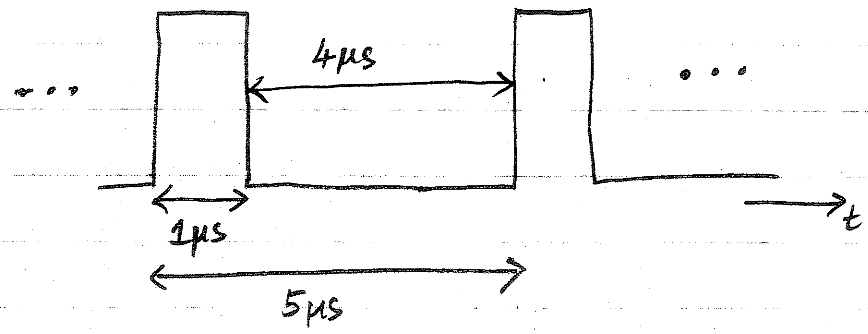
Recitation: 10/29/07

3.8

(a) $f_s = 8\,KHz$, $T_s = \frac{1}{8000}$ sec $= 125\ \mu s$

24 channels + 1 sync. pulse.

$\therefore$ time allotted to each channel $T_c = \frac{125\mu s}{25} = 5\mu s$.



Spacing betn. successive pulses in multiplexed signal $\Big\}$ $= 4\ \mu s$

(b) Highest freq. component $= 3.4\ KHz$

$\Rightarrow$ Nyquist rate $= 6.8\ KHz = f_s$

$T_s \approx 147\ \mu s$

$T_c \approx \frac{147}{25}\ \mu s = 5.88\ \mu s$

$\therefore$ spacing betn. pulses $\approx 4.88\ \mu s$.

3.23

$$Tx \rightarrow R_1 \rightarrow \cdots \rightarrow R_{n-1} \rightarrow Rx$$

Total of n sequential decisions.

p_1 = prob. of bit being inverted by any repeater

? → P_n = prob. that bit is in error at receiver (after n decisions).

(a) Note that the bit will be in error whenever there are an odd number of flips. Hence,

$$p_n = \binom{n}{1} p_1 (1-p_1)^{n-1} + \binom{n}{3} p_1^3 (1-p_1)^{n-3} + \cdots$$

$$\stackrel{?}{=} \frac{1}{2}\left[1-(1-2p_1)^n\right].$$

Now,

$$1-(1-2p_1)^n = (p_1 + (1-p_1))^n - (-p_1 + (1-p_1))^n$$

$$= \sum_{i=0}^{n} \binom{n}{i} p_1^i (1-p_1)^{n-i} - \sum_{i=0}^{n} \binom{n}{i} (-p_1)^i (1-p_1)^{n-i}$$

All even terms cancel. Odd terms add up. Hence,

$$1-(1-2p_1)^n = 2\left[\binom{n}{1} p_1 (1-p_1)^{n-1} + \binom{n}{3} p_1^3 (1-p_1)^{n-3} + \cdots\right]$$

$$= 2p_n \checkmark$$

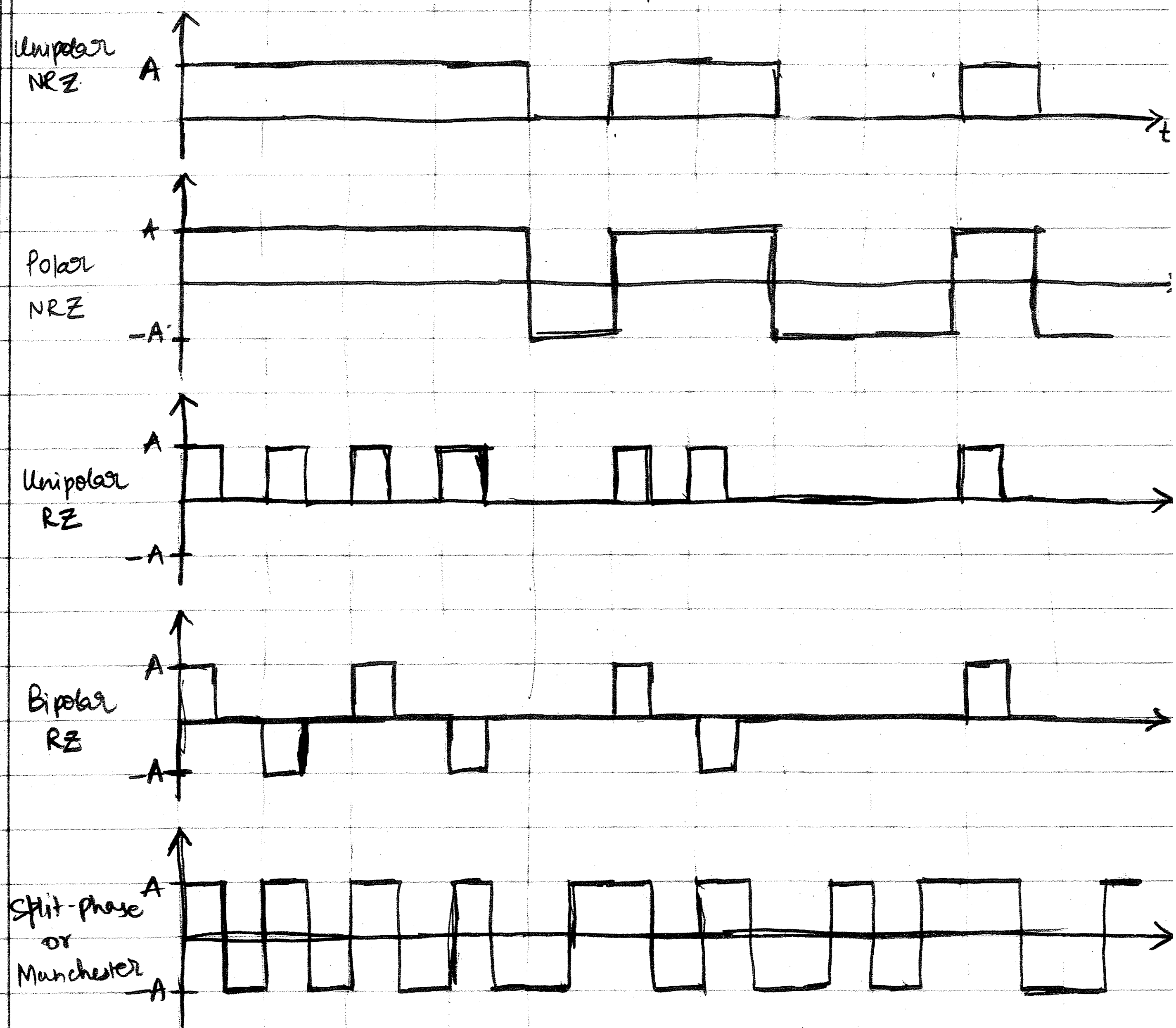
3.15 Bit stream: 1 1 1 0 0 1 0 1 0 0

Dif. encoded: 1 1 1 1 0 1 1 0 0 1 0

ref bit

0 ↔ transition

1 ↔ no transition



3.26 $m(t) = A_m \sin 2\pi f_m t$

applied to delta mod. with step-size Δ.

(a) When does slope-overload distortion occur?

$$\frac{\Delta}{T_s} < \max\left|\frac{dm(t)}{dt}\right|$$

$$\frac{dm(t)}{dt} = (A_m \cos 2\pi f_m t)\, 2\pi f_m$$

$$\max\left|\frac{dm(t)}{dt}\right| = A_m \cdot 2\pi f_m$$

$$\frac{\Delta}{T_s} < A_m \cdot 2\pi f_m \quad \text{i.e.} \quad A_m > \frac{\Delta}{2\pi f_m T_s}$$

(b) max. power that can be transmitted without slope-overload distortion?

$$\left.\begin{array}{l}\text{Power for sinusoidal signal with}\\ \text{amplitude } A_m\end{array}\right\} = A_m^2/2$$

For no slope-overload distortion:

$$A_m \leq \frac{\Delta}{2\pi f_m T_s}$$

$$\therefore \text{max. power} = \frac{\Delta^2}{8\pi^2 f_m^2 T_s^2}$$