Set-A

1) $P(\text{atmost one error})$ = Probability of zero error + Probability of one error.

$$= {}^8C_0\, p^0 (1-p)^8 + {}^8C_1\, p^1 (1-p)^7$$
$$= (1-p)^8 + 8p(1-p)^7$$

2) $f_c = 4\,GHz$.
$f_m = 2\,MHz$.
$f_c + f_m = 4002\,MHz$
$f_c - f_m = 3998\,MHz$.

$B.W = 4\,MHz = 2f_m$.

$B.W. = \frac{f_s}{2} \Rightarrow f_s = 8\,MHz$.

3) $f_m = 1.8\,KHz$.
$f_s = 2f_m = 3.6\,kHz$.

4) $f_m = 1\,kHz$.
$f_s = 1800$ samples/s $= 1.8k$.

Frequency components in sampled signal.

$n f_s \pm f_m$.,

$n = 0 \rightarrow$
$n = 1 \rightarrow 1.8k \pm 1 = 2.8k$ or 800.
$n = 2 \rightarrow 3.6k \pm 1 = 4.6k$ or $2.6k$.

5) $SNR_1 = \frac{3}{2}(2^{2n})$.
$n_1 = n$. $n_2 = n+1$.

$$\frac{SNR_1}{SNR_2} = \frac{\cancel{\frac{3}{2}}(2^{2n+2})}{\cancel{\frac{3}{2}}(2^{2n})} = 2^2 = 4$$

$\Delta S = 20\log_{10} 2$
$= 6.02\,dB$.

$SNR_1 = 10\log_{10}\frac{3}{2} + 20n\log_{10} 2$
$= 1.76 + 20n\log_{10} 2$

$SNR_2 = 1.76 + 20n\log_{10} 2 + 20\log_{10} 2$

6). $x(t) = \underbrace{6\times10^4 \operatorname{sinc}^3(400t)}_{f_1(t)} \times \underbrace{10^6 \operatorname{sinc}^3(100t)}_{f_2(t)}$.

$f_1(t) * f_2(t) = F_1(\omega) . F_2(\omega)$.

$F_1(\omega)$ B.W $= 3\times400 = 1200$ rad/s $= 600\ Hz$.

$F_2(\omega)$ BW $= 3\times100 = 300$ rad/s $= 150 Hz$.

$f_s = \min(600, 150) . 2 = 300 Hz$.

7) $SNR = 1.76 + 20n \log_{10} 2$ $\qquad n = 8$.

$= 1.76 + 20.8 \log_{10} 2$

$= 49.92$ dB.

8). Frame $= 625$. $\qquad L = 64$. $\qquad n = \log_2 64 = 6$.

Pixel $= 400 \times 400$.

Data rate $= 625 \times 400 \times 400 \times 6$

$= 600$ Mbps.

9) $\operatorname{sinc}(700t) + \operatorname{sinc}(500t)$

$= \frac{\sin(700t)}{700t} + \frac{\sin(500t)}{500t}$.

$f_m = \frac{700}{2} = 350 Hz$ $\qquad f_s = 2f_m = 700 Hz$ $\qquad T_s = \frac{1}{f_s} = \frac{1}{700} = 1.42$ ms.

10) $P(\text{atmost one bit error}) = P(\text{no error}) + P(1 \text{ error})$.

$= {}^nC_0\, p^0 (1-p)^n + {}^nC_1\, p^1 (1-p)^{n-1}$

$= (1-p)^n + np(1-p)^{n-1}$

11) $x(t) = 2\cos(800\pi t) + \cos(1400\pi t)$.

$T = 10^{-3}\,s$. $\quad f = \frac{1}{T} = 1kH_z$.

Fourier Series coefficient :

$$c_n = \frac{1}{T_0}\int_{-T/2}^{T/2} A\, e^{-jn\omega_0 t}\,.dt. = \frac{A}{T_0}\left[\frac{e^{-jn\omega_0 t}}{-j\omega_0 t}\right]_{-T/6}^{T/6}$$

$$= \frac{A}{T_0(-j\omega_0 t)}\left[e^{-jn\omega_0 T/6} - e^{jn\omega_0 T/6}\right]$$

$\Rightarrow c_n = \frac{A}{n\pi}\sin\left(\frac{n\pi}{3}\right) \qquad n = 1, 2, 4, 5, 7, 8, 10, \ldots$

$p(t)$ has $1kH_z$, $2kH_z$, $4kH_z$, ...

$x(t)$ has frequency component $= 0.4kH_z$ & $0.7kH_z$.

Sampled signal of $x(t) = x(t) \times p(t)$ will have

1 ± 0.4 and 1 ± 0.7.

2 ± 0.4 and 2 ± 0.7

4 ± 0.4 and 4 ± 0.7.

In range of $2.5kH_z$ & $3.5kH_z$.

$f = 2.7kH_z \quad (2 + 0.7)$

$= 3.3kH_z \quad (4 - 0.7)$.

12) Step Size $= d = \frac{2M_p}{L} = \frac{1.536}{128} = 0.012\,V.$

$$SNR = \frac{d^2}{12} = \frac{(0.012)^2}{12} = 12\times10^{-6}\ V^2$$

13) $f_s = 8kH_z$

Bit Rate $= nf_s = (8\times8) = 64$ kbps.

$SNR = 1.76 + 6.02n = 49.8$ dB.

14) $f_s = 2f_m.$

$$\left.\begin{array}{ll} f_{m_1} = 1200\,H_z & f_{s_1} = 2400\,H_z \\ f_{m_2} = 600\,H_z & f_{s_2} = 1200\,H_z \\ f_{m_3} = 600\,H_z & f_{s_3} = 1200\,H_z \end{array}\right\}\ \text{Total samples/s} = 4800.$$

$n = 12$ bit for each sample.

bit rate $= 4800\times12 = 57.6$ kbps.

15). Probability of error $= p.$

To receive correct bit, atleast two bits must be same.

$P(\text{error}) = P(\text{2bits with error}) + P(\text{all bits with error}).$

$$= {}^3C_2\, p^2 (1-p) + {}^3C_3\, p^3 (1-p)^0$$

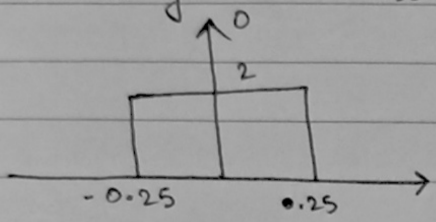
$$= p^3 + 3p^2(1-p).$$

16) Bandwidth $= \{w, w, 2w, 3w\}$.

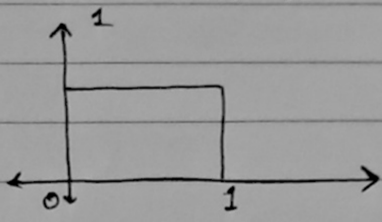
$f_s = \{2w, 2w, 4w, 6w\}$

$= \frac{1}{2}(2w + 2w + 4w + 6w\} = 7w$.

17) Probability of transmission of 0.



PDF of transmission of 1.



Probability of error of 1 $= P(0 \leq x \leq 0.2) = 0.2$.

of 0 $= P(0.2 \leq x \leq 0.25) = 0.05 \times 2 = 0.1$.

Average error $= \frac{0.2 + 0.1}{2} = 0.15$.

18) $f_m = 1.5 kH_z$

$f_s = 2f_m = 3kH_z$.

19) Area under curve $= 1$

$$\int_{-1}^{1} f_x(x)\, dx + \int_{1}^{5} f_x(x) \cdot dx + \int_{-5}^{-1} f_x(x) \cdot dx = 1.$$

$\Rightarrow 2a + 4b + 4b = 1 \quad \Rightarrow 2a + 8b = 1.$

For max entropy, $2a = 4b = 4b.$

$\Rightarrow a = 2b$

$2(2b) + 8b = 1.$

$\Rightarrow 12b = 1$

$\Rightarrow \boxed{b = \frac{1}{12}.}$

$\boxed{a = \frac{1}{6}}$