Homework report №1

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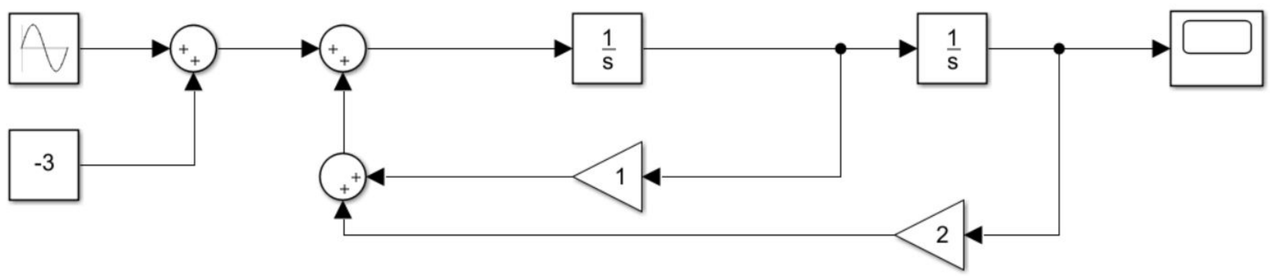
Variant n

$$\text{(n)}\quad x'' - x' - 2x + 3 = \sin 2t, \qquad x'(0) = 2, x(0) = 5$$

№2

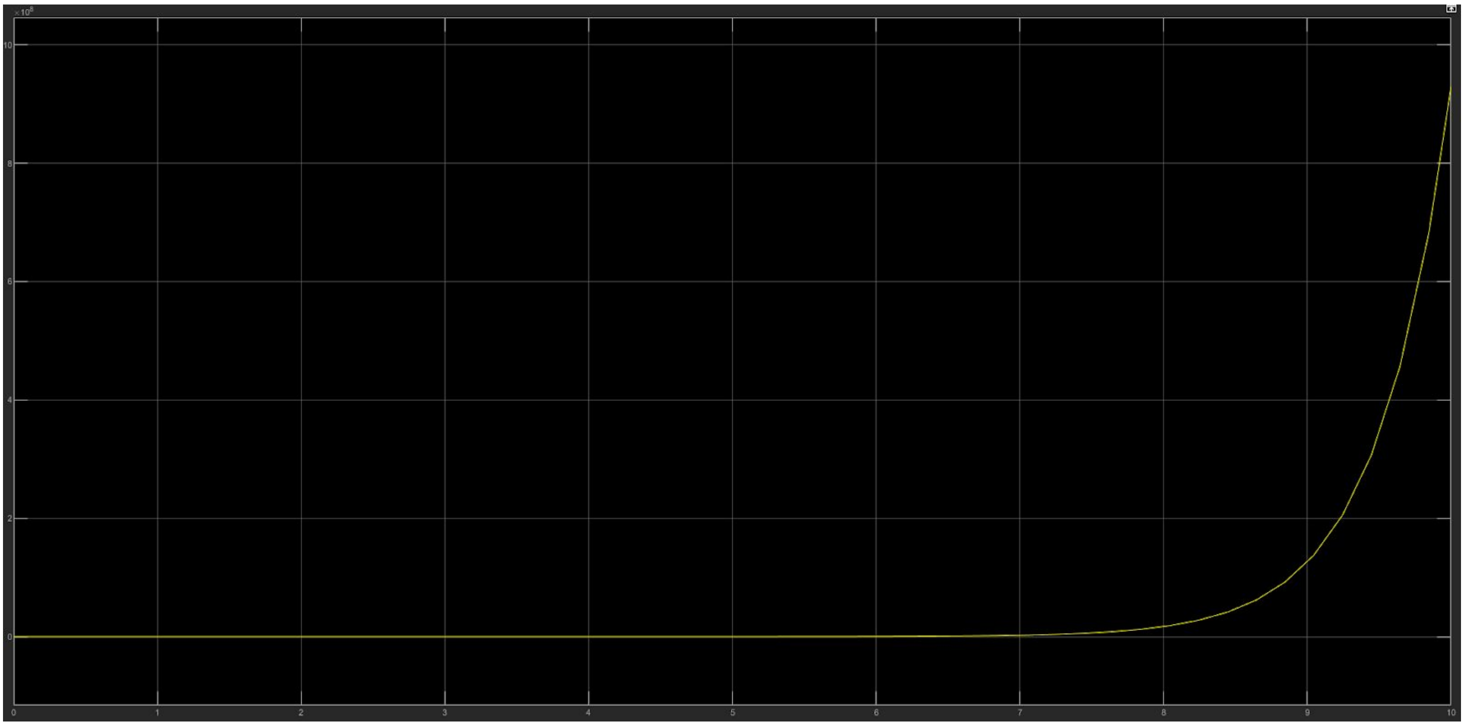
A)

Shema:



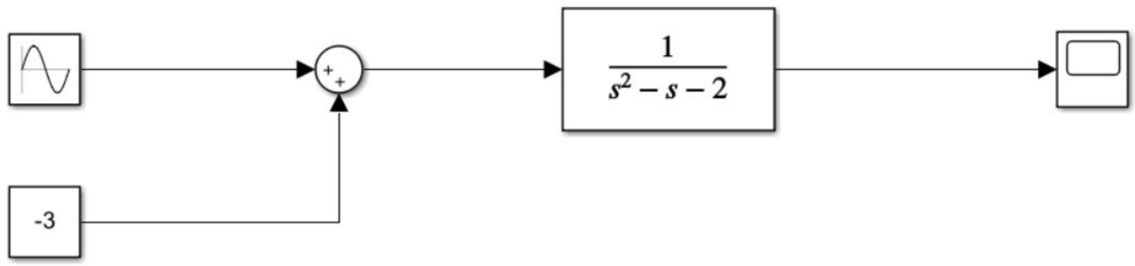
Initial conditions are inside Integrator blocks.

Plot:



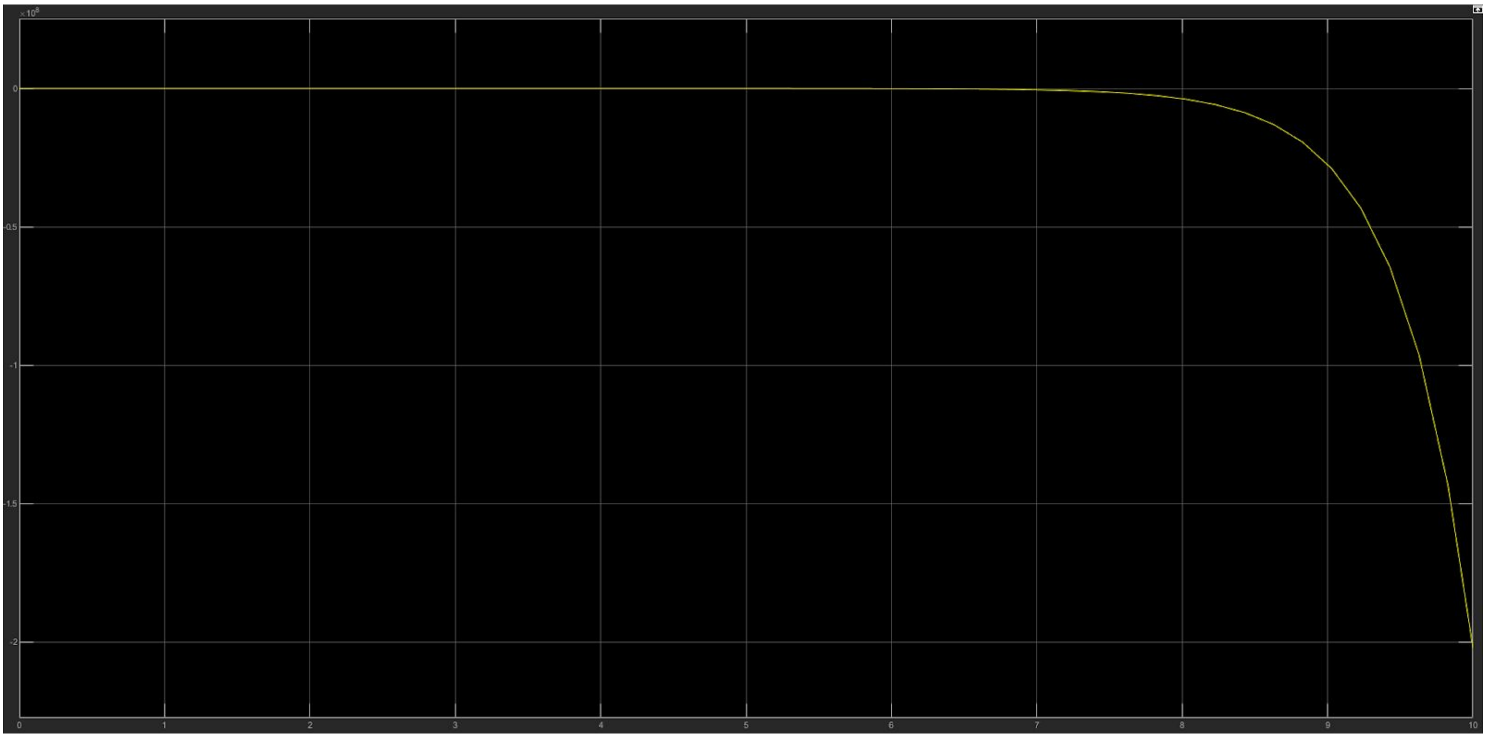
B)

Shema:



Transfer function block does not support initial conditions, so here they all are equal to zero. As a result, I have different plot.
https://uk.mathworks.com/matlabcentral/answers/38446-how-to-give-initial-condition-to-transfer-function

Plot:



C)

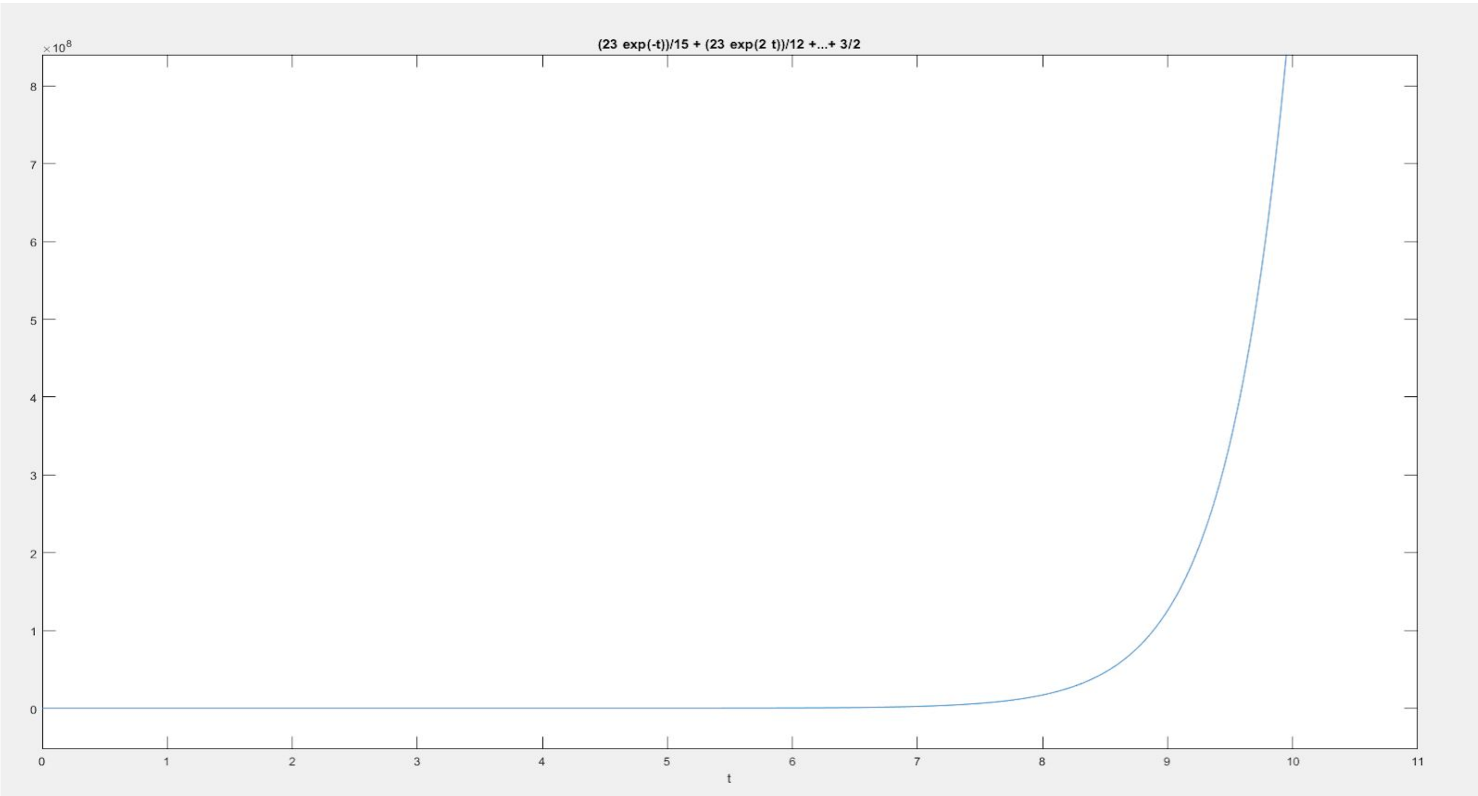
Code:

```
syms x(t)
Dx = diff(x);
eqn = diff(x,t,2) - diff(x,t) + - 2*x + 3 == sin(2*t);
cond1 = x(0) == 5;
cond2 = Dx(0) == 2;
conds = [cond1, cond2];
S(t) = dsolve(eqn, conds);
disp(eqn);
ezplot(S,[0, 11]);
```

Solution:

$$\frac{23\,e^{-t}}{15} + \frac{23\,e^{2t}}{12} + \frac{\sqrt{10}\,\cos(2\,t + \mathrm{atan}(3))}{20} + \frac{3}{2}$$

Plot:

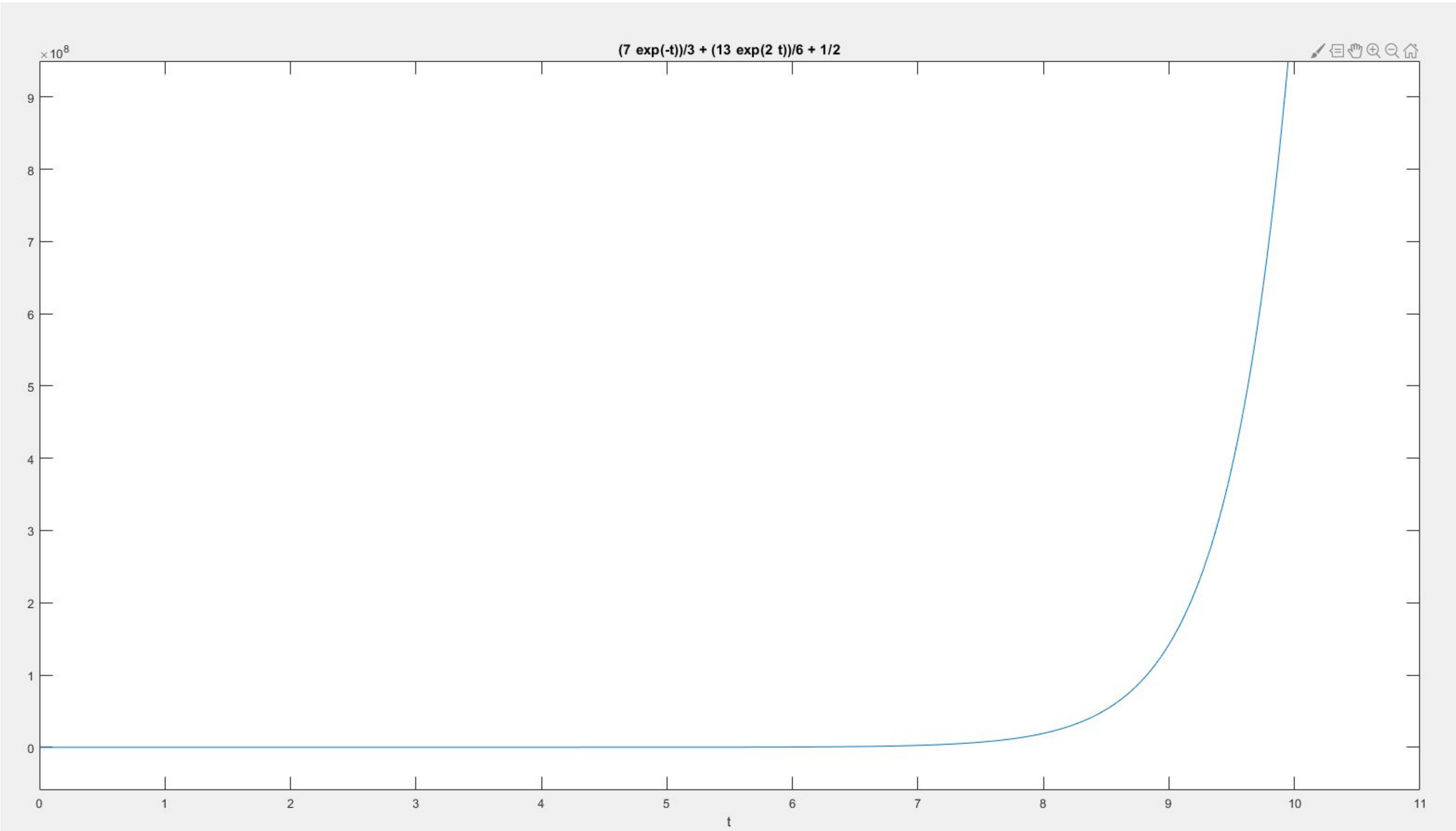


D)

Code:

```
syms s t X
f = sin(2 * t) - 3;
F = laplace(f, t, s);
Sol = solve(s*s*X - 5*s - 2 - s*X + 5 - 2*X + 1/s, X);
sol = ilaplace(Sol, s, t);
disp(sol);
ezplot(sol, [0, 11]);
```

Solution + Plot:



№3

(n) $x'' + 3x' + 3x = t$, $y = x' + 2t$

$$x'' = -3x' - 3x + t$$

$$\begin{bmatrix} x' \\ x'' \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -3 & -3 \end{bmatrix} \begin{bmatrix} x \\ x' \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} \text{t}$$

$$\begin{bmatrix} y \end{bmatrix} = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ x' \end{bmatrix} + \begin{bmatrix} 2 \end{bmatrix} \text{t}$$

№4

(n) $3x'''' + 2x''' - x'' + 2x' - 3 = u_1 + 5u_2, y = x' + u_2$

$$x'''' = \frac{1}{3}u_1 + \frac{5}{3}u_2 - \frac{2}{3}x''' + \frac{1}{3}x'' - \frac{2}{3}x' + 1$$

$$\begin{bmatrix} x' \\ x'' \\ x''' \\ x'''' \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & -\frac{2}{3} & \frac{1}{3} & -\frac{2}{3} \end{bmatrix} \begin{bmatrix} x \\ x' \\ x'' \\ x''' \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \\ \frac{1}{3} & \frac{5}{3} & 1 \end{bmatrix} \begin{bmatrix} \mathrm{u}_1 \\ \mathrm{u}_2 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} y \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x \\ x' \\ x'' \\ x''' \end{bmatrix} + \begin{bmatrix} 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} \mathrm{u}_1 \\ \mathrm{u}_2 \\ 1 \end{bmatrix}$$

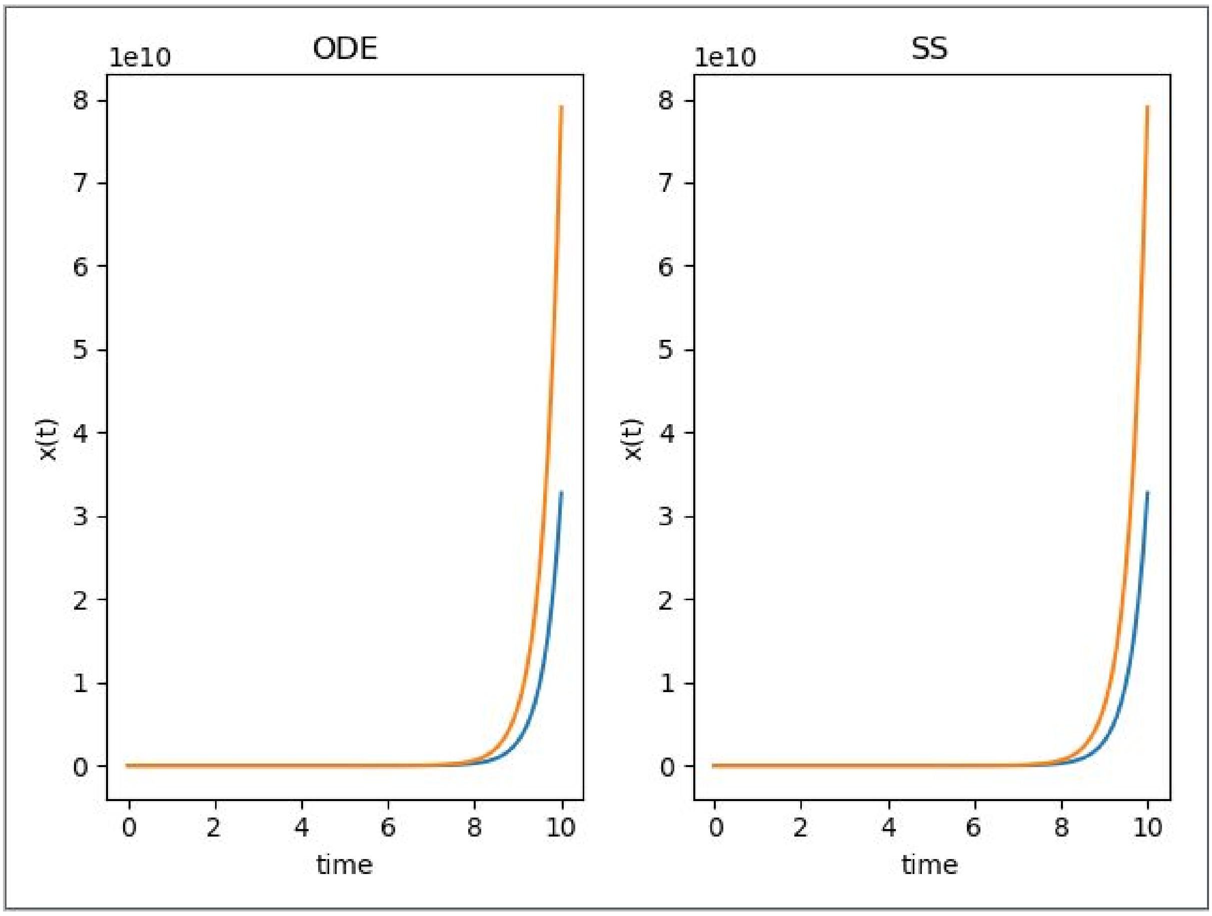
№5

Code:

```
def to_ss(coefficients, b0):
    coefficients = np.array(coefficients)
    degree = len(coefficients) # degree of the polynomial

    normalized = coefficients[1:] / coefficients[0] # divide by "ak"

    A = np.zeros((degree-1, degree-1))  # state matrix
    A[0, 0:] = -normalized
    A[1:, 0:(degree-2)] = np.eye(degree-2)

    A = np.flip(A)

    B = np.zeros((degree - 1, 1))
    B[-1][0] = b0
    return A, B
```

№6

Plots of ODE from task 2:



ODE is not stable because not all **real parts** of eigenvalues of matrix A are less, then zero.

$$\text{eigenvalues for } \begin{pmatrix} 0 & 1 \\ 2 & 1 \end{pmatrix}: \quad \lambda = 2, \lambda = -1$$

Solution diverges because ODE is not stable.