Additional Homework #4

Due: 11:59 pm on Dec 6, 2024

Problem 1 (30 pts)

Sunlight is normally incident on the surface of water with index of refraction $n = 1.33$.

1. Derive the Fresnel equations for this case first, and then obtain the energy reflection and transmission coefficients, R and T.

2. If the incident flux is $1kW/m^2$, what is the pressure that sunlight exerts on the surface of the water?

Problem 2 (35 pts)

1. Consider the Fraunhofer diffraction pattern due to two unequal slits. Let a and b be the unequal slit widths and c the distance between their centers. Derive an expression for the intensity of the pattern for any diffraction angle θ, assuming the arrangement to be illuminated by perpendicular light of wavelength λ.

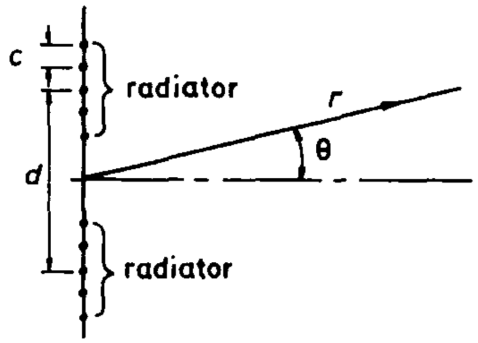
2. Use your formula from 1. to obtain expressions for the pattern in the following special cases and make a sketch of those patterns:

   (a) $a = b$,

   (b) $a = 0$.

Problem 3 (35 pts)

A sound field is created by an arrangement of identical line sources grouped into two identical arrays of N sources each as shown below.



All radiators lie in a plane perpendicular to the page and produce waves of wavelength λ.

1. Assuming $r \gg d, c, \lambda$ find the intensity of the sound produced as a function of the maximum intensity $I_m, \lambda, \theta, N, c$ and d, the distance between the centers of the arrays.

2. By taking an appropriate limit, derive an approximate result for the interference pattern produced by two slits of width a whose centers are a distance d apart.