Introduction to MATLAB
– exercises

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**Exercise 1:** Find a short MATLAB expression to build the matrix

\[ B = \begin{pmatrix}
1 & 2 & 3 & 4 & 5 & 6 & 7 \\
9 & 7 & 5 & 3 & 1 & -1 & -3 \\
4 & 8 & 16 & 32 & 64 & 128 & 256
\end{pmatrix} \]

**Exercise 2:** Give a MATLAB expression that uses only a single matrix multiplication with \( B \) to obtain

(a) the sum of columns 5 and 7 of \( B \)
(b) the last row of \( B \)
(c) a version of \( B \) with rows 2 and 3 swapped

**Exercise 3:** Give a MATLAB expression that multiplies two vectors to obtain

(a) the matrix

\[ \begin{pmatrix}
1 & 2 & 3 & 4 & 5 \\
1 & 2 & 3 & 4 & 5 \\
1 & 2 & 3 & 4 & 5
\end{pmatrix} \]

(b) the matrix

\[ \begin{pmatrix}
0 & 0 & 0 \\
1 & 1 & 1 \\
2 & 2 & 2 \\
3 & 3 & 3 \\
4 & 4 & 4
\end{pmatrix} \]

**Exercise 4:** Modify slide 30 to produce tones of falling frequency instead.

**Exercise 5:**

(a) Write down the function \( g(t) \) that has the shape of a sine wave that increases linearly in frequency from 0 Hz at \( t = 0 \) s to 5 Hz at \( t = 10 \) s.

(b) Plot the graph of this function using MATLAB’s `plot` command.

(c) Add to the same figure (this can be achieved using the `hold` command) in a different colour a graph of the same function sampled at 5 Hz, using the `stem` command.

(d) [Extra credit] Plot the graph from (c) separately. Can you explain its symmetry? [Hints: sampling theorem, aliasing].

**Exercise 6:** Use MATLAB to write an audio waveform (8 kHz sampling frequency) that contains a sequence of nine tones with frequencies 659, 622, 659, 622, 659, 494, 587, 523, and 440 Hz. Append to this waveform a copy of itself in which every other sample has been multiplied by \(-1\). Play the waveform, write it to a WAV file, and use the `spectrogram` command to plot its spectrogram with correctly labelled time and frequency axis.