

Ordinary differential equations – main task

Codes:

- RKF45, [link](http://msekcce.karlin.mff.cuni.cz/~dolejsi/Vyuka/NS_source/ODE/RKF45.tgz) http://msekcce.karlin.mff.cuni.cz/~dolejsi/Vyuka/NS_source/ODE/RKF45.tgz
 - DOPRI5, [link](http://msekcce.karlin.mff.cuni.cz/~dolejsi/Vyuka/NS_source/ODE/DOPRI5.tgz) http://msekcce.karlin.mff.cuni.cz/~dolejsi/Vyuka/NS_source/ODE/DOPRI5.tgz
 - Installation: `tar xzf RKF45.tar.gz + make`, similarly DOPRI5
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$$(ODE1) \quad y' = \frac{1}{\sin \sqrt{|x|}}, \quad y(-1) = 0, \quad x \in [-1; 2]$$

$$(ODE2) \quad y' = -\text{sign}(x)|1 - |x||y^2, \quad y(-2) = \frac{2}{3}, \quad x \in [-2; 2]$$

$$(ODE3) \quad y'' = 100y, \quad y(0) = 1, \quad y'(0) = -10 \quad x \in [0; 4]$$

$$(ODE4) \quad \begin{aligned} u' &= 998u + 1998v, & u(0) &= 1, & x &\in [0; 10] \\ v' &= -999u - 1999v, & v(0) &= 0 \end{aligned}$$

$$(ODE5) \quad y' = \frac{1}{4}\sqrt{y}, \quad y(0) = 0, \quad x \in [0; 5]$$

$$(ODE6) \quad \begin{aligned} &\text{prey (králíci) } k \text{ and predator (lišky) } l, \text{ if } k < 1 \text{ or } l < 1 \text{ then prey or predator die} \\ k' &= 2k - \alpha kl, & k(0) &= k_0, & x &\in [0; ?] \\ l' &= -l + \alpha kl, & l(0) &= l_0, & \alpha &> 0, \end{aligned}$$

(a) $\alpha = 0.01$; $k_0 = 300$; $l_0 = 150$ periodic solution, find the period

(b) $\alpha = 0.01$; $k_0 = 15$; $l_0 = 22$ prey die

(c) $\alpha = 0.01$; find k_0 and l_0 when predator die

$$(ODE7) \quad y' = \begin{cases} -1 & \text{for } y \geq 0 \\ 1 & \text{for } y < 0 \end{cases} \quad y(0) = 0, \quad x \in [0; 1],$$

$$(ODE8) \quad y' = \begin{cases} \frac{1}{1+y} & \text{for } 0 < x \leq 2 \\ 1 & \text{for } x > 2 \end{cases} \quad y(0) = 1, \quad x \in [0; 5],$$