1. Given the sequence \( x(n) \) shown here:

![Sequence Diagram]

which can be written as:

\[
x(n) = \{ 2, 1, -1, 1, 1, -2 \}
\]

where the underscore denotes the origin \( n = 0 \), sketch stem plots for the following sequences:

(a) \( y(n) = x(n-2) \)
(b) \( y(n) = x(-n-2) \)
(c) \( y(n) = x(4-n) \)
(d) \( y(n) = x(n) u(2-n) \)
(e) \( y(n) = x(n) u(1-n) u(n+1) \)
(f) \( y(n) = x(n) \left\{ u(n) - u(n-3) \right\} \)
(g) \( y(n) = x(n+2) \delta(n-1) \)
(h) \( xe(n) = \frac{x(n)+x(-n)}{2} \) "even component"
(i) \( xo(n) = \frac{x(n)-x(-n)}{2} \) "odd component"

(j) Given \( xe(n) \) and \( xo(n) \), explain how to recover \( x(n) \).

* Write your work on one side of engineering paper — as shown here!

Some of the shorter Exam Practice Problems (see p.6) may be solved directly on print outs of the posted questions, if preferred.
2. \( x(t) = \cos(2\pi F t) \rightarrow \frac{\text{C/D}}{T} \rightarrow x(n) \)

Let \( F_s = \frac{1}{T} = 16 \text{ kHz} \).

Find the digital frequency (\( \omega \)) and normalised frequency (\( f \)) of \( x(n) \) when:

(a) \( F = 7 \text{ kHz} \)
(b) \( F = 9 \text{ kHz} \)
(c) \( F = 23 \text{ kHz} \)
(d) \( F = 25 \text{ kHz} \)

Ref. Loss 3, p. 4
3. An analog signal \( x(t) \) has the Fourier spectrum shown here:

\[
\begin{array}{c}
X(F) \\
\hline
-12 \quad 12 \quad F \text{ (kHz)}
\end{array}
\]

(a) What range of sampling frequencies \( (F_s) \) allows exact reconstruction of \( x(t) \) from its samples?

(b) Suppose we sample \( x(t) \) at a rate of \( F_s = 20,000 \) samples/sec. Then we reconstruct an analog signal using the same samples/sec rate. (See eqn. 3, p. 2). Examine the particular frequency 5 kHz and see how it reconstructs at the output.

(c) Repeat (b) for the particular frequency 11 kHz.
4. \[ x(t) = 2 \sin (2400\pi t) + 3 \sin (3600\pi t) \rightarrow \text{c/d} \rightarrow \text{D/C} \rightarrow y(t) \]

\[ F_s = 3 \text{kHz} \quad F_s = 3 \text{kHz} \]

(a) Find \( y(t) \).

(b) What sampling rate (i.e., Nyquist rate) should be used to allow perfect reconstruction where \( y(t) = x(t) \)?
5. Show that

(a) \( \delta(n) = u(n) - u(n-1) \)

(b) \( u(n) = \sum_{k=-\infty}^{n} \delta(k) \)

(c) \( u(n) = \sum_{k=0}^{\infty} \delta(n-k) \)

(d) ramp sequence \( a(n) = \sum_{k=-\infty}^{n} u(k) \)
EXAM 1 PRACTICE PROBLEMS

(Lesson 15 in notes)

PART B: 1 → 7