

# task\_rdz03rspbwusy7wk\_with\_calculation

## Student Group

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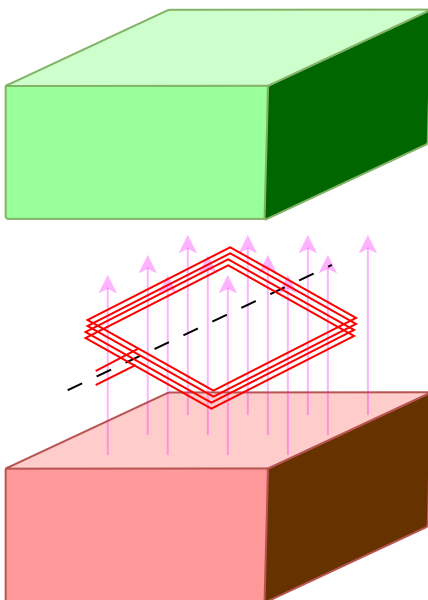
induction, coil, induced voltage, exam ee2 SS2021

### Exercise E1 Coil in a magnetic Field (written test, approx. 4 % of a 120-minute written test, SS2021)

A coil with  $n = 300$  turns and a cross-sectional area  $A = 600 \text{ cm}^2$  is located in a homogeneous magnetic field.

The rotation of the coil causes a sinusoidal change in the magnetic field in the coil with the frequency  $f = 80 \text{ Hz}$ .

The maximum value of the magnetic flux density in the coil is  $\hat{B} = 2 \cdot 10^{-6} \text{ T}$ .  
 The induced voltage is  $u_{\text{ind}}(t) = -181 \text{ V} \cdot \cos(503 \text{ s}^{-1} t)$ .



Derive the formula for the voltage induced in the coil and calculate the voltage amplitude.

Path

The induced voltage  $u_{\text{ind}}$  is given by:

$$u_{\text{ind}} = - \frac{d\Phi(t)}{dt} = - n \frac{d\Phi(t)}{dt}$$

With  $\Phi(t) = B(t) \cdot A$ , where  $A$  is the constant area of a single winding and  $B(t)$  is the changing field through this winding.

Due to the rotation, the field changes as:

$$B(t) = \hat{B} \cdot \sin(\omega t + \varphi) = \hat{B} \cdot \sin(2\pi f \cdot t + \varphi)$$

This leads to: 
$$u_{\text{ind}} = - n \frac{d}{dt} A \hat{B} \cdot \sin(2\pi f \cdot t + \varphi) \quad \&= - n \cdot A \hat{B} \cdot 2\pi f \cdot \cos(2\pi f \cdot t + \varphi)$$

The absolute value of the factor in front of the  $\cos$  is the maximum induced voltage  $\hat{U}_{\text{ind}}$ : 
$$\hat{U}_{\text{ind}} = n \cdot A \hat{B} \cdot 2\pi f \quad \&= 300 \cdot 0.06 \text{ m}^2 \cdot 2 \cdot 10^{-2} \text{ T} \cdot \pi \cdot 80 \frac{1}{\text{s}} \quad \&= 180.95... \text{ V} \quad \&= 180.95... \text{ V}$$

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