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1. The signal $x(t) = 2\cos(2\pi f_1 t) \cdot \cos(2\pi f_2 t)$, where $f_2 > f_1$, is passed

   into an ideal low-pass filter with bandwidth $|f| \le W$,

   where $f_2 - f_1 < W < f_2 + f_1$, to obtain $y(t)$. Then $y(t)$ is sampled

   at a rate $f_2 - f_1 < f_s < 2(f_2 - f_1)$ to obtain $y_\delta(t)$.

   (a) Determine the spectrum of $x(t)$, i.e., $X(f)$. (5%)

   (b) Determine $y(t)$. (5%)

   (c) Plot $Y_\delta(f)$ in the range $-f_s \sim f_s$. (10%)

2. Given a spectrum $S(f)$ as

$$S(f) = \begin{cases} A, & -B \le f \le B, \\ 0, & \text{elsewhere}, \end{cases}$$

   if we express the corresponding time function $s(t)$ as

   $s(t) = C \operatorname{sinc}(Dt)$. Determine C and D in terms of A and B. (10%)

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3. A transmission filter $g(t)$ is shown in Fig. P3.

(a) Specify the required matched filter $h(t)$. (5%)

(b) Determine the output signal from the matched filter in the time
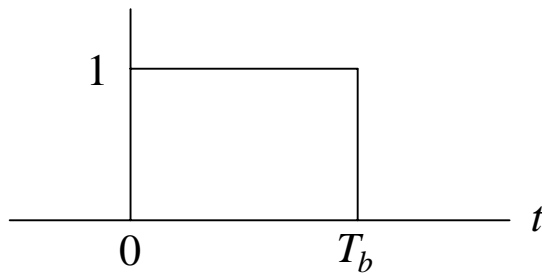
interval $0 \sim 2T_b$. (15%)

Fig. P3

4. The signal points of a pulse amplitude modulation is shown in

Fig. P4. Assume the period of the binary signal is normalized to unity

and the two-side power spectral density is $\dfrac{N_o}{2}$.

(a) Determine the signal energy per bit. (5%)

(b) Determine the bit error probability in terms of E_b/N_o, assuming

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equally likely source, in the form of $Q(x)$, where $Q(x)$ is defined as

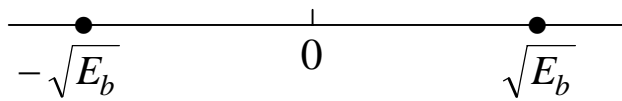$$Q(x) = \frac{1}{\sqrt{2\pi}} \int_x^\infty e^{-\frac{y^2}{2}} dy. \quad (15\%)$$

Fig. P4

5. Assume the energy of the pulse shape $g(t)$ for an 8-PSK signal over

   a signal interval T is E_g.

(a) Write the expression for the modulated signals. (5%)

(b) Give two normalized orthogonal basis vectors. (5%)

(c) Calculate the distance between any two signal points m and n. (5%)

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6.　　The state-transition of a binary channel is shown in Fig. P6.

(a) Find the conditional probabilities $P_{X|Y}(x \mid y)$, for all x and y. (10%)
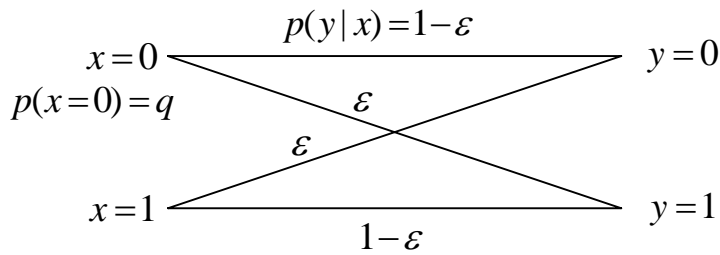
(b) Find $P_Y(y)$ for all y. (5%)

Fig. P6

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