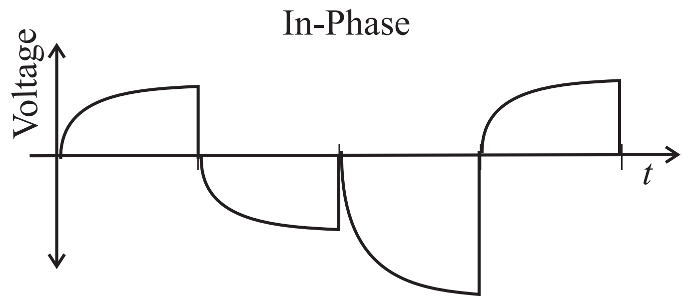
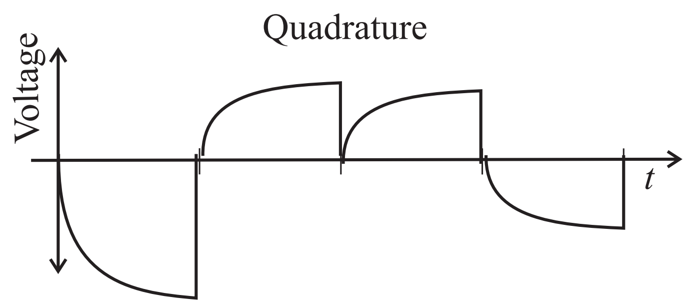
ECE 6390: Satellite Communications and Navigation Systems

Solutions to TEST 3 (Summer 2015)

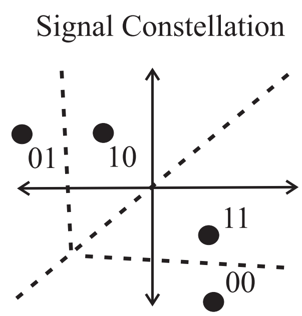
1. **Digital Transmission:**

   (a) See sketch below:



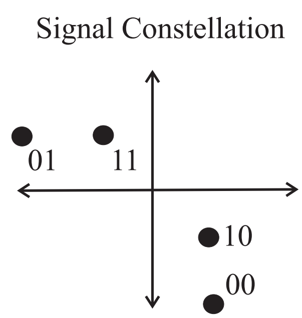


   (b) An example of good decision boundaries



   (c) Any sketched pulse with more rounded features was counted as full credit for this question.

   (d) Any arrangement that separated complementary pairs was counted as full credit, such as



(e) This analog signal must be sampled at 10 Msample/sec with 8 bits/sample to maintain 48 dB SNR. Since the modulation scheme above transmits 2 bits/symbol, the final symbol rate is 40 Msymbols/sec resulting in a symbol period of 25 ns.

(f) Any lossy form of video compression would work here, since there is a lot of uncompressed data to store on the spacecraft.

(g) 0.0016

2. **Rain Attenuation:**

(a) $\alpha = 1$, $k = 1/6$

(b) Horizontal polarization scatters more power from a wave than any other polarization due to the shape of rain drops. The attenuation constants α and k would increase.

3. **Radiolocation Analysis:**

(a) The base stations should be the points of an equilateral triangle with the user in the center.

(b) How do we adapt our GPS formula to this system from first principles? Since no spread-spectrum is being used, we may view this as a spread spectrum system where $M = 1$ and $T_c = T_b = T_s$.

$$\frac{C}{N} = \frac{10^{-80/10}}{10^{-100/10} + 1.3807 \times 10^{-20}\text{mJ K}^{-1} \times 2 \times 10^5\text{kHz} \times 150\text{K}} = 99.96 = 20.0 \text{ dB}$$

Thus, with $N_{sat} = 3$ in this case and with $T_{int} = 1$ms:

$$\sigma_r = cT_c \sqrt{\frac{N_{sat} T_b}{\left(\frac{C}{N}\right)_{\text{despread}} T_{int}}} = 12 \text{ m}$$

(c) Clock errors and multipath are sources of error. None of the other analogous errors with GPS (ephemeris, variable atmospheric delays, etc.) apply to a terrestrial system.