Answer on Question#61008 – Physics – Electric Circuits

A coil has 150 turns and each turn encloses an area of 1.0 m^2. Determine the rate of change of a magnetic field parallel to the axis of the coil in the induce a current of 0.1A in the coil. The resistance of the coil is 150Ω.

Solution. According to the condition of the problem
$R = 150\Omega$ – resistance of the coil;
$A = 1.0m^2$ – the area of coil turn;
$I = 0.1A$ – current in the coil;
$N = 150$ – number of coil turn.
$\frac{\Delta B}{\Delta t}$ – ?
Using Faradey's law of induction: The induced emf in a coil of N loops produced by a change in flux in a certain time interval is given by:

$$\varepsilon = -N\frac{\Delta\Phi}{\Delta t},$$

where $\Delta\Phi$ – change of the flux, ε – emf.
Sign minus mean that the current induced will create a magnetic field which opposes the buildup of magnetic field in the coil.
Using Ohm's law we can represented $\varepsilon = IR$.
Recalling that the flux through a loop of area A is given by $\Phi = \mathrm{BA}\cos\varphi$, where B – magnetic field, φ – the angle between the normal to the turn of coil and the magnetic field. According to the condition of the problem magnetic field parallel to the axis of the coil. Hence $\varphi = 0^0$ or $\varphi = 180^0$.
The area turns of the coil does not change. Therefore $\Delta\Phi = \Delta\mathrm{BA}\cos\varphi$ and

$$\varepsilon = -N\frac{\Delta\Phi}{\Delta t} \rightarrow IR = -\frac{\Delta\mathrm{BAN}\cos\varphi}{\Delta t}.$$

Using last formula magnitude of rate of change of a magnetic field equal

$$\frac{\Delta\mathrm{B}}{\Delta t} = \frac{IR}{\mathrm{AN}} \rightarrow \frac{\Delta\mathrm{B}}{\Delta t} = \frac{0.1\cdot 150}{1\cdot 150} = 0.1\frac{T}{s}.$$

Answer: $\frac{\Delta\mathrm{B}}{\Delta t} = 0.1\frac{T}{s}$.