Homework 3

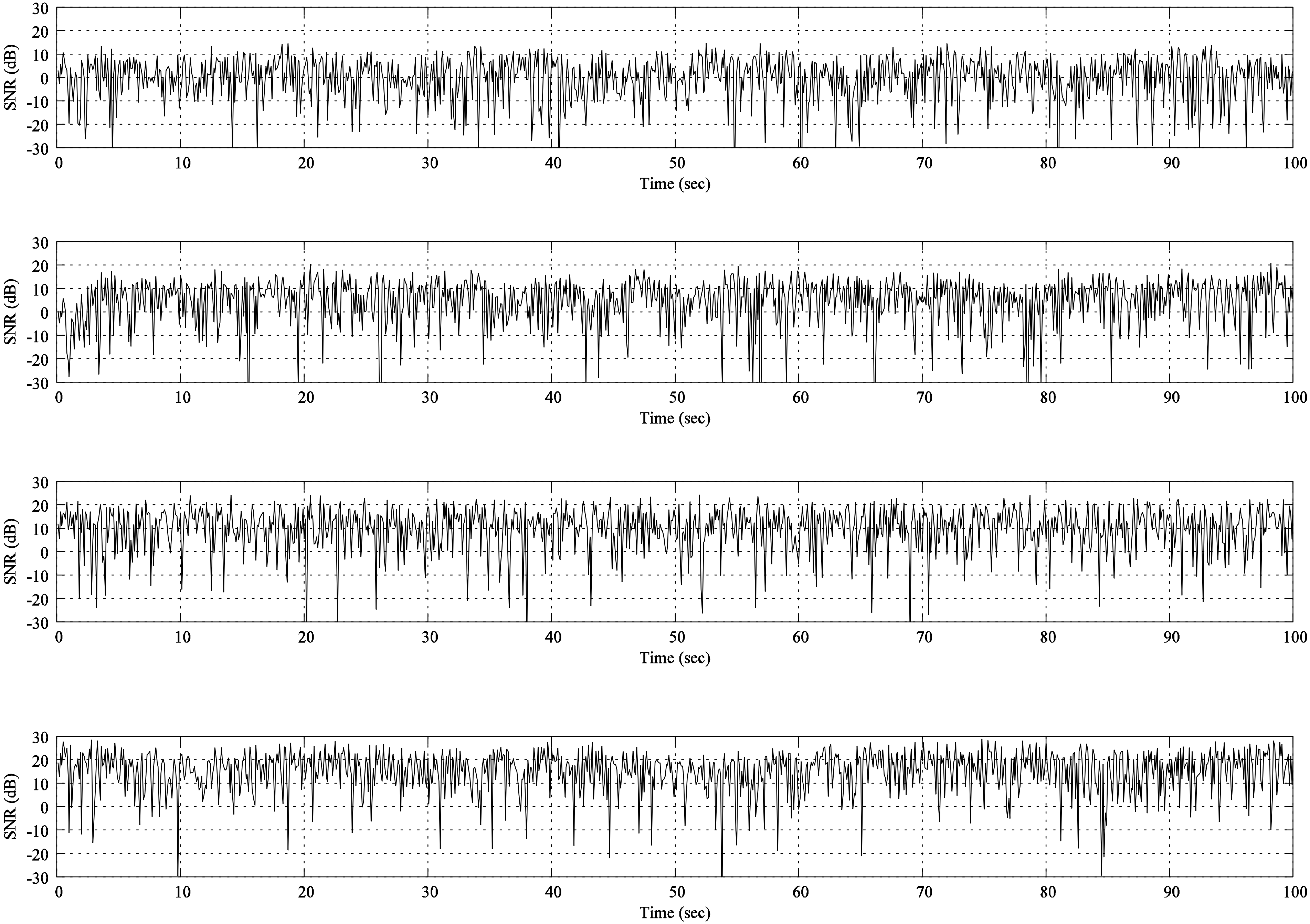
- Consider Nakagami-m fading channel with m=1

  Packet error probability after N_r^{max} retransmissions :

$$\mathrm{P}_{n,\mathrm{ARQ}} = q_n^{N_r^{\max}+1}.$$

- For the transmission modes defined in Table II and with truncated ARQ (no AMC) with retransmission limit N_r^{max} ,find the threshold $\bar{\gamma}_{n,\mathrm{th}}$ for n =1,2,…,6 such that

  - P_{loss} requirement is satisfied $\bar{\gamma} \geq \bar{\gamma}_{n,\mathrm{th}}$,
  - P_{loss} requirement is not satisfied $\bar{\gamma} < \bar{\gamma}_{n,\mathrm{th}}$



SNR (dB)
30
20
10
0
-10
-20
-30
0
10
20
30
40
50
60
70
80
90
100
Time (sec)

Homework #3 Solution

- Average PER at the physical layer for Mode n :

$$q_n = \overline{PER}(n) = \int_0^{\infty} PER_n(g)\,p(g)\,dg = 1 - e^{-\frac{g_{pn}}{\bar{g}}} + \frac{a_n}{1 + g_n \bar{g}} e^{-(g_n + 1/\bar{g})g_{pn}}$$

- Then

$$q_n^{(N_{\max}+1)} \le \mathrm{P}_{\mathrm{loss}}$$

$$\Downarrow$$

$$q_n \le P_{target} = \sqrt[(N_{\max}+1)]{P_{loss}}$$

- Threshold:

$$Threshold = \min\left\{ \bar{g} \,\middle|\, 1 - e^{-\frac{g_{pn}}{\bar{g}}} + \frac{a_n}{1 + g_n \bar{g}} e^{-(g_n + 1/\bar{g})g_{pn}} \le P_{target} \right\}$$

```
A = [274.7229, 90.2514, 67.6181, 50.1222, 53.3987, 35.3508];
G = [7.9932,   3.4998,  1.6883,  0.6644,  0.3756,   0.09  ];
R = [-1.5331,  1.0942,  3.9722,  7.7021, 10.2488,  15.9784];
for i = 1:6
    P_loss   = exp(-(i)*log(10));
    for k = 0:3
        N_max    =  k;
        P_target =  P_loss^( 1/(N_max +1) );
        Results  = [P_loss,N_max,P_target];
        for Mode=1:6
            a        = A(Mode);
            g        = G(Mode);
            r        = exp(0.1*R(Mode));
            step     = 1;
            Flag     = 0;
            n        = 0;
            while(Flag < 1)
                n       = n + 1;
                ave_SNR = r + n*step;
                y       = 1-exp(-r/ave_SNR) + a*exp(-(g+1/ave_SNR)*r)/(1+ave_SNR*g);
                if(y <= P_target)
                    Flag   = 1;
                    value  = 10*log10(ave_SNR);
                end
            end
            Results   = [Results, value];
        end
        format short g
        Results
    end
end
```