EE 370

Solution, HW #12

(7.3-1, 7.3-2, 7.3-4, 7.3-5)

7

7.3-1 A rate 6kbps requires a bandwidth of at least 3kHz for transmission using Nyquist Criterion Pulses. Since 4KHZ BW is available, we have an excess bandwidth of 1 KHZ.

∴ r = 1/3.

7.3-2 (a) Quantization error = $\frac{\Delta v}{2} = \frac{1}{2}\frac{2m_p}{L} \leq 0.01$

$\Rightarrow L \geq 100$. Choose $L = 128$ $(n=7)$.

(b) Sampling rate = 4000×1.25 = 5000 Samples/sec.

Total transmission rate for 8 users =

= 5000×7×8 = 280 kbps.

The minimum BW required for transmission with zero ISI is 140kHZ $(r=0)$.

Using raised-cosine pulse with $r = 0.2$, ~~the~~ we require a bandwidth of 140×1.2 = 168 kHZ.

7.3-5 It is clear from Fig P7.3-5 that the minimum required bandwidth is 1 MHZ.

∴ Transmission rate = 2 Mbps.

Excess BW = 0.2 MHZ.

$\therefore r = \frac{0.2}{1} = 0.2$.

7.3-4

(a) For the pulse to satisfy Nyquist Criterion of zero ISI, its spectrum must satisfy the equation:

$$\sum_{n=-\infty}^{\infty} P(\omega - n\omega_b) = \text{Constant}.$$

Since the spectrum $P(\omega)$ has odd symmetry around $\omega = \pi \times 10^6$, it does satisfy the Nyquist Criterion.

(b) From FT tables

$$p(t) = \text{sinc}^2(10^6 t)$$

$p(t)$ goes to zero at $t = \pm 10^{-6}, \pm 2\times10^{-6}, \ldots$

Hence pulse transmitted at a rate of 10^6 bps will have zero ISI.

(c) $R_b = 10^6$ bps $=$ 1 Mbps.

Note ~~that~~ this rate requires a minimum of 0.5 MHz bandwidth. The spectrum of the pulse extends to $2\pi \times 10^6$ rad/sec $= 10^6$ Hz $=$ 1 MHz.

Therefore the excess BW over the minimum required BW is 0.5 MHz.

$$\therefore r = \frac{0.5}{0.5} = 1.$$

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Solution HW # 13

(7.7-3, 7.8-1, ~~7.9-2~~)

7.7-3

(a) In 8-ary signaling, each pulse represents $\log_2 8 = 3$ bits.

Therefore the bandwidth is reduces by a factor of 3 (i.e from $B_{8\text{-ary}} = \frac{1}{3} B_{\text{binary}}$).

(b) For the binary case, with $\pm A/2$ amplitudes

$$\overline{P}_2 = \frac{1}{2}\left(\frac{A}{2}\right)^2 + \frac{1}{2}\left(\frac{A}{2}\right)^2 = \frac{A^2}{4} \text{ watts.}$$

For the 8-ary case, with: $\pm A/2$, $\pm 3A/2$, $\pm 5A/2$, $\pm 7A/2$

$$\overline{P}_8 = \frac{1}{8}\left[2\left(\frac{A}{2}\right)^2 + 2\left(\frac{3A}{2}\right)^2 + 2\left(\frac{5A}{2}\right)^2 + 2\left(\frac{7A}{2}\right)^2\right]$$

$$= \frac{1}{4}\left[\frac{A^2 + 9A^2 + 25A^2 + 49A^2}{4}\right] = \frac{21A^2}{4} \text{ watts.}$$

∴ Power is increased by a factor of 21.

7.8-1 (a) For full-width pulses, the ~~essential~~ theoretical bandwidth goes to infinity. However, the essential bandwidth for Polar signaling is R_b, that is 1 MHZ.

(See Page 303 of your textbook).

[illegible] For carrier modulated signal (PSK or ASK in this case are the same), the bandwidth is doubled, i.e 2 MHZ.

(b) The spectrum of FSK looks like two spectra of ASK at f_{c0} & f_{c1} (spaced by 0.1 MHZ).

The bandwidth is then 2.1 MHZ.