

# Department of Mathematics and Statistics

## MATH1010, CALCULUS & LINEAR ALGEBRA I

### Matlab Assignment Question Sheet

Your submission must be a single PDF file.

Create a word document or similar. Copy/paste the relevant code and output from the Matlab command window to the document. Please ensure each question is labelled, i.e. Question 1, Question 2, etc.

Once you have finished the assignment, save your document as a PDF file. Append all figures to this file and upload to iLearn. Google ‘merge pdf’ to find online sources that merge multiple PDF files.

1. [5 marks] Consider the system of linear equations

$$\begin{aligned}x_1 + x_2 - 3x_3 - 2x_4 + 2x_5 &= 1, \\-x_1 + 2x_3 + x_4 &= 1, \\x_1 + 2x_2 - x_3 - x_4 + 2x_5 &= 4, \\-2x_1 - 2x_2 + 15x_3 + 9x_4 - 9x_5 &= -1, \\x_1 - x_2 + 2x_3 - 2x_4 - 3x_5 &= -1\end{aligned}$$

for the unknown vector  $\mathbf{x} = (x_1, x_2, x_3, x_4, x_5)^T$ .

- (a) In Matlab, define the matrix  $A$  and vector  $\mathbf{b}$ , such that  $A\mathbf{x} = \mathbf{b}$ . *Copy/paste the Matlab code and output for  $A$  and  $\mathbf{b}$  to your document.*
- (b) Using the command `rref` determine the solution to the homogeneous system  $A\mathbf{x} = \mathbf{0}$ . *Copy/paste the Matlab code and output to your document and state the solution to the homogeneous system.*
- (c) Using the command `A\b` determine the solution to the inhomogeneous system  $A\mathbf{x} = \mathbf{b}$ . *Copy/paste the Matlab code and output to your document.*

2. [6 marks] Consider the line given by the vector equation

$$\mathbf{r} = \begin{pmatrix} 1 \\ 3 \\ -1 \end{pmatrix} + t \begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix} \quad \text{for } t \in \mathbb{R},$$

and the plane given by the Cartesian equation

$$3x - y + 5z = 7.$$

- (a) By hand (i.e., the method presented in lectures), determine the value of  $t$  and the corresponding point  $(a, b, c)$  at which the line intersects the plane. *Add the values for  $t$  and  $(a, b, c)$  to your document.*
- (b) In Matlab define `[x,y]=meshgrid(0:4)` and using `mesh(x,y,z, 'linestyle', 'none', 'facecolor', 'red')` plot the plane. Type `hold on`.
- (c) In Matlab define `t = linspace(-2,2)`. Using the `plot3()` command, plot the line in the same figure as the plane. *Add the parametric equations of the line to your document.*
- (d) In the same figure, plot the point of intersection  $(a, b, c)$  of the line and plane; use the command `plot3(a,b,c, 'ko', 'markersize', 20, 'MarkerFaceColor', 'k')`.
- (e) Add an appropriate title, and  $x$ ,  $y$ ,  $z$ -labels to your figure and save as a PDF. *Attach the figure to the main document, using the online merge packages.*

3. [4 marks] Consider the functions

$$f(x) = \sqrt{9 - x} \quad \text{and} \quad g(x) = x^2.$$

- (a) Determine the domain of the composite function  $(f \circ g)(x)$ . In Matlab, define the domain of  $f \circ g$  using the `linspace` command, and define the composite function  $f \circ g$ . *Copy/paste the code to your document.*
- (b) Plot the composite function using the `plot()` command.
- (c) Add an appropriate title, and  $x$ ,  $y$ -labels to your figure and save as a PDF. *Attach the figure to the main document, using the online merge packages.*

4. [6 marks] Consider the function

$$A(t) = 3t^5 - 5a^2t^3,$$

where  $a \in \mathbb{R}$ .

- (a) Define  $t$  and  $a$  as symbolic variables. (Use the `syms` command.) *Copy/paste the relevant code to your document.*
- (b) Create the symbolic function  $A$ . (Use the `syms` command.) *Copy/paste the Matlab code and output to your document.*
- (c) Find  $A'(t)$ . (Use the `diff` command. See section 1.9.1 of the MATLAB Manual). *Copy/paste the Matlab code and output to your document.*
- (d) Solve  $A'(t) = 0$ . (Use the `solve` command. See section 1.9.3 of the MATLAB Manual.) *Copy/paste the Matlab code and output to your document.*
- (e) Find  $A(-2a)$  and  $A(2a)$ . (Use `subs(A,t)`) *Copy/paste the Matlab code and output to your document.*

5. [4 marks] Use MATLAB to determine the following integrals.

- (a) Determine

$$\int \tanh x \, dx.$$

(Use the `syms` and `int` commands. See section 1.9.1 of the MATLAB Manual). *Copy/paste the Matlab code and output to your document.*

- (b) Determine

$$\int x^4 \exp(-6x) \, dx.$$

Use the `pretty` command to make your answer more readable. (Use `help pretty` for more information.) *Copy/paste the Matlab code and output to your document.*