(滿分為 100 分)

(15分) (1) A simple model for a multipath communication channel is shown in
Figure 1-1. (a) Find $H(f) = Y(f)/X(f)$ for this channel and plot $|H(f)|$ for
$\beta = 1$ and 0.5. (b) In order to equalize the channel-induction distortion,
an equalization filter is used. We use a tapped delay-line or transversal
filter, as shown in Figure 1-2 to approximate the equalizer. Write down a
series expression for $H_Y(f) = Z(f)/Y(f)$ for the equalizer in terms of $\beta_i$'s
and $\Delta$. (c) Find the resulting equalizer $H_Y(f)$ to accommodate this
channel, i.e., to determine the values of $\beta_i$'s in terms of $\beta$, assuming
that $\Delta = \frac{1}{m}$. (每 - 3 题 5分)

(20分) (2) Consider the bandpass signal
$$x(t) = 2W \text{sinc}(2Wt) \cos(2\pi ft)$$
(a) Obtain and sketch the frequency spectrum of $x(t) = x(t) + jx(t)$. (5分)
Where $\hat{x}(t)$ is the Hilbert transform of $x(t)$. Assume that $f_0 > 2W$.
(b) Obtain and sketch the frequency spectrum of the complex envelope,
$\tilde{x}(t)$. Where the complex envelope is defined in $x(t) = \text{Re}\{\tilde{x}(t) e^{j2\pi ft}\}$. (10分)
(c) Obtain and sketch the complex envelope $\tilde{x}(t)$. (5分)

(20分) (3) A sinusoidal signal wave, $A \cos(2\pi ft)$, is to be sampled, uniformly
quantized and digitalized by R-bit encoder (i.e., R-bits/sample).
(a) Find the (SNR)$_o$, the signal-to-quantization noise-ratio, of this
uniform quantizer.
(b) Calculate the (SNR)$_o$ in dB for the cases of $R = 6$ and $R = 9$
respectively. (每 - 3 题 10分)

(15分) (4) A random signal is given by the sample function, $x(t) = A \cos(2\pi ft + \theta)$,
where $A$ is normally distributed with zero mean and variance of 2, $\theta$ is
uniformly distributed in $[0, 2\pi]$, $A$ and $\theta$ are statistically independent.
(a) Is the random signal wide-sense stationary?
(b) Find the autocorrelation function and its power spectrum density.
(c) If $A$ is uniformly distributed in $[0, 2]$, what are the answers in (a) and (b)?
(每 - 3 题 5分)
(15% (5) Consider a phase modulation (PM) system, with the modulated wave defined by

\[ s(t) = A_c \cos(2\pi f_c t + k_p m(t)) \]

where \( k_p \) is the phase sensitivity and \( m(t) \) is the message signal. The additive white Gaussian noise \( n(t) \) at the phase detector input is

\[ n(t) = n_x(t) \cos(2\pi f_c t) - n_y(t) \sin(2\pi f_c t) \]

Assuming that the carrier-to-noise ratio at the detector input is high compared with unity, determine

(a) the output signal-to-noise ratio, assuming power spectral density in passband is \( N_0/2 \).
(b) the figure of merit of the system.
(c) Compare your results with FM system for the case of monotone analysis.

(15% (6) The modulator-demodulator of a differential phase-shift keying (DPSK) are shown in figure 6-1 and figure 6-2. \( d(t) \) is the bit stream to be transmitted. \( T_b \) is the bit pulse width. \( 5T_b = n, n \) is an integer. The truth table for the logic gate LG is given in table 6-1. If the bit stream is \( d(t) = 00101001101 \),

(a) Determine \( b(t) \). Draw the logic waveforms to illustrate the response, \( b(t) \), to the input \( d(t) \).
(b) Show that the output of the demodulator receiver as figure 6-2 yields the original data, \( d(t) \).
(c) From the discussion in (a) and (b), tell what are the merits (advantages) the DPSK have.

![Figure 6-1](image)

![Figure 6-2](image)

<table>
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<th>( d(t) )</th>
<th>( b(t - T_b) )</th>
<th>( b(t) )</th>
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