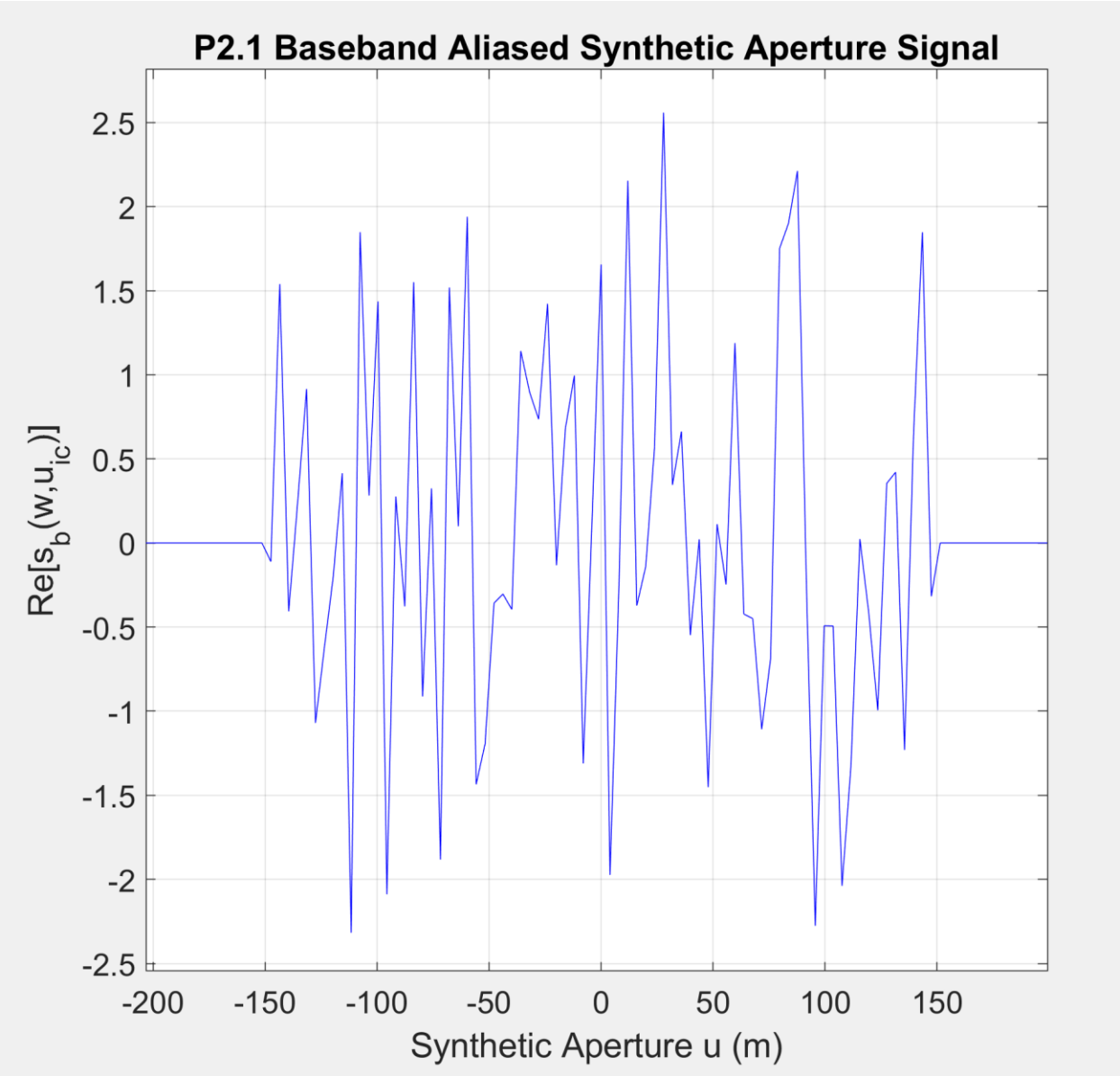
EE562 PROJECT #2

Based on the given problem, Matlab program was generated and the results are as follows:

P2.1

Result



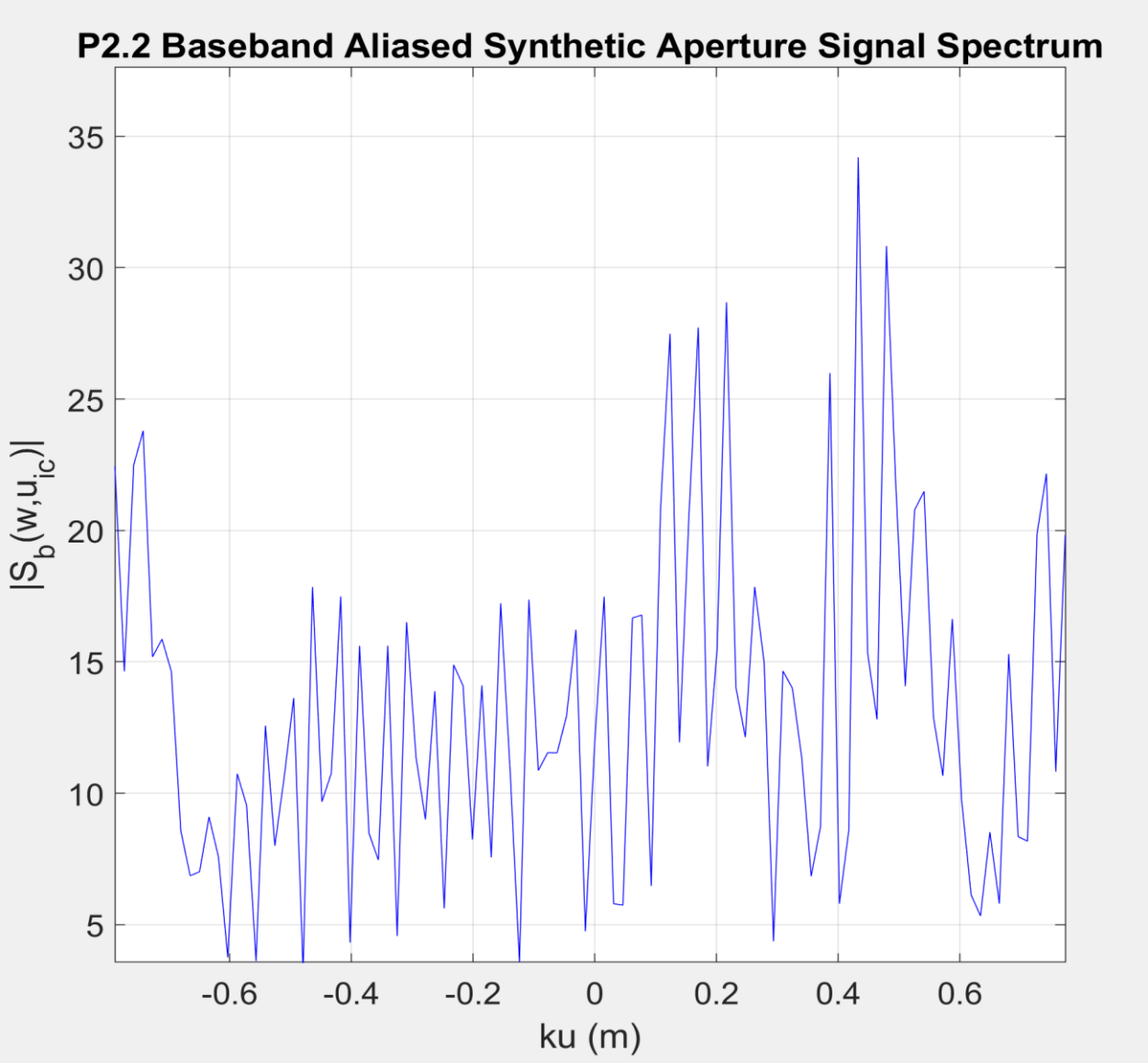
Analysis

Cross range imaging target area is twice the cross range size of the target area ($2Y_0$). Initially the targets are assigned in the given target area. According to the problem, there are 4 targets and the radar is in the location (0,u). As the imaging follows squint mode, the squint angle, squint range and the Doppler frequency shift due to squint is calculated. Then slow time compression is

performed to save the PRF (this is done to reduce the hardware limitations of the radar system). Finally, the synthetic aperture signal s(w,u) is mixed with the exp(-cj*kus*uc) for baseband conversion. This resultant signal is plotted with the synthetic aperture u in the u domain. The signal is within the limit [-L,L]. Here L=150m, so the signals are confined between [-150,150]. Since s has origin at (Xc,Yc), the signals are also centered at 0.

P2.2

Result

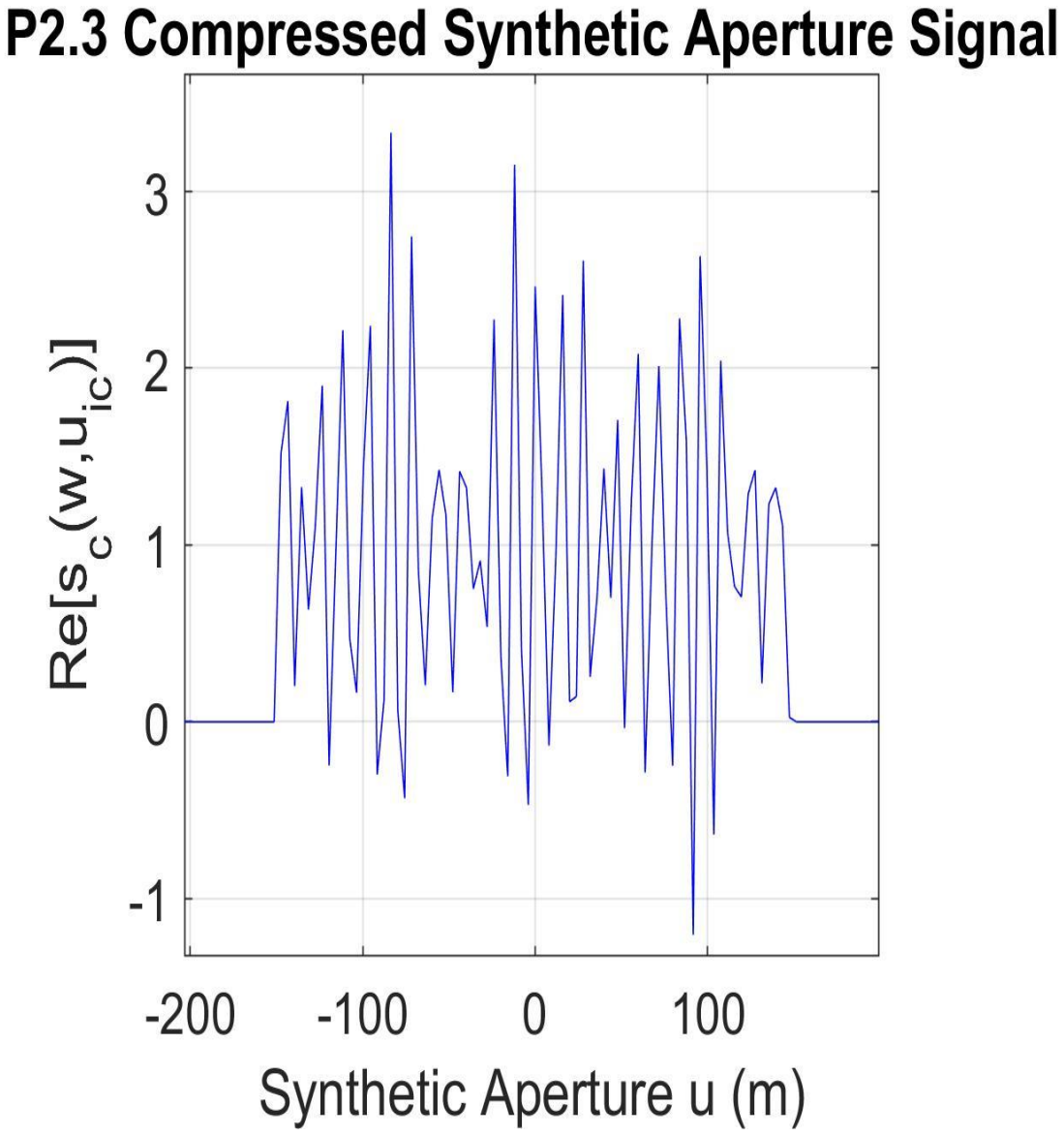


Analysis

The signal defined in the previous problem is transformed into the frequency domain by taking fast Fourier transform of it. This is called the Baseband aliased synthetic aperture signal spectrum. This is plotted in ku domain.

P2.3

Result

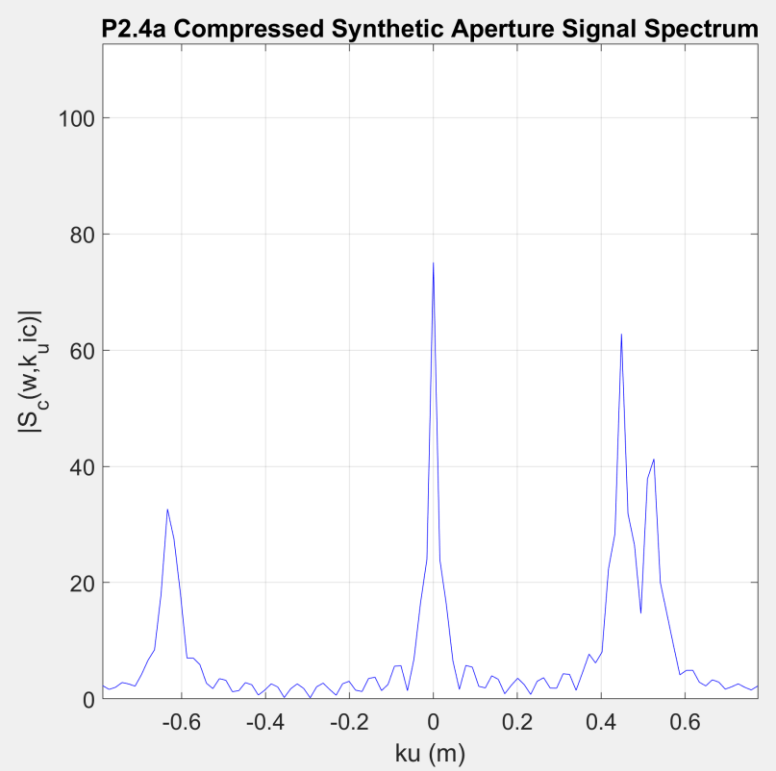


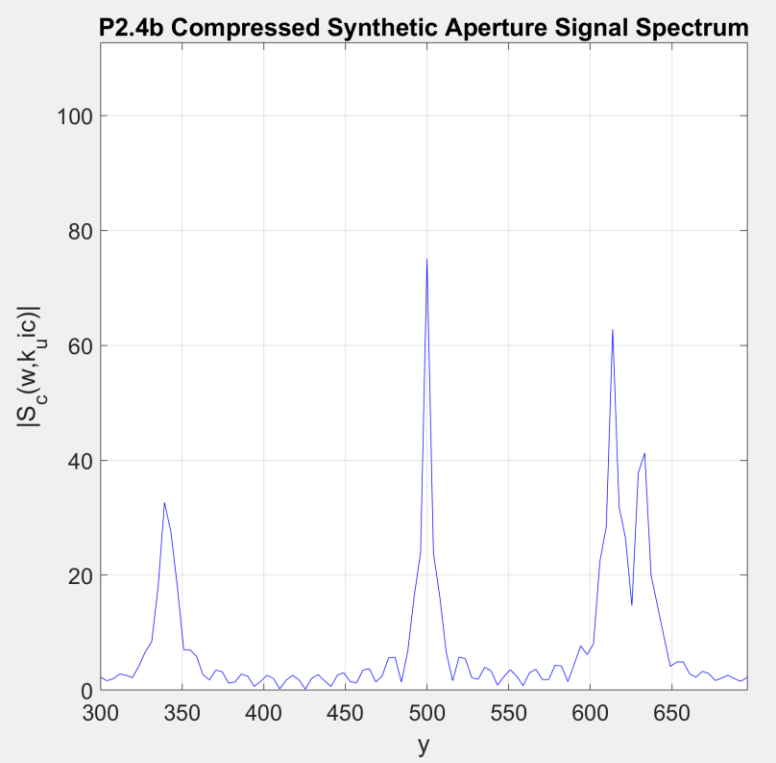
Analysis

First the reference signal is defined, where it is given as s0=exp(cj*2*k*sqrt(Xc^2+(Yc-uc).^2)). Then the synthetic aperture signal is mixed with the reference signal for compression. This signal is called as compressed synthetic signal aperture. The important fact is that the synthetic aperture signal s(w,u) is passband and not baseband converted. The resultant signal is plotted against the synthetic aperture in u domain. The signal is between [-L,L], that is [-150,150].

P2.4

Result


P2.4a Compressed Synthetic Aperture Signal Spectrum
|S_c(w,k_u ic)|
ku (m)
0
20
40
60
80
100
-0.6
-0.4
-0.2
0
0.2
0.4
0.6


P2.4b Compressed Synthetic Aperture Signal Spectrum
|S_c(w,k_u ic)|
y
0
20
40
60
80
100
300
350
400
450
500
550
600
650

Analysis

The compressed signal is converted into its frequency domain by taking Fourier transform. This is called as the compressed synthetic aperture signal aperture. There are two plots in this. In the first one, it is plotted against ku in ku domain and in the second one it is plotted against y in y domain. In both the plots, the 4 high peaks are indicating the 4 targets present in the target area.

MATLAB CODE:

```
clear all
close all

cj=sqrt(-1);
pi2=2*pi;

c=3e8;
fc=200e6;
lambda=c/fc;
k=pi2/lambda;
Xc=2e3;

L=150;
Y0=200;
Yc=500;

theta_c=atan(Yc/Xc);
Rc=sqrt(Xc^2+Yc^2);
kus=2*k*sin(theta_c);

Xcc=Xc/(cos(theta_c)^2);

du=(Xcc*lambda)/(4*(Y0+L));
duc=(Xcc*lambda)/(4*Y0);

L_min=max(Y0,L);

mc=2*ceil(L_min/duc);
uc=duc*(-mc/2:mc/2-1);
dkuc=pi2/(mc*duc);
kuc=dkuc*(-mc/2:mc/2-1);
dku=dkuc;


m=2*ceil(pi/(du*dku));
du=pi2/(m*dku);
u=du*(-m/2:m/2-1);
ku=dku*(-m/2:m/2-1);


ntarget=4;


yn(1)=0;            fn(1)=1;
yn(2)=.7*Y0;        fn(2)=0.8;
```

```
yn(3)=.6*Y0;          fn(3)=1;
yn(4)=-0.8*Y0;       fn(4)=0.6;

s=zeros(1,mc);
for i=1:ntarget;
    dis=sqrt(Xc^2+(Yc+yn(i)-uc).^2);
    s=s+fn(i)*exp(-cj*2*k*dis).*(abs(uc) <= L);
    s1=s;
end;

s=s.*exp(-cj*kus*uc);
fs=fty(s);

sc=s1.*exp(cj*2*k*sqrt(Xc^2+(Yc-uc).^2));
fsc=fty(sc);
y=(kuc)*Rc/(2*k*cos(theta_c))+Yc;



figure(1)
plot(uc,real(s),'b-'); grid on;
xlabel('Synthetic Aperture u (m)')
ylabel('Re[s_b(w,u_{ic})]');
title('P2.1 Baseband Aliased Synthetic Aperture Signal');
axis([uc(1) uc(mc) 1.1*min(real(s)) 1.1*max(real(s))]);
axis('square');
set(gca,'fontsize',16);

figure(2)
plot(kuc,abs(fs),'b-'); grid on;
xlabel('ku (m)')
ylabel('|S_b(w,u_{ic})|');
title('P2.2 Baseband Aliased Synthetic Aperture Signal Spectrum');
axis([kuc(1) kuc(mc) 1.1*min(abs(fs)) 1.1*max(abs(fs))]);
axis('square');
set(gca,'fontsize',16);

figure(3)
plot(uc,real(sc),'b-'); grid on;
xlabel('Synthetic Aperture u (m)')
ylabel('Re[s_c(w,u_{ic})]');
title('P2.3 Compressed Synthetic Aperture Signal');
axis([uc(1) uc(mc) 1.1*min(real(sc)) 1.1*max(real(sc))]);
axis('square');
set(gca,'fontsize',16);
```

```
figure(4)
plot(kuc,abs(fsc),'b-'); grid on;
xlabel('ku (m)')
ylabel('|S_c(w,k_u{ic})|');
title('P2.4a Compressed Synthetic Aperture Signal Spectrum');
axis([kuc(1) kuc(mc) -0.5*min(abs(fsc)) 1.5*max(abs(fsc))]);
axis('square');
set(gca,'fontsize',16);

figure(5)
plot(y,abs(fsc),'b-'); grid on;
xlabel('y')
ylabel('|S_c(w,k_u{ic})|');
title('P2.4b Compressed Synthetic Aperture Signal Spectrum');
axis([min(y) max(y) -0.5*min(abs(fsc)) 1.5*max(abs(fsc))]);
axis('square');
set(gca,'fontsize',16);
```