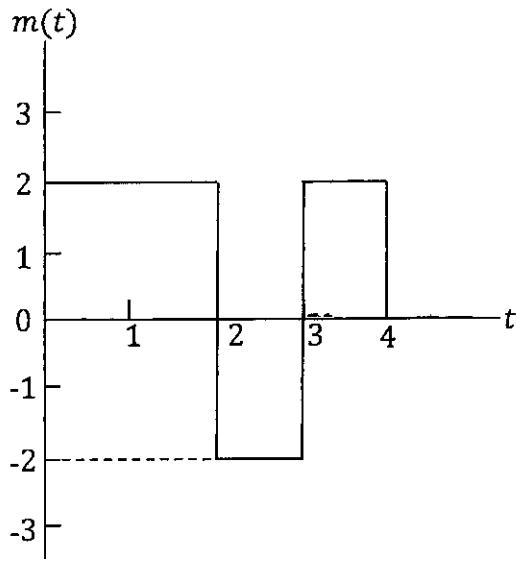
國立臺北大學 108 學年度碩士班一般入學考試試題

系（所）組別：通訊工程學系

科　　目：通訊原理

☐可 ☑不可使用計算機

1. **(30 pt)** True or false.
   A. Signals that are neither energy nor power signals cannot be found.
   B. The vestigial-sideband modulation requires a bandwidth that is smaller than the bandwidth of the double-sideband modulation but larger than the bandwidth of the single-sideband modulation.
   C. Stereophonic FM radio uses orthogonal frequency for multiplexing.
   D. For stationary processes, means and variances are independent of time, and the correlation coefficient depends only on the time difference.
   E. An AM signal cannot be demodulated without coherent demodulation techniques.
   F. A periodic signal has infinite power.
2. **(10 pt)** Find the time-average autocorrelation function and power spectral density of $x(t) = 3 + 3\cos(10\pi t) + 3\sin(10\pi t)$.
3. **(10 pt)** An FM modulator with $f_d = 10$ Hz/V. Plot the frequency deviation in hertz and the phase deviation in radians for the message signal shown in the following figure.



4. Consider the BPSK system whose transmitted signal is given by

$$x(t) = \begin{cases} A\cos(2\pi f_c t), & m = 0, \\ -A\cos(2\pi f_c t), & m = 1, \quad 0 \le t \le T, \quad f_c >> \frac{1}{T}, \end{cases}$$

The message m has the distribution of $\mathbb{P}(m = 0) = 4/9$ and $\mathbb{P}(m = 1) = 5/9$. The received signal is given by $y(t) = x(t) + n(t)$ where $n(t)$ is a zero mean white Gaussian noise with power spectral density $N_0/2$ for all f.

i) **(10pt)** Use coherent demodulation to demodulate the received signal and formulate the detection problem as hypothesis testing. You must derive the probability density function for each hypothesis.

ii) **(10pt)** Derive the detection threshold η_{ML} of maximum likelihood detection for the hypothesis testing problem derived in part i). Also, derive the detection threshold η_{MAP} of maximum a posterior detection.

iii) **(10pt)** Derive the average probability of error based on η_{MAP} in part ii).

Hint: $Q(x) \triangleq \int_x^\infty \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}} dy$ and $Q(-x) = \int_{-\infty}^x \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}} dy$.

5. Let $\{a_k\}$ be a sequence of data which is multiplied with a pulse shaping function $h(t)$. The transmitted signal is given by $x(t) = \sum_{k=-\infty}^{\infty} a_k h(t - kT_s)$. At the receiver, we sample this signal every T_s seconds to get the discrete signal $x[n] = \sum_{k=-\infty}^{\infty} a_k h[n - k]$ for every integer n.

i) **(7pt)** Derive the condition on $h(t)$, in time domain, such that there will be no inter-symbol interference?

ii) **(7pt)** Now, derive from part i) the condition on $H(f)$, in frequency domain, which guarantees no inter-symbol interference.

iii) **(6pt)** Provide an example of $H(f)$ satisfying the condition in part ii). Show in time domain that it indeed will not result in any inter-symbol interference.

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