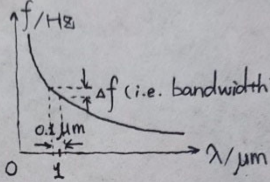
1. Oil pipeline: half-duplex system
River: simplex system
Walkie-talkie: half-duplex system.

2. (referenced the answer)

$f = \frac{c}{\lambda}$



$$\therefore \Delta f = \left|\Delta\lambda \cdot \frac{df}{d\lambda}\Big|_{\lambda_0}\right|$$

$$= \left|\Delta\lambda \cdot \left(-\frac{c}{\lambda_0^2}\right)\right|$$

$$= \Delta\lambda \cdot \frac{c}{\lambda_0^2} = 0.1\,\mu m \cdot \frac{3\times10^8\,m/s}{1\,\mu m^2}$$

$$= 3\times10^{13}\,Hz$$

3. $$a_n = \frac{2}{T}\int_0^T g(t)\sin(2\pi nft)\,dt$$

$$= -\frac{1}{\pi n}\int_0^1 t\,d\cos(2\pi nt)$$

$$= -\frac{1}{\pi n}$$

$$b_n = \frac{1}{\pi n}\int_0^1 t\,d\sin(2\pi nt) = 0$$

$$c = \frac{2}{T}\int_0^T t\,dt = 1$$

4. As the sampling rate is 1kHz, according to the sampling theorem, signals with a frequency over 500Hz will not be sampled properly. So

(i) The maximum baud rate is 1kBaud, so the maximum data rate is $\log_2 V$ kbps, where V is the number of bits carried by each symbol.

(ii) According to Shannon's theorem, the maximum data rate is

$$W\cdot\log_2(1+S/N) = 500Hz\cdot\log_2(1+30dB)\ bit$$

$$= 500\cdot\log_2(1+1000)\ bps$$

$$\approx 5kbps$$

5. According to Nyquist's theorem,

data rate $\leq 2W\log_2 V = 2\times 3k \times \log_2 2$ bps $= 6$kbps

According to Shannon's theorem,

data rate $\leq W\log_2(1+S/N) = 3k \times \log_2(1+100) \approx 21$kbps

$\therefore$ max data rate $=$ 6kbps.

6. (referenced the answer)

According to Nyquist's theorem,

data rate $\leq 2W\log_2 V$ $\quad \therefore\ W \geq \cancel{\frac{2\log_2 V}{B}}\ \frac{B}{2\log_2 V}$.

for NRZ, the coding efficiency is 1 bit / symbol

$\therefore\ W \geq \frac{B}{2\times 1} = \frac{B}{2}$ (Hz)

for Manchester encoding, each 2 symbol carries 1 bit.

$\therefore\ W \geq \frac{B}{2\times 1/2} = B$ (Hz)

for MLT-3, each 4 transitions can complete a full cycle, so

$$W \geq \frac{B}{2\times \log_2 4} = \frac{B}{4}\ \text{(Hz)}$$

$\log_2 4$ $\quad$ 4 (Hz)

7. NRZI uses a transition to indicate an 1, so we'd only prove that there will be no more than 3 contiguous 0's.

For each 5B codeword, there'll be at most one 0 in the front and at most two 0's in the end. So there would at most be 3 continuous 0's.

8. $\vec{S}\cdot\vec{T} = 0 \Leftrightarrow \frac{1}{n}\sum_{i=0}^{n-1} s_i t_i = 0$

$\Leftrightarrow -\frac{1}{n}\sum_{i=0}^{n-1} s_i t_i = 0$

$\Leftrightarrow \frac{1}{n}\sum_{i=0}^{n-1} s_i(-t_i) = 0$

$\Leftrightarrow \vec{S}\cdot\vec{\overline{T}} = 0$.

9. (Maybe Fig. 2-28?) $\quad \vec{S} = (-1,+1,-3,+1,-1,-3,+1,+1)$

$\vec{S}\cdot\vec{A} = [1+(-1)+3+1+(-1)+3+1+1]/8 = 1$

$\vec{S}\cdot\vec{B} = [1+(-1)+(-3)+(-1)+(-1)+(-3)+1+(-1)]/8 = -1$

$\vec{S}\cdot\vec{C} = [1+1+3+1+(-1)+(-3)+(-1)+(-1)]/8 = 0$

$\vec{S}\cdot\vec{D} = [1+\overset{1}{\cancel{(-1)}}+3+(-1)+1+3+1+(-1)]/8 = 1$

$\therefore$ Station A & D sended 1, B sended 0, C sended nothing.

10. $15M \times 10km \times 2 \times \pi \times 0.5mm^2 \times 9g/cm^3 \times 6\$/kg = 1.27 \times 10^{10}\$$.

11. If use 10 frames, the random pattern 0101010101 has a probability $\frac{1}{1024} < 0.001$.

12. $(12 \times 90 - 12 \times 3 - 1) \times 9 \times 8 \times 8000 = 600.8 \times 10^6 bps = 600.8Mbps$

13. total delay $D = \frac{1}{b} \cdot \frac{x(p+h)}{p} + (k-1)\frac{p}{b}$

$$= \frac{x}{b} + \frac{xh}{bp} + \frac{k-1}{b}p$$

$$\therefore \frac{dD}{dp} = -\frac{xh}{bp^2} + \frac{k-1}{b}$$

$\therefore$ when $p = \sqrt{\frac{xh}{k-1}}$, $\frac{dD}{dp} = 0$, D reaches the minimum.

14. (a) 10Mbps (b) (c) 27Mbps.

15. Sorry! I didn't find what "previous problem" meant, and I couldn't understand the answer either...