \text{m even} \end{cases}$$

where

$$\langle \dots \rangle = \frac{1}{2\pi} \int_0^{2\pi} d\mu \dots$$

3. A sextupole magnet of 4 cm inner diameter is limited by max field of 1 Tesla at the pole tip. What is the maximum sextupole gradient for this magnet in kGauss/cm²?
4. Consider a FODO cell, what is the phase advance would be needed to construct a -I transformation matrix out of this cell.
5. Show that a sextupole pair separated by -I transformation has a complete cancellation of geometric aberrations in both horizontal and vertical planes.
6. Construct a “fish” diagram for $\phi_s = 35^\circ$. At a minimum, show the separatrix, two constant energy curves inside the separatrix, and one constant energy curve outside of the separatrix. Also, display at least 10 points on each curve. It will be easiest to generate the results with a programmable calculator or simple computer code.