Contents


```
%{

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Description:
AME 60614: Numerical Methods
Homework: 2
Due: 9/24/2024


%}
```

Preparation of the Workspace

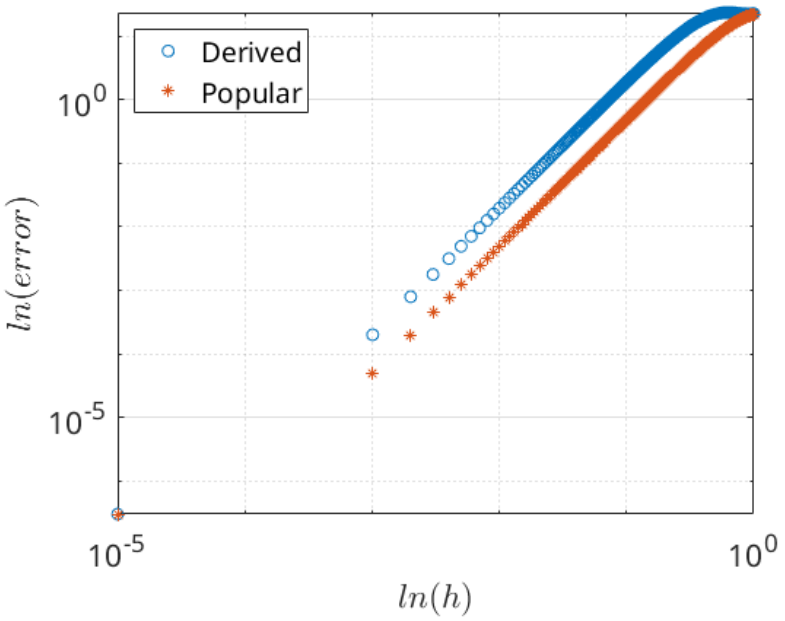
```
clear all
clc
close all
```

Preperation of Figures

```
fontsize = 16;
set(0,'DefaultTextInterpreter','latex')
set(0,'DefaultAxesFontSize',fontsize)
set(0,'DefaultLegendFontSize',fontsize)
colors  = ["#000000","#1b9e77","#d95f02","#7570b3","#0099FF","#FF0000"];
```

problem 1

```
del_h = linspace(1,1e-5,1e3);
x = 1.5;
exact = -25*sin(5*x);

for i = 1:length(del_h)

    der_app(i) = (sin(5*(x-2*del_h(i))) - 2* sin(5*(x)) + sin(5*(x+2*del_h(i)))) / (4*del_h(i)^2);
    pop_app(i) = (sin(5*(x-1*del_h(i))) - 2* sin(5*(x)) + sin(5*(x+1*del_h(i)))) / (del_h(i)^2);
    der_err(i) = abs(der_app(i)-exact);
    pop_err(i) = abs(pop_app(i)-exact);
end

figure
loglog(del_h,der_err,'o')
hold on
loglog(del_h,pop_err,'*')
legend("Derived", "Popular",Location="northwest")
grid on
xlabel('$ln(h)$')
ylabel('$ln(error)$')

%{
Comments on plot.

The derived and popular finite differencing formulas both become second
order accurate. However, the popular formula has less error over all and is
more receptive of larger grid spacing.

%}
```



problem 2

```
syms h
A = [ 1 1 1 1; -h 0 h 2*h; h^2/2 0 h^2/2 2*h^2; -h^3/6 0 h^3/6 (2*h)^3/6];
B = [0;-1;0;0];

X = linsolve(A,B)
```

```
X =

1/(3*h)
1/(2*h)
   -1/h
1/(6*h)
```

problem 3

```
% part a
syms h a
A2 = [1 1 1 1; 0 h 2*h 3*h; 0 h^2/2 2*h^2 (3*h)^2/2;0 h^3/6 (2*h)^3/6 (3*h)^3/6];
B2 = [0;-1-a;-a*h;-a*h^2/2];

X2 = linsolve(A2,B2)


% part b

syms h
A3 = [0 1 1 1 1; 1 0 h 2*h 3*h; h 0 h^2/2 2*h^2 (3*h)^2/2; h^2/2 0 h^3/6 (2*h)^3/6 (3*h)^3/6; h^3/6 0 h^4/24 (2*h)^4/24 (3*h)^4/24];
B3 = [0;-1;0;0;0];

X3 = linsolve(A3,B3)
```

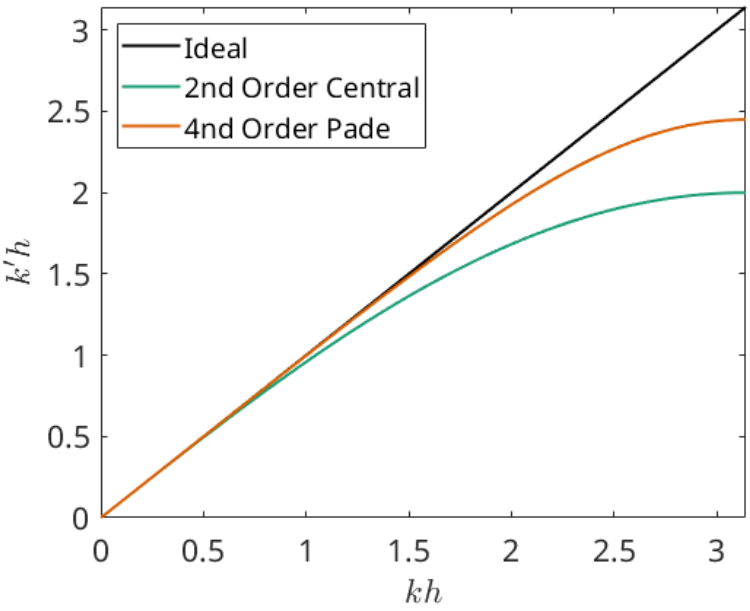
```
X2 =

(2*a + 11)/(6*h)
   (a - 6)/(2*h)
-(2*a - 3)/(2*h)
   (a - 2)/(6*h)


X3 =
```

```
       3
 17/(6*h)
 -3/(2*h)
 -3/(2*h)
  1/(6*h)
```

problem 4

```
kh = linspace(0,2*pi);
k_prime_square = 2-2*cos(kh);
k_prime_square_2 = 12*(2-2*cos(kh))./(10+2*cos(kh));

figure
plot(kh,kh,Color=colors(1),LineWidth=1.5)
hold on
plot(kh,k_prime_square.^.5,Color=colors(2),LineWidth=1.5)
plot(kh,k_prime_square_2.^.5,Color=colors(3),LineWidth=1.5)
xlim([0,pi])
legend("Ideal","2nd Order Central","4nd Order Pade",Location="northwest")
xlabel("$kh$")
ylabel("$k'h$")

% part b

syms h
A4 = [0 0 1 1 1; 0 0 -h 0 h; 1 1 h^2/2 0 h^2/2; -h h -h^3/6 0 h^3/6; h^2/2 h^2/2 h^4/24 0 h^4/24];
B4 = [0; 0; -1; 0; 0];

X4 = linsolve(A4,B4)
```

```
X4 =

      1/10
      1/10
-6/(5*h^2)
12/(5*h^2)
-6/(5*h^2)
```



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