1. Prove spectrum properties(N is WSS)：
   (1) $R_{N_I}(\tau) = R_{N_Q}(\tau)$ and $R_{N_I,N_Q}(\tau) = -R_{N_I,N_Q}(\tau)$
   (2) $R_N(\tau) = R_{N_I}(\tau)\cos(2\pi f_c\tau) - R_{N_Q,N_I}(\tau)\sin(2\pi f_c\tau)$
   (3) $R_{\tilde{N}}(\tau) = R_{N_I}(\tau) + jR_{N_Q,N_I}(\tau)$
   (4) $R_N(\tau) = \mathrm{Re}\{R_{\tilde{N}}(\tau)\exp(j2\pi f_c\tau)\}$
   (5) $S_{\tilde{N}}(f)$ is real valued.
   (6) $S_{N_I}(f) = S_{N_Q}(f)$ and $S_{N_I,N_Q}(f) = -S_{N_Q,N_I}(f)$
   (7) $S_N(f) = \frac{1}{2}(S_{\tilde{N}}(f - f_c) + S_{\tilde{N}}(-f - f_c))$

2. Consider a square-law detector, using a nonlinear device whose transfer characteristic is defined by

$$v_2 = a_1 v_1(t) + a_2 v_1^2(t)$$

where a_1 and a_2 are constants, $v_1(t)$ is the input, and $v_2(t)$ is the output. The input consists of the AM wave

$$v_1(t) = A_c[1 + k_a m(t)]\cos(2\pi f_c t)$$

(1) Evaluate the output $v_2(t)$.

(2) Find the conditions for which the message signal $m(t)$ may be recovered from $v_2(t)$.