

Here are some sample questions, mostly from old tests. Most of the test will be quite similar to these, but other topics that we covered are still fair game.

1. Your friend has a data set represented by vectors \mathbf{x} and \mathbf{y} and is considering using a polynomial interpolation, a spline interpolation, or a least squares approximation.
 - (a) For polynomial interpolation, explain to them:
 - what it is,
 - how you get it in MATLAB, and
 - in what situations it is better than the other methods.
 - (b) Do the same for spline interpolation.
 - (c) Do the same for least squares approximation.
2. Estimate the integral $\int_{-3}^1 x^2 dx$ using L_4 , R_4 , T_4 and S_4 . Calculate the exact value and the errors of each of the approximations.
3. Approximate the integral $\int_0^\pi \sin x dx$ using M_4 and S_4 . Which do you expect to be more accurate?
4. Write a well-commented MATLAB **function** program to do the Trapezoid Rule for integration of a function given by data. Let the inputs be vectors \mathbf{x} and \mathbf{y} , representing a list of points $(x_i, y_i) = (x_i, f(x_i))$. Assume $x_i < x_{i+1}$ but do not assume the x values are evenly spaced.
5. Write a well-commented MATLAB **function** program to do the midpoint method for integration. Let the inputs be the function f , the endpoints a , b and the number of subintervals n .
6. Write a well-commented MATLAB **function** program to do Simpson's rule for integration. Let the inputs be the function f , the endpoints a , b and the number of subintervals n .
7. Write a well-commented MATLAB **function** program to do the four-corners method for integration of a function $f(x, y)$ on a rectangle $a \leq x \leq b$, $c \leq y \leq d$ using m subintervals in x and n subintervals in y . Let the inputs be $(\mathbf{f}, \mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}, \mathbf{m}, \mathbf{n})$.
8. Write a well-commented MATLAB **function** program to do the center-point method for integration of a function $f(x, y)$ on a rectangle $a \leq x \leq b$, $c \leq y \leq d$ using m subintervals in x and n subintervals in y . Let the inputs be $(\mathbf{f}, \mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}, \mathbf{m}, \mathbf{n})$. Include comments.
9. Suppose you know $f(1) = 2$, $f(3/2) = 3$, $f(2) = 5$, and $f(5/2) = 4$. Compute:
 - the forward difference approximation of $f'(1)$,
 - the backward difference approximation of $f'(3/2)$,
 - the centered difference approximation of $f'(2)$, and
 - the centered difference approximation of $f''(2)$.

10. Complete the program below. Include comments in your code.

```
function I = mycenterright(f,a,b,c,d,m,n)
% Computes an approximate integral of a function of two
% variables f(x,y) on a rectangle.
% Splits into small rectangles and on each one evaluates f at
% the center of the right edge.
%
% Inputs:
%   a,b -- define the interval in x, namely a<x<b.
%   c,d -- define the interval in y, namely c<y<d.
%   m -- the number of (evenly spaced) intervals to use in x.
%   n -- the number of (evenly spaced) intervals to use in y.
% Output: The approximate value of the integral.
```

11. Describe and give formulas for 2 methods to approximate double integrals based on triangles.
12. Compare and contrast *truncation* error and *loss-of-precision* (also known as loss-of significance) error. Illustrate each with an example.
13. For the function $f(x) = x^2$ you need to find $f'(5)$, but you can't remember whether $f'(x) = 2x$ or $f'(x) = x^3/3$. You remember that

$$f'(5) = \lim_{h \rightarrow 0} \frac{f(5+h) - f(5)}{h},$$

so you try:

```
> h=10^(-50)
> ((5+h)^2-5^2)/h
```

which gives the result: `ans = 0`. Is this the correct answer? Explain what happened and why.

14. Explain what would happen if you ran the following MATLAB commands:

```
> format long
> for i=1:30
>   x=10^i*pi
>   mypi=x-10^i
>   error=(pi-mypi)/pi
> end
```