1-5.

a). $P_{e,BPSK} = Q\left(\sqrt{\frac{2E_b}{N_0}}\right) = 10^{-5} \Rightarrow \frac{2E_b}{N_0} = 4.2649$ dB.

$\frac{E_b}{N_0} = 9.09465\,dB = 8.1183 \Rightarrow E_b = 8.1183 \times N_0 = 8.1183 \times 10^{-8}$ W/Hz

$P_{av} = \frac{E_b}{T_b} = 8.1183 \times 10^{-2}$ W ( $T_b = \frac{1}{k_b} = 10^{-6}$ s )

b) $P_{e,CFSK} = Q\left(\sqrt{\frac{E_b}{N_0}}\right) = 10^{-5}$.

$\frac{E_b}{N_0} = 6.08465\,dB = 16.2355$.

$T_b = 10^{-5}$ s. $\Rightarrow P_{av} = 1.62355 \times 10^{-2}$ W.

$E_b = 1.624 \times 10^{-7}$ W/Hz

c). $P_{e,ASK} = Q\left(\sqrt{\frac{E_b}{N_0}}\right) \Rightarrow \frac{E_b}{N_0} = 6.08465\,dB = 16.2355$

$T_b = \frac{1}{k_b} = 0.333 \times 10^{-3}$ s.

$\Rightarrow E_b = 16.2355 \times 10^{-7}$ W/Hz $\Rightarrow P_{av} = \frac{E_b}{T_b} = 4.87065 \times 10^{-4}$ W.

d) Data rate ↑ $\Rightarrow T_b$ ↓, $B_{Ek}$ fixed $\Rightarrow$ average power 增加10倍.

e) If the noise power spetral density is small by 10, the average power of received is increasing by the equal factor 10.

4-8.

a.

| | | |
|---|---|---|
| 1 1 1 0 0 | 1 1 0 1 0 | 1 0 0 0 0 | message sequence |
| 1 1 1 1 0 1 | 1 1 0 0 1 | 1 0 1 0 1 | encoded sequence |
| 0 0 0 0 π 0 | 0 0 π π 0 | 0 π 0 π 0 | transmitted phase. |

b.

| | | |
|---|---|---|
| 1 1 1 1 1 | 0 0 0 0 0 | 1 1 1 1 1 | message sequence |
| 1 1 1 1 1 1 | 0 1 0 1 0 | 0 0 0 0 0 | encoded sequence |
| 0 0 0 0 0 0 | π 0 π 0 π | π π π π π | transmitted phase |

c.

| | | |
|---|---|---|
| 1 0 1 0 1 | 0 1 0 1 0 | 1 0 1 0 1 | message sequence |
| 1 1 0 0 1 1 | 0 0 1 1 0 | 0 1 1 0 0 | encoded sequence |
| 0 0 π π 0 0 | π π 0 0 π | π 0 0 π π | transmitted phase. |

1-19.

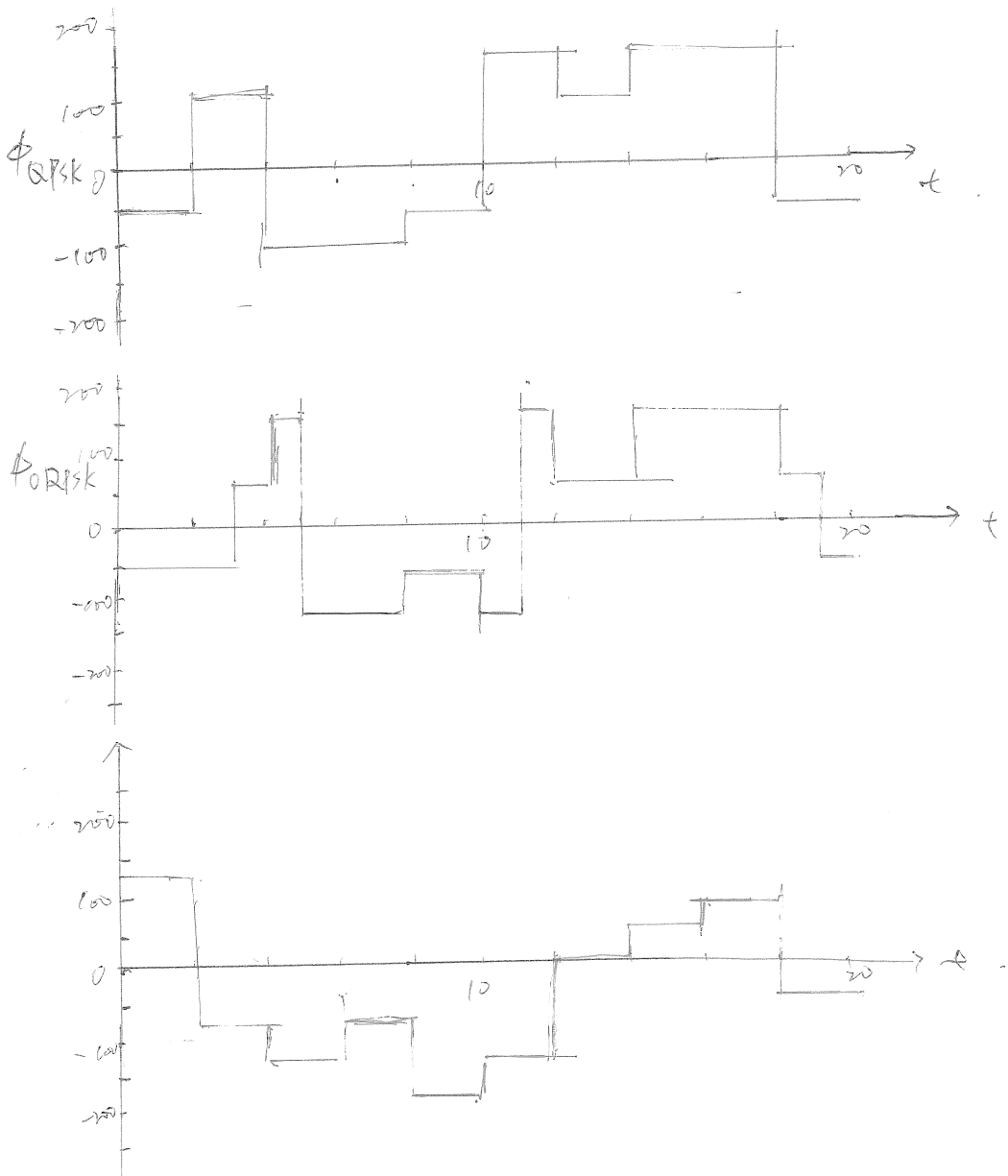
The same data sequence as used in Problem 1-15 will be used here.

It is: 11100 10111 00100 00011.

From Table 1-5; the sequence of phase increments for $\pi/4$-DQPSK is $-\frac{3\pi}{4}, \frac{3\pi}{4}, -\frac{\pi}{4}, -\frac{\pi}{4}, -\frac{3\pi}{4}, \frac{\pi}{4}, \frac{3\pi}{4}, \frac{\pi}{4}, \frac{\pi}{4}, -\frac{3\pi}{4}$, or in term of degrees the phase increments are $-135, 135, -45, -45, -135, 45, 135, 45, 45, -135$.

The total phase is constrained to be between $-180$ and $180$ degrees.

The excess phase plots below are for QPSK, DQPSK and $\pi/4$-DQPSK in order of occurrence.



1-21

a)

$$s(t) = A \sin[\omega_0 t + d(t) \cos^{-1} a]$$

$$= A \sin(\omega_0 t) \cos(d(t) \cos^{-1} a) + A \cos(\omega_0 t) \sin(d(t) \cos^{-1} a)$$

$$= A \sin(\omega_0 t) \cos(\cos^{-1} a) + A \cos(\omega_0 t) d(t) \sin(\cos^{-1} a)$$

$$= A a \sin(\omega_0 t) + d(t) A \sqrt{1-a^2} \cos(\omega_0 t)$$

where $\sin(\cos^{-1} a) = \sqrt{1-a^2}$

b) $P_c = \int_0^T [Aa \sin(\omega_0 t)]^2 dt = \frac{1}{2} A^2 a^2$

$P_m = \int_0^T [d(t) A \sqrt{1-a^2} \cos(\omega_0 t)]^2 dt$

$= \frac{1}{2} A^2 (1-a^2)$

where $d^2(t) = 1$

therefore $\frac{P_c}{P_m} = \frac{\frac{1}{2} A^2 a^2}{\frac{1}{2} A^2 (1-a^2)} = \frac{a^2}{(1-a^2)}$