Problem 1. 25 points.

(a) There are three very long, extremely thin, parallel wires. One with current $i_1$ and one with $i_2$ and one with $i_3$. In cross-section, the wires are located at the corners of a square of side $W$. If all currents flow into the page, find the magnetic field vector at the fourth corner.

(b) What would be the force on a length $H$ of wire if it was parallel to the other wires at the fourth corner and had a current $i_4$ coming out of the page?

Be neat. Neatness helps. Work neatly.
Problem 2. 25 points.

A very long thin wire carries a current $i$. It has the shape and dimensions shown below.

Find the magnetic field at the point $P$. 

If you work neatly I will find more partial credit for you!
Physics 208: Electricity and Magnetism, Exam 3

Problem 3. 25 points.

A rectangular circuit containing a capacitor $C$ is located near an infinitely long narrow wire carrying a current $i_0 \cos \omega t$ where $i_0$ and $\omega$ are constants. The circuit has no resistance and its self-inductance can be ignored. Find the charge on the top capacitor plate as a function of time.

Long straight wire, current $i = i_0 \cos \omega t$

Make sure you are being neat. Working neatly will help you get it right.
Problem 4. (25 points)

(a) In the circuit below, the capacitor is originally charged with $Q_0$ on the top plate, and $-Q_0$ on the bottom. At $t = 0$ the switch $S$ is closed. Please note that all wires in this circuit have no resistance.

Derive the equation for the charge on the capacitor as a function of time assuming the self-inductance of the circuit can be ignored. Solve the equation.

(b) In the circuit below, the capacitor is originally charged with $Q_0$ on the top plate, and $-Q_0$ on the bottom. At $t = 0$ the switch $S$ is closed. Derive the equation for the charge on the plates as a function of time if the self-inductance of the circuit is $L$ and the resistance of the circuit is negligible. Solve the equation.

Work neatly! If you are neat, I can read what you did and maybe find more points for you.
\[
\vec{F} = \frac{1}{4\pi \varepsilon_0} \frac{q_1 q_2}{r^2} \vec{r}
\]
\[
d\vec{B} = \frac{\mu_0 i}{4\pi} \frac{d\vec{s} \times \vec{r}}{r^3}
\]
\[
\frac{d\vec{s}}{dt} = \frac{dx}{dt} \vec{i}_x + \frac{dy}{dt} \vec{i}_y = \frac{dr}{dt} \vec{i}_r + r \frac{d\theta}{dt} \vec{i}_\theta
\]
\[
\oint \vec{E} \cdot d\vec{r} = -\frac{d}{dt} \oint \vec{B} \cdot d\vec{s}
\]
\[
C = \frac{Q}{V} \quad R = \rho \frac{l}{A}
\]

For parallel plates \( C = \frac{\Delta Q}{d} \)
\[
\int \vec{B} \cdot d\vec{s} = \pm Li
\]
\[
\oint \vec{B} \cdot d\vec{s} = \mu_0 i_{\text{enclosed}}
\]
\[
\vec{F} = q(\vec{v} \times \vec{B} + \vec{E}) \quad d\vec{F} = i(d\vec{s} \times \vec{B})
\]

**POTENTIALLY USEFUL INTEGRALS**
\[
\int \frac{dx}{(x^2 + C)^{\frac{3}{2}}} = \frac{x}{C(x^2 + C)^{\frac{1}{2}}} + \text{Constant}
\]
\[
\int \frac{x \, dx}{(x^2 + C)^{\frac{3}{2}}} = \frac{-1}{(x^2 + C)^{\frac{1}{2}}} + \text{Constant}
\]

**DO NOT WASTE TIME ON ARITHMETIC**

If you do remove this sheet,

**DO NOT TURN IT IN!**