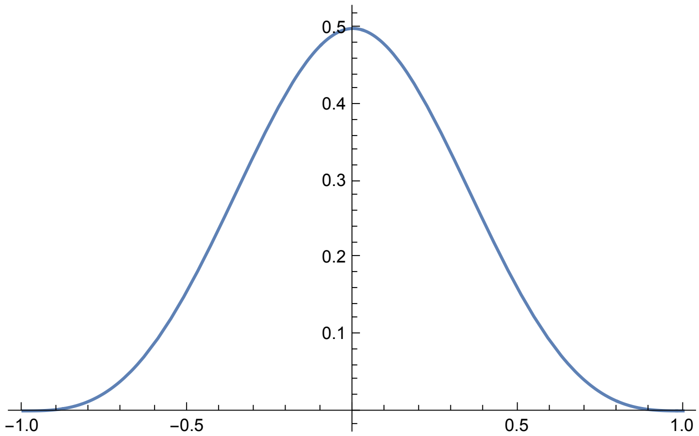
E1 2018

1. a) Use of a matched filter corresponding to an impulse response that replicates the cosine pulse with a physical delay. Alternatively a correlator can be used

b) The output envelope is represented by the
auto-correlation of a cosine pulse of finite duration 1 μs

```
T = 2  (* half -cosine pulse duration T/2 = 1μs *);
```

$$\text{Plot}\left[\left\{\frac{1}{4}\,(T-2\,\text{Abs}[t])\,\text{Cos}\left[\frac{2\,\pi\,t}{T}\right]+\frac{T}{4\,\pi}\,\text{Abs}\left[\text{Sin}\left[\frac{2\,\pi\,t}{T}\right]\right]\right\},\ \{t,\,-T/2,\,T/2\}\right]$$



2.

$TR = 60\,000;\ ToF = 0.5\times10^{-3}$ (*Time of flight*); $c = 3.\times10^{8}$;
$freq = 2.9\times10^{9};\ \lambda = c/freq;$
```
MajorAxis = c ToF;
a = MajorAxis / 2;
e = TR / MajorAxis(*eccentricity, = 0.4 *);
```

$\theta = 75\,°;$

$$R1 = a\,\frac{1-e^2}{1+e\,\text{Cos}[\theta]}\ \text{(* distance from target to receiver *)}$$

57 090.

```
R2 = 2 a - R1(* distance from target to transmitter *)
```

9.291×10^{4}

$PT = 50\,000;\ GT = 10^{3.5};\ GR = 10^{2.7};$

(* $\frac{Pt\ \lambda^2 GT\ GR\ RCS}{(4\ \pi)^3 R1^2 R2^2} \geq K\ Teq\ \Delta f (S/N)_1$;
$\Delta f \approx 1/(2T)$ (assuming matched filter, rectangular pulses);
$(S/N)_1 \approx 11$dB (10 pulses integrated, see graphic) *)

$T = 1.5\times10^{-6};\ \Delta f = 1/(2\,T);\ SN1 = 10^{1.1};$
$F = 10;\ T0 = 290;\ Teq = F\,T0;$
$K = 1.38\times10^{-23};$

$$RCSmin = \frac{K\ Teq\ \Delta f\ SN1\ (4\ \pi)^3\ R1^2\ R2^2}{PT\ \lambda^2\ GT\ GR}$$

11.06

Ans: 11.06 m^2

3 a)

```
prf1 = 750; c = 3 × 10^8; f = 5.25 × 10^9; λ = 3 × 10^8 / f
```

0.05714

```
vb = λ prf1 / 2 (* ms^-1*)
```

21.43

```
vbkmh = vb * 3.6 (* km h^-1*)
```

77.14

```
vb1kmh = (vbkmh - 5)
```

72.14

```
vb1 = vb1kmh / 3.6
```

20.04

The “range of velocities” superimposing with the clutter spectrum is then [72.14, 77.14]km/h or [20.04, 21.43]m/s

b) In the case prf2 would be such that the blind velocity would be equal to the previous vb1, than there would be no spectral superposition. Thus

```
vb2 = vb1 (* m/s *)
```

20.04

This would require

```
prf2 = 2 vb2 / λ
```

701.4

5 a)

Assumption: the code behaves similar to a Barker code

The time elapsed between the pulse centers coming form the two targets is

$$\delta t = \frac{1}{2}\ \frac{250.}{3\times 10^8}\ \text{"s"}$$

4.167×10^{-7} s

a)

Sub-pulse duration

$$\text{Tsub} = \frac{30. \times 10^{-6}}{150}$$

$2. \times 10^{-7}$

The spectral bandwidth necessary for recognizing a rectangular sub-pulse is about

$$\Delta f = \frac{2}{\text{Tsub}}$$

$1. \times 10^{7}$

b) the half duration of the time main lobe is the sub-pulse duration after compression, that is, 2×10^{-7};
Since the pulse centers form the two targets are separated by 4.167×10^{-7} these do not superimpose although they are relatively closed.
The time side lobes have amplitudes of about 1/150 relative to the main lobe, although with variations, since it is not a true Barker code.