Cleaning workspace

```
clear;
clc;
```

Loading data:

```
if isfile('data.mat')
     load('data.mat');
end
```

Problem:

```
a = -1; % Left boundary
b = 1;  % Right boundary

u_a = 0; % Value at left boundary
u_b = 0; % Value at right boundary

n = 5; % How many coordinate functions to take
disp([ 'Solving problem with n=' num2str(n) ' coordinate functions']);
```

```
Solving problem with n=5 coordinate functions
```

Matlab solution:

```
h = 0.05; % Step
X = linspace(a, b, (b-a)/h);
init_sol = bvpinit(X, [0 0]);
sol = bvp4c(@odefun, @bcfun, init_sol);
y_matlab = deval(sol, X);
```

Galerkin method:

```
y_galerkin = Galerkin(a, b, n);
```

```
Solving system:
   -2.2622    0.5385    0.4520    0.0227   -0.0007    2.6667
   -1.3457   -3.0292    0.6348    0.4399    0.0074   -0.5333
   -0.0279   -1.7789   -4.2084    0.5475    0.3900         0
    0.0478   -0.1541   -2.1322   -5.4899    0.3980         0
    0.0054    0.0387   -0.2602   -2.4434   -6.8165         0

Condition number of system:
    3.6565

Decomposition coefficients:
   -1.0808
    0.6146
   -0.2450
    0.0676
   -0.0122
```

Collocations method:

```
y_collocations = Collocations(a, b, n);
```

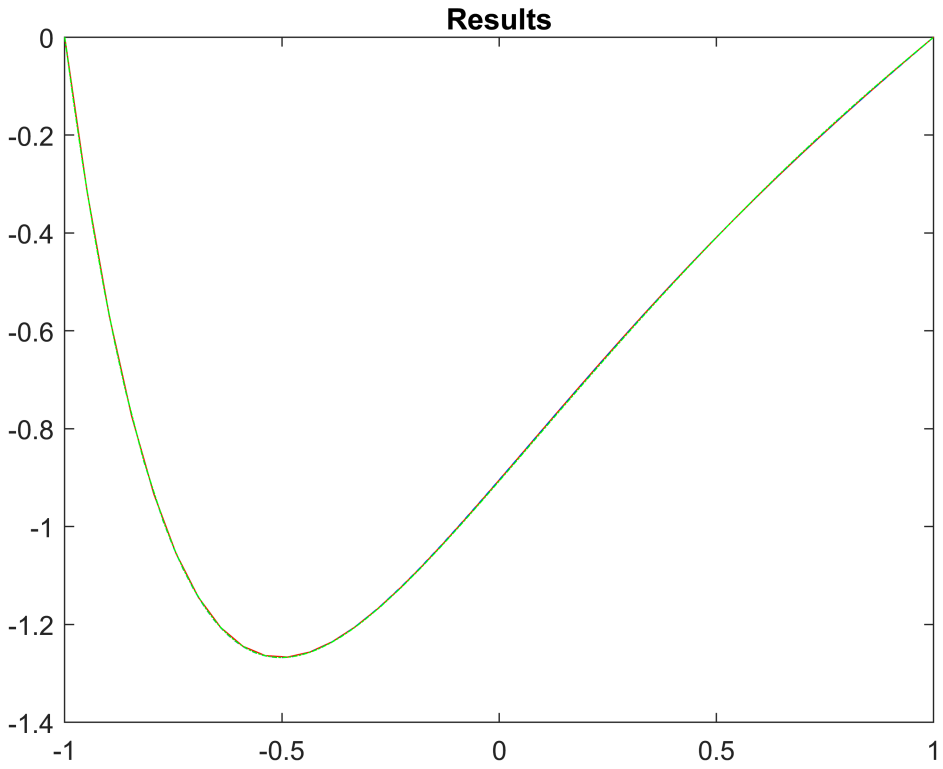
```
Solving system:
    0.4321    1.2040   -5.9024   13.8670  -24.3774    2.9511
   -0.2152    2.4879   -3.6755    0.1781    6.4939    2.5878
   -1.6667    2.0000    3.7500   -3.0000   -6.8750    2.0000
   -3.2283   -4.0507   -0.2898    7.2580   12.6522    1.4122
   -3.9364  -10.9190  -22.2885  -38.0541  -56.6834    1.0489

Condition number of system:
   26.3192

Decomposition coefficients:
   -1.0813
    0.6148
   -0.2429
    0.0683
   -0.0122
```

Plots:

```
figure;
plot(X, y_matlab(1,:), '-r');
hold on;
fplot(y_galerkin, [a b], '--b');
fplot(y_collocations, [a b], '-.g');
title('Results');
hold off;
```



Checking values at points:

```
points = [-0.5 0 0.5];
y_matlab_check = deval(sol, points);
for i = 1:length(points)
    point = points(i);
    disp([ 'Difference at x=' num2str(point) ':' ]);

    y_matlab_value = y_matlab_check(1, i);
    syms x;
    y_galerkin_value = vpa(subs(y_galerkin, x, point));
    y_galerkin_diff = y_matlab_value - y_galerkin_value;
    disp('  Galerkin: ');
    disp(y_galerkin_diff);

    y_collocations_value = vpa(subs(y_collocations, x, point));
    y_collocations_diff = y_matlab_value - y_collocations_value;
    disp('  Collocations: ');
    disp(y_collocations_diff);
end
```

```
Difference at x=-0.5:
  Galerkin:
0.00030384461875204008988538353919218
  Collocations:
0.00021106935147515340270274984690868
Difference at x=0:
```

```
  Galerkin:
```
$$-0.00018788675224596035687185668905386$$
```
  Collocations:
```
$$0.0019177257390477350177532267494485$$
```
Difference at x=0.5:
  Galerkin:
```
$$-0.00002731781091627675763432111868147$$
```
  Collocations:
```
$$0.00033213950773826612697359715598022$$

Saving data:

```
save('data.mat');
```

Functions:

```
function dydx = odefun(x_, y)
    %p = @(x_actual)(subs(P(), x, x_actual));
    syms x;
    p = P();
    q = Q();
    r = R();
    f = F();
    dy_2 = subs((q/p) * y(2) + (r/p) * y(1) - (f/p), x, x_);
    dydx = [
        y(2);
        dy_2
    ];
end

function res = bcfun(ya, yb)
    res = [
        ya(1);
        yb(1)
    ];
end
```