MATLAB

Basic Commands. All functions in MATLAB must be entered in lower case only.

To create the vector \( u = (1 \ 3 \ 5 \ -1) \), we enter

\[
\gg u = [1 \ 3 \ 5 \ -1] <\ Return\ key >
\]

The polynomial \( P(x) = x^3 + 3x^2 + 5x - 1 \) is defined the same way as a vector.

\[
\gg P = [1 \ 3 \ 5 \ -1] <\ Return\ key >
\]

using the left and right brackets.

\[
\gg [2 \ 3 \ 5 \ 4 \ 6 \ -4] <\ Return\ key >
\]

produces the matrix

\[
\begin{bmatrix}
2 & 3 & 5 \\
4 & 6 & -4
\end{bmatrix}
\]

The \( n \times n \) identity matrix \( I_n \) is denoted by \( \text{eye}(n) \). The \( m \times n \) zero matrix is \( \text{zeros}(m, n) \) and \( \text{ones}(m, n) \) is the \( m \times n \) matrix whose entries are equal to one. The transpose of a matrix \( A \) is denoted by \( A' \).

To Create the full-cycle permutation matrix

\[
P_4 = \begin{bmatrix}
0 & 0 & 0 & 1 \\
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0
\end{bmatrix} = \begin{bmatrix}
(0 & 0 & 0) \\
(1 & 0 & 0) \\
(0 & 1 & 0) \\
(0 & 0 & 1)
\end{bmatrix}
\]

we enter

\[
\gg P_4 = [\ \text{zeros}(1,3) \ 1 \ ; \ \text{eye}(3) \ \text{zeros}(3,1) \ ] <\ Return\ key >
\]

or

\[
\gg I3 = \text{eye}(3) \ ; Z3 = \text{zeros}(1,3) \ ; P = [Z3 \ 1 \ ; I3 \ Z3'] <\ Return\ key >
\]

Let \( u = [3 \ 4 \ 1 \ 5] \), then the matrix

\[
B = \begin{bmatrix}
u \\
uP_4 \\
uP_4^2 \\
uP_4^3
\end{bmatrix} = \begin{bmatrix}
3 & 4 & 1 & 5 \\
4 & 1 & 5 & 3 \\
1 & 5 & 3 & 4 \\
5 & 3 & 4 & 1
\end{bmatrix}
\]

may be obtained by entering

\[
\gg \text{for } i = 1:4, \ B(i,1:4) = u * P_4^{(i-1)} ; \text{end} <\ Return\ key >
\]

\[
\gg B <\ Return\ key >
\]

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

\[
\gg C = B(1:3,2:4) <\ Return\ key >
\]

produces the matrix

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

The function \( \text{rem}(a,b) \) finds the remainder of \( a/b \). Thus in order to change a numerical vector (or matrix) into a boolean vector (or matrix), one should use the function \( \text{rem} \). For example if

\[
u = [2 \ 3 \ 5 \ -1] , \ \text{then } v = \text{rem}(u,2) = [0 \ 1 \ 1 \ 1]
\]
and if the matrix
\[ M = \begin{pmatrix} 2 & 3 & 5 \\ 4 & 6 & -4 \end{pmatrix}, \] then \( S = \text{rem} (M, 2) = \begin{pmatrix} 0 & 1 & 1 \\ 0 & 0 & 0 \end{pmatrix} \)

\section*{Row Operations on a Matrix.}
\[
\Rightarrow G = \begin{bmatrix} 0 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 \end{bmatrix}, \quad T = G ; < \text{Return key} >
\]

Interchanging the first and the third rows:
\[
\Rightarrow G(1,:) = T(3,:), \quad G(3,:) = T(1,:); < \text{Return key} >
\]

Changing the \( (1,2) \) and \( (3,2) \) entries of \( G \) to zeros:
\[
\Rightarrow G(1,:) = \text{rem}(G(1,:), G(2,:)), \quad G(3,:) = \text{rem}(G(3,:), G(2,:)) < \text{Return key} >
\]

Changing the last row of \( G \) into a zero row:
\[
\Rightarrow G(4,:) = \text{rem}(G(4,:), G(3,:)) < \text{Return key} >
\]

Removing the last row of \( G \):
\[
\Rightarrow G = G(1:3,:) < \text{Return key} >
\]

Defining the \( 5 \times 2 \) matrix \( H \) by using the last two columns of \( G \) and adding the \( 2 \times 2 \) identity matrix:
\[
\Rightarrow X = G(:,4:5); \quad H = [X ; \text{eye}(2)] < \text{Return key} >
\]

Note that \( GH \) is the \( 5 \times 2 \) zero matrix.

\( G \) is a generator of a linear code \( C \) of order \( 2^3 = 8 \) and information rate of \( 3/5 \). The rows of \( G \) form a basis of \( C \) and the columns of \( H \) form a basis of \( C^\perp \).

\textit{California State University, East Bay}