ME 1020 Engineering Programming with MATLAB

Problem 9.19:

19. Compare the performance of the forward, backward, and central difference methods for estimating the derivative of $y(x) = e^{-x} \sin(3x)$. Use 101 points from $x = 0$ to $x = 4$. Use a random additive error of ± 0.01.

```matlab
% Problem 9.19
clear
clc
disp('Problem 9.19: Scott Thomas')
N = 101;
k = 1:N;
x = linspace(0,4,N);
y = exp(-x).*sin(3*x);
RandomNumber = (0.01 - (-0.01))*rand(1,N) + (-0.01);
yRandom = y + RandomNumber;

% Backward difference
dydx_b = zeros(1,N);
for k=2:N
    dydx_b(k) = (y(k) - y(k-1))/(x(k) - x(k-1));
end

% Forward difference
for k=1:N-1
    dydx_f(k) = (y(k+1) - y(k))/(x(k+1) - x(k));
end

% Central difference
for k=2:N-1
    dydx_c(k) = (y(k+1) - y(k-1))/(x(k+1) - x(k-1));
end
x2 = [0 4];
y2 = [0 0];
subplot(2,1,1)
plot(x,yRandom,'o-'), xlabel('x'), ylabel('y'),title('Problem 9.19: Scott Thomas')
subplot(2,1,2)
plot(x(2:N),dydx_b(2:N), x(1:N-1),dydx_f(1:N-1), x(2:N-1),dydx_c(2:N-1), x2,y2,'m'),
xlabel('x'), ylabel('dy/dx')
legend('Backward','Forward','Central','Location','NorthEast')
```

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