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 = 4; % How many coordinate functions to take
disp([ 'Solving problem with n=' num2str(n) ' coordinate functions']);
```

```
Solving problem with n=4 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    2.6667
   -1.3457   -3.0292    0.6348    0.4399   -0.5333
   -0.0279   -1.7789   -4.2084    0.5475         0
    0.0478   -0.1541   -2.1322   -5.4899         0

Condition number of system:
    2.9312

Decomposition coefficients:
   -1.0805
    0.6148
   -0.2439
    0.0680
```

Collocations method:

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

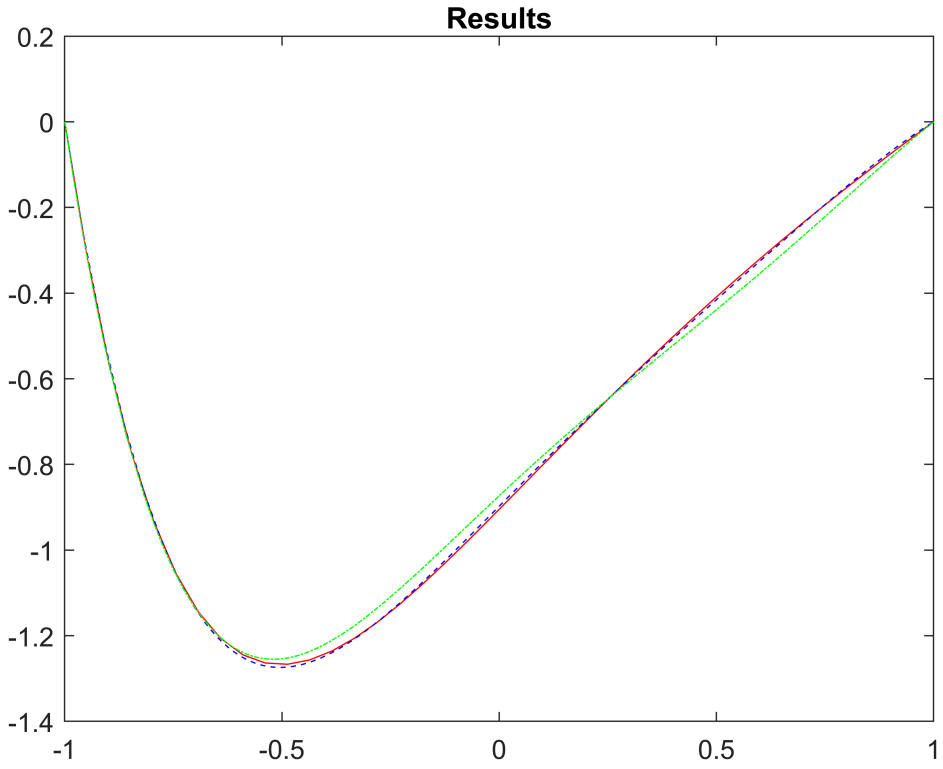
```
Solving system:
    0.3922    1.3164   -5.8306   12.7058    2.9239
   -0.6772    2.8038   -1.2514   -4.4813    2.3827
   -2.7095   -1.2097    4.2300    7.3219    1.6173
   -3.8971  -10.3327  -19.8724  -31.3444    1.0761

Condition number of system:
   15.8341

Decomposition coefficients:
   -1.0773
    0.5915
   -0.2722
    0.0772
```

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:
0.0067004071445980707341649740271805
  Collocations:
-0.013512028907078649318102003817899
Difference at x=0:
  Galerkin:
-0.0072797648704310893852387209790322
  Collocations:
-0.031697986041196807294184623060573
Difference at x=0.5:
  Galerkin:
0.0064851905290826405980908475612523
  Collocations:
0.029893142015771050849087808742865
```

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
```