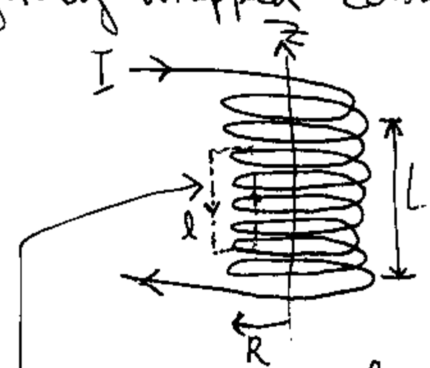
Exam 2 results:

Mean score 50
Std. dev. 23

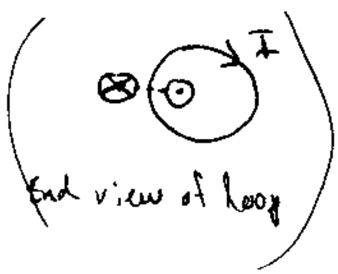
Problem score averages (fractions):
1) 0.49
2) 0.71
3) 0.40
4) 0.42

One more application of Ampère's Law: solenoid.
Tightly wrapped coil of current:



$N = nL$ windings (so n windings per unit length):

Amperian Loop: $\oint \vec{B} \cdot d\vec{l} = +l B_{z\,in} - l B_{z\,out} = \mu_0 I_{encl}$



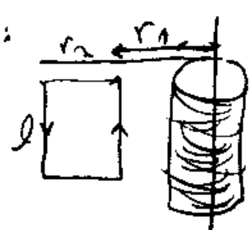
End view of loop

$$(B_{z\,in} - B_{z\,out}) \cancel{l} = -\mu_0 n \cancel{l} I$$

$$\text{So } B_{z\,in} = -\mu_0 n I + B_{z\,out}$$

$B_r = 0$ everywhere, by symmetry (and $\text{div}\vec{B} = 0$).
B_ϕ = <u>constant</u> by symmetry, for fixed r.
= zero, because can't create any fixed-r amperian loop (in or out of cylinder) that has nonzero current through it.

Now, find $B_{z\,out}$: Draw a loop outside the solenoid:



Since $B_r = 0$, $\oint \vec{B} \cdot d\vec{l}$

$$\oint \vec{B} \cdot d\vec{l} = l B_z(r_1) - l B_z(r_2) = \mu_0 I_{encl} = 0$$

$$\text{So } B_z(r_1) = B_z(r_2)$$

But, since $B_z(r \to \infty)$ obviously vanishes, $B_{z\,out} = 0$ <u>everywhere</u>. $\Rightarrow \vec{B} = 0$ outside $\vec{B} = -\mu_0 n I \hat{z}$ inside!