```
    v(i) = 3;
  end
end
```

Section 20.2 of *An Introduction to* MATLAB explains the `if` statement in more detail.

Plotting graphs

The simplest plot command has the form `plot(x,y)`, where x and y are vectors of the same length, n say. It plots a graph of the points (x_1, y_1), (x_2, y_2), $\ldots$, (x_n, y_n). For example, type in the following lines to get a plot of $\sin t$ against t.

```
t = [0:0.01:2*pi];
v = sin(t);
plot(t,v)
```

Section 10 of *An Introduction to* MATLAB describes how to make multi-plots, 3D plots and how to change the axes scaling and line styles. Axis labels and a title can be added using the `xlabel`, `ylabel` and `title` commands; e.g. try out the command `ylabel('sin t')`

Text strings

The argument of the above `ylabel` command is an example of a text string — i.e. a collection of characters surrounded by single quotes. Another example is
`st = 'my name is Frankenstein'`
Note that both quotes are the same. Commands like `disp`, `input` and `error` use text strings. Another useful command is `num2str`, which converts a number into a string. As an example of how to use it and a slightly more complicated string expression, type
`title(['plot of sin t up to ', num2str(2*pi)])`
to label your graph.
Note that in the above example using `title`, the string has more than one element. If more than one string element is used (typically when mixing words and numbers), then the string elements to be joined together must be enclosed in square brackets and separated by commas.

1.4 M-files

MATLAB can be used in two main ways. You can either type instructions directly at the prompt or make up a file or files containing the instructions you want MATLAB to execute and feed this file (called an M-file) to MATLAB. An M-file is a computer program written in MATLAB's own language. Typing commands at the prompt is fine if you want to execute single commands, but errors usually creep into the typing of longer expressions and sequences of operations and it is a pain having to retype things used over and over again. In general, you should use M-files, and the mechanism for creating them is described in Section 1.3 above.
There are two different kinds of M-files, script files and function files, which act in slightly different ways. Script M-files act as a shorthand for a sequence of MATLAB commands and are a bit easier to use than function M-files. We discuss both types of M-files below, and Sections 13 and 21 of *An Introduction to* MATLAB also describe them in detail.

7. (a) Use the editor to create a function M-file called **anysump.m** which takes as **input** the positive integer N, and as **output** the result p of the summation

$$p = \sum_{j=1}^{N} j^{-2}.$$

(b) Compute from the Matlab command window, the value of the sum for $N = 5, 10, 15, 20$.

8. (a) Follow the examples in Section 10 of *An Introduction to* MATLAB to plot $f(x) = x^2 + x - 1$ with a “dashed” line style. Use $x = -5 : 0.05 : 5$ for the x coordinates.

(b) Add labels to the x and y axes and add your name as the title of the graph.

(c) Annotate the graph to show which curve is being depicted. (`legend`, see the Lecture notes)

9. (a) Follow the examples in Section 10 of *An Introduction to* MATLAB to plot $f(x) = x + x^2 - x^3/10 - 10$ with a “dashed” line style and $g(x) = \cos(x)$ with a solid line in the same graph. Use $x = 0 : 0.05 : 10$ for the x coordinates.

(b) Add labels to the x and y axes and add your name as the title of the graph.

(c) Annotate the graph to show which curve is which and place the text “f=g here” near where the curves cross. (`legend, text`, see the Lecture notes)

10. Write a function M-file that takes as **input** the positive integer n and number r, and **outputs** the sum

$$\sum_{k=1}^{n} k^r.$$

Use it to check the identity

$$\sum_{k=1}^{n} k^2 = \frac{n(n+1)(2n+1)}{6}$$

for various values of n.

11. Plot an (x, y) graph for $x \in [-5, 5]$ when $y = \sin(x) + 1 - x$. Use the information from the graph to help the built-in function `fzero` find the root of the equation $\sin(x) + 1 - x = 0$.

2.2 Problem set 2

1. Produce 4 separate graphs against x for $x \in [-\pi, \pi]$ (labelled appropriately), of the functions (a)-(d) below all in the same Figure window (`subplot`).

   (a) $x^3/20 + x^2/10$,

   (b) $\cos x$,

   (c) $\sin^2 x$,

   (d) e^{-x^2}.

2. (a) Write a function M-file using `for` loops to define the $N \times N$ tridiagonal matrix A and vector b given by

$$A = \begin{pmatrix} \beta & \gamma & 0 & \dots & 0 \\ \alpha & \beta & \gamma & & \vdots \\ 0 & \ddots & \ddots & \ddots & 0 \\ \vdots & & \alpha & \beta & \gamma \\ 0 & \dots & 0 & \alpha & \beta \end{pmatrix}, \quad b = \begin{pmatrix} \sin(1) \\ \sin(2) \\ \cdots \\ \sin(N-1) \\ \sin(N) \end{pmatrix},$$

   which will work for any integer $N \geq 3$. Make sure that b is a column vector. The matrix A is called **tridiagonal** because all its entries are zero apart from those on or immediately next to the diagonal.

   (b) For $\alpha = 1$, $\beta = 4$, $\gamma = -1$, find the solution x of $Ax = b$ in the case $N = 4$, and find the 42nd element of the solution x in the case $N = 199$. (Use the backslash \ command.)

   (c) Use the command `eig` to find the eigenvalues and eigenvectors of the matrix A with $N = 5$, $\alpha = \gamma = 1$, $\beta = 2$.

3. So far we have seen two ways of solving $Ax = b$ for x where A is an $N \times N$ matrix and b an N vector.

Method	MATLAB commands
Gaussian elimination	`x = A\b;`
Full inversion	`Ai = inv(A); x = Ai*b;`

   We would like to test which method takes the least cpu time.

   (a) Write an function M-file where the **input** is the size N and the **output** is the time (`cputime`) in seconds it takes by each of the two methods to compute the solution of $Ax = b$ for randomly chosen A and b (`rand`).

   (b) Then write a second M-file for depicting the two resulting times for $N = 100, 150, 200, \dots, 800$. Label the graph appropriately.

4. Newton's method for finding a solution of the equation $f(x) = 0$ is the following iteration.
   Step 1 Make a guess at the solution (call it x_1),
   Step 2 calculate the sequence of values $x_2, x_3, \dots$ from

$$x_{k+1} = x_k - \frac{f(x_k)}{f'(x_k)} \quad \text{for } k = 1, 2, 3 \dots ,$$