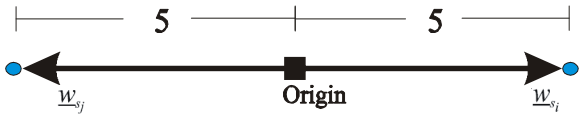
5 Topic: Digital Modulators & Line Codes

27. The next figure illustrates the signal constellation points of two M-ary signals $s_i(t)$ and $s_j(t)$ of equal energy.



The energy of each of these two signals is

(a) 25,
(b) 50,
(c) 75,
(d) 100,
(e) none of the above.

28. Consider a random binary sequence of 0's and 1's. This binary sequence is transmitted as a random signal with 1's and 0's being sent using the pulses $s_1(t)$ and $s_0(t)$ described below:

$$0 \longmapsto s_0(t) = 3\text{rect}\left\{\frac{t}{1ms}\right\} \text{ mV}$$

and

$$1 \longmapsto s_1(t) = -3\text{rect}\left\{\frac{t}{1ms}\right\} \text{ mV}$$

If 1's and 0's are statistically independent with $\Pr(1) = \Pr(0) = 0.5$, find the Power Spectral Density of the transmitted signal.

29. A binary PSK signal is decoded coherently in the presence of white noise having a double sided power spectral density 0.5×10^{-6} Watts/Hz. If $\Pr(1) = \Pr(0)$ and the bit rate is 220 kbits/sec, what is the average received signal power at which a probability of error of 10^{-5} can be achieved? (10%)

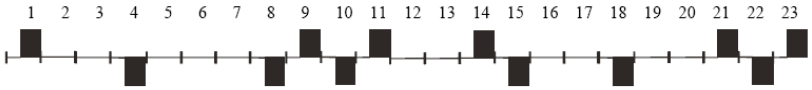
30. Consider a Biphase Shift-keyed digital modulator/demodulator operating the presence of additive white Gaussian noise with double-sided power spectral density $0.5 \times 10^{-9} W/Hz$. The digital modulator maps zeros and ones as follows:

$$\begin{aligned} 0 &\longmapsto s_0(t) = 3\cos(2\pi F_c t - 30^0) \\ 1 &\longmapsto s_1(t) = 3\cos(2\pi F_c t + 30^0) \\ \text{for } 0 &\leq t \leq T_{cs} \end{aligned}$$

where $\Pr(0) = \Pr(1)$, $T_{cs} = 4ns$ and $F_c = \frac{5}{T_{cs}}$. Find

(a) the Energy Utilisation Efficiency (EUE); [5 marks]
(b) the bit error rate p_e at the demodulator's output. [5 marks]

31. The following HDB3 encoded signal



represents the binary sequence:

(a) 1 0 0 1 0 0 0 0 1 1 1 0 0 0 1 0 0 0 0 0 1 1 1

(b) 1 0 0 1 0 0 0 1 1 1 1 0 0 1 1 0 0 1 0 0 1 1 1

(c) 1 0 0 1 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 1 1 1

(d) 1 0 0 1 0 0 0 0 1 1 0 0 0 0 1 0 0 0 0 0 1 1 1

(e) None of the above.