ME02: Nonuniformly Charged Finite Rod off Axis [50 points].

Consider a finite rod of length $L = 1\,\mathrm{m}$. The rod is characterized by a nonuniform linear charge distribution with density λ varying linearly with distance ℓ on the rod such that $\lambda(\ell = 0) = 0$ (i.e., at the very beginning of the rod) and $\lambda(\ell = 2L) = 2kL$ (i.e., at the very end of the rod); the coefficient $k = 2\,\mathrm{C\,m^{-2}}$. Find the electrostatic field at a point P aligned with the ending edge of the rod and at a distance $L/2$ from that edge (see figure). Basically, this observation point P is on a circle (of radius $L/2$) normal to the rod and that has the ending edge of the rod as center. When viewed from top, the position of P on the circle forms an angle $3\pi/5$, as indicated in the figure. [45 points] *Hint: After setting up the integral as we have done in class, solve the integral using, e.g., WolframAlpha but after substituting all given numerical values. Approximate the field with two decimal digits.*

What is the field at the same point P but for an arbitrary angle φ instead of $3\pi/5$? [5 points]

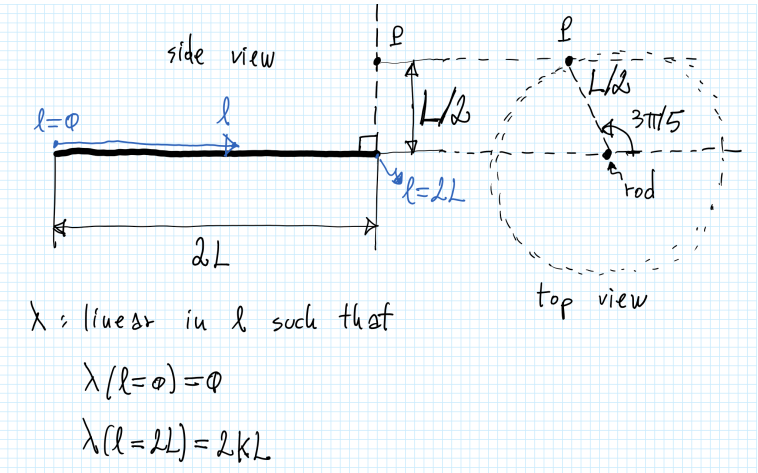

Figure M2