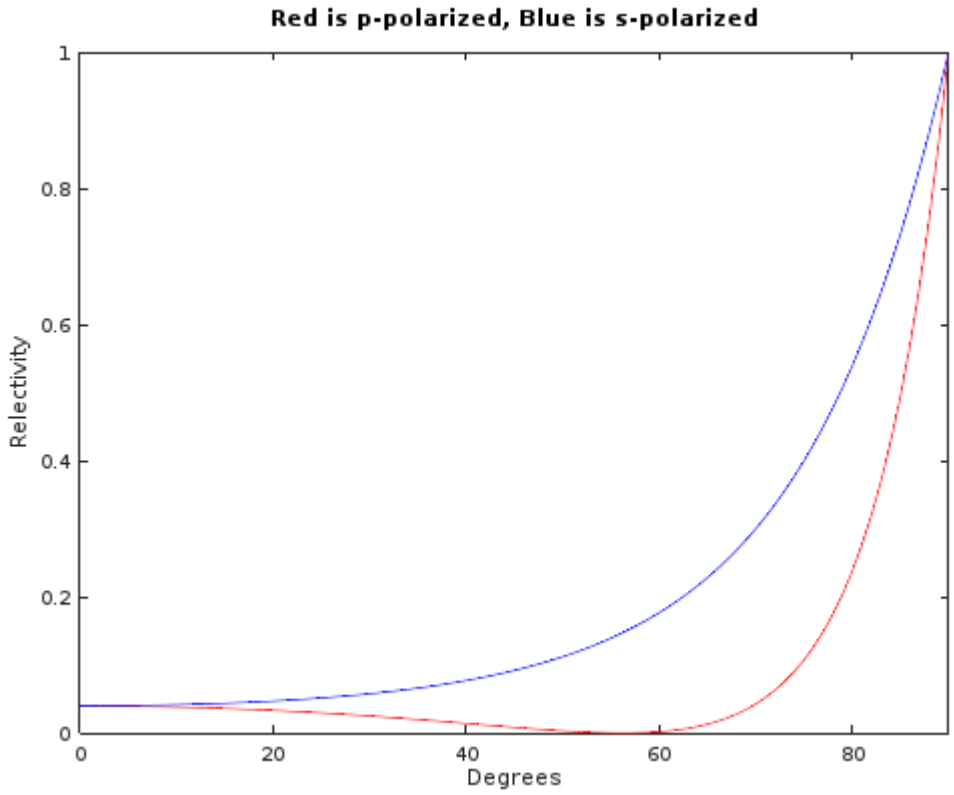
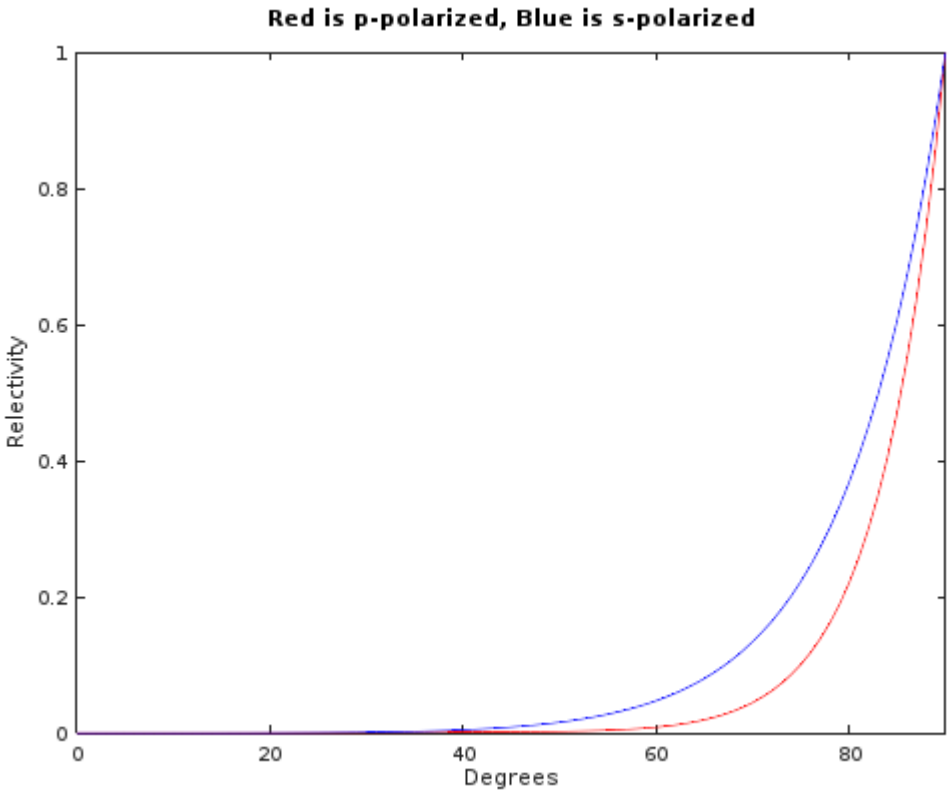
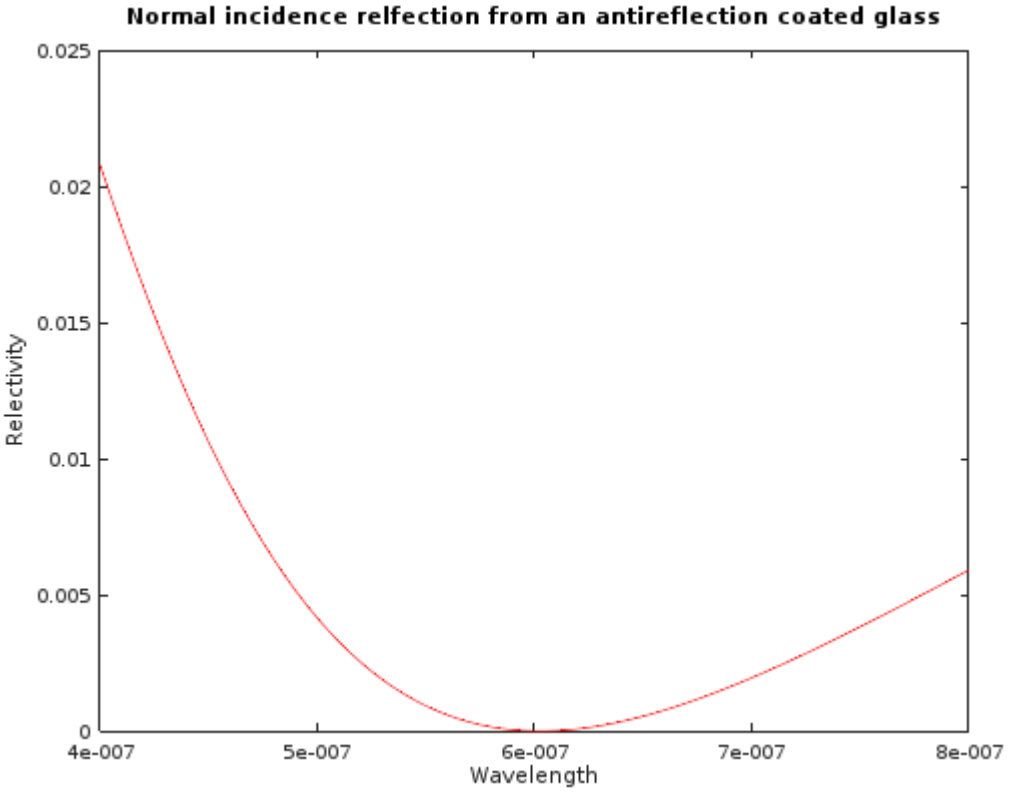
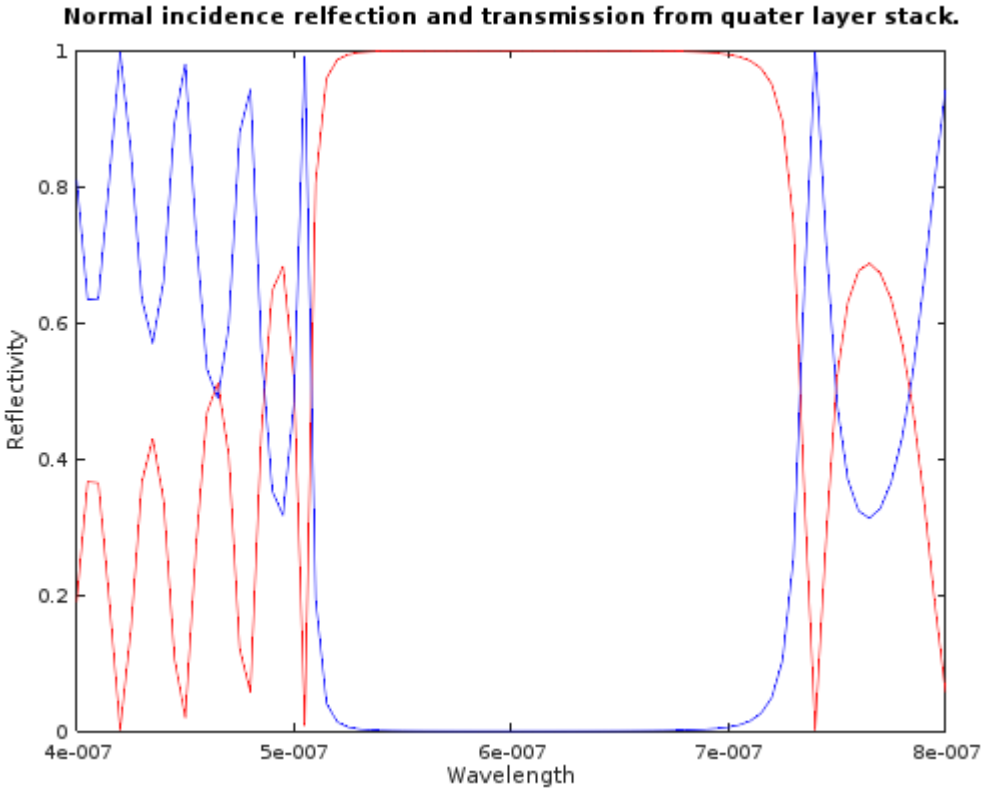
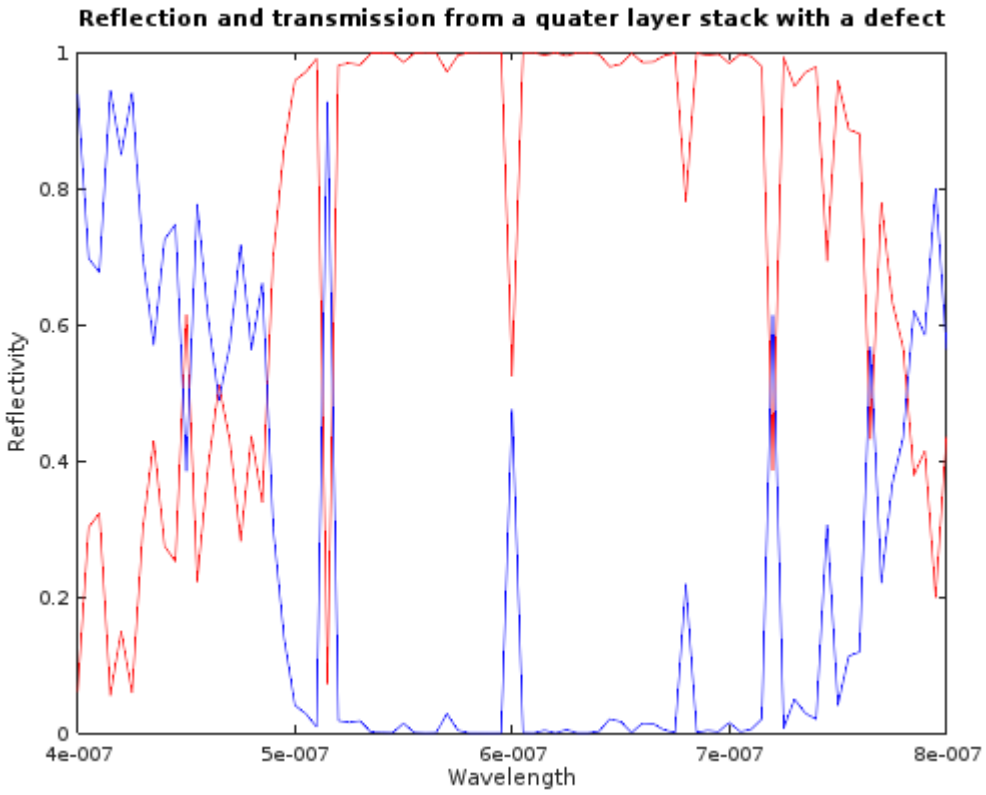
The order of the plots will be from exercise 1 to 4. The fourth and fifth plots will be from exercise 4.


Red is p-polarized, Blue is s-polarized
Relectivity
Degrees
0
0.2
0.4
0.6
0.8
1
0
20
40
60
80


Red is p-polarized, Blue is s-polarized
Relectivity
Degrees
0
0.2
0.4
0.6
0.8
1
0
20
40
60
80


Normal incidence relfection from an antireflection coated glass
0.025
0.02
0.015
0.01
0.005
0
Relectivity
4e-007
5e-007
6e-007
7e-007
8e-007
Wavelength


Normal incidence relfection and transmission from quater layer stack.
1
0.8
0.6
0.4
0.2
0
Reflectivity
4e-007
5e-007
6e-007
7e-007
8e-007
Wavelength


Reflection and transmission from a quater layer stack with a defect
Reflectivity
Wavelength
0
0.2
0.4
0.6
0.8
1
4e-007
5e-007
6e-007
7e-007
8e-007

Program codes.

```
%*****************************************************************************************%
%***************************** Transfer Matrix ***************************************%
% Jonathan Shipley
% Scientific Modeling
% 4/28/17
% Description: This is the first program that runs through relfection and transmission with
%                                       changing angle.
%*****************************************************************************************%
%*****************************************************************************************%

% clear all previous variables
clear;

n = [1 1.5];
d = [0 0];
%n = [1 1.225 1.5];
%d = [0 123e-9 0];
lambda = 600e-9; % 600 nm
degrees = 0:1:90;
sqrte0u0 = sqrt(8.85418782e-12 * pi *4e-7);
numberOflayers = length(n) - 1;
% ask if p or s polarized
choice = input('Input p or so for polarization of light: ', 's')

% convert theta to radians
for k =1:length(degrees)
        theta(k) = degrees(k) * (pi / 180);
end


for k = 1:length(theta)

        M = cell(numberOflayers-1, 1);
        transferMatrix = [1 0; 0 1];
        % find all angles from reflection within layers
        phi(1) = theta(k);
        for noL = 1:numberOflayers
                phi(noL + 1) = acos(sqrt(1 - ((n(noL)/n(noL+1))^2) * sin(phi(noL))^2));
        end

        for q = 1:numberOflayers
                M{q} = getMatrixOfLayer(lambda, phi(q + 1), n(q + 1), d(q+1), choice);
                transferMatrix *= M{q};
        end
        m11 = transferMatrix(1,1);
        m12 = transferMatrix(1,2);
        m21 = transferMatrix(2,1);
        m22 = transferMatrix(2,2);

        % get y0 and ys
        if choice =='s'
```

```
            y0 = n(1) * sqrte0u0 * cos(phi(1));
            ys = n(end) * sqrte0u0 * cos(phi(end));
        elseif choice =='p'
            y0 = n(1) * sqrte0u0 / cos(phi(1));
            ys = n(end) * sqrte0u0 / cos(phi(end));
        end

        r(k) = (y0 * m11 + y0*ys*m12 - m21 - ys*m22)/(y0*m11 + y0*ys*m12 + m21 + ys*m22);
        R(k) = abs(r(k))^2;
end

if choice == 'p'
        plot(degrees, R, 'r')
        hold;
elseif choice =='s'
        plot(degrees, R, 'b')
        hold;
end
title('Red is p-polarized, Blue is s-polarized')
xlabel('Degrees')
ylabel('Relectivity')
xlim([0 90])
ylim([0 1])



%*************************************************************************************************%
%****************************** Transfer Matrix ************************************************%
% Jonathan Shipley
% Scientific Modeling
% 4/28/17
% Description: This is the second program that runs through relfection and transmission with
%                                       changing wavelength.
%*************************************************************************************************%
%*************************************************************************************************%

% clear all previous variables
clear;

%n = [1 1.225 1.5];
%d = [0 123e-9 0];

n = [1 1.5 2.5 1.5 2.5 1.5 2.5 1.5 2.5 1.5 2.5 1.5 2.5 1.5 2.5 1.5 2.5 1.5 2.5 1.5 2.5 1];
d = [0 100 60 100 60 100 60 100 60 100 60 100 60 100 60 100 60 100 60 100 60 0]*1e-9;
d(11) = 120;

lambda = [400:5:800]*10^-9;
theta = 0;
sqrte0u0 = sqrt(8.85418782e-12 * pi *4e-7);
numberOflayers = length(n) - 1;
% ask if p or s polarized
choice = input('Input p or so for polarization of light: ', 's')

for k = 1:length(lambda)

        M = cell(numberOflayers-1, 1);
```

```
        transferMatrix = [1 0; 0 1];

        % find all angles from reflection within layers
        phi(1) = theta;
        for noL = 1:numberOflayers
                phi(noL + 1) = acos(sqrt(1 - ((n(noL)/n(noL+1))^2) * sin(phi(noL))^2));
        end

        for q = 1:numberOflayers
                M{q} = getMatrixOfLayer(lambda(k), phi(q + 1), n(q + 1), d(q+1), choice);
                transferMatrix *= M{q};
        end
        m11 = transferMatrix(1,1);
        m12 = transferMatrix(1,2);
        m21 = transferMatrix(2,1);
        m22 = transferMatrix(2,2);

        % get y0 and ys
        if choice =='s'
                y0 = n(1) * sqrte0u0 * cos(phi(1));
                ys = n(end) * sqrte0u0 * cos(phi(end));
        elseif choice =='p'
                y0 = n(1) * sqrte0u0 / cos(phi(1));
                ys = n(end) * sqrte0u0 / cos(phi(end));
        end

        r(k) = (y0 * m11 + y0*ys*m12 - m21 - ys*m22)/(y0*m11 + y0*ys*m12 + m21 + ys*m22);
        t(k) = (2 * y0)/(y0 * m11 + y0*ys*m12 + m21 + ys*m22);
        R(k) = abs(r(k))^2;
        T(k) = abs(t(k))^2;
end

plot(lambda, R, 'r');
hold;
plot(lambda, T, 'b');

title('Normal incidence relfection and transmission from quater layer stack with a defect.')
xlabel('Wavelength')
ylabel('Relectivity')



% function that returns the transfer matrix of a given layer

function M = getMatrixOfLayer(lambda, thetaOut, indexn, dThick, pOrs)

        sqrte0u0 = sqrt(8.85418782e-12 * pi *4e-7);
        % get delta
        delta = ((2 *pi)/ lambda) * indexn * dThick * cos(thetaOut);

        % get y1
        if pOrs == 's'
                y1 = (indexn * sqrte0u0) * cos(thetaOut);      % s polarized
        elseif pOrs =='p'
                y1 = (indexn * sqrte0u0) / (cos(thetaOut));    % p polarized
```

```
end

m11 = cos(delta);
m12 = 1i * sin(delta)/y1;
m21 = 1i * y1 * sin(delta);
m22 = cos(delta);

M(1,1) = m11;
M(1,2) = m12;
M(2,1) = m21;
M(2,2) = m22;
```