Electrodynamics III Exam 4 problems

Vol. 8 sec. 64. Excitation of currents by acceleration

Landau Problem 2. (requires doing also section 63 Landau Problem 3).

1. Show ****
2. Find original papers on the Stewart-Tolman effect and summarize how the experiment was performed and the effects observed. Find one other more recent paper that cites ST and summarize.
3. For a loop of 1-mm-radius gold wire, who much linear acceleration is needed for each length element to produce a current of 1 nA. Compare to gravity. If the radius of the loop is 10 cm and it starts from rest, how many rpm is there for this acceleration after 1 s.
4. What magnitude of current flows in a 1 mm radius Au wire formed in a loop of radius b = 10 cm which is stopped from  = 1000 rpm within 1 ms?

Vol. 8 sec. 88. The propagation of waves in an inhomogeneous medium

Landau Problem: Surface Plasmon Polariton wavefunction and dispersion relation

1. Work through the derivation of the wavefunction (vol. 3, section 46, Eq. (46.9)) for a particle in 1D motion in the quasiclassical case.
2. Show that the E-wave solution 88.7 is the same as for 1D quantum mechanical motion in a homogeneous external field, U = Fx. See vol. 3 section 24.
3. Derive Eq. (88.8). See v. 3, section 47 and problem 2 above.
4. Work through the derivation in v.3 Appendix b on the Airy function.
5. The carrier density in the ionosphere ranges from 103 to 106 cm-3. What range of plasma frequencies does this correspond to in MHz? Take the mass of the carriers to be the electron mass. The Height of the ionosphere ranges from 50 to 1000 km. What rf pulse round trip times does this correspond to?
6. Check that H1 and H2 (p307) are approximate solutions to 88.10) as z approaches zero.
7. Near the point z = 0 where  = 0, the H-wave solution is H = H0(1+(1/2)a2 log(z)). For  = 2, plot the Re and Im parts of the second term about z = 0. What is the limit of H as z goes to zero?
8. Derive (88.11).
9. Consider a surface plasmon polariton (SSP) at the interface between air and silver. Plot the dispersion curve  vs. k using the permittivity spectrum given in the figure from Cleary et al. (2010) below. Ignore the imaginary part ”. Also plot the “light line”  = ck.
10. Show for an H-wave that <Sz>t = 0 for z > 0 and <Sz>t > 0 for z < 0, where  = 0 on the plane z = 0.



Section 90. Resonant cavities.

Landau Problem 1.

1. Derive the first unnumbered equation after (90.4).
2. Derive the last equation on page 311, i.e. the 2nd unnumbered equation after (90.7).
3. Prove the identity at the bottom of page 311.
4. Derive the first and second lines on p. 312.
5. Show <**Sn**>t = c’|**Ht**|2/8

Section 91. Waveguides

1. Derive (91.1)
2. Derive (91.2)
3. Derive (91.4) for H waves.
4. Derive 91.5)
5. Show that condition (91.6) on the circumference of the waveguide cross section ensures that the boundary condition **Hn** = 0 is satisfied.
6. Derive the equations after (91.8) for the intensity of an E-wave and equation (91.9).
7. Derive the total energy flux for H-waves, the equivalent of (91.9) for E-waves.
8. For principal waves, show that E = -grad2, 2 = 0, and  = constant on the boundary.
9. Derive (91.13)
10. Derive (91.14)
11. Derive (91.15)
12. Find the paper by Rayleigh 1897 on waveguides and summarize in 1 page.

Section 92. Scattering of electromagnetic waves by small particles

1. Find the paper by Rayleigh 1871 related to this section. Summarize in 1 page.
2. Derive (92.3)
3. Derive (92.4)

Section 93. Absorption of electromagnetic waves by small particles

1. Derive (93.2)
2. Derive (93.4)
3. Derive (93.5)
4. Derive (93.5) by the second method (Poynting vector, superconductor).