1, Practice 1.1

a) The main code of this program:

```
%% the introduction of this program
disp('-----------------------------------');
disp('This is Class Practice 1.1');
disp('This is done by student GaoQi-Amber, 16/7/2023');
disp('given the K and L and we can get N for all combinations');
disp('-----------------------------------')
```

```
%% get the value
% The user is prompted for K and L
disp('please input the range of K:  ');
%get the value of K from user
K = input('K = ');
disp('please input the range of L:  ');
L = input('L = ');
```

```
%% Calculate the size of N and output
%prompt
fprintf('the outputs are:  \n');
%In the first layer cycle, L grows from 1 to L, and K increases by 1
for k = 1:K
    %The second layer loops
    for l = 1:L
        N = k^2 + k*l + l^2;    %Calculate N
        fprintf('(K, L) = (%d, %d), N = %d\n', k, l, N);    %output
    end
end
```

b) The process after we run this program:

```
-----------------------------------
This is Class Practice 1.1
This is done by student GaoQi-Amber, 16/7/2023
given the K and L and we can get N for all combinations
-----------------------------------
please input the range of K:
K =
```

c) Next, we can input the value of the range of K, for example 4

```
-----------------------------------
This is Class Practice 1.1
This is done by student GaoQi-Amber, 16/7/2023
given the K and L and we can get N for all combinations
-----------------------------------
please input the range of K:
K = 4
please input the range of L:
L =
```

d) Then input the value of the range of L, and we can get the result：

```
-----------------------------------
please input the range of K:
K = 4
please input the range of L:
L = 5
the outputs are:
(K, L) = (1, 1), N = 3
(K, L) = (1, 2), N = 7
(K, L) = (1, 3), N = 13
(K, L) = (1, 4), N = 21
(K, L) = (1, 5), N = 31
(K, L) = (2, 1), N = 7
(K, L) = (2, 2), N = 12
(K, L) = (2, 3), N = 19
(K, L) = (2, 4), N = 28
(K, L) = (2, 5), N = 39
(K, L) = (3, 1), N = 13
(K, L) = (3, 2), N = 19
(K, L) = (3, 3), N = 27
(K, L) = (3, 4), N = 37
(K, L) = (3, 5), N = 49
(K, L) = (4, 1), N = 21
(K, L) = (4, 2), N = 28
(K, L) = (4, 3), N = 37
(K, L) = (4, 4), N = 48
(K, L) = (4, 5), N = 61
>>
```

2, Practice 1.2

a) the main code:

```
%% the introduction of this program
disp('-----------------------------------');
disp('This is Class Practice 1.2');
disp('This is done by student GaoQi-Amber, 16/7/2023');
disp('We want to know what is the SIR when N is 7 or 12');
disp('-----------------------------------')

%% get the value
%get the value of alpha from user
alpha = input('please input the alpha:  ');


%% Calculate the SIR and output
disp('when the N is 7: ');
N=7;
Q=sqrt(3*N);
SIR=1/(((2*(Q+1)^alpha+(Q-1)^alpha)/(Q^2-1)^alpha)+(((Q+0.5)^alpha+(Q-0.5)^alpha)/(Q^2-0.25)^alpha)+(1/Q^alpha));
fprintf('SIR is %g\n',SIR);

disp('when the N is 12: ');
N=12;
Q=sqrt(3*N);
SIR=1/(((2*(Q+1)^alpha+(Q-1)^alpha)/(Q^2-1)^alpha)+(((Q+0.5)^alpha+(Q-0.5)^alpha)/(Q^2-0.25)^alpha)+(1/Q^alpha));
fprintf('SIR is %g\n',SIR);
```

b) then we can get the answer in the situation of the different alpha

```
-----------------------------------
This is Class Practice 1.2
This is done by student GaoQi-Amber, 16/7/2023
We want to know what is the SIR when N is 7 or 12
-----------------------------------
please input the alpha:  2.7
when the N is 7:
SIR is 8.02355
when the N is 12:
SIR is 18.0212
```

3, Practice 1.3

a) the main code:

```
%% get the value
K=input('what is the range of k?');
L=input('what is the range of l?');
alpha=input('what is the the pathloss exponent?');

fprintf('\n')
disp('the outputs are: ')
fprintf('\n')
```

```
%% Calculate the size of N and output
%prompt
fprintf('the outputs are:  \n');

%now we add a new layer to loop all the alpha's situation
%each loop a would add 0.5
for a=1:0.5:alpha
    for k = 1:K
        for l = 1:L
            N = k^2 + k*l + l^2;    %Calculate N

            SIRapp=(sqrt(3*N))^alpha/6; %Calculate the approxinated SIR
            SIPapp_dB=10*log10(SIRapp); %Convert it to dB form

            Q=sqrt(3*N);
            %Calculate the accurate SIR
            SIRacc=1/(((2*(Q+1)^alpha+(Q-1)^alpha)/(Q^2-1)^alpha)+(((Q+0.5)^alpha+(Q-0.5)^alpha)/(Q^2-0.25)^alpha)+(1/Q^alpha));
            %Convert it to dB form
            SIRacc_dB=10*log10(SIRacc);

            fprintf('(K, L) = (%d, %d), alpha is %g, N = %d and the approxinated SIR is %g dB the accurate SIR is %g dB\n', k, l, a, N,SIPapp_dB,SIRacc_dB);    %output
        end
    end
end
```

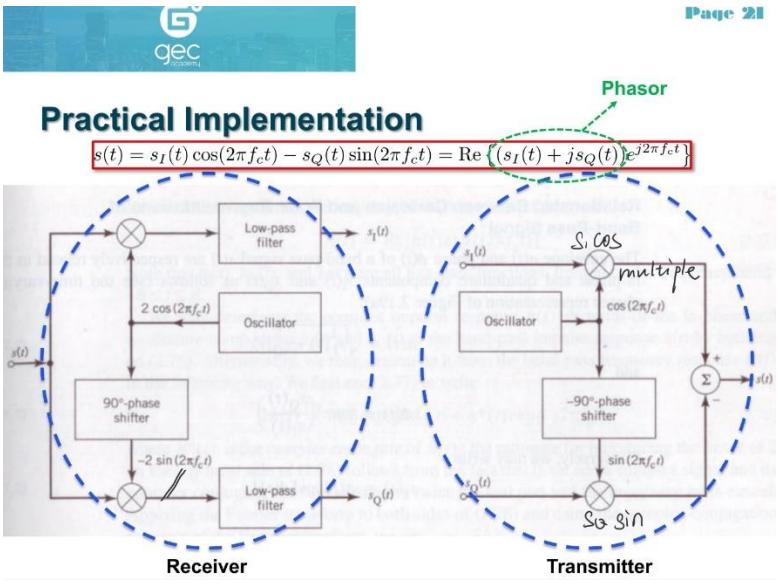
b) the result:

what is the range of k?2
what is the range of l?4
what is the the pathloss exponent?2.7

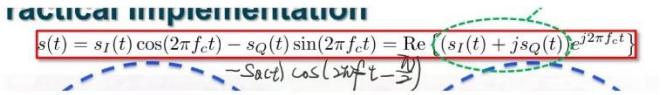
the outputs are:

the outputs are:
(K, L) = (1, 1), alpha is 1, N = 3 and the approxinated SIR is 5.10076 dB the accurate SIR is 3.00009 dB
(K, L) = (1, 2), alpha is 1, N = 7 and the approxinated SIR is 10.0684 dB the accurate SIR is 9.04367 dB
(K, L) = (1, 3), alpha is 1, N = 13 and the approxinated SIR is 13.6979 dB the accurate SIR is 13.0668 dB
(K, L) = (1, 4), alpha is 1, N = 21 and the approxinated SIR is 16.5096 dB the accurate SIR is 16.0676 dB
(K, L) = (2, 1), alpha is 1, N = 7 and the approxinated SIR is 10.0684 dB the accurate SIR is 9.04367 dB
(K, L) = (2, 2), alpha is 1, N = 12 and the approxinated SIR is 13.2286 dB the accurate SIR is 12.5578 dB
(K, L) = (2, 3), alpha is 1, N = 19 and the approxinated SIR is 15.9228 dB the accurate SIR is 15.4473 dB
(K, L) = (2, 4), alpha is 1, N = 28 and the approxinated SIR is 18.1963 dB the accurate SIR is 17.8365 dB
(K, L) = (1, 1), alpha is 1.5, N = 3 and the approxinated SIR is 5.10076 dB the accurate SIR is 3.00009 dB
(K, L) = (1, 2), alpha is 1.5, N = 7 and the approxinated SIR is 10.0684 dB the accurate SIR is 9.04367 dB
(K, L) = (1, 3), alpha is 1.5, N = 13 and the approxinated SIR is 13.6979 dB the accurate SIR is 13.0668 dB
(K, L) = (1, 4), alpha is 1.5, N = 21 and the approxinated SIR is 16.5096 dB the accurate SIR is 16.0676 dB
(K, L) = (2, 1), alpha is 1.5, N = 7 and the approxinated SIR is 10.0684 dB the accurate SIR is 9.04367 dB
(K, L) = (2, 2), alpha is 1.5, N = 12 and the approxinated SIR is 13.2286 dB the accurate SIR is 12.5578 dB
(K, L) = (2, 3), alpha is 1.5, N = 19 and the approxinated SIR is 15.9228 dB the accurate SIR is 15.4473 dB
(K, L) = (2, 4), alpha is 1.5, N = 28 and the approxinated SIR is 18.1963 dB the accurate SIR is 17.8365 dB
(K, L) = (1, 1), alpha is 2, N = 3 and the approxinated SIR is 5.10076 dB the accurate SIR is 3.00009 dB
(K, L) = (1, 2), alpha is 2, N = 7 and the approxinated SIR is 10.0684 dB the accurate SIR is 9.04367 dB
(K, L) = (1, 3), alpha is 2, N = 13 and the approxinated SIR is 13.6979 dB the accurate SIR is 13.0668 dB
(K, L) = (1, 4), alpha is 2, N = 21 and the approxinated SIR is 16.5096 dB the accurate SIR is 16.0676 dB
(K, L) = (2, 1), alpha is 2, N = 7 and the approxinated SIR is 10.0684 dB the accurate SIR is 9.04367 dB

4, For the question in the middle of class:



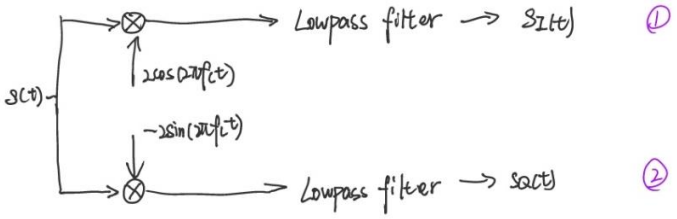
a) Proof formula



$$= Re\left[S_I(t)e^{2\pi f t} - S_Q(t)e^{2\pi f t - \frac{\pi}{2}}\right]$$

$$= Re\left[S_I(t)e^{2\pi f t} + jS_Q(t)e^{2\pi f t}\right]$$

b) The process by which s(t) is broken down into sI(t) and sQ(t).



① After getting the wave from the oscillator :

$$\text{signal} = 2S(t)\cos = 2S_I\cos^2(2\pi f_c t) - 2S_Q\sin(2\pi f_c t)\cdot\cos(2\pi f_c t)$$

$$= S_I\cos(4\pi f_c t) - S_Q\sin(4\pi f_c t) + S_I$$

$2\cos^2 x = \cos 2x + 1$

$2\sin x\cos x = \sin 2x$

after passing the filter, the high frequency section can be eliminated

then the signal will be S_I.

② $\text{signal} = -2S(t)\sin(2\pi f_c t)$

$$= -2S_I\cos(2\pi f_c t)\sin(2\pi f_c t) + 2S_Q\sin^2(2\pi f_c t)$$

$$= -S_I\sin(4\pi f_c t) + S_Q - S_Q\cos(4\pi f_c t)$$

$2\sin^2 x = 1 - \cos 2x$

then pass the pass-low filter to eliminat the high frequency part in signal

then signal = S_Q