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
$\gg\ u = [\ 1\ 3\ 5\ \ -1\ ]\ <\ \textit{Return key}\ >$
The polynomial $P(x) = x^3 + 3x^2 + 5x - 1$ is defined the same way as a vector.
$\gg\ P = [\ 1\ 3\ 5\ \ -1\ ]\ <\ \textit{Return key}\ >$
using the left and right brackets.
$\gg\ [2\ 3\ 5\ ; 4\ 6\ \ -4\ ]\ <\ \textit{Return key}\ >$
produces the matrix

$$\begin{matrix} 2 & 3 & 5 \\ 4 & 6 & -4 \end{matrix}$$

The $n \times n$ identity matrix I_n is denoted by $eye(n)$. The $m \times n$ zero matrix is $zeros(m, n)$ and $ones(m, n)$ 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

$$P4 = \begin{bmatrix} 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} = \begin{bmatrix} \begin{pmatrix} 0 & 0 & 0 \end{pmatrix} & (1) \\ \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} & \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \end{bmatrix}$$

we enter
$\gg\ P4 = [\ zeros(1, 3)\ 1\ ;\ eye(3)\ zeros(3, 1)\ ]\ <\ \textit{Return key}\ >$
or
$\gg\ I3 = eye(3)\ ; Z3 = zeros(1, 3)\ ;\ P = [\ Z3\ 1\ ;\ I3\ Z3'\ ]\ <\ \textit{Return key}\ >$
Let $u = [\ 3\ 4\ 1\ 5\ ]$, then the matrix

$$B = \begin{bmatrix} u \\ uP4 \\ uP4^2 \\ uP4^3 \end{bmatrix} = \begin{bmatrix} 3 & 4 & 1 & 5 \\ 4 & 1 & 5 & 3 \\ 1 & 5 & 3 & 4 \\ 5 & 3 & 4 & 1 \end{bmatrix}$$

may be obtained by entering
$\gg\ for\ i = 1:4,\ B(i, 1:4)\ =\ u * P4^{\wedge(i-1)}\ ;\ end\ <\ \textit{Return key}\ >$
$\gg\ B\ <\ \textit{Return key}\ >$

$$\begin{matrix} 3 & 4 & 1 & 5 \\ 4 & 1 & 5 & 3 \\ 1 & 5 & 3 & 4 \\ 5 & 3 & 4 & 1 \end{matrix}$$

$\gg\ C = B(1:3, 2:4) <\ \textit{Return key}\ >$
produces the matrix

$$\begin{matrix} 4 & 1 & 5 \\ 1 & 5 & 3 \\ 5 & 3 & 4 \end{matrix}$$

The function $rem(a, b)$ 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 rem. For example if

$$u = [\ 2\ 3\ 5\ \ -1\ ]\ ,\quad \text{then}\quad v =\ rem\,(u, 2) = [\ 0\ 1\ 1\ 1]$$

and if the matrix

$$M = \begin{pmatrix} 2 & 3 & 5 \\ 4 & 6 & -4 \end{pmatrix} \quad , \quad \text{then} \quad S = \ rem\ (M, 2) = \begin{pmatrix} 0 & 1 & 1 \\ 0 & 0 & 0 \end{pmatrix}$$

♣ **Row Operations on a Matrix.**

$\gg$ $G = [0\ 1\ 1\ 0\ 0\ ; 0\ 1\ 0\ 1\ 0\ ; 1\ 1\ 1\ 0\ 0\ ; 0\ 0\ 1\ 1\ 0\ ]\ ,\ T = G\ ;\ <\ Return\ key\ >$

$$\begin{matrix} 0 & 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 \end{matrix}$$

Interchanging the first and the third rows:

$\gg$ $G(1,:) = T(3,:)\ ,\ G(3,:) = T(1,:)\ ;\ <\ Return\ key\ >$

$$\begin{matrix} 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 \end{matrix}$$

Changing the $(1,2)$ and $(3,2)$ entries of G to zeros:

$\gg$ $G(1,:) = rem(G(1,:) + G(2,:), 2)\ ;\ G(3,:) = rem(G(3,:) + G(2,:), 2)\ <\ Return\ key\ >$

$$\begin{matrix} 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 \end{matrix}$$

Changing the last row of G into a zero row:

$\gg$ $G(4,:) = rem(G(4,:) + G(3,:), 2)\ <\ Return\ key\ >$

$$\begin{matrix} 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{matrix}$$

Removing the last row of G:

$\gg$ $G = G(1:3,:)\ <\ Return\ key\ >$

$$\begin{matrix} 1 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 1 & 0 \end{matrix}$$

Defining the 5×2 matrix H by using the last two columns of G and adding the 2×2 identity matrix:

$\gg$ $X = G(:, 4:5)\ ;\ H = [X\ ; eye(2)\ ] <\ Return\ key\ >$

$$\begin{matrix} 1 & 0 \\ 1 & 0 \\ 1 & 0 \\ 1 & 0 \\ 0 & 1 \end{matrix}$$

Note that GH is the 5×2 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 $C^{\perp}$.