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%HW-3 Prb-9
%Navneet Singh (nsingh1@andrew.cmu.edu)
function problem9
```

Given equation is $-u^{"} + \pi^2 u = 2\pi^2 sin(\pi x)$

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%We are going to convert this to two IVP problems as follows:
%
%
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$$-u^{"} + \pi^2 u = 2\pi^2 sin(\pi x)$$

```
%With initial values of [0,0]
%
%Second equation is hompogenous equation
%
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$$-u^{"} + \pi^2 u = 0$$

```
%with inital values of [0,1]


clc       %clear screen
clear all %clearing all stored variables
close all %close previous plots


%defining range of xi
xspan = [0, 0.25, 0.50, 0.75, 1];

%To estimate u1(x) and u2(x) at xspan we can use MATLAB's ode45
 function as
%it is based on RK4 method.

 %Solving corresponding non-homogenous IVP problem
[x, u1]= ode45(@dudx1, xspan, [0,0]);
fprintf('Value of u1 at [0, 0.25, 0.50, 0.75, 1] is as follows:')
u1(:,1)

%Solving corresponding hompogenous IVP problem
[x, u2] = ode45(@dudx2, xspan, [0,1]);
fprintf('\nValue of u2 at [0, 0.25, 0.50, 0.75, 1] is as follows:')
u2(:,1)

%Neither u1 nor u2 satisfies Dirichlet BC at x=1, so we will need c.

% As u(1) = 0. So, u1(1) + c*u2(1) = 0.
% c = -u1(1)/u2(1)
%calculating value of c
c = -u1(end,1)/u2(end,1);
fprintf('Value of c that give approxmate solution = %f\n', c);
```

```
%Calculating value of w(x).
w = u1(:,1) + c*u2(:,1);

fprintf('\nValues of function W(x) at points in xspan is as follows
\n')
w

%Calculating error at each point of xspan
y = sin(pi.*xspan)';
fprintf('Exact error at each point is : ')
error = y -w

%The u(1), corresponding non-homogenous IVP
function f = dudx1(x, u)
     f = zeros(2,1);
     f(1) = u(2);
     f(2) = -2*(pi^2)*sin(pi*x) + (pi^2)*u(1);

end

% The u(2), corresponding homogenous IVP is given as below
function f = dudx2(x, u)
     f = zeros(2,1);
     f(1) = u(2);
     f(2) = (pi^2)*u(1);

end
```

```
Value of u1 at [0, 0.25, 0.50, 0.75, 1] is as follows:
ans =

         0
   -0.1616
   -1.3013
   -4.5209
  -11.5488


Value of u2 at [0, 0.25, 0.50, 0.75, 1] is as follows:
ans =

         0
    0.2765
    0.7325
    1.6641
    3.6761

Value of c that give approxmate solution = 3.141595

Values of function W(x) at points in xspan is as follows

w =
```

```
         0
    0.7071
    1.0000
    0.7071
         0

Exact error at each point is :
error =

   1.0e-05 *

         0
    0.1247
   -0.1512
   -0.0423
    0.0000


end
```

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