EEL 6502 Digital Signal Processing I

Answers to Home Work Problems (Chapter 2)

2.22 a) $y(n) = 2\,\delta(n-1) + \delta(n-2)$

b) $y(n) = -2\,\delta(n) + 5\,\delta(n-1) - \delta(n-3)$

c) $y(n) = \delta(n-2) + 2\,\delta(n-3) + 3\,\delta(n-4) + 4\,\delta(n-5) + 5\,\delta(n-6)$
$+ 5\,\delta(n-7) + 4\,\delta(n-8) + 3\,\delta(n-9) + 2\,\delta(n-10) + 2\,\delta(n-11)$
$+ 2\,\delta(n-12) + 3\,\delta(n-13) + 4\,\delta(n-14) + 5\,\delta(n-15) + 5\,\delta(n-16)$
$+ 4\,\delta(n-17) + 3\,\delta(n-18) + 2\,\delta(n-19) + \delta(n-20)$

2.24 $y(n) = \sum_{k=4}^{\infty} h(n-k)$ where h(n) is the impulse response of the system.

2.35 a) non linear
b) $y(n) = 3\,\delta(n+6) + 2\,\delta(n+5)$
c) $\delta(n) = x_1(n) - x_2(n)$ and $\delta(n) = \frac{1}{2}\, x_2(n+1)$

2.36 a) not time-invariant
b) $y1(n) = -\delta(n+1) + 3\,\delta(n) + 3\,\delta(n-1) + \delta(n-3)$
$y2(n) = -\delta(n+1) + \delta(n) - 3\,\delta(n-1) - \delta(n-3)$
$y3(n) = 2\,\delta(n+2) + \delta(n+1) - 3\,\delta(n) + 2\,\delta(n-2)$

2.39 a) not time-invariant
b) not linear
c) Linear but not time invariant

2.42 a) $h(n) = \alpha^n u(n) + \beta\alpha^{(n-1)} u(n-1)$

b) $H(e^{j\omega}) = \dfrac{1+\beta e^{-j\omega}}{1-\alpha e^{-j\omega}} \quad for\ |\alpha| < 1$

c) $y(n) - \alpha y(n-1) = x(n) + \beta x(n-1)$

d) System is causal
System is stable if $|\alpha| < 1$.

2.43 a) $X_R(e^{j\omega}) = \dfrac{1 - a\cos(\omega)}{1 - 2a\cos(\omega) + a^2}$

b) $X_I(e^{j\omega}) = \dfrac{-a\sin(\omega)}{1 - 2a\cos(\omega) + a^2}$

c) $$|X(e^{j\omega})| = \left(\frac{-a\sin(\omega)}{1-2a\cos(\omega)+a^2}\right)^{1/2}$$

d) $$\angle X(ej\omega) = \arctan\left(\frac{-a\sin(\omega)}{1-a\cos(\omega)}\right)$$

2.44 a) 6

b) -2ω

c) 4π

d) $X_R(e^{j\omega}) = ½\ A(\omega)\ (e^{j2\omega} + e^{-j2\omega})$

½ a(n+2) + ½ a(n-2) = ½ x(n+4) + ½ x(n)

2.45 $y(n) = e^{-j\pi n}\omega(n) + \omega(n)$