Electrodynamics A (PHY 5346) Fall 2016 Classwork and Homework

Every exercise counts 10 points unless stated differently.

Set 1:

(1) Exercise E.62: Solenoid. Homework, due 1/17/2017 before class.

Set 2:

(2) Exercise E.63: Magnetic dipoles. Homework, due 1/19/2017 before class.
(3) Exercise E.65: Magnetic moment of a disk. Homework, due 1/19/2017 before class.

Set 3:

(4) Exercise E.66: Magnetism in matter. Homework, due 1/26/2017 before class.
(5) Exercise E.67: Faraday's law. Homework, due 1/26/2017 before class.
(6) Exercise E.68: LCR circuit. Homework, due 1/26/2017 before class.
(7) Exercise E.69: Complex numbers and integration. Classwork, due 1/26/2017 in class.

Set 4:

(8) Exercise E.70: Generalized Residue Theorem. Homework, due 2/2/2017 before class.
(9) Exercise E.71: Green function by Fourier transformation. Homework due 2/2/2017 before class.
(10) Exercise E.24: Current density of a point charge. Homework due 2/2/2017 before class.

Set 5:

(11) Exercise E.72: Wave equation with point source. Homework, due 2/9/2017 before class.
(12) Exercise E.73: Covariant retarded Green function. Homework, due 2/9/2017 before class.

(13) Four-potential of a moving point particle. Homework, due 2/9/2017 before class.

For simplicity use in this problem $c = 1$ for the speed of light and arbitrary, dimensionless time and distance units.
Let t be the time in an inertial frame K. For $t \geq 0$ the speed of a point particle in K is given by $\vec{\beta} = \beta \hat{x}^1$ with $\beta = \beta(t) = \tanh(t)$ and its initial position at time $t = 0$ is at the origin $\vec{r}_0 = \vec{0}$. All questions are with respect to the K frame.

(a) Find the distance of the particle from the origin, $r(t) = r^1(t)$, as function of the time.
(b) Evaluate $\beta(t_1)$ and $r(t_1)$ numerically for $t_1 = 0.6931472$.
(c) At which time x^0 does an observer at the origin $\vec{x} = 0$ observe the electromagnetic potentials which correspond to the position $r(t_1)$ of the point particle?
(d) Take q_e for the charge of the point particle and find the electromagnetic potentials, which are observed at the space-time point defined by x^0 from (c) and $\vec{x} = 0$. You may use

$$\Phi\left(x^0, \vec{x}\right) = \left[\frac{q}{\left(1 - \vec{\beta}\cdot\hat{n}\right) R}\right]_{\text{ret}}, \quad \vec{A}\left(x^0, \vec{x}\right) = \left[\frac{q\,\vec{\beta}}{\left(1 - \vec{\beta}\cdot\hat{n}\right) R}\right]_{\text{ret}},$$

or, equivalently,

$$A^\alpha(x) \;=\; \frac{q\,U^\alpha(\tau^0)}{[x - r(\tau^0)]^\beta\; U_\beta(\tau^0)}\,.$$

Set 6:

(14) Exercise E.74: Charge conjugation, parity and time reveersal in electrodynamics. Homework, due 2/16/2017 before class.
(15) Exercise E.76: Proca Lagrangian. Homework, due 2/16/2017 before class.
(16) Exercise E.75: Electromagnetic energy-momentum tensor. Homework, due 2/16/2017 before class.

Set 7:

(17) Exercise E.77: Lorentz force and energy-momentum tensor. Homework, due 3/2/2017 before class.

(18) Exercise E.78: Field energy of a sphere. Homework, due 3/2/2017 before class.
(19) Exercise E.82: Covariant derivation of the wave equation for fields. Homework, due 3/2/2017 before class.

Set 8:

(20) Exercise E.80: 1D wave equation for a dispersive medium. Homework, due 3/9/2017 before class.
(21) Exercise E.83: Energy density and Poynting vector for plane waves. Homework, due 3/9/2017 before class.
(22) Exercise E.89: Reflection and transmission of a circularly polarized wave. Homework, due 3/9/2017 before class.

Set 9:

(23) Exercise E.84: Wave with a finite transverse extension. Homework, due 3/23/2017 before class.
(24) Exercise E.90: A model for dispersion. Homework, due 3/23/2017 before class.
(25) Exercise E.91: Faraday Effect. Homework, due 3/23/2017 before class.
(26) Exercise E.93: Principal value integral (1) and (2). Classwork, due 3/21/2017 in class, 5 points.
Exercise E.93: Principal value integral (3). Homework, due 3/23/2017 in class, 5 points.

Set 10:

(27) A. Exercise E.93: Principal value integral (4) and (5). Look up the Typos Corrections as posted on the Web!
B. Show the fall-off behavior $|\epsilon_0(\omega_R) - 1| \sim 1/|w_R|^2$ for $\omega_R \to \infty$.
Homework, due 3/30/2017 in class.
(28) Exercise E.92: A relation for the group velocity. Homework, due 3/30/2017 before class.
(29) Exercise E.94: Kramers-Kronig relation for a model. Homework, due 3/30/2017 before class.

Set 11:

(30) Exercise E.95: Skin depth. Homework, due 4/6/2017 before class.

(31) Exercise E.96: TM waves in a rectangular wave guide. Homework, due 4/6/2017 before class.
(32) Exercise E.99: Cubic cavity oscillator. Homework, due 4/6/2017 before class.

Set 12:

(33) Exercise E.97: Cylindrical wave guide: T_{11} mode power transmission. Homework, due 4/13/2017 before class.
(34) Exercise E.101: Hertz vector. Homework, due 4/13/2017 before class.
(35) Exercise E.103: Vector potential of two current loops. Homework, due 4/18/2017 before class.