1. *Vector and scalar potentials*

   D.J. Griffiths, *Introduction to Electrodynamics*, 3rd international edition, Prentice Hall, 2003

   (a) *Differential equations for scalar and vector potential*, problem **10.1**, page 418.

   (b) *Vector Coulomb potential*, problem **10.3**, page 420.

   (c) *Gauge transformation*, problem **10.5**, page 420.

   (d) *Retarded vector potential*, problem **10.10**, page 427.

2. *Dipole radiation*

   D.J. Griffiths, *Introduction to Electrodynamics*, 3rd international edition, Prentice Hall, 2003

   (a) *Retarded potentials of an oscillating dipole*, problem **11.1**, page 449.

   (b) *Oscillating magnetic dipole*, problem **11.5**, page 454.

3. *Rectangular metallic waveguide, TM modes*

   Recall the discussion of rectangular metallic waveguides in Lecture F. Using the general intermediate results as given on the sheets, transfer the theory to transverse magnetic (TM) fields. These are characterized by a vanishing longitudinal magnetic field component $H_z = 0$, thus by a pure transverse magnetic mode profile.

   (a) Write the second order equation that holds for the longitudinal electric field component E_z of the mode profile in the interior $(x, y) \in [0, a] \times [0, b]$ of the waveguide.

   (b) Write the expressions that relate the transverse electric and magnetic components E_x, E_y, H_x, H_y to the principal component E_z.

   (c) Figure out the boundary/interface conditions for E_z at $x = 0, a$ and at $y = 0, b$. Using the expressions from (3b), verify that the boundary conditions for E_z imply the proper homogeneous boundary conditions for E_x, E_y, H_x, H_y.

   (d) The differential equation from (3a) and the boundary conditions from (3c) establish an eigenvalue problem for the principal electric component E_z of the mode profile. Solve this problem by the method of *separation of variables*. State expressions for the discrete propagation constants β_{mn}^{TM} of the TM_{mn}-modes.

   (e) Give expressions for the cutoff frequencies $\omega_{mn}^{\mathrm{TM}}$ of the TM-modes, and state the indices, propagation constant, and the cutoff frequency of the fundamental TM mode.

Hand in your solutions until Wednesday, October 16, 10:45. Good luck!