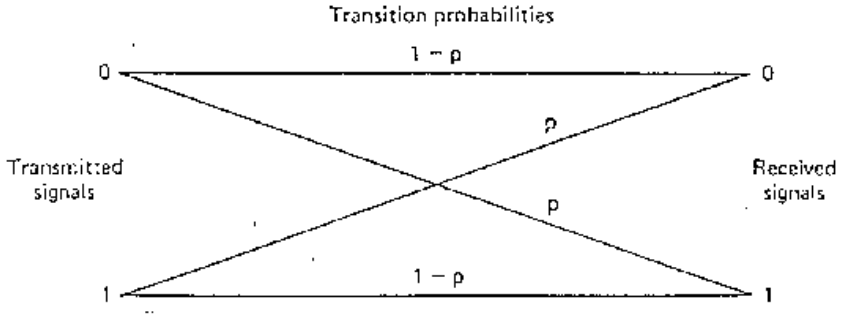
1. The transition probabilities of the Binary symmetric channel is shown (10%) in Fig 1. The transmitted signal is either Binary zero or Binary one with equal probability.
(A) Find the channel capacity as function of p.
(B) Find the maximun capacity and the corresponding values of p. Make your conclusion for the results you obtained.

Fig 1



2. Obtain the Fourier series coefficient for the pulse train $v(t)$ shown in Fig 2. (10%) Plot the spectrum for each frequency component.

3. White noise with two-sided power spectral density 1/2 N_0 is added to a signal (10%) having the power spectral density shown in Fig 3. The sum (signal plus noise) is filtered with an ideal lowpass filter with unity passband gain and bandwidth B > W. Determine the signal-to-noise ratio at the filter output. By what factor will the signal-to-noise ratio increase if B is reduced to W?

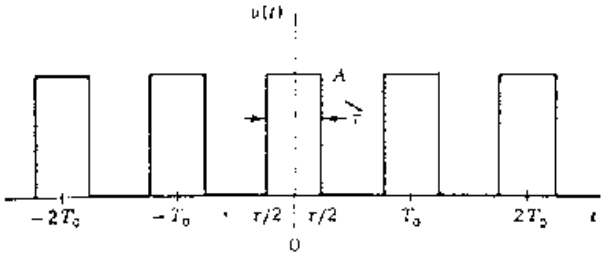
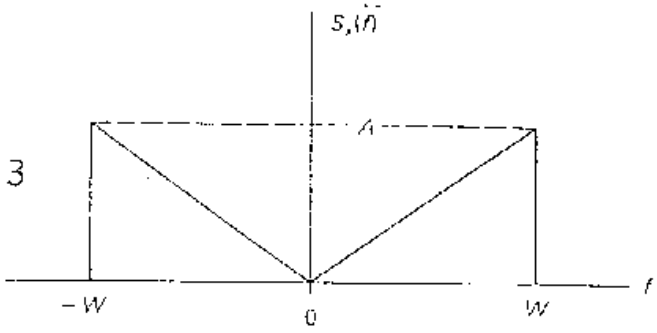


Fig 2

Fig 3



4. Show that the periodic signal X and Y are orthogonal and are equal in power (10%) where Y is the Hilbert Transform of X.

5. A narrowband FM signal has a carrier frequency of 100 kHz and a deviation (10%) ratio of 0.05. The modulation bandwidth is 5 kHz. This signal is used to generate a wideband FM signal with a deviation ratio of 20 and a carrier frequency of 100 MHz. The scheme utilized to accomplish this is an Armstrong wideband FM generator using a frequency multiplier and a mixer. Give the required value of frequency multiplication, n. Also, fully define the mixer by giving *two* permissible frequencies for the local oscillator, and define the required bandpass filter (center frequency and bandwidth).

6. A certain continuous random variable has the cumulative distribution function (10%)

$$Fx(x) = \begin{cases} 0, & x < 0 \\ Ax^3, & 0 \le x \le 10 \\ B, & x > 10 \end{cases}$$

(a) Find the proper values for A and B.
(b) Plot Fx(x).
(c) Obtain and plot the pdf fx(x).

參考用

7. Consider a systematic (7,4) block code whose parity-check equation are : (10%)

$$P1 = M1 \oplus M2 \oplus M3$$
$$P2 = M2 \oplus M3 \oplus M4$$
$$P3 = M1 \oplus M3 \oplus M4$$

where Mi are message digit and Pi are parity check digits
(A) Find the generator matrix and parity check matrix for this code.
(B) A received vector (sequence) is V = 0110110, compute the syndrome and find the correct sequence.

8. A serial bit stream, proceeding at a rate of 10 kbps from a source, is given as (10%)

110 011

This sequence is passed through a data spliter. Associate the odd-indexed bits with *d1(t)* and the even-indexeed bits with *d2(t)*.
(a) What is the symbol rate for *d1* and *d2* ?
(b) What are the successive values of θ_i assuning QPSK modulation? At what time intervals may θ_i switch?
(c) What are the successive values of θ_i assuming OQPSK modulation? At what time intervals may θ_i switch values?

9. Consider a 15-bit, maximal-length PN code. It is generated by feeding back the (10%) second and the last stages of a four-stage shift register. Assuming a 1 1 1 1 initial state, find all the other possible states of the shift register. What is the sequence? Find and plot its periodic autocorrelation function.

10. Consider the set of three finite-energy signals (10%)

$$s_1(t) = 1, \qquad 0 \le t \le 1$$
$$s_2(t) = \cos 2\pi t, \qquad 0 \le t \le 1$$
$$s_3(t) = \cos^2 \pi t, \qquad 0 \le t \le 1$$

(A) Find an orthonormal basis for the signal space spanned by these three signals.
(B) Expressed each signal in terms of these orthogonal basis.