1. A box of 100 mobile phones contains 20 that are defective. Two mobile phones are selected at random, without replacement, from the box.

   (a) *(5%)* What is the probability that the first one selected is defective?

   (b) *(5%)* What is the probability that the second one selected is defective given that the first one was defective?

   (c) *(5%)* What is the probability that both are defective?

2. Consider the binary communication channel shown below. The channel input symbol X may assume the state 0 or the state 1, and, similarly, the channel output symbol Y may assume either the state 0 or the state 1. Because of the channel noise, an input 0 may convert to an output 1 and vise versa. The channel is characterized by the channel transition probabilities p_0, q_0, p_1, and q_1, defined by

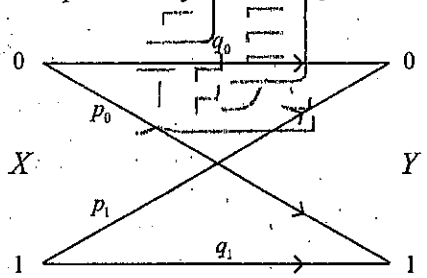
$$p_0 = P(y_1 \mid x_0) \quad \text{and} \quad p_1 = P(y_0 \mid x_1)$$
$$q_0 = P(y_0 \mid x_0) \quad \text{and} \quad q_1 = P(y_1 \mid x_1)$$

   where x_0 and x_1 denote the events $(X=0)$ and $(X=1)$, respectively, and y_0 and y_1 denote the events $(Y=0)$ and $(Y=1)$, respectively. Note that $p_0+q_0=1=p_1+q_1$. Let $P(x_0)=0.5$, $p_0=0.1$, and $p_1=0.2$.

   (a) *(5%)* Find $P(y_0)$ and $P(y_1)$.

   (b) *(5%)* If a 0 was observed at the output, what is the probability that a 0 was the input state?

   (c) *(5%)* Calculate the probability of error P_e.



3. Briefly explain each of the followings:

(a) *(7%)* The stationarity conditions for strict-sense stationary, wide-sense stationary, and cyclostationary processes.

(b) *(7%)* The central limit theorem (CLT).

(c) *(7%)* The relation between correlation function and power spectral density (PSD).

(d) *(7%)* The additive white Gaussian noise (AWGN).

(e) *(7%)* The method of envelop detection for amplitude modulation (AM).

(f) *(7%)* The difference between carrier-sense multiple access (CSMA) with collision detection (CD) and with collision avoidance (CA).

(g) *(7%)* The advantage(s) and disadvantage(s) of differential modulation.

(h) *(7%)* In general, a frequency-modulated (FM) signal can be written as

$$s(t) = A_c \cos\left[2\pi f_c t + 2\pi k_f \int_{-\infty}^{t} m(\tau)d\tau\right]$$

where k_f is the frequency deviation (or named frequency sensitive). What is the purpose of this factor?

(i) *(7%)* For M-ary phase-shift keying (M-PSK) and M-ary quadrature amplitude modulation (M-QAM) with the same value of M and equal transmit energy, which one may generally provide better error-rate performance? Why?

(j) *(7%)* Why can direct-sequence spread-spectrum (DSSS) system suppress narrowband interference?