EE302 Homework #4

Assigned 10/14/09, Due 10/23/09 (by 4:30 in dropbox in MSEE 330)

1. Text, problem 3.41, page 134.

2. Text, problem 4.32, page 218

3. A Gaussian random volatage X volts is input to a half wave rectifier and the output voltage is $Y = Xu(X)$ Volts were $u(x)$ is the unit step function. Assume X has mean 0 volts and variance σ^2 Volts^2. The output voltage Y is then applied accross a (nonrandom) resistance of R ohms. The answers below should be expressed in terms of the Φ or Q function or in closed form (no integrels).*Remark*: you may wish to use the fact that if X is a Gaussian random variable then $\mathrm{E}\left[\left(X-\overline{X}\right)^4\right] = 3\sigma^4$

   (a) Find the probability that the current which flows through the resistor exceeds 1 Amp.

   (b) Find the probability that the power which is dissipated in the resistor exceeds 1 watt.

   (c) Find the mean and variance of the current which flows through the resistor

   (d) Find the mean and variance of the power which is dissipated in the resistor.

4. Text, problem 4.68, page 221. *Note;*A chip is preferred for a target lifetime if the probability that the chips lasts at least the target lifetime is larger

5. A random voltage X which is uniformly distributed between a and b $(a < b)$ is to be quantized into a discrete random variable $Y = q(X)$ which has $K \geq 2$ levels.The quantization error is $E = X - Y = X - q(X)$. Your answers below should be for general K except where you are asked to sketch something for particular K.

   (a) Find the quantizer function $q(x)$ such that the quantization intervals are all the same length, and the quantization value assigned to a quantization interval is the midpoint of the interval. Sketch the quantizer function $q(x)$ for $K = 2, 3$.

   (b) Find the quantization error function $g(x) = x - q(x)$. Sketch the quantization error function $g(x)$ for $K = 2, 3$.

   (c) Find the pdf of the quantized value $Y = q(X)$, and the pdf of the quantization error $E = g(X)$.

   (d) Find the mean square quantization error $\mathrm{E}\left[E^2\right]$. Do this computation using the pdf for X, and also using the pdf for E..

6. Text, problem 3.39, p. 134. *Hint:* X is the first arrival time in a Bernouilli process, or equivalently, the trial where the event of interest first happens in a sequence of Bernouilli trials.

7. Text, problem 4.69, p. 222. *Note*: the assumption that the interarrival times are independent exponential random variables is equivalent to assuming arrivals occur according to a Poisson process