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August 22, 2005

Examination

Electrodynamics, TFYY67, NFYD70
August 22, 14.00-18.00
Elektromagnetisk fältteori och vågutbredning

The examination consists of 4 problems. Each correctly solved problem gives 4 points. The points you have earned from solving the home-work problems will be added to the results of the examination. The grades will be set according to:

grade 3: total score of 8-11 points
grade 4: 12-15 points
grade 5: 16-20 points

grade G: 8-14 points
grade VG: 15-20 points

Allowed to bring to the examination: “Classical Electromagnetic Radiation” by Heald & Marion, Physics Handbook, English dictionary, electronic calculator.

Additional material might be distributed during the examination.

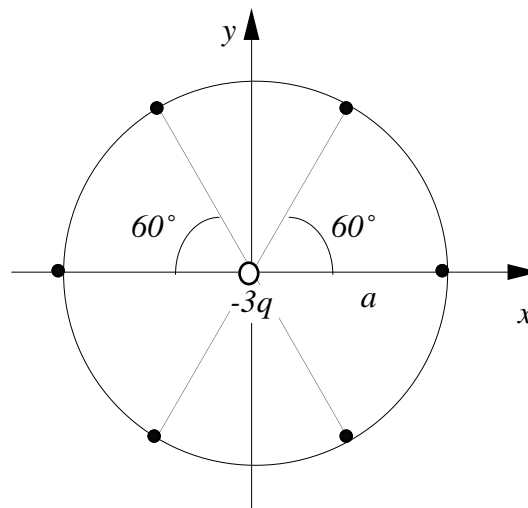
The solutions should be in either English or Swedish.

1. A spherical symmetric charge distribution is given by

$$\rho(r) = \rho_a \cdot (r/a)e^{-(r/a)} \quad ; \quad \rho_a = \frac{q}{24\pi a^3}$$

Calculate the electric field, \mathbf{E} , everywhere.

2. A charge that accelerates radiates. For non-relativistic charges the electric and magnetic radiation fields are proportional to $\mathbf{R} \times (\mathbf{R} \times \mathbf{a})$ and $\mathbf{R} \times (\mathbf{R} \times (\mathbf{R} \times \mathbf{a}))$, respectively. Expand the cross-products to show that the poynting vector is proportional to $|\mathbf{R} \times \mathbf{a}|^2$.
3. Three equal homogeneously charged very thin rings, each of radius a and total charge q , all with their centers at the origin and axes in the xy -plane are placed according to the figure. The figure shows a cross-section of the three-dimensional geometry. There is furthermore a point charge at the origin.



Make a multipole expansion of the resulting potential and keep terms up to and including the quadrupole contribution.

4. In the lectures we derived the stray fields of a parallel plate capacitor using conformal mapping. It was rather complicated to find the suitable analytic function. The present problem is much simpler. The task is to find the stray fields and potentials with the idealization that the separation between the plates is infinitesimal. Let one of the plates have potential zero and cover half the xz -plane, with $x > 0$. The other plate has potential V and is placed just below the first plate with an infinitesimal separation.

(Hint: Try to find an analytical function whose real or imaginary part satisfies the boundary conditions).