1. (a) Matlab code:

```matlab
%------------------------------------------------------
% P1a
% % generate the signal \delta[n] and plot it
% %
% n = -10:10; % values of the time variable
% delta_n = [zeros(1,10) 1 zeros(1,10)];
% stem(n,delta_n);
% axis([-10 10 0 1.5]);
% title('Unit Sample Function');
% xlabel('Time index n');
% ylabel('\delta[n]');
```

![Plot of Unit Sample Function](image.png)
% P1b
% generate the signal \delta[n-2] and plot it

n = -10:10; % values of the time variable
delta_nm2 = [zeros(1,12) 1 zeros(1,8)];
stem(n,delta_nm2);
axis([-10 10 0 1.5]);
title('Shifted Unit Sample Function');
xlabel('Time index n');
ylabel('\delta[n-2]');
% P1c
% generate the signal u[n] and plot it
n = -10:10; % values of the time variable
un = [zeros(1,10) ones(1,11)];
stem(n,un);
axis([-10 10 0 1.5]);
title('Unit Step Function');
xlabel('Time index n');
ylabel('u[n]');
% generate the signal $u[-n-3]$ and plot it

\begin{verbatim}
\%. P1d
\%
\%
\% n = -10:10;   \% values of the time variable
\% u_mnm3 = [ones(1,8) zeros(1,13)];
\% stem(n,u_mnm3);
\% axis([-10 10 0 1.5]);
\% title('Flipped and Shifted Unit Step Function');
\% xlabel('Time index n');
\% ylabel('u[-n-3]');
\end{verbatim}
2.

(a)

```
% P2a

% generate and plot a discrete-time cosine signal
%

n = 0:40; % values of the time variable
w = 0.1*2*pi; % frequency of the sinusoid.
phi = 0; % phase offset.
A = 1.5; % amplitude.

xn = A * cos(w*n - phi);
stem(n,xn);
axis([0 40 -2 2]);
grid;
title('Discrete-time Sinusoid');
xlabel('Time index n');
ylabel('x[n]');
```

(b) The signal has values from $n = 0$ to $n = 40$, so the length is 41.
(c) We have:
\[ \frac{\omega}{2\pi} = \frac{0.2\pi}{2\pi} = \frac{1}{10} = \frac{m}{N} \]
So the fundamental period is \( N = 10 \) and each period of the discrete-time signal looks like \( m = 1 \) period of the continuous-time function.

(d) The \texttt{grid} command draws grid lines on the graph.

(e)

\begin{verbatim}
%----------------------------------------------------------
% P2b
% generate and plot another discrete-time cosine signal
% n = 0:49;                        % values of the time variable
w = 0.4*2*pi;                    % frequency of the sinusoid.
phi = pi/2;                      % phase offset.
A = 2.5;                         % amplitude.
xn = A * cos(w*n - phi);
stem(n,xn);
axis([0 50 -3 3]);
grid;
title('Another Discrete-time Sinusoid');
xlabel('Time index n');
ylabel('x[n]');
\end{verbatim}

Another Discrete−time Sinusoid
3.

(a)

%----------------------------------------------------------
% P3a
% plot a bunch of discrete-time sine signals
%

% The frequency will be w = k*pi/8.
% Load up the k's into a vector:
% kvals = [-29 -3 -1 1 3 5 7 9 13 15 33 21];

% make a counter to index the "next" k to use:
next_k = 1;

n = 0:63; % the time variable

% There are 12 k values. We will plot four per
% figure. So we will need three figures all
% together. Loop on figures.
for Fig_num=1:3
    figure(Fig_num); % selects the "current" figure

    % each time through this loop, we are going to do
    % 4 of the k's. Loop on Sub Figure number:
    for SubFig_num = 1:4
        k = kvals(next_k);
        next_k = next_k + 1;
        w = k * pi/8; % the frequency
        xn = sin(w*n);
        subplot(4,1,SubFig_num);
        stem(n,xn);
        title(sprintf('%d\pi/8',k));
    end    % for SubFig_num
end    % for Fig_num
(b) For $\omega_0 = -\frac{3\pi}{8}, -\frac{\pi}{8}, \frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \text{ and } \frac{7\pi}{8}$, we have that $-\pi \leq \omega_0 \leq \pi$. So these discrete sinusoids are not aliased.

The rest of the frequencies $\omega_0$ are outside the range $[-\pi, \pi]$, so these signals will be aliased. Remember, when $\omega_0$ is outside the range $[-\pi, \pi]$, then the graph of $\sin(\omega_0 n)$ is the same as the graph of $\sin(\omega_1 n)$ for another frequency $\omega_1$ that is inside the range $[-\pi, \pi]$ and differs from $\omega_0$ by an integer multiple of $2\pi$.

- Since $\sin(\omega_0 n) = -\sin(-\omega_0 n)$, the graph of $\sin(-\frac{3\pi}{8} n)$ is the negative of the graph of $\sin\left(\frac{3\pi}{8} n\right)$.
- Likewise, the graph of $\sin(-\frac{\pi}{8} n)$ is the the negative of the graph of $\sin\left(\frac{\pi}{8} n\right)$.
- For the rest of the frequencies, $|\omega_0| > \pi$, so each of these signals is just a different name for a discrete sinusoid whose frequency is in the range $[-\pi, \pi]$.
- $\frac{13\pi}{8} - 2\pi = -\frac{3\pi}{8}$, so the graph of $\sin\left(\frac{13\pi}{8} n\right)$ is the same as the graph of $\sin\left(-\frac{3\pi}{8} n\right)$.
- Likewise, $\frac{15\pi}{8} - 2\pi = -\frac{\pi}{8}$, so the graph of $\sin\left(\frac{15\pi}{8} n\right)$ is the same as the graph of $\sin\left(-\frac{\pi}{8} n\right)$.
- $\frac{33\pi}{8} - 2\pi = \frac{17\pi}{8}$ and $\frac{17\pi}{8} - 2\pi = \frac{\pi}{8}$. Thus $\sin\left(\frac{33\pi}{8} n\right)$ and $\sin\left(\frac{\pi}{8} n\right)$ are the same signal. Their graphs are the same.
- $-\frac{29\pi}{8} + 4\pi = \frac{3\pi}{8}$, so $\sin\left(-\frac{29\pi}{8} n\right)$ and $\sin\left(\frac{3\pi}{8} n\right)$ are the same signal; they have the same graph.
\[ \frac{21\pi}{8} - 2\pi = \frac{5\pi}{8}, \text{ so } \sin\left(\frac{21\pi}{8}n\right) \text{ and } \sin\left(\frac{5\pi}{8}n\right) \text{ have the same graph.} \]

(c) \[ \frac{9\pi}{8} - 2\pi = -\frac{7\pi}{8}, \text{ so } \sin\left(\frac{9\pi}{8}n\right) = -\sin\left(\frac{7\pi}{8}n\right). \] The graphs of \( \sin\left(\frac{9\pi}{8}n\right) \) and \( \sin\left(\frac{7\pi}{8}n\right) \) are therefore negatives of one another.

4.

(a)

\begin{verbatim}
%-------------------------------------------------------------------------------
% P4a
% %
% % generate and plot a discrete-time cosine signal
% %
% n = 0:120; % values of the time variable
% w = 0.09; % frequency of the sinusoid.
% xn = cos(w*n);
% stem(n,xn);
% axis([0 120 -1.0 1.0]);
% grid;
% title('Discrete-time Sinusoid');
% xlabel('Time index n');
% ylabel('x[n]');
\end{verbatim}
(b) We have:
\[
\frac{\omega}{2\pi} = \frac{0.09}{2\pi} \notin \mathbb{Q}.
\]
The signal is therefore \textbf{not periodic}.

5.

(a)

```matlab
%--------------------------------------------------------------------------
% P5a
%
% generate and plot a continuous-time complex sinusoid
% t = -4:0.01:4; % values of the time variable
w = 2.2; % frequency of the sinusoid.
xt = exp(j*w*t);
xtR = real(xt);
xtI = imag(xt);
figure(1); % make Fig 1 active
plot(t,xtR,'-b'); % '-b' means 'solid blue line'
axis([-4 4 -1.0 2.0]);
grid;
hold on; % add more curves to the same graph
plot(t,xtI,'-r'); % 'r' = red
title('Real and Imaginary parts');
xlabel('Time t');
ylabel('x(t)');
legend('Re[x(t)]','Im[x(t)]');
hold off;

mag = abs(xt);
phase = angle(xt);
figure(2); % make Fig 2 active
plot(t,mag,'-g'); % '-' = solid line; 'g' = green
grid;
hold on; % add more curves to the graph
plot(t,phase,'-r'); % 'r' = red
title('Magnitude and Phase');
legend('|x(t)|','arg[x(t)]');
xlabel('Time t');
ylabel('x(t)');
hold off;
```
% P5b
%
% generate and plot a continuous-time damped complex exponential
%
\t \texttt{t} = 0:0.01:4; \quad \% values of the time variable
\texttt{w} = 8.0; \quad \% frequency of the sinusoid.
xt = 3.0*exp(-t/2).*exp(j*w*t);
xtR = real(xt);
xtI = imag(xt);
figure(1); \quad \% make Fig 1 active
plot(t,xtR,'-b'); \quad \% '-b' means 'solid blue line'
axis([0 4 -3 3]);
grid;
hold on; \quad \% add more curves to the same graph
plot(t,xtI,'-r'); \quad \% 'r' = red
title('Real and Imaginary parts');
xlabel('Time t');
ylabel('x(t)');
legend('Re[x(t)]','Im[x(t)]');
hold off;

mag = abs(xt);
phase = angle(xt);
figure(2); \quad \% make Fig 2 active
plot(t,mag,'-g'); \quad \% '-g' = solid line; 'g' = green
grid;
hold on; \quad \% add more curves to the graph
plot(t,phase,'-r'); \quad \% 'r' = red
title('Magnitude and Phase');
legend('|x(t)|','arg[x(t)]');
xlabel('Time t');
ylabel('x(t)');
hold off;