Electrodynamics II
HW 2

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Due: March 7

1. A particle of charge q and mass m is moving in a uniform electric field $\mathbf{E}$. The vector of the initial particle velocity $\mathbf{v}_0$ at the time $t = 0$ is perpendicular to the electric field. Calculate as a function of time the angular distribution and total energy of induced EM radiation.

2. A particle of mass m and charge q is moving perpendicular to the uniform magnetic field $\mathbf{B}$. The initial kinetic energy of this particle is E_0. Determine a time dependence of the particle energy $E(t)$.

3. Electron with the mass m_e and charge $-e$ and proton with the mass M_p and charge $+e$ attract each other according to the Coulomb law and their relative motion is described by the elliptic trajectory:

$$1 + \varepsilon \cos\phi = \frac{a(1-\varepsilon^2)}{r}$$

where r is the radius of a relative motion and the semi-major axis a and the eccentricity ε are

$$a = \frac{e^2}{2|E|}, \quad \varepsilon = \sqrt{1 - \frac{2|E|M^2}{\mu e^4}}.$$

Here E is the total energy of a relative motion ($E < 0$), μ is the reduced mass and M is the angular momentum. Calculate the power of EM radiation averaged over a full revolution in the ellipse. Answer has to be presented as a function of E, M, e, m_e, and M_p.

4. Determine the differential effective cross-section for scattering of the linearly polarized EM wave by a charged harmonic oscillator with the frequency of vibration ω_0. The oscillator mass and charge are q and m respectively.

5. Determine the differential total effective cross-section for scattering of EM waves by an electric dipole $\mathbf{d}$ which, mechanically, is a rigid rotor with the moment of inertia J. The frequency ω of the EM wave is significantly larger than the frequency of a free rotation of the rotor and only the forced rotation under the action of the force $\mathbf{d} \times \mathbf{E}$ can be considered.