# MIDTERM EXAM – ASTRON 202/PHYS 213

## FEBRUARY 20, 2001

**INSTRUCTIONS:** You have 2 hours to work this midterm. You may use the distributed lecture notes and your brains. You may not use any other notes or books. Please show your work and explain it clearly. Good luck!

**1.** Two idendical bodies having mass $M$ and charge $Q$ are in a circular *gravitational* orbit about each other. The orbit has period $T$. How does the radiated electromagnetic power depend on $M$, $Q$ and $T$?

**2.** A neutral pion decays into two photons via $\pi^o \rightarrow 2\gamma$, where each photon has energy $m_\pi c^2/2$ in the pion's rest frame. If a pion is observed to be moving with some (possibly relativistic) velocity $c\beta$, what is the probability that one of the decay photons will be observed to have energy between $\epsilon$ and $\epsilon + d\epsilon$?

**3.** In a frame of reference in which there is no electric field but only a magnetic field $\mathbf{B}$ which varies slowly in space, the quantity ${p_\perp}^2/B$ is an adiabatic invariant. The same quantity is also a Lorentz invariant. Find an explicitly Lorentz invariant expression for ${p_\perp}^2/B$, where $p_\perp = |\mathbf{p} \times \mathbf{B}|\,/B$ is the component of the momentum perpendicular to the field.