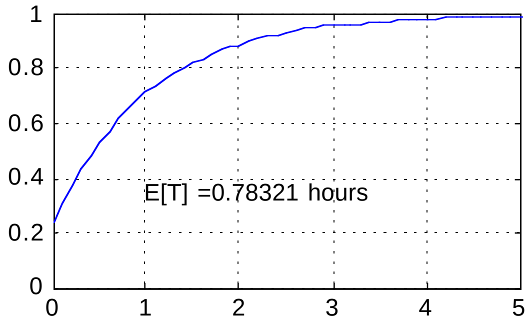
λ–σ Acoustic Detection Model and ROC Curves

1. Using the λ–σ model with SE_bar = -3.5dB; λ=4 jumps/hr; and σ=5 dB,
   a. compute and plot CDF $F_T(t)$ for t=0:.1:5 hours;
   b. compute mean time to detection as

$$E[T] = \int_{t=0}^{\infty} \left(1 - F_T(t)\right) dt \,.$$



Ans:

CDF =
1 - (1-Φ(-3.5/5)) exp(-4*Φ(-3.5/5)*t)

meanT = simrule(1-CDF,dt)

2. Assume a single look for a known signal in Gaussian noise. When there is no target, the received voltage signal is $N(0, 5^2)$. When the target is present, the received signal is $N(s, 5^2)$.

a. Allow the detection threshold ν to vary from –20 to 20 dB, and then plot $(Pf(\nu),Pd(\nu))$ (i.e. the ROC curve) for each s=[0:2:20] dB.

b. Now assume:

   s = target signal level = 10 dB;
   c1 =cost of a missed detection = 10;
   c2 = cost of a false alarm = 3; and
   p = Prob(target present) = .3. So,
   $c(\nu)$=average_cost_per_look = p*c1*(1-Pd(ν)) + (1-p)*c2*Pf(ν).

Using MATLAB, plot $c(\nu)$, identify the minimum cost detection threshold ν^* and the associated point on the ROC curve.

c. Verify by direct differentiation that $\nu^* \approx 4.1$ db.