Here are some sample questions from old tests. Some topics that we covered are not represented by these questions, but are still fair game.

1. List your 10 least favorite Matlab commands.

2. Suppose \( f(x) \) has been defined as an inline function. Give MATLAB commands to plot it on the interval \([0, 10] \).

3. Write a MATLAB function program that calculates the sum of the squares of the first \( n \) integers.

4. For \( f(x) = x^3 - 6 \), do 2 iterations of Newton’s method, starting with \( x_0 = 2 \).

5. For \( f(x) = x^2 - 5 \), do 2 iterations of Newton’s method, starting with \( x_0 = 2.0 \). What is the relative error of \( x_2 \)? About how many more steps would be needed to make the error less than \( 10^{-16} \)?

6. Write a Matlab program to do \( n \) steps of the bisection method for a function \( f \) with starting interval \([a, b] \). Let \( f, a, b \) and \( n \) be the inputs and the final \( x \) the output.

7. Write a MATLAB program to do \( n \) steps of Newton’s method for a function \( f \) with starting interval \([a, b] \). Let \( f, f', x_0 \) and \( n \) be the inputs and the final \( x \) the output.

8. Write a MATLAB script program that will use Newton’s method to find a root of the system of functions \( f_1(x, y) = x^3 - y^2 + 1 \) and \( f_2(x, y) = y^3 + x - 1 \) starting from the initial guess \((0, 0)\).

9. For \( f(x) = x^2 - 5 \), do 2 iterations of the bisection method, starting with \([a, b] = [2, 3]\). What is the relative error? About how many more steps would be needed to make the error less than \( 10^{-6} \)?

10. Write a function program which will find the roots of a function \( f \) on an interval \([a, b] \).

11. Let \( A = \begin{bmatrix} 1 & 0.5 \\ 2 & 1 \end{bmatrix} \). Find the LU factorization with pivoting.

12. Let \( A = \begin{bmatrix} -1 & 5 \\ 2 & 2 \end{bmatrix} \). Find the LU factorization with pivoting.

13. Find the LU decomposition of \( A \) using pivoting if needed:
\[
A = \begin{bmatrix} 3 & -2 \\ 6 & 1 \end{bmatrix}
\]

14. Given that the LU decomposition of \( A = \begin{bmatrix} 3 & 3 \\ 1 & 2 \end{bmatrix} \) is \( LU = \begin{bmatrix} 1 & 0 \\ 1/3 & 1 \end{bmatrix} \begin{bmatrix} 3 & 3 \\ 0 & 1 \end{bmatrix} \), solve \( Ax = b \) where \( b = (1, 2)' \).
15. Write a Matlab program to that solves a linear system $Ax = b$ using LU decomposition. Let $A$, $b$ and $tol$ be the inputs and $x$ the output. If the error (residual) is not less than $tol$, then display a warning.

16. Suppose $A^{-1} = \begin{bmatrix} -1 & 2 \\ 1 & -1 \end{bmatrix}$. Using $v_0 = (1,1)'$ as the starting vector do 2 iterations of the Inverse Power Method for $A$. What do the results mean?

17. Suppose $A = \begin{bmatrix} -1 & 2 \\ 1 & -1 \end{bmatrix}$. Using $v_0 = (1,1)'$ as the starting vector do 2 iterations of the Power Method for $A$. What do the results mean?

18. Write a Matlab program to do $n$ iterations of the Power Method. Let the matrix $A$ and $n$ be inputs and let $[e,v]$ (the eigenvalue and eigenvector) be the outputs.

19. What is the condition number of a matrix? How do you find it with Matlab? What are the implications of the condition number when solving a linear system? What is the engineering solution to a problem with a bad condition number?

20. Give the MATLAB commands, or sequences of commands for solving a linear system $Ax = b$ in as many ways as you know. Which of these are the worst and best?

21. What is the command in MATLAB to produce the eigenvalues and eigenvectors of a matrix. Which method does it use? What will be the form of the output?

22. Find the eigenvalues and eigenvectors of the matrix:

   $$A = \begin{bmatrix} 3 & 2 \\ 2 & 3 \end{bmatrix}$$

23. Write a MATLAB function program that takes an input $n$, produces a random $n \times n$ matrix $A$ and random vector $\tilde{b}$, solves $Ax = \tilde{b}$ (using the built in command) and outputs the residual (number).