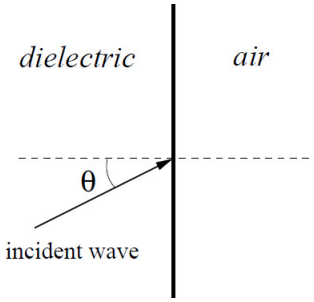
Electricity and Magnetism

Do two of the following three problems, each on a separate page (or pages) and write your name on every page you turn in.

Problem 1

A plane electromagnetic wave is incident on a flat interface between a non-absorbing dielectric medium and the air. At normal incidence, the transmission coefficient of this wave is eight times greater than the reflection coefficient (i.e. $T = 8R$ when $\theta = 0$). Find the critical angle θ_c of total internal reflection for this wave.



Problem 2

A square wire frame with a side length L carries a uniform linear charge density λ. Calculate the electric field at the center of the frame and the electric potential at the center of the frame, assuming the potential at infinity is zero.

Problem 3

Recall that the general solution for the potential with cylindrical symmetry is given by

$$V(s,\phi) = a_0 + b_0 \ln s + \sum_{k=1}^{\infty} s^k \left(a_k \cos k\phi + b_k \sin k\phi\right) + \sum_{k=1}^{\infty} s^{-k} \left(c_k \cos k\phi + d_k \sin k\phi\right),$$

where all of the a_k, b_k, c_k, d_k are constants, to be determined by the boundary conditions.

Now, consider an infinitely long cylinder of radius R pointing along the z axis. The cylinder is placed in a uniform electrical field of magnitude E_0 pointing in the x direction. Find the surface charge induced in the cylinder, given that you have the following boundary conditions:

(i)	$V = 0$	when $s = R$
(ii)	$V \to -E_0 x = -E_0 s \cos\phi$	for $s \gg R$.

Determine all unknown parameters a, b, c, d.
Hint: Only two parameters will be non-zero.