**Problem 2**

a) First the electron velocity is calculated from the current I:

$$I = jS = ne_0vbc\,, \qquad v = \frac{I}{ne_0bc} = 25\,\mathrm{m/s}\,.$$

The components of the electric field are obtained from the electron velocity. The component in the direction of the current is

$$E_\parallel = \frac{v}{\mu} = 3.2\,\mathrm{V/m}\,. \qquad \text{(0.5p.)}$$

The component of the electric field in the direction $b$ is equal to the Lorentz force on the electron divided by its charge:

$$E_\perp = vB = 2.5\,\mathrm{V/m}\,. \qquad \text{(1p.)}$$

The magnitude of the electric field is

$$E = \sqrt{E_\parallel^2 + E_\perp^2} = 4.06\,\mathrm{V/m}\,. \qquad \text{(0.5p.)}$$

while its direction is shown in Fig. 5 (Note that the electron velocity is in the opposite direction with respect to the current.) (1.5 p.)

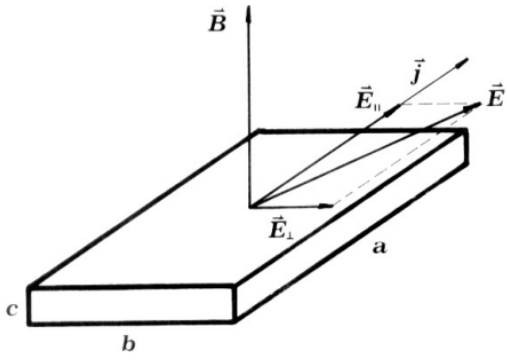



Fig. 5

b) The potential difference is

$$U_H = E_\perp b = 25\,\mathrm{mV} \qquad \text{(1p.)}$$

c) The potential difference $U_H$ is now time dependent:

$$U_H = \frac{IBb}{ne_0bc} = \frac{I_0B_0}{ne_0c}\sin\omega t\sin(\omega t + \delta)\,.$$

The DC component of $U_H$ is

$$\overline{U}_H = \frac{I_0B_0}{2ne_0c}\cos\delta\,. \qquad \text{(3p.)}$$

d) A possible experimental setup is-shown in Fig. 6

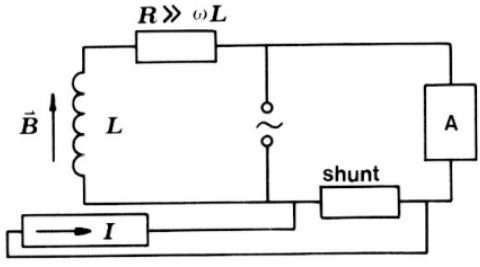



Fig. 6

(2 p.)