1) Using tables or a computer, for a zero-mean Gaussian distribution, determine the probability that x (the indepenant variable) exceeds 1σ, 2σ, 3σ, 4σ.

I am going to assume that you are looking for the complement to the integral of the the gaussian distribution between -$\alpha\sigma$ and +$\alpha\sigma$ where α equals 1, 2, 3, and 4. This can be done by finding the difference between the CDF function for the distribution evaluated at the two different points.

The code to determine the integral is defined below:

```
getNormIntegral = function(x, sd = 1) {
  res = pnorm(x*sd, sd = sd) - pnorm(-1*x*sd, sd = sd)
  return(1.0 - res)
}
```

Number of σ	Probability to Exceed
1	`getNormIntegral(1)` = 0.3173
2	`getNormIntegral(2)` = 0.0455
3	`getNormIntegral(3)` = 0.0027
4	`getNormIntegral(4)` = 0.0001

2) Choose a set of resonable values of P_D, P_{FA}, n, and n_e, and compute D_e = required SNR for detection, using the methodology outlined in Section 4.1. (Charts 33 and 34)

To solve this problem I will use equation 4.16 from the text.

$$SNR_{\text{required}} = D_e(n, n_e) = \frac{D_0(1)L_i(n)L_f(n_e)}{n}$$

In this equation $D_0(1)$ is the detectability factor for a non-fluctuating target with a single integration pulse, $L_i(n)$ represents the losses due to integration, $L_f(n_e)$ are the losses due to the Swerling case, and n is the number of pulses that are being integrated over. Assuming that we are dealing with a Swerling-1 case ($n_e = 1$) and we substitute equation 4.11 into the above, the equation is modified to take the following form:

$$\begin{aligned} SNR_{\text{required}} = D_e(n, n_e) &= \frac{D_0(1)\left(\frac{nD_0(n)}{D_0(1)}\right)\left(\frac{D_1(1)}{D_0(1)}\right)}{n} \\ &= \end{aligned}$$

3) For a binary integrator, assume $P_D(1/1) = 0.7$. Find the probability of *exactly* 5 out of 8 detections, and the probability of *at least* 5 out of 8 detections.

The probability of m out of n detections given a specific probability p is found through the application of the binomial.

$$P_D(m, n) = \binom{n}{m} p^m \left(1 - p\right)^{n-m}$$

The answer for the first question of exactly 5 out of 8 is `dbinom(5, 8, 0.7) =` 0.25. The answer for the second question for the probability of at least 5 out of 8 can be found by taking the complement of the cumulative distribution function evaluated at 4 success; `1 - pbinom(4,8,0.7) =` 0.81.