

USPAS Graduate Accelerator Physics Homework 4

Due date: Wednesday January 29, 2021

1 FODO cell with partial dipole occupancy

(10 points) Suppose that a single dipole placed centrally between thin D and F quadrupoles in a FODO half-cell has a bend angle θ , but occupies only a fraction of the available space L .

- How do the maximum and minimum matched dispersion functions compare to a FODO cell with 100% dipole occupancy?
- What happens if there are N evenly distributed dipoles in each half-cell, with the same total bend angle θ ?

2 Twiss parameters from a one-turn matrix

(10 points) Suppose that the following one-turn matrix M transforms motion from $s = 0$ to $s = C$ around the circumference of an accelerator:

$$\begin{pmatrix} -1.05746 & -3.59421 & 0.00000 & 0.00000 & 0.00000 & 35.44680 \\ 0.00189 & -0.93923 & 0.00000 & 0.00000 & 0.00000 & -0.82369 \\ 0.00000 & 0.00000 & 1.72622 & -72.45113 & 0.00000 & 0.00000 \\ 0.00000 & 0.00000 & 0.05149 & -1.58161 & 0.00000 & 0.00000 \\ -0.80399 & -36.25338 & 0.00000 & 0.00000 & 1.00000 & -50.03916 \\ 0.00000 & 0.00000 & 0.00000 & 0.00000 & 0.00000 & 1.00000 \end{pmatrix}$$

- What are the fractional parts of the horizontal and vertical tunes?
- What are the horizontal Twiss functions (β, α, γ) at $s = 0$?
- What is the dispersion function and its slope, η and η' , at $s = 0$?

3 RHIC slip factor and synchrotron tune

(10 points) The circumference of RHIC is 3.834 km, and the harmonic number of the high frequency RF system is 7×360 , with transition $\gamma_T = 22.89$. Assume that the total RF voltage is 6 MV.

- What is the slip factor for gold ions circulating with $\gamma = 100$?
- If the gold ions are fully stripped, what is the synchrotron tune?

4 Standard map tune Q_0 versus time step Δt .

(10 points) Derive Equation 4.39 from Equations 4.36, 4.37, and 4.38.