Question 1

Let a zero-mean stationary Gaussian random envelope $a(t)e^{j2\pi\nu t}$ with the coherence function $R(t_1, t_2)$, **Karhunen-Loeve expansion** $a(t) = \sum_{i=0}^{\infty} a_i g_i(t)$ **over the interval** $[-T/2, T/2]$**, and expansion eigen values** $\mathcal{E}\{|a_i|^2\} = \lambda_i$ **impinge on a photo-detector having the deterministic multiplication gain** $g = 1$**, quantum efficiency** η **and area** A**.**

(a) Find the characteristic function $\Psi_m(j\omega)$ of the carrier generation mean parameter m.

(b) Find the characteristic function $\Psi_k(j\omega)$ of the output carrier count k.

(c) Find the mean of the output carrier count $\bar{k}$.

(d) Find the variance of the output carrier count σ_k^2.

(e) Find the SNR of the output carrier count.

(f) Find the shot noise level of the output current.

(g) Evaluate the previous parts if the envelope is a baseband colored noise with the power spectral density N_0/A over the optical bandwidth $[-B_o/2, B_o/2]$.