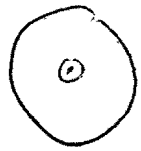
① (a) $B(t) = 4.5t^2 + 3.1t$



$\Phi_B = B \cdot A = B(\pi r^2)$

$\mathcal{E} = \frac{d\Phi_B}{dt} = \pi r^2 \frac{dB}{dt} = \pi (0.052\,m)^2 (9t + 3.2)(10^{-3})$

$= \pi (0.052\,m)^2 (9 \cdot 1.5 + 3.2)(10^{-3}) = 0.14\,mV$

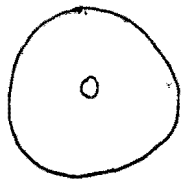
(b) $I = \frac{\mathcal{E}}{R} = \frac{0.14\,mV}{0.21\,\Omega} = 0.67\,mA$

B is out of the page and increasing, so the current must produce a field that is into the page.
⇒ current is clockwise

(c) $emf = \int \vec{E}_{NC} \cdot d\vec{l} = \int E_{NC}\, dl = E_{NC} \int dl = E_{NC}(2\pi r)$

$E_{NC} = \frac{\mathcal{E}}{2\pi r} = \frac{0.14mV}{2\pi(0.052m)} = 0.43\,mV/m$

clockwise around the loop (tangent to the circle).

② 

at $t = 3.0s$, $I = 3A$ clockwise
$t = 3.2$ $I = 5A$ counterclockwise

(a) Assume B = uniform over area of small ring

$B_i = \frac{\mu_0 I}{2R} = \frac{(4\pi \times 10^{-7})(3A)}{2(0.5m)} = 3.77 \times 10^{-6}\,T$ into page

$B_f = \frac{(4\pi \times 10^{-7})(5A)}{2(0.5m)} = 6.28 \times 10^{-6}\,T$ out of page

area of small ring $= \pi r^2 = \pi (0.005m)^2 = 7.85 \times 10^{-5} m^2$

$\mathcal{E} = \frac{\Delta\Phi}{\Delta t} = A \frac{\Delta B}{\Delta t} = (7.85 \times 10^{-5} m^2)\left(\frac{10.05 \times 10^{-6}\,T}{0.2\,s}\right)$

$= 3.9 \times 10^{-9} V$

$$\mathcal{E} = \int \vec{E}_{NC} \cdot d\vec{\ell} = \int E_{NC}\, d\ell = E_{NC} \int d\ell = E_{NC}(2\pi r)$$

$$E_{NC} = \frac{\mathcal{E}}{2\pi r} = \frac{3.9 \times 10^{-9} V}{2\pi (0.005\ m)} = 1.3 \times 10^{-7}\ V/m$$

Direction of ΔB is out of page
$\Rightarrow$ $-\Delta B$ is into page
$\Rightarrow$ E_{NC} is clockwise (tangent to circle)

(b) $I = \frac{\mathcal{E}}{X} = \frac{3.9 \times 10^{-9} V}{5000\ \Omega}$

$= 0.78\ nA$ clockwise