





```

clc;
close all;
Q=23;
levels=1:Q;
[x, Fs] = audioread('Sample_rec_dc.wav');
signal_power_unif = sum((x).^2) / length(x) ;
mx = max(x);
mn = min(x);
xq=x;
sqnr_nu=levels;
sqnr_u=levels;
step = (mx-mn)./levels;
for i= 1:Q
    R=zeros(1,i);
    for j =1:i
        R(j)= (2^j)*(step(i)/23);
    end
    for k= 1 : length(x)
        for j = 1 : i
            if(abs(x(k))<=R(j))
                xq(k)=sign(x(k))*R(j);
                break
            end
        end
        if(xq(k)==x(k))
            xq(k)=sign(x(k))*R(i);
        end
    end
    %xq = mn+ in*step(i);
    noise = xq - x;
    noise_power = sum((noise).^2) / N ;
    sqnr_nu(i) = 10*log10(signal_power_unif/noise_power);
    disp([2*i,"-",sqnr_nu(i)]);
end
xq_u= x;
for i= 1:Q
    in = round((x-mn)/step(i));
    xq_u = mn+ in*step(i);
    noise = xq_u - x;
    noise_power = sum((noise).^2) / length(noise) ;
    sqnr_u(i) = 10*log10(signal_power_unif/noise_power);
    disp([2*i,"-",sqnr_u(i)]);
end
sound(xq,Fs);
plot(x);
title('Original Audio Signal');
plot(xq);
title('Non-Uniform Quantized Audio Signal');
plot(xq_u);
title('Uniformly Quantized Audio Signal');
plot(1:2:2*Q,sqnr_nu,'b',LineWidth=2);
plot(1:2:2*Q,sqnr_u,'--g',LineWidth=2);
legend('sqnr of non uniform quantization' , 'sqnr of uniform
quantization','Location','northwest')
xlabel("Quantization Levels");
ylabel("SQNR in db");
title("Sqnr VS Quantization Levels");

```

Non-Uniform Quantizer

"2"	"_"	"-5.0952"
"4"	"_"	"0.42406"
"6"	"_"	"2.6267"
"8"	"_"	"3.428"
"10"	"_"	"4.1445"
"12"	"_"	"4.6816"
"14"	"_"	"4.6811"
"16"	"_"	"5.1561"
"18"	"_"	"5.4177"
"20"	"_"	"5.5331"
"22"	"_"	"5.5661"
"24"	"_"	"5.216"
"26"	"_"	"5.057"
"28"	"_"	"5.1003"
"30"	"_"	"5.2645"
"32"	"_"	"5.5001"
"34"	"_"	"5.6427"
"36"	"_"	"5.6962"
"38"	"_"	"5.7612"
"40"	"_"	"5.7574"
"42"	"_"	"5.7544"
"44"	"_"	"5.7475"
"46"	"_"	"5.6059"

Uniform Quantizer

"2"	"_"	"-20.8325"
"4"	"_"	"0.37977"
"6"	"_"	"-10.5959"
"8"	"_"	"2.265"
"10"	"_"	"-5.6305"
"12"	"_"	"4.4576"
"14"	"_"	"-2.2908"
"16"	"_"	"6.1856"
"18"	"_"	"0.27641"
"20"	"_"	"7.3692"
"22"	"_"	"2.4137"
"24"	"_"	"8.3254"
"26"	"_"	"4.2262"
"28"	"_"	"9.1697"
"30"	"_"	"5.8201"
"32"	"_"	"9.8809"
"34"	"_"	"7.239"
"36"	"_"	"10.5184"
"38"	"_"	"8.5335"
"40"	"_"	"11.0461"
"42"	"_"	"9.728"
"44"	"_"	"11.5139"
"46"	"_"	"10.8276"

```

clc;
close all;
Q=23;
n = 1:Q;
levels=1:Q;
for i= n;
    levels(i)=2^i;
end;
disp(n);
disp(levels);
N=100000;
x=rand(1,100000)-1/2;
signal_power_unif = sum((x).^2) / N ;
mx = max(x);
mn = min(x);
xq=x;
sqnr_u=n;
step = (mx-mn)./levels;
disp(step);
for i= 1:Q
    in = round((x-mn)/step(i));
    xq = mn+ in*step(i);
    noise = xq - x;
    noise_power = sum((noise).^2) / N ;
    sqnr_u(i) = 10*log10(signal_power_unif/noise_power);
    disp([2^i,"-",sqnr_u(i)]);
end
hold on ;
plot(levels,sqnr_u,'b',LineWidth=2);
plot(levels,10*log10(12*signal_power_unif*(levels.^2)/(mx-mn)^2),'--g',LineWidt
h=2);
y=randn(1,N)/sqrt(12);
maxy = max(y);
miny = min(y);
yq=y;
sqnr=n;
signal_power = sum((y).^2) / N ;
step = (maxy-miny)./levels;
for i= 1:Q
    in = round((y-miny)/step(i));
    yq = miny + in*step(i);
    noise = yq - y;
    noise_power = sum((noise).^2) / N ;
    sqnr(i) = 10*log10(signal_power/noise_power);
    disp([2^i,"-",sqnr(i)]);
end
plot(levels,sqnr,LineWidth=2);
plot(levels, 10*log10(12*signal_power*(levels.^2)/(maxy-miny)^2)
,'--r',LineWidth=2);
xlabel("Quantization Levels");
ylabel("SQNR in db");
title("Sqnr VS Quantization Levels");
legend('sqnr of uniform signal' , 'theoritical sqnr of uniform','sqnr of
gaussian signal','theoritical sqnr of gaussian','Location','southeast')
grid on;

```

SONR of Uniform Signal

"2"	"-"	"6.0185"
"4"	"-"	"12.0366"
"8"	"-"	"18.0675"
"16"	"-"	"24.0946"
"32"	"-"	"30.0797"
"64"	"-"	"36.1193"
"128"	"-"	"42.167"
"256"	"-"	"48.1467"
"512"	"-"	"54.2209"
"1024"	"-"	"60.2057"
"2048"	"-"	"66.2381"
"4096"	"-"	"72.2527"
"8192"	"-"	"78.2499"
"16384"	"-"	"84.3114"
"32768"	"-"	"90.3058"
"65536"	"-"	"96.3494"
"131072"	"-"	"102.3592"
"262144"	"-"	"108.3709"
"524288"	"-"	"114.389"
"1048576"	"-"	"120.4258"
"2097152"	"-"	"126.4797"
"4194304"	"-"	"132.4557"
"8388608"	"-"	"138.4655"

SONR of Gaussian

"2"	"-"	"0.39951"
"4"	"-"	"4.0706"
"8"	"-"	"10.0303"
"16"	"-"	"16.016"
"32"	"-"	"22.0389"
"64"	"-"	"28.072"
"128"	"-"	"34.1023"
"256"	"-"	"40.1218"
"512"	"-"	"46.1352"
"1024"	"-"	"52.1637"
"2048"	"-"	"58.1834"
"4096"	"-"	"64.1985"
"8192"	"-"	"70.2102"
"16384"	"-"	"76.2288"
"32768"	"-"	"82.2422"
"65536"	"-"	"88.285"
"131072"	"-"	"94.2919"
"262144"	"-"	"100.3112"
"524288"	"-"	"106.3439"
"1048576"	"-"	"112.3598"
"2097152"	"-"	"118.3805"
"4194304"	"-"	"124.3879"
"8388608"	"-"	"130.407"