Closed book. No calculators are to be used for this quiz.
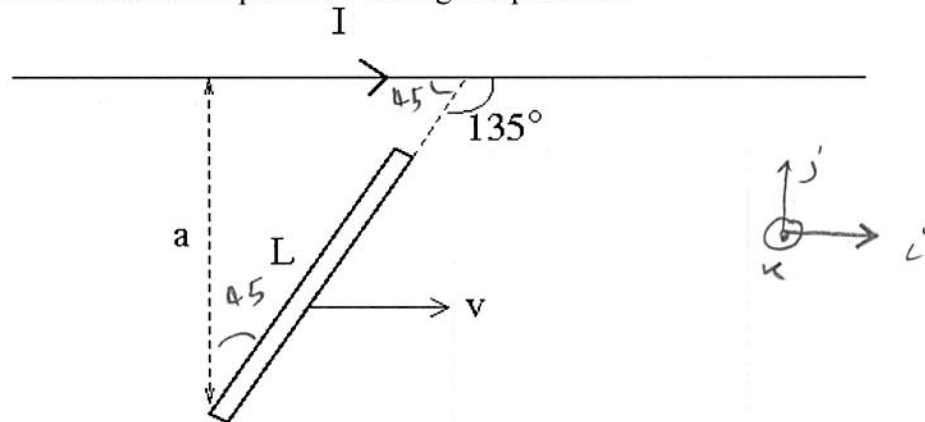**Quiz duration: 10 minutes**

Name: Student ID: Signature:

A long straight wire is carrying a constant current "I" in the direction as shown in the figure. A metal bar of length "L" is moving with a constant velocity "v" parallel to the wire. Find the induced emf between the ends of the wire in terms of the given parameters. Indicate which point has the highest potential.

$$d\varepsilon = (\vec{v} \times \vec{B}) \cdot \vec{dl}$$

$$d\varepsilon = -v_0 B \, dy$$

$$\varepsilon = -\int_{a-L\cos 45}^{a} v_0 B \, dy =$$

$$= -\int_{a-L\cos 45}^{a} v_0 \frac{\mu_0 I}{2\pi} \frac{dy}{y} = -\frac{\mu_0 v_0 I}{2\pi} \ln \frac{a}{a-L\cos 45}$$

$$= \frac{\mu_0 v_0 I}{2\pi} \ln \left(1 - \frac{a}{L\cos 45}\right)$$

$$v = v_0 \, \hat{i} \left.\begin{matrix} \\ \\ \end{matrix}\right\} \to v \times B = v_0 B \, \hat{j}$$

$$B = -B \, \hat{k}$$

$$\vec{dl} = -dx \, \hat{i} - dy \, \hat{j}$$

$$\vec{B} = \frac{\mu_0 I}{2\pi y} \, \hat{k} \qquad \text{This } \vec{B} \text{ in my plane}$$

Closed book. No calculators are to be used for this quiz.
**Quiz duration: 10 minutes**

Name: **Student ID:**   **Signature:**

A long straight wire is carrying a constant current "I" in the direction as shown in the figure. A metal bar of length "L" and a square loop with side length "L" are moving with a constant velocity "v" parallel to the wire. Find the induced emf between the ends of the wire and in the loop in terms of the given parameters. Indicate which points have the highest potential.

(a)   (b)

$$d\varepsilon = \left(\vec{v} \times \vec{B}\right) \cdot \vec{d\ell}$$
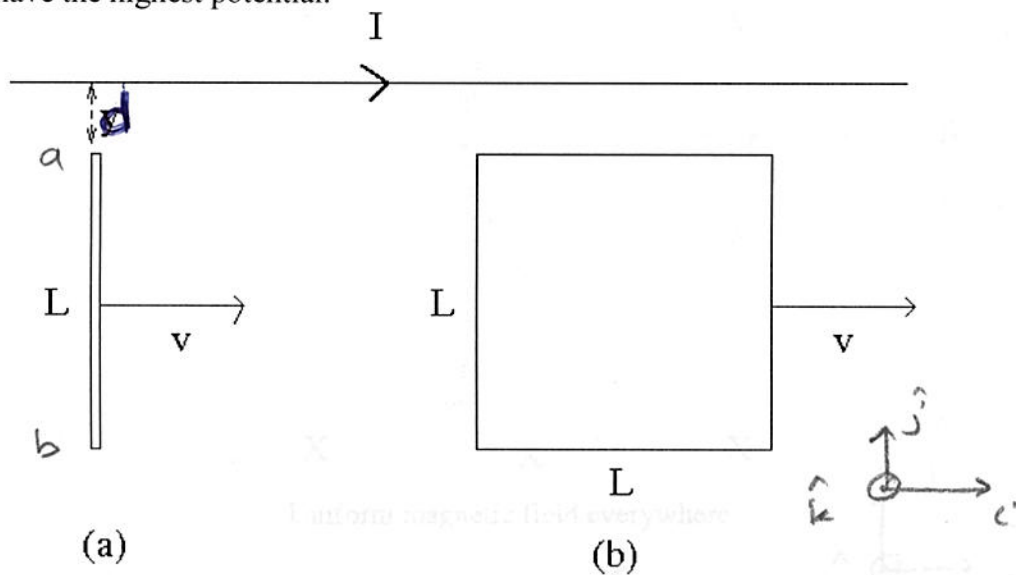
$$d\varepsilon = -\frac{v_0 \mu_0 I}{2\pi y} dy$$

$$V_{ba} = \int_a^b -\frac{v_0 \mu_0 I}{2\pi y} dy = -\frac{v_0 \mu_0 I}{2\pi} \ln y \Big/_d^{L+d}$$

$$V_{ba} = -\frac{v_0 \mu_0 I}{2\pi} \ln\left(1 + \frac{L}{d}\right)$$

$$V = v_0 \,\hat{c} \qquad \longrightarrow \qquad \vec{v} \times \vec{B} = -v_0 B \,\hat{j}$$

$$B = -B_0 \,\hat{k}$$

$$d\ell = -dy \,\hat{j}$$

$$\vec{B} = \frac{-\mu_0 I}{2\pi y} \,\hat{k} = B\,\hat{k} \qquad \text{In } x\text{-}j \text{ plane}$$

b) Since there is no change in flux through the loop, there is no emf induced in it.

Closed book. No calculators are to be used for this quiz.
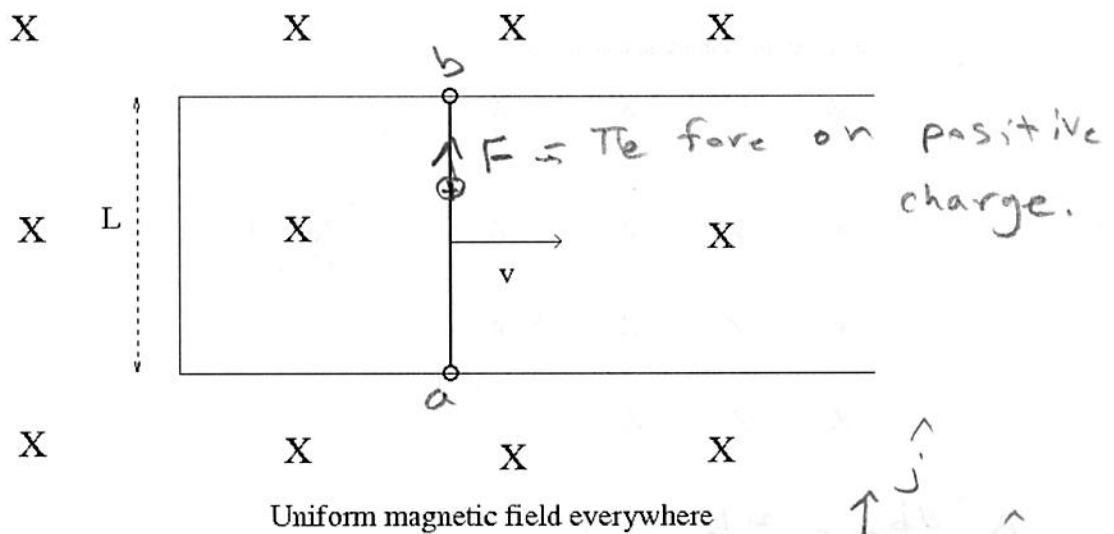**Quiz duration: 10 minutes**

Name: Student ID: Signature:

Consider the U-shaped slide-wire generator under the uniform magnetic field of
strength B as shown in the figure. If the slide-wire moves with a constant speed "v",
find the induced emf between its ends in terms of the given parameters. Indicate
which point has the highest potential.

$$F = q\vec{v} \quad \text{fore on positive charge.}$$

Uniform magnetic field everywhere

$$d\varepsilon = (\vec{v} \times \vec{B}) \cdot \vec{dl}$$

$$V = V_0 \hat{\imath}$$
$$B = -B_0 \hat{k}$$
$$\left. \right] \longrightarrow \vec{v} \times \vec{B} = V_0 B_0 \hat{\jmath}$$

$$dl \text{ is in } -d\hat{\jmath} \text{ direction}$$

$$\int_a^b d\varepsilon = \int_a^b -V_0 B_0 \, dy$$

$$V_{ab} = \varepsilon = -V_0 B_0 \int_0^L dy \implies \boxed{\varepsilon = -V_0 B_0 L}$$

$$V_{ab} = V_a - V_b = -V_0 B_0 L$$

The Point b has higher potential than point a.

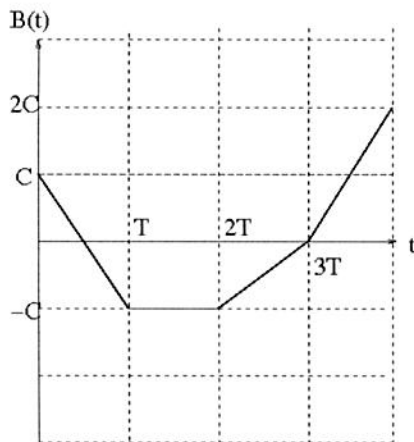**Closed book. No calculators are to be used for this quiz.**
Quiz duration: 10 minutes

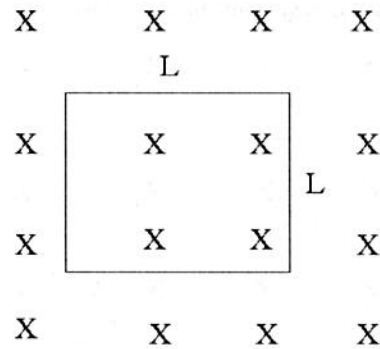**Name:**   **Student ID:**   **Signature:**

Consider a square loop in a uniform time-varying magnetic field, for which the magnitude of the field varies with time according to the graph shown in the figure. Sketch the graph of the induced emf in the loop as a function of time. Indicate the directions of the induced current at a given time.

B(t)

square loop in a uniform magnetic field

$\varepsilon = -\dfrac{d\Phi}{dt} = -\dfrac{dB}{dt}$ A

$B_1 = -\dfrac{2c}{T} t + c$ $0 \leq t \leq T$

$B_2 = -c$ $T \leq t < 2T$

$B_3 = \dfrac{c}{T} t - c$ $2T \leq t < 3T$
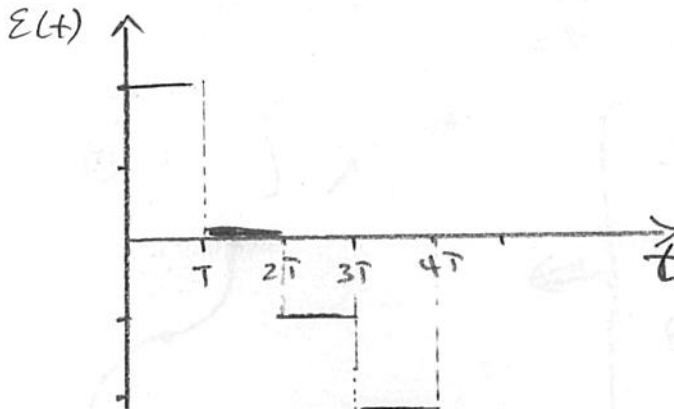
$B_4 = \dfrac{2c}{T} t$ $3T < t < 4T$

$\varepsilon_1 = \dfrac{2c}{T}$

$\varepsilon_2 = 0$

$\varepsilon_3 = -\dfrac{c}{T}$

$\varepsilon_4 = -\dfrac{2c}{T}$

$\varepsilon(t)$

Closed book. No calculators are to be used for this quiz.
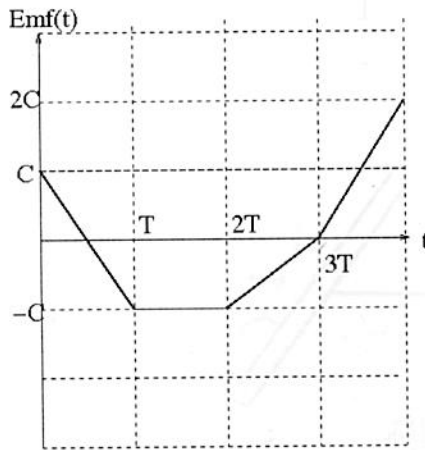**Quiz duration: 10 minutes**

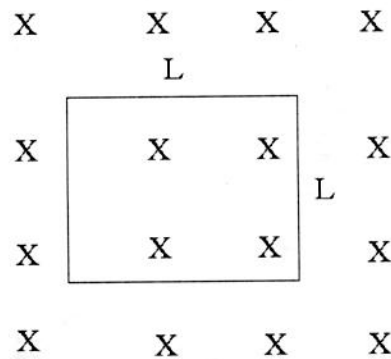**Name:**   **Student ID:**   **Signature:**

Consider the square loop in a uniform time-varying magnetic field, for which the induced emf varies with time according to the graph shown in the figure. Sketch the graph of the magnitude of the magnetic field as a function of time. Indicate the directions of the induced current at a given time.
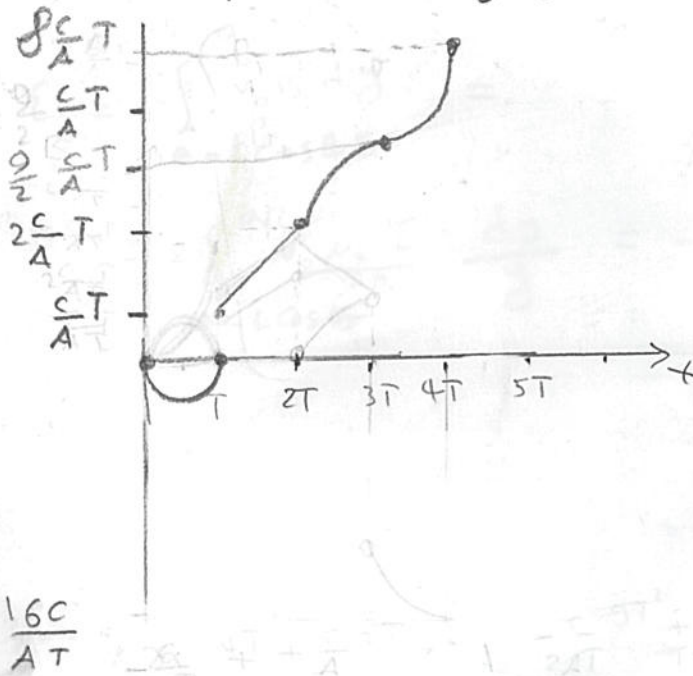

square loop in a uniform magnetic field

$$\mathcal{E} = -\frac{d\Phi}{dt} \Rightarrow \mathcal{E} = -\frac{d(BA)}{dt} \Rightarrow -A\frac{dB}{dt}$$

$$\Rightarrow B = -\int \frac{\mathcal{E}}{A}\, dt$$

$$\begin{cases} \mathcal{E}_1 = -\frac{2c}{T}t + c & 0 < t < T \\[4pt] \mathcal{E}_2 = -c & T < t < 2T \\[4pt] \mathcal{E}_3 = \frac{c}{T}t - 3c & 2T < t < 3T \\[4pt] \mathcal{E}_4 = \frac{2c}{T}t - \frac{6c}{T} & 3T < t < 4T \end{cases}$$

$$\begin{cases} B_1 = \frac{c}{AT}t^2 - \frac{ct}{A} \Big| B_2 = \frac{c}{A}t \\[6pt] B_3 = -\frac{c}{2AT}t^2 + \frac{3c}{A}t \\[6pt] B_4 = -\frac{c}{AT}t^2 + \frac{6c}{TA}t \end{cases}$$