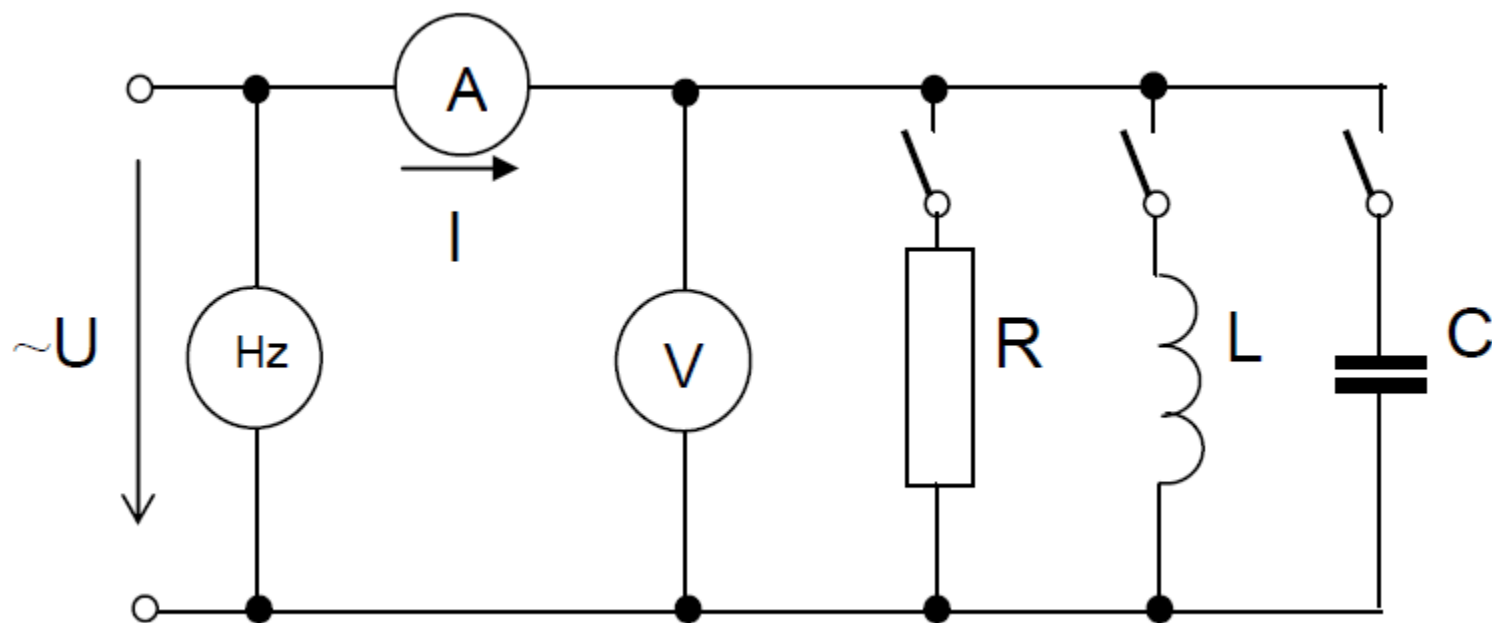


## **6. Měření na RLC obvodu**

# Zadání

- a. pro kmitočet  $f = 50 \text{ Hz}$  změřte všechny proudy ( $I_R, I_L, I_C, I_{RL}, I_{RC}, I_{LC}, I_{RLC}$ )
- b. vypočítejte  $R, X_L, X_C$ , pro  $I_{RLC}$  vypočítejte impedanci  $Z$  a admitanci  $Y$
- c. vypočítejte úhel fázového posunu  $\varphi$  mezi napětím a proudem  $I_{RLC}$
- d. určete, pro jaký kmitočet bude obvod v rezonanci
- e. pro  $I_{RL}, I_{RC}, I_{LC}, I_{RLC}$  sestrojte v měřítku fázorové diagramy

# Schéma zapojení



# Tabulka naměřených hodnot

$U=10V$ ,  $f=50Hz$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Příklad výpočtu

$$R = \frac{U}{I_{RLC}} = \frac{10}{0,0508} = \mathbf{196,850\Omega}$$

$$x_L = \frac{U}{I_L} = \frac{10}{0,0262} = \mathbf{377,358\Omega}$$

$$L = \frac{x_L}{2\pi f} = \frac{377,358}{2 \times \pi \times 50} = \mathbf{1,201H} \rightarrow 1201mH$$

$$x_C = \frac{U}{I_C} = \frac{10}{0,0125} = \mathbf{800\Omega}$$

$$C = \frac{1}{2\pi f x_C} = \frac{1}{2 \times \pi \times 50 \times 800} = \mathbf{0,000003978F} \rightarrow 3,978\mu F$$

# Příklad výpočtu

pro  $I_{RLC}$ :

impedance

$$\omega = 2\pi f = 2 \times \pi \times 50 = \mathbf{314,159}$$

$$\begin{aligned} Z &= \frac{U}{I} = \frac{1}{\sqrt{\frac{1}{R^2} + \left(\omega C - \frac{1}{\omega L}\right)^2}} \\ &= \frac{1}{\sqrt{\frac{1}{196,850^2} + \left((314,159 \times 0,000003978) - \frac{1}{(314,159 \times 1,201)}\right)^2}} \\ &= \mathbf{189,765\Omega} \end{aligned}$$

# Příklad výpočtu

pro  $I_{RLC}$ :

admittance

$$\omega = 2\pi f = 2 \times \pi \times 50 = \mathbf{314,159}$$

$$Y = \frac{1}{Z} = \frac{1}{189,765} = 5,269 \cdot 10^{-3} \Omega^{-1} \rightarrow \mathbf{0,005269\Omega^{-1}}$$

$$\begin{aligned} Y &= \sqrt{\frac{1}{R^2} + \left(\omega C - \frac{1}{\omega L}\right)^2} \\ &= \sqrt{\frac{1}{196,850^2} + \left((314,159 \times 0,000003978) - \frac{1}{(314,159 \times 1,201)}\right)^2} \\ &= 5,269 \cdot 10^{-3} \Omega^{-1} \rightarrow \mathbf{0,005269\Omega^{-1}} \end{aligned}$$

# Příklad výpočtu

rezonanční frekvence

$$f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2 \times \pi \times \sqrt{1,201 \times 0,000003978}} = \mathbf{72,814Hz}$$



# Příklad výpočtu

Vypočteme  $I_{RL}$ ,  $I_{RC}$ ,  $I_{LC}$ ,  $I_{RLC}$  a porovnáme s naměřenými hodnotami  $I_{RL}$ ,  $I_{RC}$ ,  $I_{LC}$ ,  $I_{RLC}$ .

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

$$I_{RL} = \sqrt{I_R^2 + I_L^2} = \sqrt{0,0459^2 + 0,0265^2} = \mathbf{0,0530A} \rightarrow 53,0mA$$

$$I_{RC} = \sqrt{I_R^2 + I_C^2} = \sqrt{0,0459^2 + 0,0125^2} = \mathbf{0,0475A} \rightarrow 47,5mA$$

$$I_{LC} = I_C - I_L = 0,0125 - 0,0265 = \mathbf{-0,014A} \rightarrow -14,0mA$$

$$I_{RLC} = \sqrt{I_R^2 + (I_C - I_L)^2} = \sqrt{0,0459^2 + (0,0125 - 0,0265)^2} = \mathbf{0,0479A} \rightarrow 47,9mA$$

# Graf, fázorový diagram $I_{RC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



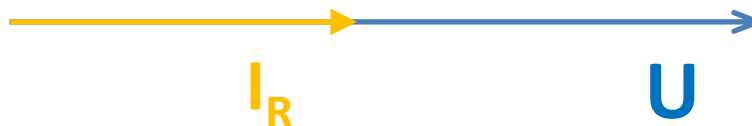
$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{RC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



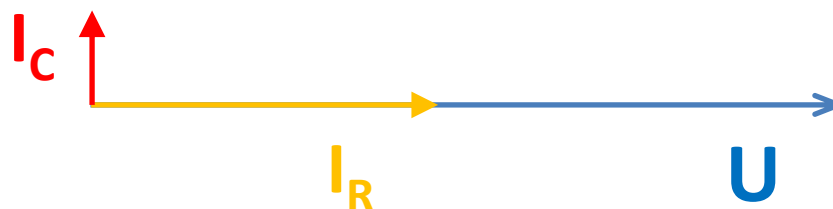
$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{RC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



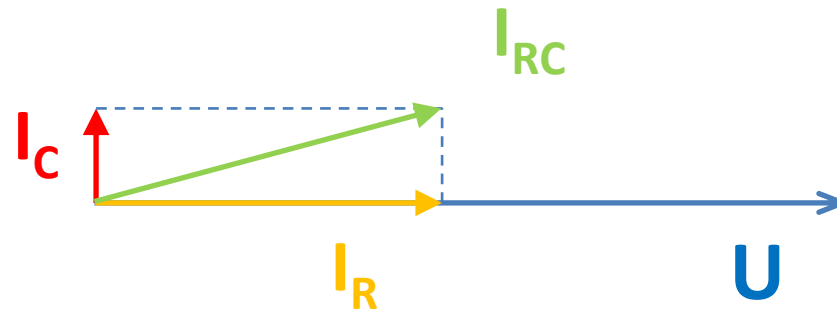
$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{RC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{RL}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



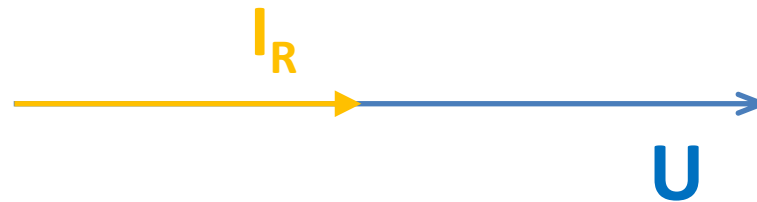
$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{RL}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



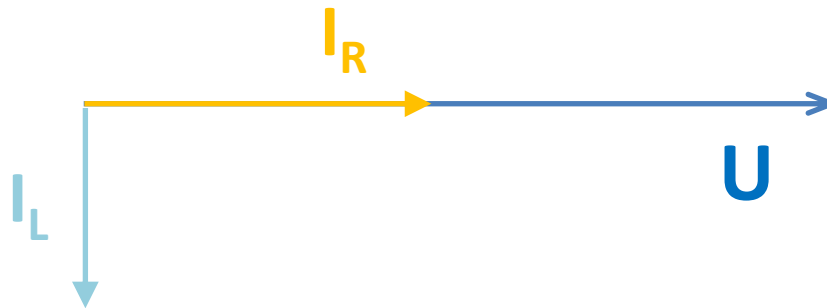
$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{RL}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



$U=10\text{V}, f=50\text{Hz}$

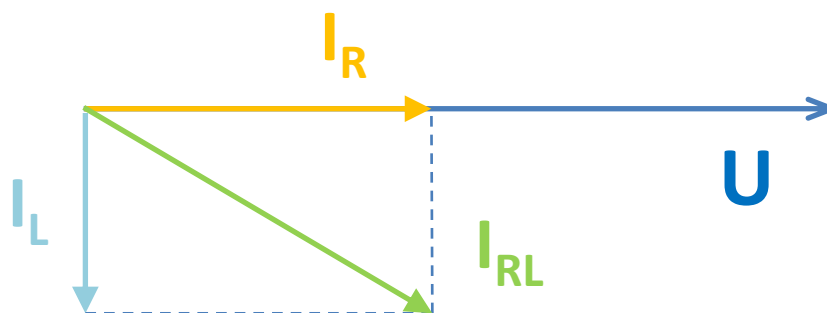
| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |



# Graf, fázorový diagram $I_{RL}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



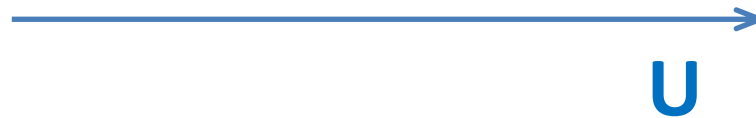
$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{LC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{LC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{LC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{LC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{RLC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



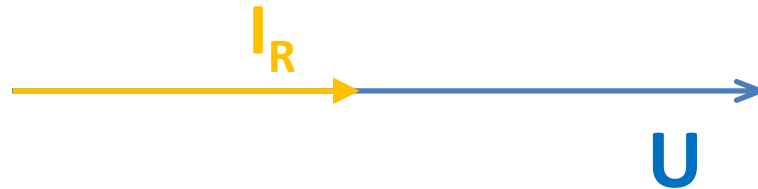
$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{RLC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



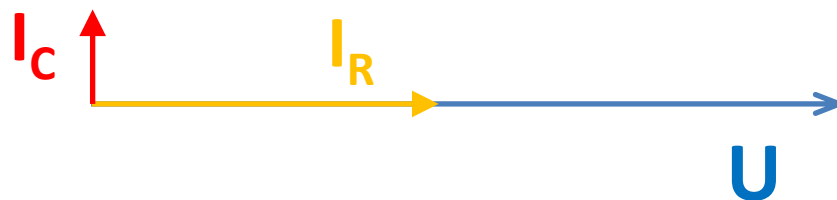
$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{RLC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



$U=10\text{V}, f=50\text{Hz}$

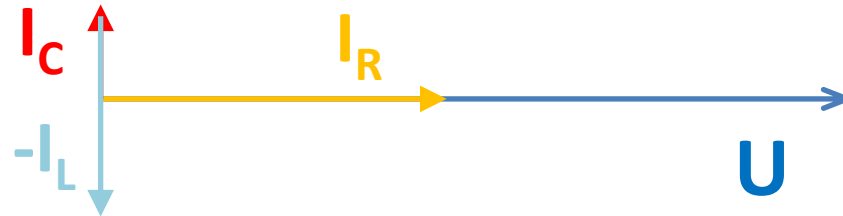
| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |



# Graf, fázorový diagram $I_{RLC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



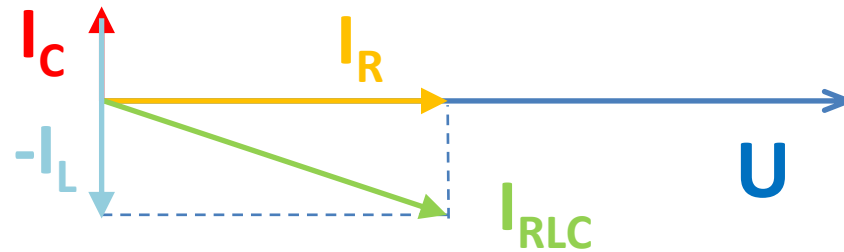
$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |

# Graf, fázorový diagram $I_{RLC}$

$M_U : 1\text{cm} = 1\text{V}$

$M_I : 1\text{cm} = 10\text{mA}$



$U=10\text{V}$ ,  $f=50\text{Hz}$

| $I_R$ (mA) | $I_L$ (mA) | $I_C$ (mA) | $I_{RL}$ (mA) | $I_{RC}$ (mA) | $I_{LC}$ (mA) | $I_{RLC}$ (mA) |
|------------|------------|------------|---------------|---------------|---------------|----------------|
| 45,9       | 26,5       | 12,5       | 55,0          | 47,5          | 14,5          | 50,8           |