PROBLEM 6

The switch S is closed at t=0. (a) Find the current in $R_2$ as a function of time. (b) Write the differential equation for the current in L as a function of time. (c) After the current in $R_2$ has reached a steady state $S$ is opened. Call this a new $t=0$. Find the current in $R_1$ as a function of time. Specify its direction.

b) Walk around the outer loop, starting at point A ⇒

$$E - I_2R_2 - L\frac{dI_2}{dt} = 0$$

a) There are two possible solutions for the simple R-L circuits we have studied. They are on the front page and are the following: ① $I = I_0(1 - e^{-RtL})$ and ② $I = I_0 e^{-RtL}$

① is a growth function with $I=0$ at $t=0$. Therefore it is the one that will solve the above eq. At $t = \infty$,

$$\frac{dI}{dt} = 0 \text{ and } E = I_0 R_2 \Rightarrow I_0 = \frac{E}{R_2}. \text{ So, } I_2 = \frac{E}{R_2} (1 - e^{-RtL})$$

(c) The current has now reached a steady state. This means $I_2 = \frac{E}{R_2}$. The inductor will oppose any sudden changes
So the current through $L$ just after the switch is opened will be as it was just before the switch was opened.

Further, $I$ will be decaying so the answer will be of the form $I = I_0 e^{-\frac{Rt}{L}}$ with $I_0 = \frac{\varepsilon}{L}$ and $R = R_1 + R_2$ as the two resistors are in series.