Appendix A:

MATLAB Code of Schrenk Method Program to Calculate the Wing Lift Distribution

```
% schrenk method program to calculate wing lift
distribution for straight
% wing developed by work group in 21-07-1435
% inputs:
%   W: gross weight
%   S: reference area
%   Lam: taper ratio
%   AR: aspect ratio
%   A_LE: sweep angle of leading edge
%   Clmax: maximum lift coefficient
%   V: airspeed Velocity
%   rho: air density
% outputs:
%   b: wing span
%   y: span wise position
%   C1: chord length for elliptic wing
%   C2: chord length for trapezoidal wing
%   C3: average chord length
%   C4: schrenk lift distribution
%   Cr: chord length at the root
%   Ct: chord length at the tip
%   MAC: mean aerodynamic chord
%   Ybar: span wise location of MAC
%   x: chord wise position at any span wise
location
%   e: chord wise position at the root
%   d: quarter chord distance from the leading
edge at span wise location
%   q: dynamic pressure
%   l: local lift distribution
%   L: total lift distribution

% notice: the lift at tip of wing does not
necessary equal to zero! But
% the lift distribution in LE and TE must equal
to zero
```

```
clc; clear all

% calculating the span
S=12.2;
lam=0.5;
AR=8;
b=sqrt(AR*S);

% dividing the half span into 50 segments
y=linspace(0,b/2,51);

% calculating elliptic chord, trapezoidal chord,
average chord and
% schrenk lift distribution
for i=1:51
    C1(i)=(4*S/(pi*b))*sqrt(1-(2*y(i)/b)^2);
    C2(i)=(2*S/(b*(1+lam)))*(1-(2*y(i)/b)*(1-
lam));
    C3(i)=(C1(i)+C2(i))/2;
    C4(i)=C3(i)/C2(i);
end

% plotting the three curves
figure
plot(y,C1,'b -','linewidth',3)
hold on
plot(y,C2,'g --','linewidth',3)
hold on
plot(y,C3,'r -.','linewidth',2)
legend('C1=elliptic','C2=trapezoidal','C3=average
')
xlabel('span wise')
ylabel('chord length')
title('chord    length    for    elliptic    wing,
trapezoidal wing and the average')
grid on
axis auto

%plotting schrenk
figure
plot(y,C4,'b -','linewidth',3)
xlabel('span wise')
ylabel('lift distribution')
title('schrenk lift distribution')
```

```
grid on
axis auto

% calculating wing geometry and chord wise
position at the root
% with dividing the chord wise into 20 segments
Cr=2*S/(b*(1+lam));
Ct=lam*Cr;
MAC=(2/3)*Cr*(1+lam+lam^2)/(1+lam);
Ybar=(b/6)*((1+2*lam)/(1+lam));
A_LE=atand((1-lam)/(AR*(1+lam)));
e=linspace(0,Cr,21);

% calculating chord wise position at any span
wise location
for i=1:51
    for j=1:21
        x(i,j)=e(j)+y(i)*(tand(A_LE)-4*e(j)*(1-
lam)/(AR*Cr*(1+lam)));
    end
    % calculating quarter chord distance from LE
    d(i)=x(i,6)-x(i,1);
end

% plotting wing shape configuration
figure
plot(x)
xlabel('span wise')
ylabel('chord length')
title('wing shape configuration')
grid on
axis auto

% calculating schrenk lift distribution
for i=1:51
    for j=1:6
        % lift distribution from LE to C/4 for
any span wise location
        l(i,j)=((x(i,j)-x(i,1))/d(i))*C4(i);
    end
    for j=6:21
        % lift distribution from C/4 to TE for
any span wise location
```

```
        l(i,j)=((x(i,j)-x(i,1)-C2(i))/(d(i)-
C2(i)))*C4(i);
    end
end

% calculating final lift distribution
V=100;
rho=1.25;
CLmax=2.34;
q=0.5*rho*V^2;
L=q*S*CLmax*l;

% schrenk lift distribution surface
figure
mesh(L)
xlabel('chord wise')
ylabel('span wise')
zlabel('lift')
title('schrenk lift surface')
axis auto

figure
surf(L)
xlabel('chord wise')
ylabel('span wise')
zlabel('lift')
title('schrenk lift surface')
axis auto
```