

PHYS 942 Final Exam

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PHYS 942
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253 DeMeritt

Name, please write clearly: _____

Note: Open book (Jackson). 250 points max, 100 are a perfect score! Please write clearly. **Show all your steps!**

- (50 points) Consider a power line with a resistance R_{line} that supplies the power P_{load} to the load end.

 - What is the minimum voltage V_{min} needed at the generator end to supply the power P_{load} to the load end?
 - Show that for any voltage $V > V_{\text{min}}$ at the generator end there are two solutions in terms of the current I in the line and the load resistance R that supply P_{load} . Which solution incurs the smallest losses in the power line?
- (50 points) A particle of mass M and 4-momentum P decays into two particles of mass m_1 and m_2 . Use the invariance of scalar products of 4-vectors to determine the *total* energy and the *kinetic* energy of the resulting particles in the rest frame of the decaying particle.
- (50 points) A light beam of intensity (power/area) I_0 and frequency ω_0 directed along the positive x -axis is reflected normally by a perfect mirror moving along the positive x -axis with relativistic velocity v . What is the frequency ω and the intensity I of the reflected light in terms of ω_0 and I_0 ?
- (50 points) Given a uniform beam of charged particles with a linear charge density λ , moving with relativistic speed v and uniformly distributed within a circular cylinder of radius R , what is:

 - the electric field \mathbf{E}
 - the magnetic field \mathbf{B}
 - the energy density of the field
 - the momentum density of the field

throughout space, i.e., inside and outside the beam, as observed by a stationary observer?
- (50 points) Two electrons of velocity v (relativistic) in the lab frame move parallel to each other in the positive x -direction. Assume that at $t = 0$ they are located at $x = 0$ and $y = \pm d$, respectively. How much are the electrons separated when reaching $x = L$?