國立臺北大學 106 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. True of false.
   i) **(2%)** Analog communication is preferred over digital in long distance communication since we can decode and retransmit analog signals when the signal-to-noise ratio (SNR) is large.
   ii) **(2%)** As long as the sampling frequency is larger than 2 times the signal bandwidth, one can easily reconstruct the original signal from samples.
   iii) **(2%)** Split phase line coding can provide self-synchronization.
   iv) **(2%)** For sending a same signal, linear modulation typically requires a larger bandwidth than angle modulation.

2. Consider sending a message $m(t)$ whose power spectral density (PSD) is $S_m(f) = f^4$ for $|f| \leq W$ and $S_m(f) = 0$ otherwise. The transmitted signal is given by $x(t) = m(t)\cos 2\pi f_c t$. The signal is corrupted by an additive white Gaussian noise with PSD $N_0/2$.
   i) **(5%)** Pass the received signal through an ideal bandpass filter centered at f_c with bandwidth $B \geq 2W$. The noise then becomes $n_c(t)\cos 2\pi f_c t - n_s(t)\sin 2\pi f_c t$ narrowband noise. Draw $S_{n_c}(f)$ the PSD of $n_c(t)$.
   ii) **(8%)** The output signal now is $y(t) = x(t) + n_c(t)\cos 2\pi f_c t - n_s(t)\sin 2\pi f_c t$. Use a coherent demodulator followed by a low-pass filter with bandwidth W to demodulate it. Derive the demodulation signal and the SNR at the demodulator output.
   iii) **(8%)** Suppose the signal is further corrupted by an interference $k(t) = sinc(wt)$ and the received signal after the bandpass filter becomes $y_2(t) = (t) + k(t)\cos 2\pi(f_c + 2W)t + n_c(t)\cos 2\pi f_c t - n_s(t)\sin 2\pi f_c t$. Design a low-pass filter for the demodulator in part ii) such that the signal-to-interference-plus-noise ratio (signal power divided by the sum of interference and noise power) is maximized.

3. Let $\{a_k\}$ be a sequence of data which is multiplied with a pulse shaping function $h(t)$ and sent every T_s seconds. The signal is given by $x(t) = \sum_{k=-\infty}^{\infty} a_k h(t - kT_s)$. 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) **(5%)** Derive the condition on $h(t)$, in time domain, such that there will be no inter-symbol interference?
   ii) **(8%)** Now, derive from part i) the condition on $H(f)$, in frequency domain, which guarantees no inter-symbol interference.
   iii) **(8%)** 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.

4. **(10%)** In wireless communication systems, Additive White Gaussian Noise (AWGN) channel is often assumed. What do "Additive", "White", and "Gaussian" mean?

5. **(10%)** Plot the 16QAM and 8PSK constellations with normalized power 1. How many bits can one 16QAM symbol and one 8PSK symbol carry, respectively?

6. **(10%)** A matrix H for a linear block code is defined such that each vector v is a valid codeword if and only if $\mathrm{H}v^T = 0$. Assume that
$$H = \begin{bmatrix} 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}.$$
   i) Is the vector $v_1 = [1\ 0\ 0\ 1\ 0\ 1]$ a valid codeword vector? Why or why not?
   ii) How many valid codewords can you find?

7. **(20%)** Given $\varphi_1(t) = 1,\ \varphi_2(t) = t,\ \varphi_3(t) = 3t^2 - 1$,
   i) Show that $\varphi_1(t)$ and $\varphi_2(t)$ are mutually orthogonal over the interval (-2, 2)
   ii) Are $\varphi_1(t)$ and $\varphi_3(t)$ mutually orthogonal over the interval (-1, 1)? Why or why not?

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