Problem 1

For this problem we simply employ Faraday's Law to find the potential it produces and then use $V = IR$ to obtain the current. So, to find the total flux we need to integrate the B-field over the x dimension. This gives the following:

$$\Phi_B = \frac{-0.18}{2\pi}\left[\sin(5\pi 10^7 t - 0.4\pi) - \sin(5\pi 10^7 t)\right] \tag{1}$$

Then to get to the emf we take the negative $\frac{d}{dt}$ of the flux Φ and divide by $2R$ or 30 Ω and remember the B-field was in μ T. This should yield the following:

$$i = 1.76\sin(5\pi 10^7 t - 0.2\pi) \tag{2}$$

Problem 2

Starting off with the flux expression below

$$\Phi = \mu_o I sin(\omega t)(d - \sqrt{d^2 - b^2}) \tag{3}$$

We the know that

$$-\frac{d\Phi}{dt} = V cos(\omega t) \tag{4}$$

so we can get the expression for the max V from the above. Then, knowing that the ammeter reads rms current, we also know that:

$$\sqrt{2}i = \frac{V}{R}, \tag{5}$$

where i is the ammeter current in the loop, and I is the current in the wire. By plugging in our value for V and then rearranging for the I we can get the following expression:

$$I = \frac{\sqrt{2}Ri}{\mu_o\omega(d - \sqrt{d^2 - b^2})} \tag{6}$$

Plugging in the appropriate values gives:

$$I = .234 Amps \tag{7}$$

For the second part of the problem you can simply take the arccos of the ratio of the new current to the old current giving:

$$\alpha = 45.2^o \tag{8}$$

Problem 3

This is in the book; please (of course) be sure to understand it.

Problem 4

This can be done if you define

$$x = t - R\sqrt{\mu\epsilon} \tag{9}$$

And then use the chain rule when taking derivatives, note the second order makes the sign not matter. *Snively notes that Lieffers could probably have said more here, but encourages you to try it since this is indeed a straightforward problem.*

Problem 5

For this problem the best way to compare the 2 currents is just by taking the ratio of them, the displacement current over the conduction current:

$$\frac{\omega\epsilon}{\sigma} = 9.75 * 10^{-}8 \tag{10}$$

This can then be repeated for Teflon's values as stated in the problem. For the second part of the problem we start with our source free equations as so:

$$\nabla \times \mathbf{H} = \sigma\mathbf{E} \tag{11}$$

$$\nabla \times \mathbf{E} = -j\omega\mu\mathbf{H} \tag{12}$$

If we then take the curl of Ampere's law again we get:

$$\nabla^2\mathbf{H} - j\omega\mu\mathbf{H} = 0 \tag{13}$$