國立高雄大學 101 學年度研究所碩士班招生考試試題

科目：通訊系統
考試時間：100 分鐘

系所：
電機工程學系(通訊組)
本科原始成績：100 分

是否使用計算機：是

1. (12%) Briefly describe the following terminologies used in communication systems:
   (a) white noise
   (b) frequency modulation (FM)
   (c) time-division multiplexing (TDM).

2. (10%) A wireless channel of bandwidth 2 MHz is perturbed by additive white Gaussian noise. According to Shannon's information capacity theorem, find the minimum signal-to-noise power ratio (SNR) required to support information transmission through the channel at a data rate of 10^7 bits per second (bps).

3. (16%) Fig. 1 shows the spectrum $M(f)$ of a band-limited message $m(t)$, where $M(f)=0$ for $|f|$ > 10 kHz. The message $m(t)$ is amplitude modulated (AM) with a carrier $c(t)=\cos(2\pi f_c t)$ of frequency f_c = 1 MHz.
   (a) Briefly draw the circuit of an AM modulator. For example, you may use $\oplus$ to represent an adder, and use $\otimes$ to represent a multiplier.
   (b) Plot the spectrum of the modulated signal.

4. (10%) Fig.1 shows the spectrum $M(f)$ of a band-limited message $m(t)$, where $M(f)=0$ for $|f|$ > 10 kHz. The message $m(t)$ is sampled instantaneously by an impulse train $p(t)=\sum_{n=-\infty}^{\infty}\delta(t-nT_s)$. If the sampled signal is to be recovered by an ideal reconstruction filter, what is the criterion of the sampling period T_s to avoid aliasing?

5. (12%) Draw the modulated waveforms of the binary sequence 10101101 by using the following pulse-code modulated (PCM) waveforms
   (a) unipolar nonreturn-to-zero (NRZ)
   (b) alternate mark inversion (AMI)
   (c) Manchester code

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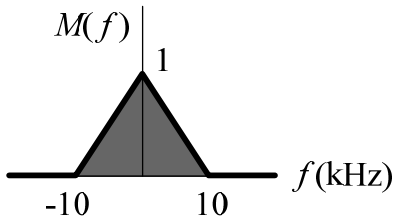

Fig. 1

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6. (24%) Fig. 2(a) shows a pair of pulses $s_1(t)$ and $s_2(t)$.
   (a) Show that $s_1(t)$ and $s_2(t)$ are orthogonal to each other over the time interval [0, T].
   (b) Determine the matched filters for the pulses $s_1(t)$ and $s_2(t)$ considered individually.
   (c) Form a two-dimensional matched filter by connecting the two matched filters of Part (b) in parallel, as shown in Fig. 2(b). When the pulse $s_2(t)$ is applied to the two-dimensional matched filter, find the output signals $y_1(t)$ and $y_2(t)$.

7. (16%) Consider a binary phase-shift keying (BPSK) system, the pair of signals $s_1(t)$ and $s_2(t)$ used to represent binary bits 1 and 0, respectively, is defined by

$$s_1(t) = +A\cos(2\pi f_b t) \quad \text{and} \quad s_2(t) = -A\cos(2\pi f_b t)$$

   where $0 \leqq t \leqq T_b$, $f_b = 1/T_b$, and T_b is the bit duration. The signal amplitude A = 10 mV and bit rate $R_b = 10^6$ bits per second (bps) are used.
   (a) Find the bit duration T_b and transmitted signal energy per bit E_b.
   (b) The signal is transmitted through a channel perturbed by additive white Gaussian noise of zero mean and single-sided power spectral density $N_0 = 10^{-11}$ W/Hz, and is received by the coherent BPSK demodulator. Suppose that $s_1(t)$ and $s_2(t)$ are transmitted with an equal probability, find the bit error probability P_b with the aid of Fig. 3.

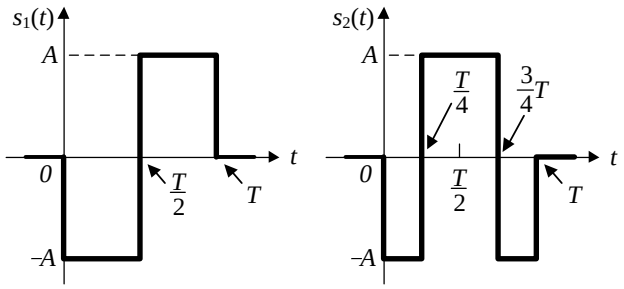

Fig. 2(a)

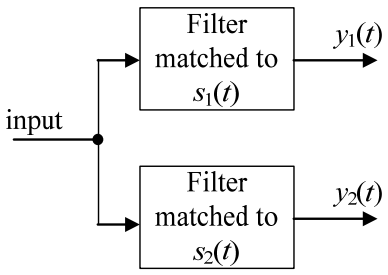

Fig. 2(b)

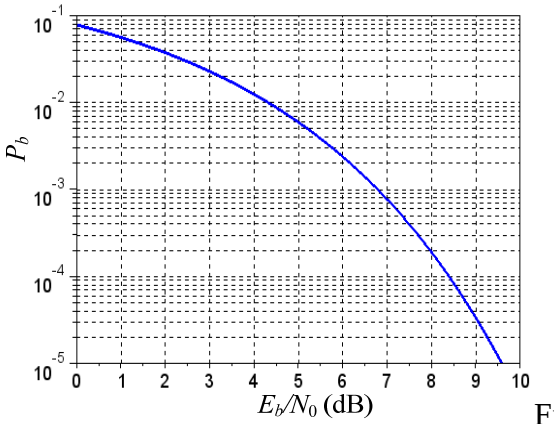

Fig. 3 P_b versus E_b/N_0 for a coherent BPSK system.

Reference Data
log 2 = 0.3010
log 3 = 0.4771
log 5 = 0.6990
log 7 = 0.8451