

MA3237 2110: Project #1

Due on Thursday, 20 Feb 2014

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Matlab Code

```
clear; close all;
function f = F(x)
    f=pi^2*sin(pi*x);
end % function
%-----
function u = U(x)
    u=sin(pi*x);
end % function
%-----
function upp = A(u)
    m=size(u,1);
    DD=sparse(1:m,1:m,2,m,m)+sparse(2:m,1:m-1,-1,m,m)+sparse(1:m-1,2:m,-1,m,m);
    upp = DD*u;
end % function
%-----
function x_bar=rgd_solve(A,f,h)
    m=size(f,1);
    DD=sparse(1:m,1:m,2,m,m)+sparse(2:m,1:m-1,-1,m,m)+sparse(1:m-1,2:m,-1,m,m);
    x_bar = DD\ (f*h^2);
end % function
%-----
function x_bar=cgd_solve(A,f,h,iter_max = 100)
    b = f*h^2;
    k = 0;
    x = zeros(size(b));
    r = b - A(x);
    p = r;

    while(k < iter_max && max(abs(r)) >= 0.000000001)
        k = k + 1;
        a = r'*p./(p'*(A(p)));
        x = x + a*p;
        r_old = r;
        r = r - a*(A(p));
        b = r'*r./(r_old'*r_old);
        p = r + b*p;
    end %while
    x_bar = x;

end % function
%-----
N=[10,20,40,80];
drawStr={'r','b-.','g—','y:'};
maxerr = zeros(length(N),1);

error_plot = figure(1);
hold on;
```

```
grid on;
legendStr=cell(1,length(N));
I = 1;
for n = N
    h = 1/n;
    mesh = linspace(0,1,n+1)';
    Au = F(mesh);

    x_bar = [0;cgd_solve(@A, Au(2:end-1),h);0];
    err = x_bar - U(mesh);
    plot(mesh, err , drawStr(I), 'LineWidth',1, 'MarkerSize',2)
    maxerr(I) = max(abs(err));
    clear("err")
    legendStr{I}=[ 'n=',num2str(n)];
    I = I+1;
end

legend(legendStr);
xlabel('x');
ylabel('Error at grid points:  $u_i - u_{\{ex\}}(x_i)$ ')
print(error_plot, 'error_plot.tex', '-S900,450', '-dtex')
hold off;

error_n_plot = figure(2);
loglog(1./N,maxerr, 'd-b', 'LineWidth',1, 'MarkerSize',5)
set(gca, 'XDir', 'reverse');
grid on;
hold on;
loglog(1./N,(1./N).^2, '-r', 'LineWidth',1);
legend('  $|u - u_{\{ex\}}| - \{\infty\}$ ', 'h.v.s.  $h^2$ ');
xlabel('h');
print(error_n_plot, 'error_n_plot.tex', '-S900,450', '-dtex')
hold off;
```

