In[ ]:=
```
Ibias = {3, 3, 5, 5, 2.5}
input1[t_] := 1 Sin[π t / 400] HeavisideTheta[t - 00.1]
inputAnti[t_] := 1 Sin[(π (t - 400) / 400)] HeavisideTheta[t - 00.1]
inputAdv[t_] := 1 Sin[(π (t - 50) / 400)] HeavisideTheta[t - 00.1]
inputLag[t_] := 1 Sin[(π (t + 50) / 400)] HeavisideTheta[t - 00.1]


(*f1 = 3(*input corrisponding to 1*)
    f2 = 3(*input corrisponding to 0*)
     θ=40
      input1[t_]:=f1 Iinj[100,300][t]+f1 Iinj[500,300][t]+f2 Iinj[900,300][t]
        input2[t_]:=f1 Iinj[100+θ,300][t]+f2 Iinj[500+θ,300][t]+f1 Iinj[900+θ,300][t]
*)
time = 1200
Fv[V_, W_][Ii_, k_, b_] := -3 V + ((1 / k) * V^2 + 40 + 100 b - W + Ii)
Fw[V_, W_][a_, b_] := a (b (V) - W)
Iinj [start_, dur_][t_] := HeavisidePi[(t - start) / dur - 1 / 2]
T[x_] := Transpose[x]
L[x_] := Length[x]
(*base parameters of the neurons*)
k = 25
a = 1 / 10.
b = .2
c = 10
d = .01
tau = 10

(*synaptic weights*)
go = 4
gee = 2
gei = 5
gie = -10
gii = -10

ClassicalRungeKuttaCoefficients[4, prec_] :=
 With[{amat = {{1 / 2}, {0, 1 / 2}, {0, 0, 1}}, bvec = {1 / 6, 1 / 3, 1 / 3, 1 / 6}, cvec = {1 / 2, 1 / 2, 1}},
  N[{amat, bvec, cvec}, prec]]
```

Out[ ]=
```
{3, 3, 5, 5, 2.5}
```
Out[ ]=
```
1200
```
Out[ ]=
```
25
```
Out[ ]=
```
0.1
```
Out[ ]=
```
0.2
```
Out[ ]=
```
10
```
Out[ ]=
```
0.01
```
Out[ ]=
```
10
```
Out[ ]=
```
4
```
Out[ ]=
```
2
```
Out[ ]=
```
5
```
Out[ ]=
```
-10
```
Out[ ]=
```
-10
```

NOR

In[ ]:=
```
Ibias = {5.05, 5.05, 2.6, 2.6, -5}
solSyncNOR = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      input1[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
```

```
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] + input1[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]],
    Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAntiNOR = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAnti[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
```

```
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAnti[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAdvNOR = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAdv[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
```

```
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAdv[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solLagNOR = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputLag[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
```

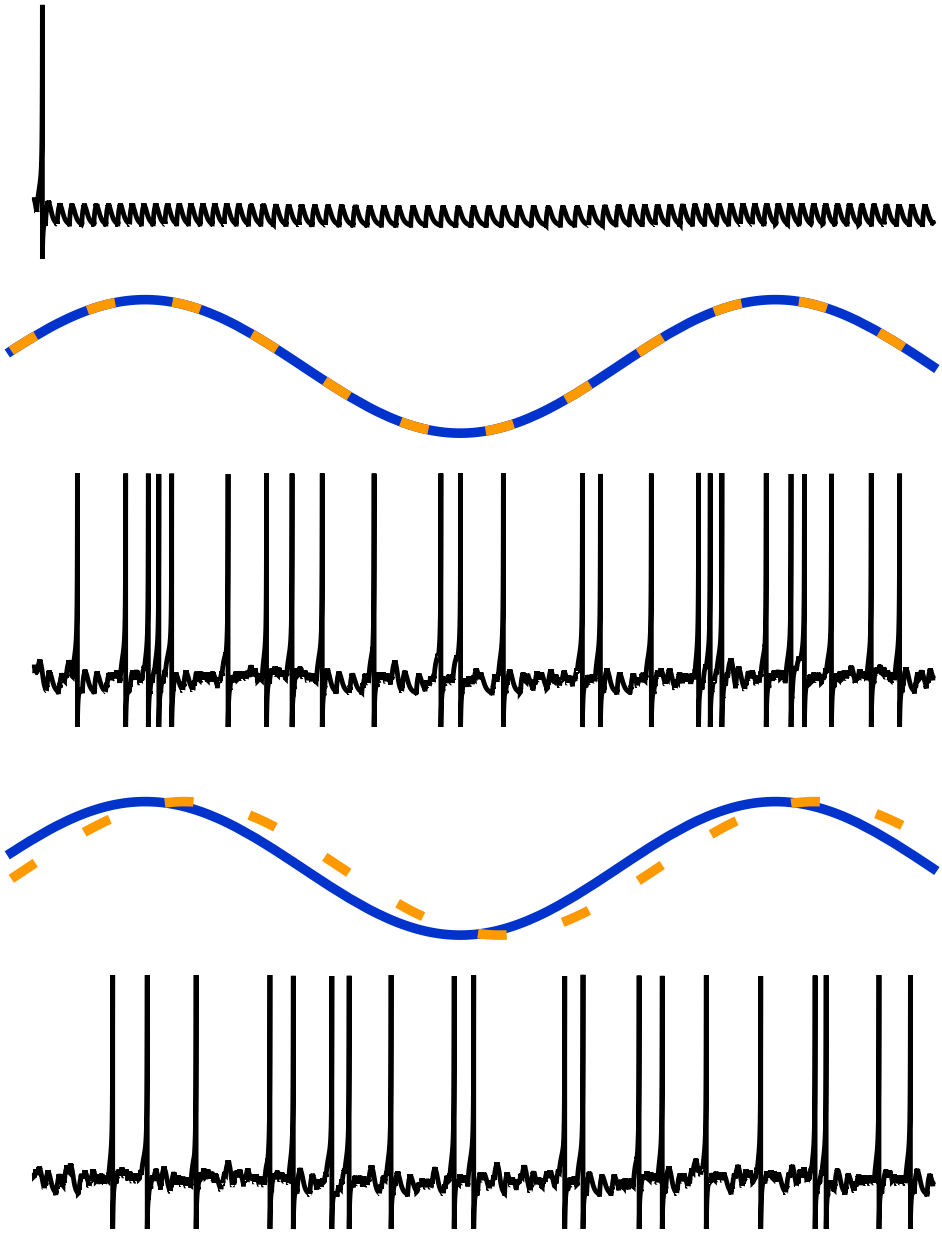
```
      inputLag[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
     Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
     tau Si2'[t] == -Si2[t], Si2[0] == 0,
     WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuron out*)
     Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
     Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
     WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
    {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
    {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];
NORout = Column[{
    Plot[Vo[t] /. solSyncNOR, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
     PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
     AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
    Plot[{input1[t], input1[t]},
     {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
       {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
     ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
    Plot[Vo[t] /. solAdvNOR, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
     PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
     AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
    , Plot[{input1[t], inputAdv[t]},
     {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
       {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
     ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
    Plot[Vo[t] /. solLagNOR, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
     PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
     AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
    Plot[{input1[t], inputLag[t]},
     {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
       {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
     ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
    Plot[Vo[t] /. solAntiNOR, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
     PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
     AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
    Plot[{input1[t], inputAnti[t]},
```

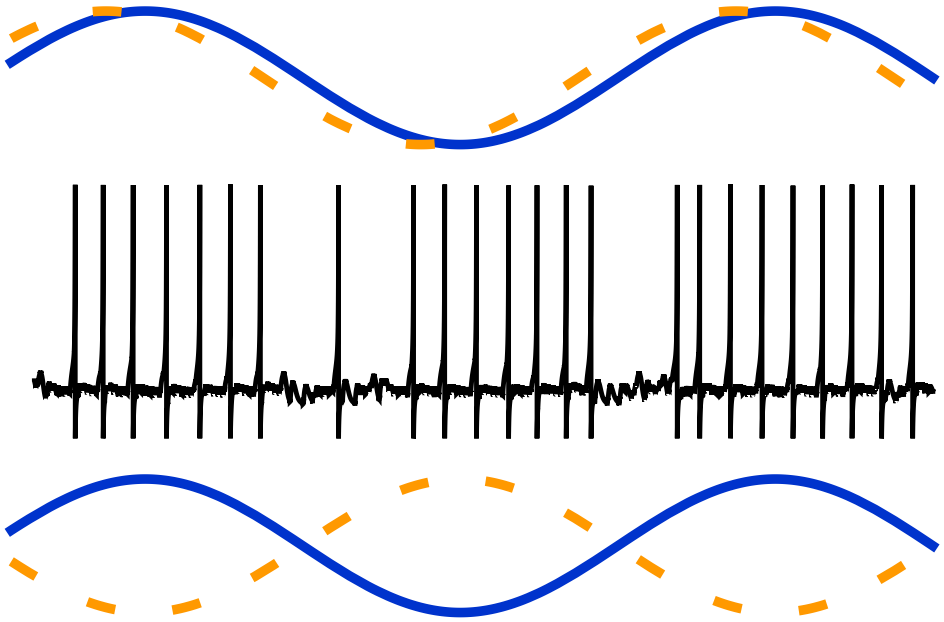
```
{t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
  {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False]

}]
```

Out[ ]=

```
{5.05, 5.05, 2.6, 2.6, -5}
```

Out[ ]=





NXOR

In[ ]:=
```
Ibias = {3.6, 3.6, 3.3, 3.3, -2.05}
solSyncNXOR = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
       input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
       input1[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
```

```
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuroni2*)
   Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] + input1[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]],
   Vi2[0] == 0,
   Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
   tau Si2'[t] == -Si2[t], Si2[0] == 0,
   WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuron out*)
   Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
   Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
   WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
  {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
  {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAntiNXOR = NDSolve[
  {(*neuron e1*)
   Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
     input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
   We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
   tau Se1'[t] == -Se1[t], Se1[0] == 0,
   WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuron e2*)
   Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
     inputAnti[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
   We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
   tau Se2'[t] == -Se2[t], Se2[0] == 0,
   WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuron i1*)
   Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
   Vi1[0] == 0,
   Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
   tau Si1'[t] == -Si1[t], Si1[0] == 0,
   WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuroni2*)
   Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
     inputAnti[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
```

```
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAdvNXOR = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAdv[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAdv[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
```

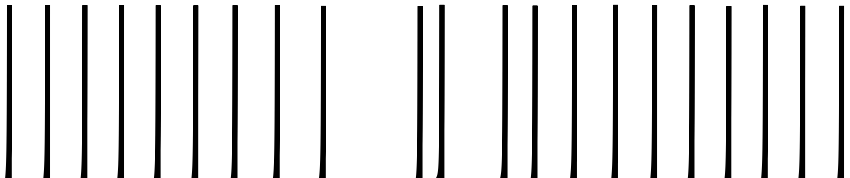
```
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solLagNXOR = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputLag[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputLag[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
```

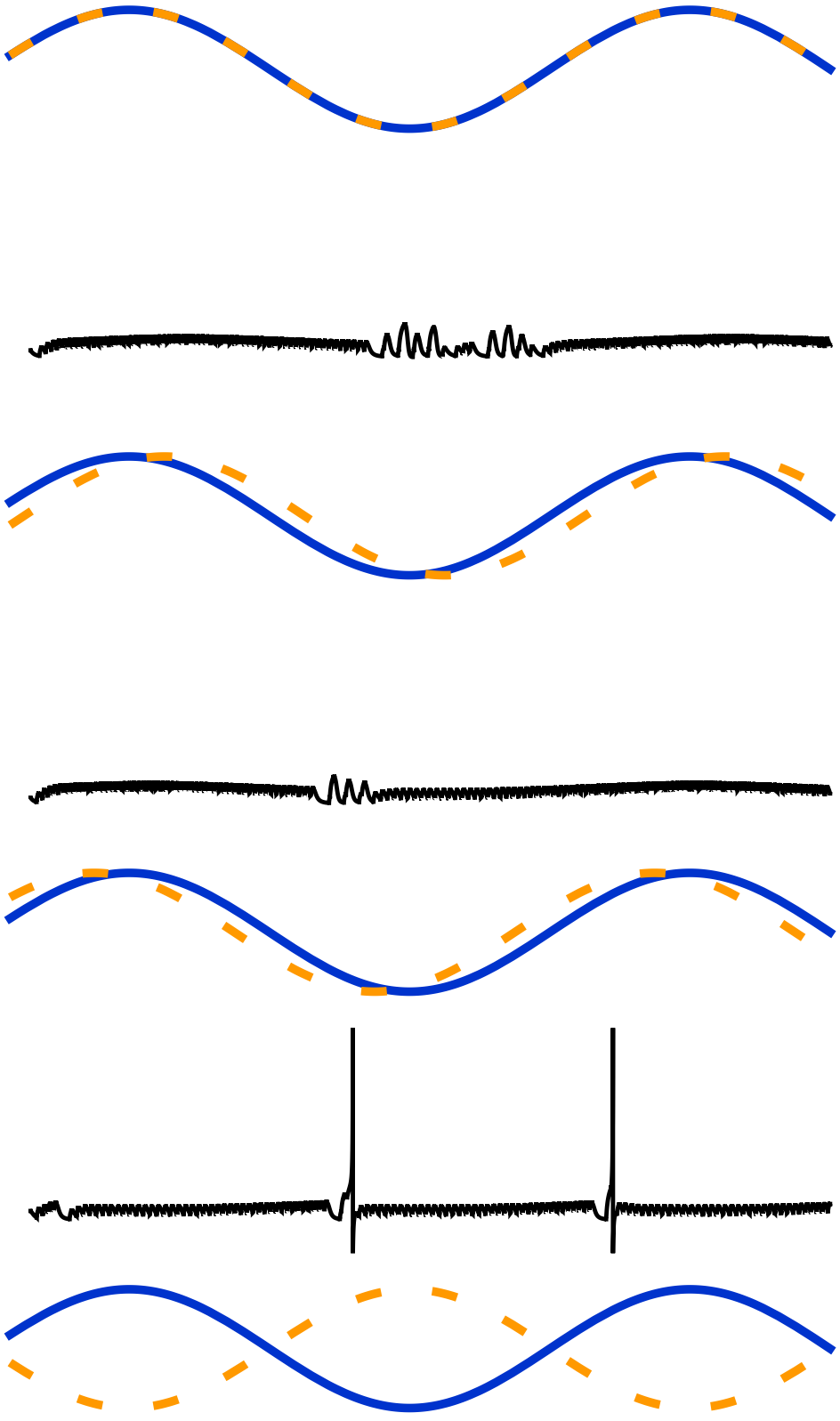
```
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
  {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
  {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];
NXORout = Column[{
  Plot[Vo[t] /. solSyncNXOR, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
   PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
   AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  Plot[{input1[t], input1[t]},
   {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
  Plot[Vo[t] /. solAdvNXOR, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
   PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
   AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  , Plot[{input1[t], inputAdv[t]},
   {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
  Plot[Vo[t] /. solLagNXOR, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
   PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
   AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  Plot[{input1[t], inputLag[t]},
   {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
  Plot[Vo[t] /. solAntiNXOR, {t, 30, time}, ImageSize → 500,
   PlotRange → {0, 140}, PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
   AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  Plot[{input1[t], inputAnti[t]},
   {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False]

 }]
```

Out[ ]=

```
{3.6, 3.6, 3.3, 3.3, -2.05}
```

Out[ ]=





NAND

In[ ]:=
```
Ibias = {4, 4, 3.75, 3.75, -2.}
solSyncNAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      input1[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] + input1[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]],
    Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAntiNAND = NDSolve[
```

```
    {(*neuron e1*)
     Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
        input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
     We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
     tau Se1'[t] == -Se1[t], Se1[0] == 0,
     WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuron e2*)
     Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
        inputAnti[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
     We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
     tau Se2'[t] == -Se2[t], Se2[0] == 0,
     WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuron i1*)
     Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
     Vi1[0] == 0,
     Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
     tau Si1'[t] == -Si1[t], Si1[0] == 0,
     WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuroni2*)
     Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
        inputAnti[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
     Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
     tau Si2'[t] == -Si2[t], Si2[0] == 0,
     WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuron out*)
     Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
     Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
     WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
    {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
    {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAdvNAND = NDSolve[
    {(*neuron e1*)
     Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
        input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
```

```
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAdv[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAdv[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solLagNAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
```

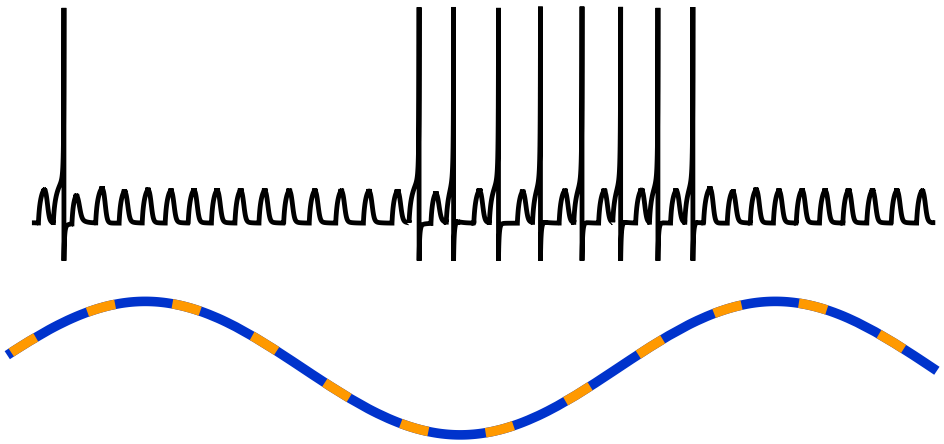
```
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputLag[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputLag[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];
NANDout = Column[{
   Plot[Vo[t] /. solSyncNAND, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
   Plot[{input1[t], input1[t]},
    {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
      {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
    ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
   Plot[Vo[t] /. solAdvNAND, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
```

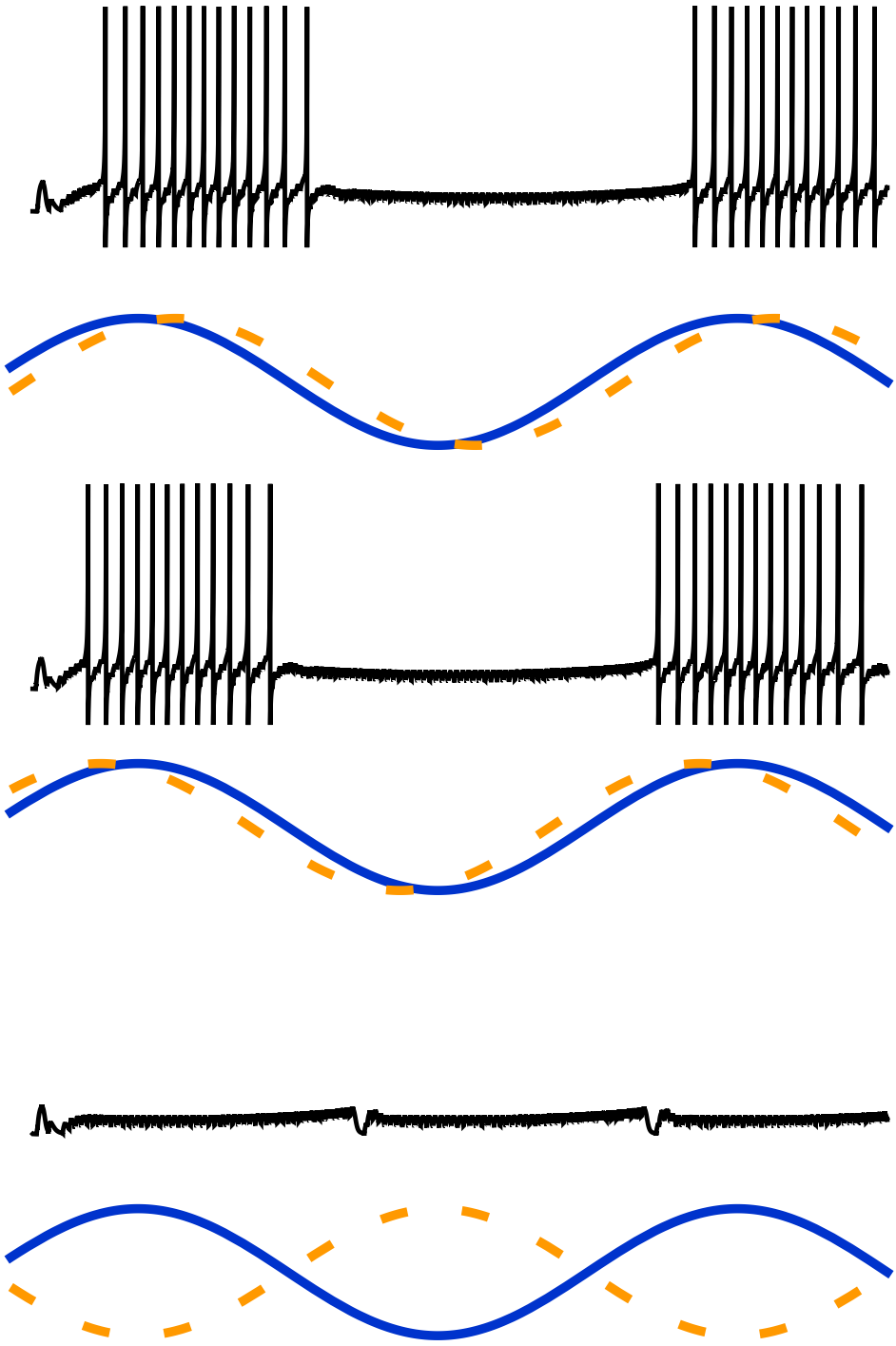
```
, Plot[{input1[t], inputAdv[t]},
 {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
   {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
 ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
Plot[Vo[t] /. solLagNAND, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
 PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
 AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
Plot[{input1[t], inputLag[t]},
 {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
   {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
 ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
Plot[Vo[t] /. solAntiNAND, {t, 30, time}, ImageSize → 500,
 PlotRange → {0, 140}, PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
 AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
Plot[{input1[t], inputAnti[t]},
 {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
   {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
 ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False]

}]
```

Out[ ]=

```
{4, 4, 3.75, 3.75, -2.}
```

Out[ ]=





NOR

In[ ]:=
```
Ibias = {4, 4, 4.5, 4.5, -2.}
solSyncAND = NDSolve[
```

```
    {(*neuron e1*)
     Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
       input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
     We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
     tau Se1'[t] == -Se1[t], Se1[0] == 0,
     WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuron e2*)
     Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
       input1[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
     We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
     tau Se2'[t] == -Se2[t], Se2[0] == 0,
     WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuron i1*)
     Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
     Vi1[0] == 0,
     Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
     tau Si1'[t] == -Si1[t], Si1[0] == 0,
     WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuroni2*)
     Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] + input1[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]],
     Vi2[0] == 0,
     Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
     tau Si2'[t] == -Si2[t], Si2[0] == 0,
     WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuron out*)
     Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
     Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
     WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
    {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
    {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAntiAND = NDSolve[
    {(*neuron e1*)
     Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
       input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
```

```
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAnti[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAnti[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAdvAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
```

```
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAdv[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAdv[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solLagAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputLag[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
```

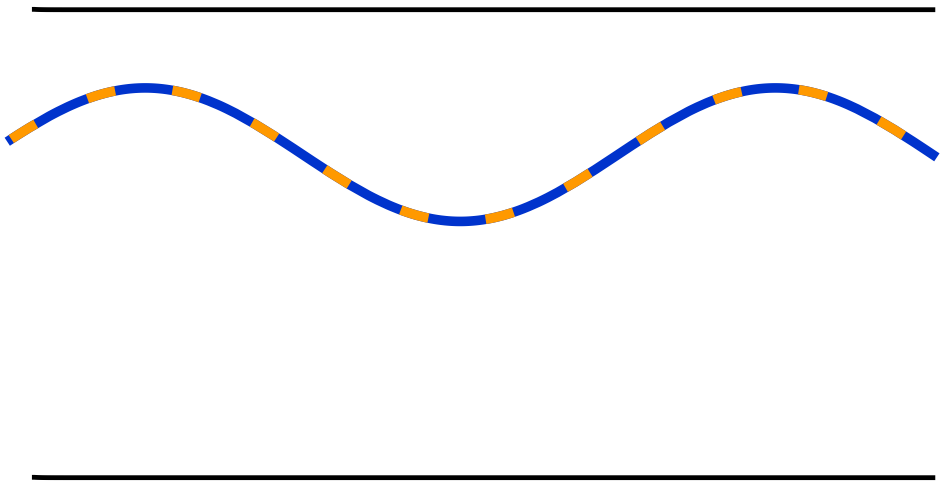
```
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputLag[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];
NOR2out = Column[{
   Plot[Vo[t] /. solSyncAND, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
   Plot[{input1[t], input1[t]},
    {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
      {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
    ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
   Plot[Vo[t] /. solAdvAND, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
   , Plot[{input1[t], inputAdv[t]},
    {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
      {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
    ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
```

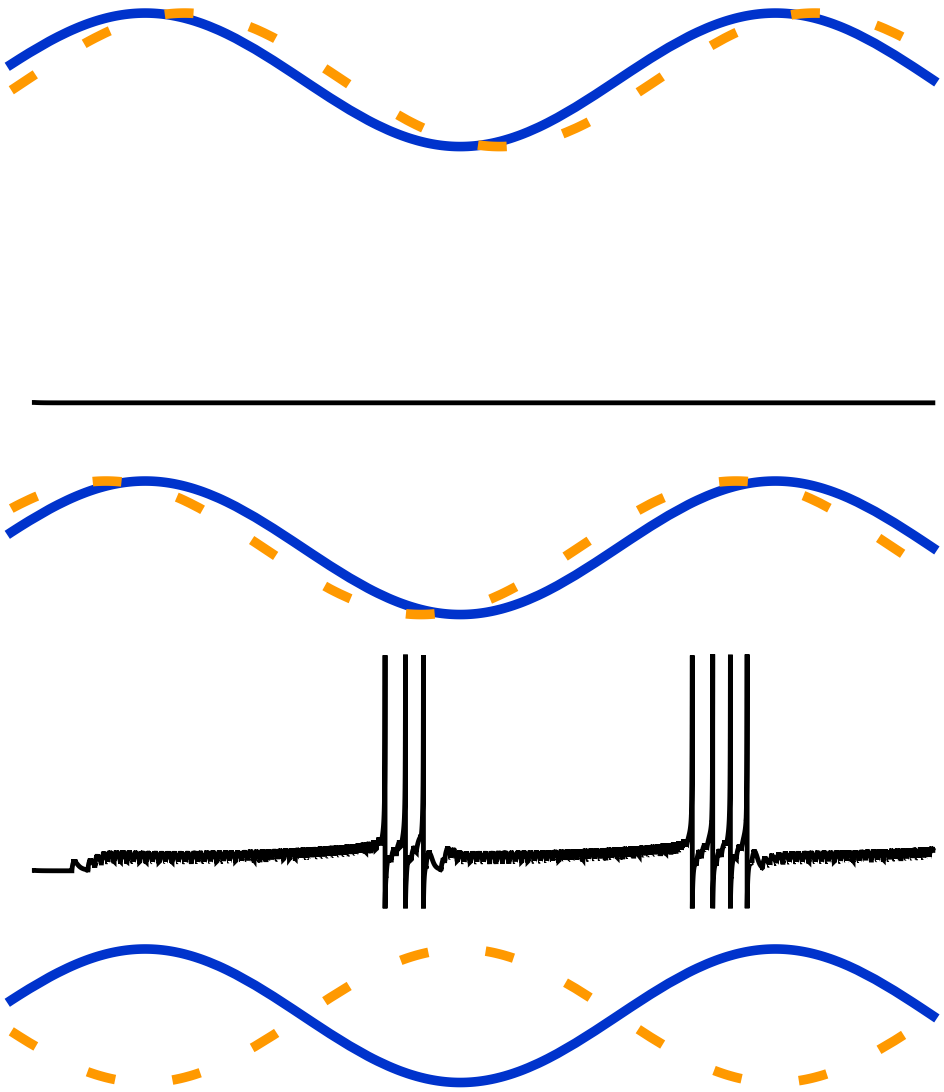
```
Plot[Vo[t] /. solLagAND, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
 PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
 AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
Plot[{input1[t], inputLag[t]},
 {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
   {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
 ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
Plot[Vo[t] /. solAntiAND, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
 PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
 AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
Plot[{input1[t], inputAnti[t]},
 {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
   {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
 ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False]

}]
```

Out[ ]=

```
{4, 4, 4.5, 4.5, -2.}
```

Out[ ]=





AND

In[ ]:=
```
Ibias = {3.5, 3.5, 3.1, 3.1, -2.1}
solSyncAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
```

```
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
       input1[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] + input1[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]],
    Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAntiAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
       input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
       inputAnti[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
```

```
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAnti[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAdvAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAdv[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
```

```
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAdv[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solLagAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputLag[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
```

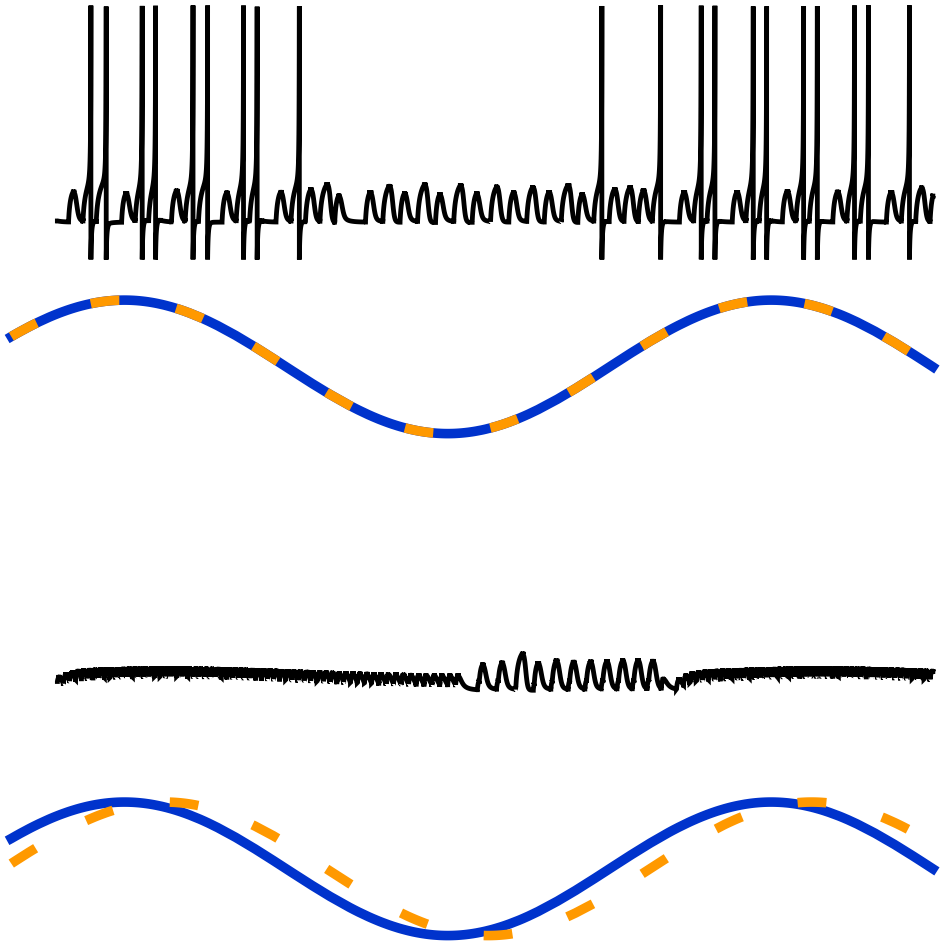
```
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuroni2*)
   Vi2 '[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
     inputLag[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
   Wi2 '[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
   tau Si2 '[t] == -Si2[t], Si2[0] == 0,
   WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuron out*)
   Vo '[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
   Wo '[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
   WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
  {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
  {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];
ANDout = Column[{
  Plot[Vo[t] /. solSyncAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
   PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
   AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  Plot[{input1[t], input1[t]},
   {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
  Plot[Vo[t] /. solAdvAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
   PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
   AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  , Plot[{input1[t], inputAdv[t]},
   {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
  Plot[Vo[t] /. solLagAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
   PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
   AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  Plot[{input1[t], inputLag[t]},
   {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
  Plot[Vo[t] /. solAntiAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
```

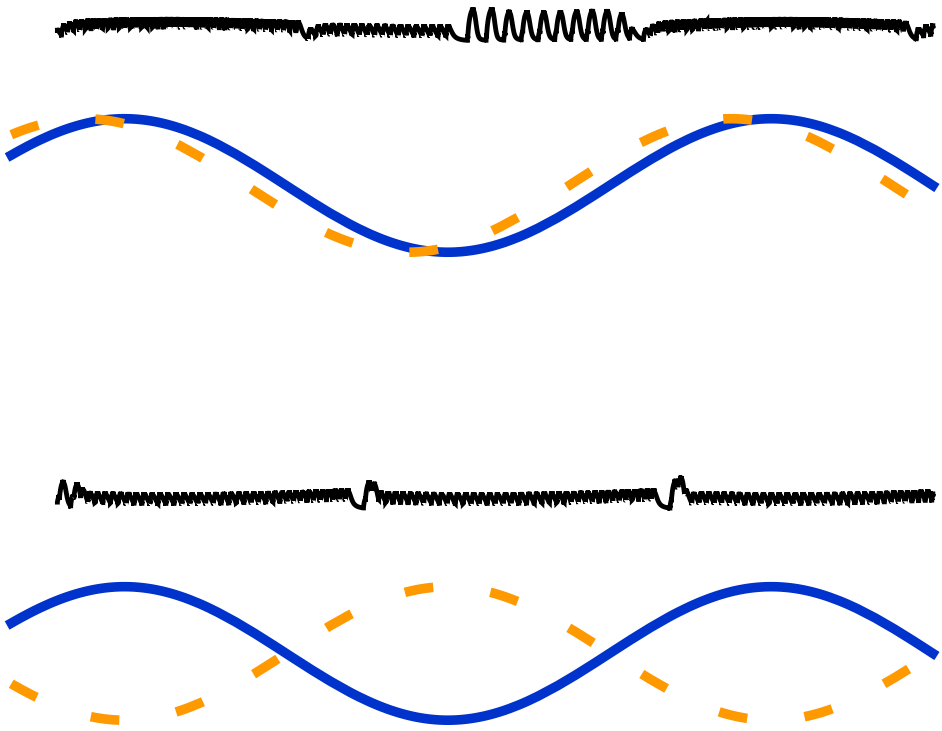
```
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  Plot[{input1[t], inputAnti[t]},
   {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False]

 }]
```

Out[ ]=

```
{3.5, 3.5, 3.1, 3.1, -2.1}
```

Out[ ]=





OR

In[ ]:=
```
Ibias = {4, 4, 3.5, 3.5, -2.1}
solSyncAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      input1[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
```

```
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] + input1[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]],
    Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAntiAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAnti[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
```

```
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAnti[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAdvAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAdv[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
```

```
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuroni2*)
   Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
     inputAdv[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
   Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
   tau Si2'[t] == -Si2[t], Si2[0] == 0,
   WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuron out*)
   Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
   Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
   WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
  {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
  {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solLagAND = NDSolve[
  {(*neuron e1*)
   Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
     input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
   We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
   tau Se1'[t] == -Se1[t], Se1[0] == 0,
   WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuron e2*)
   Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
     inputLag[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
   We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
   tau Se2'[t] == -Se2[t], Se2[0] == 0,
   WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuron i1*)
   Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
   Vi1[0] == 0,
   Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
   tau Si1'[t] == -Si1[t], Si1[0] == 0,
   WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuroni2*)
   Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
     inputLag[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
```

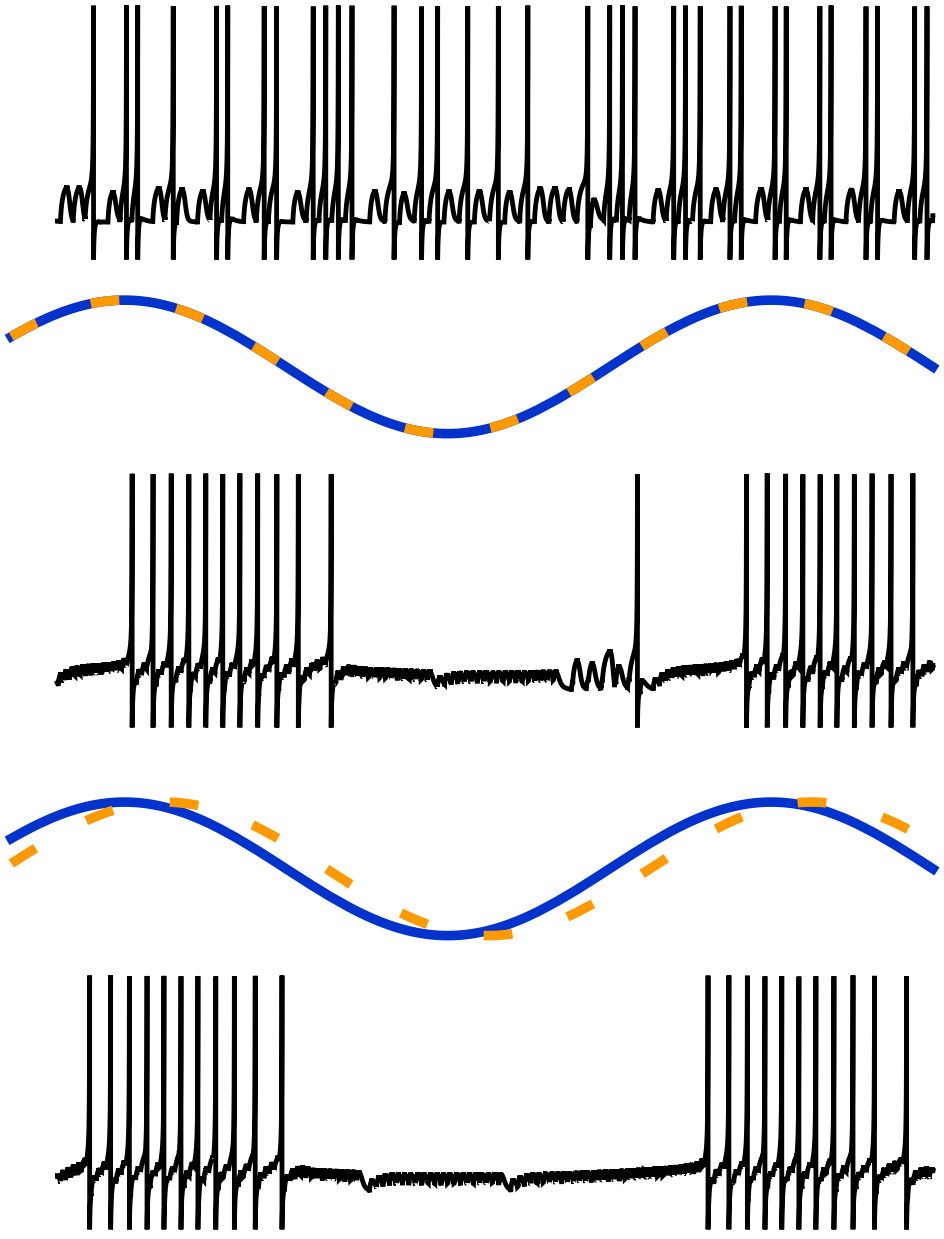
```
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];
ORout = Column[{
   Plot[Vo[t] /. solSyncAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
   Plot[{input1[t], input1[t]},
    {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
      {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
    ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
   Plot[Vo[t] /. solAdvAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
   , Plot[{input1[t], inputAdv[t]},
    {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
      {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
    ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
   Plot[Vo[t] /. solLagAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
   Plot[{input1[t], inputLag[t]},
    {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
      {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
    ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
   Plot[Vo[t] /. solAntiAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
   Plot[{input1[t], inputAnti[t]},
    {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
```

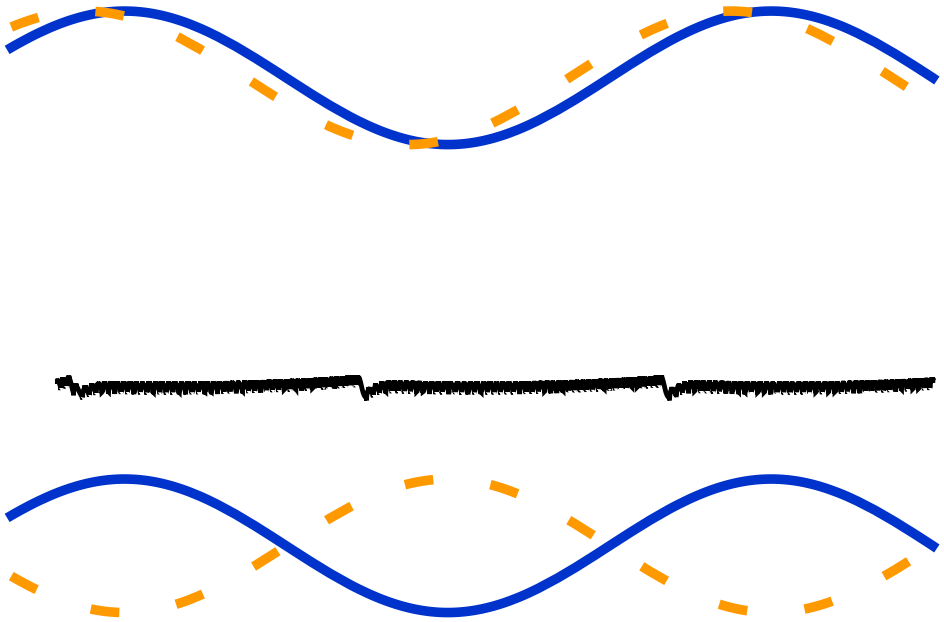
```
    {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
  ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False]

 }]
```

Out[ ]=

```
{4, 4, 3.5, 3.5, -2.1}
```

Out[ ]=





XOR

In[ ]:=
```
Ibias = {2, 2, 2.5, 2.5, 1.1}
solSyncAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      input1[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
```

```
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuroni2*)
   Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] + input1[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]],
   Vi2[0] == 0,
   Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
   tau Si2'[t] == -Si2[t], Si2[0] == 0,
   WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuron out*)
   Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
   Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
   WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
  {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
  {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAntiAND = NDSolve[
  {(*neuron e1*)
   Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
     input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
   We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
   tau Se1'[t] == -Se1[t], Se1[0] == 0,
   WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuron e2*)
   Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
     inputAnti[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
   We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
   tau Se2'[t] == -Se2[t], Se2[0] == 0,
   WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuron i1*)
   Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
   Vi1[0] == 0,
   Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
   tau Si1'[t] == -Si1[t], Si1[0] == 0,
   WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
   (*neuroni2*)
   Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
     inputAnti[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
```

```
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAdvAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAdv[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAdv[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
```

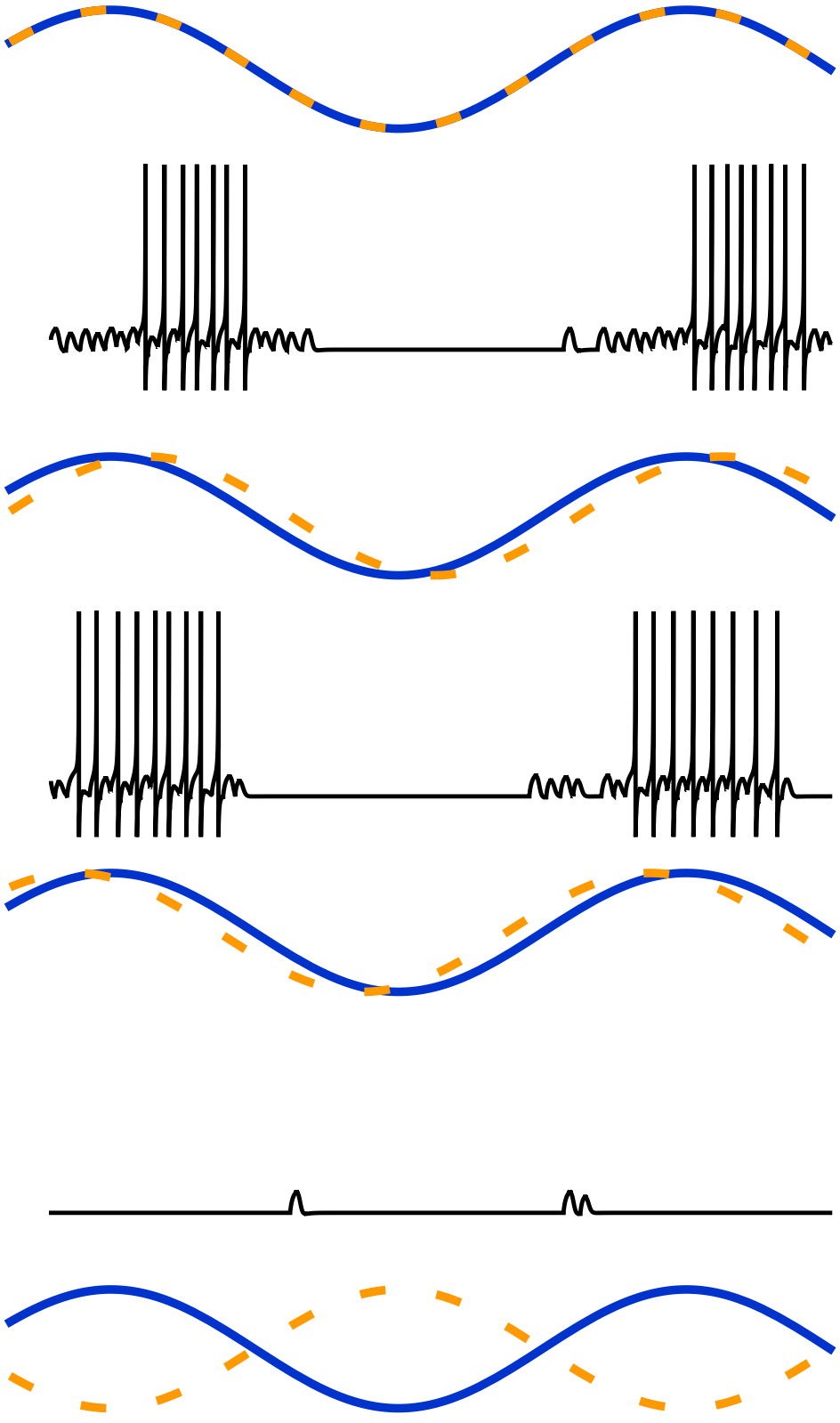
```
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solLagAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputLag[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputLag[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
```

```
    "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
  {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
  {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];
XORout = Column[{
  Plot[Vo[t] /. solSyncAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
   PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
   AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  Plot[{input1[t], input1[t]},
   {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
  Plot[Vo[t] /. solAdvAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
   PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
   AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  , Plot[{input1[t], inputAdv[t]},
   {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
  Plot[Vo[t] /. solLagAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
   PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
   AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  Plot[{input1[t], inputLag[t]},
   {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
  Plot[Vo[t] /. solAntiAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
   PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
   AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
  Plot[{input1[t], inputAnti[t]},
   {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
     {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
   ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False]
 }]
```

Out[ ]=

```
{2, 2, 2.5, 2.5, 1.1}
```

Out[ ]=



NIMP

In[ ]:=
```
Ibias = {1.5, 0, 2.5, 2.5, 2}
solSyncAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      input1[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] + input1[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]],
    Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAntiAND = NDSolve[
```

```
{(*neuron e1*)
 Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
    input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
 We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
 tau Se1'[t] == -Se1[t], Se1[0] == 0,
 WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
  "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
 (*neuron e2*)
 Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
    inputAnti[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
 We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
 tau Se2'[t] == -Se2[t], Se2[0] == 0,
 WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
  "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
 (*neuron i1*)
 Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
 Vi1[0] == 0,
 Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
 tau Si1'[t] == -Si1[t], Si1[0] == 0,
 WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
  "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
 (*neuroni2*)
 Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
    inputAnti[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
 Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
 tau Si2'[t] == -Si2[t], Si2[0] == 0,
 WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
  "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
 (*neuron out*)
 Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
 Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
 WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
  "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
{Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
{t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAdvAND = NDSolve[
 {(*neuron e1*)
  Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
     input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
```

```
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAdv[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAdv[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solLagAND = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
```

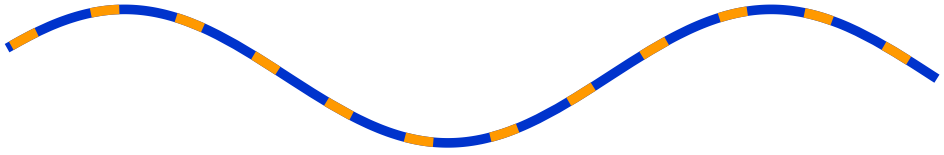
```
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputLag[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputLag[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];
NIMPout = Column[{
   Plot[Vo[t] /. solSyncAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
   Plot[{input1[t], input1[t]},
    {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
      {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
    ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
   Plot[Vo[t] /. solAdvAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
```

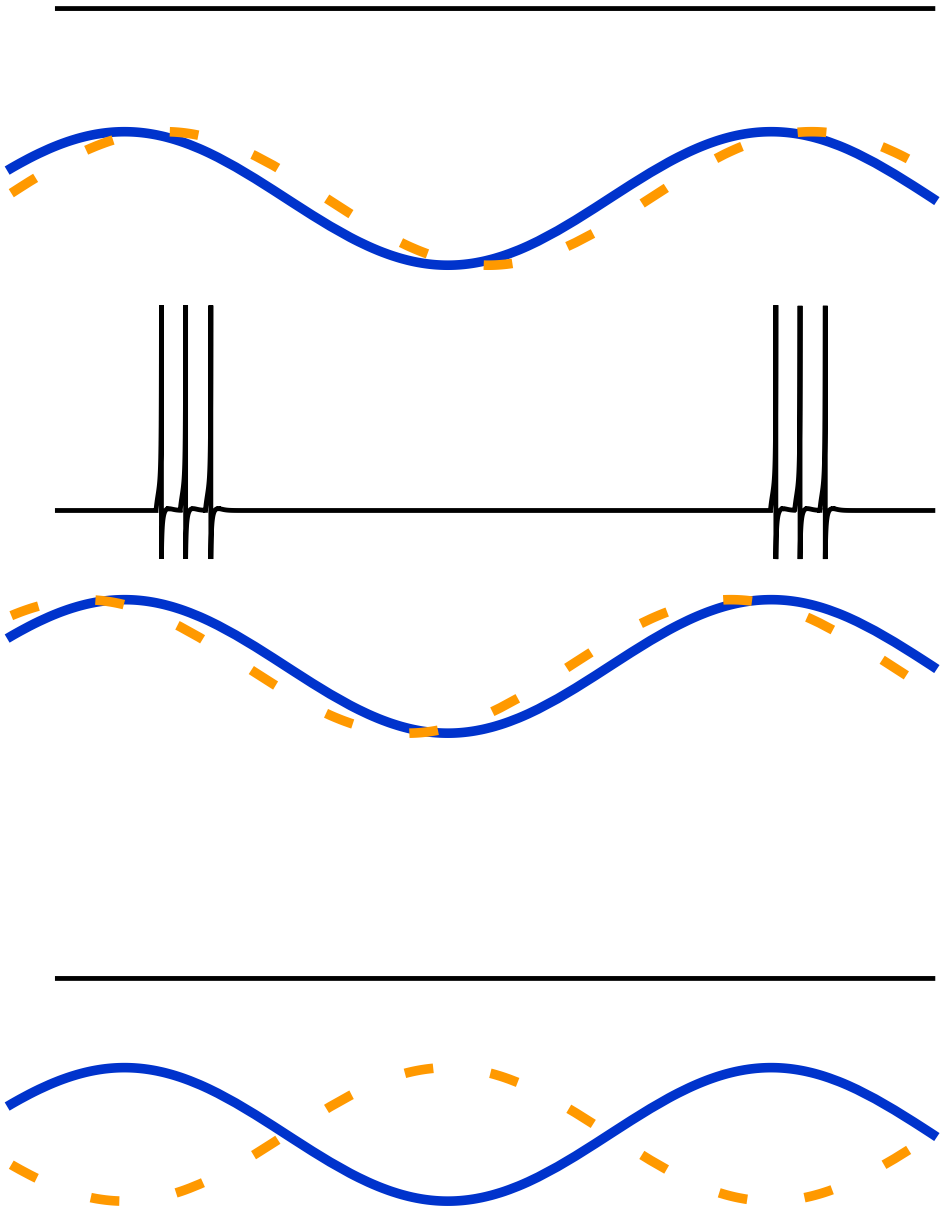
```
, Plot[{input1[t], inputAdv[t]},
 {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
   {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
 ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
Plot[Vo[t] /. solLagAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
 PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
 AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
Plot[{input1[t], inputLag[t]},
 {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
   {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
 ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
Plot[Vo[t] /. solAntiAND, {t, 60, time}, ImageSize → 500, PlotRange → {0, 140},
 PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
 AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
Plot[{input1[t], inputAnti[t]},
 {t, 60, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
   {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
 ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False]

}]
```

Out[ ]=

```
{1.5, 0, 2.5, 2.5, 2}
```

Out[ ]=





IMP

In[ ]:=
```
Ibias = {3.0 - .01, 3.19, 3.5, 3.4, -0}
solSyncNXOR = NDSolve[
```

```
    {(*neuron e1*)
     Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
        input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
     We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
     tau Se1'[t] == -Se1[t], Se1[0] == 0,
     WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuron e2*)
     Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
        input1[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
     We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
     tau Se2'[t] == -Se2[t], Se2[0] == 0,
     WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuron i1*)
     Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
     Vi1[0] == 0,
     Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
     tau Si1'[t] == -Si1[t], Si1[0] == 0,
     WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuroni2*)
     Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] + input1[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]],
     Vi2[0] == 0,
     Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
     tau Si2'[t] == -Si2[t], Si2[0] == 0,
     WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
     (*neuron out*)
     Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
     Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
     WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
      "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
    {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
    {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAntiNXOR = NDSolve[
    {(*neuron e1*)
     Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
        input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
```

```
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAnti[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAnti[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solAdvNXOR = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
```

```
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputAdv[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputAdv[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];

solLagNXOR = NDSolve[
   {(*neuron e1*)
    Ve1'[t] == Fv[Ve1[t], We1[t]][Ibias[[1]], k, b] +
      input1[t] + gee Se2[t] + gie Si1[t] + Ibias[[1]], Ve1[0] == 0,
    We1'[t] == Fw[Ve1[t], We1[t]][a, b], We1[0] == 6,
    tau Se1'[t] == -Se1[t], Se1[0] == 0,
    WhenEvent[Ve1[t] == 130, {Ve1[t] → c, We1[t] → We1[t] + d, Se1[t] → Se1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron e2*)
    Ve2'[t] == Fv[Ve2[t], We2[t]][Ibias[[2]], k, b] +
      inputLag[t] + gee Se1[t] + gie Si2[t] + Ibias[[2]], Ve2[0] == 0,
    We2'[t] == Fw[Ve2[t], We2[t]][a, b], We2[0] == 6,
```

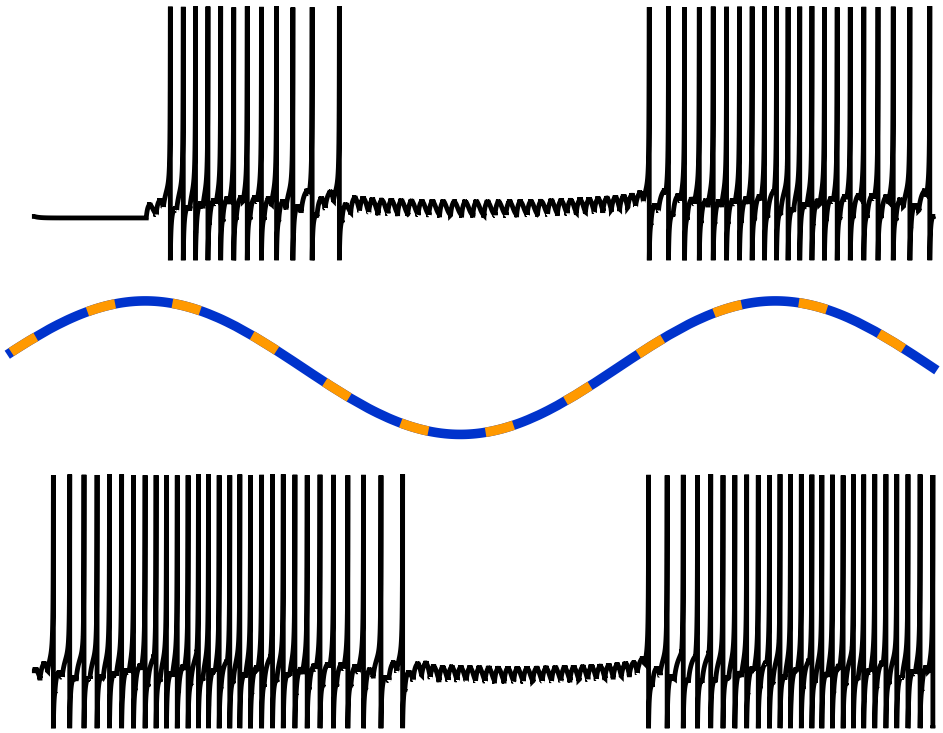
```
    tau Se2'[t] == -Se2[t], Se2[0] == 0,
    WhenEvent[Ve2[t] == 130, {Ve2[t] → c, We2[t] → We2[t] + d, Se2[t] → Se2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron i1*)
    Vi1'[t] == Fv[Vi1[t], Wi1[t]][Ibias[[3]], k, b] + input1[t] + gii Si2[t] + gei Se1[t] + Ibias[[3]],
    Vi1[0] == 0,
    Wi1'[t] == Fw[Vi1[t], Wi1[t]][a, b], Wi1[0] == 6,
    tau Si1'[t] == -Si1[t], Si1[0] == 0,
    WhenEvent[Vi1[t] == 130, {Vi1[t] → c, Wi1[t] → Wi1[t] + d, Si1[t] → Si1[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuroni2*)
    Vi2'[t] == Fv[Vi2[t], Wi2[t]][Ibias[[4]], k, b] +
      inputLag[t] + gii Si1[t] + gei Se2[t] + Ibias[[4]], Vi2[0] == 0,
    Wi2'[t] == Fw[Vi2[t], Wi2[t]][a, b], Wi2[0] == 6,
    tau Si2'[t] == -Si2[t], Si2[0] == 0,
    WhenEvent[Vi2[t] == 130, {Vi2[t] → c, Wi2[t] → Wi2[t] + d, Si2[t] → Si2[t] + 1},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"],
    (*neuron out*)
    Vo'[t] == Fv[Vo[t], Wo[t]][Ibias[[5]], k, b] + go Se1[t] + go Se2[t], Vo[0] == 0,
    Wo'[t] == Fw[Vo[t], Wo[t]][a, b], Wo[0] == 6,
    WhenEvent[Vo[t] == 130, {Vo[t] → c, Wo[t] → Wo[t] + d},
     "DetectionMethod" → "Sign", "LocationMethod" → "LinearInterpolation"]},
   {Ve1, We1, Se1, Ve2, We2, Se2, Vi1, Wi1, Si1, Vi2, Wi2, Si2, Vo, Wo},
   {t, 0, time}, Method → {"TimeIntegration" → "Adams"}, Compiled → True];
IMPout = Column[{
   Plot[Vo[t] /. solSyncNXOR, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
   Plot[{input1[t], input1[t]},
    {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
      {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
    ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
   Plot[Vo[t] /. solAdvNXOR, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
    PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
    AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
   , Plot[{input1[t], inputAdv[t]},
    {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
      {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
    ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
```

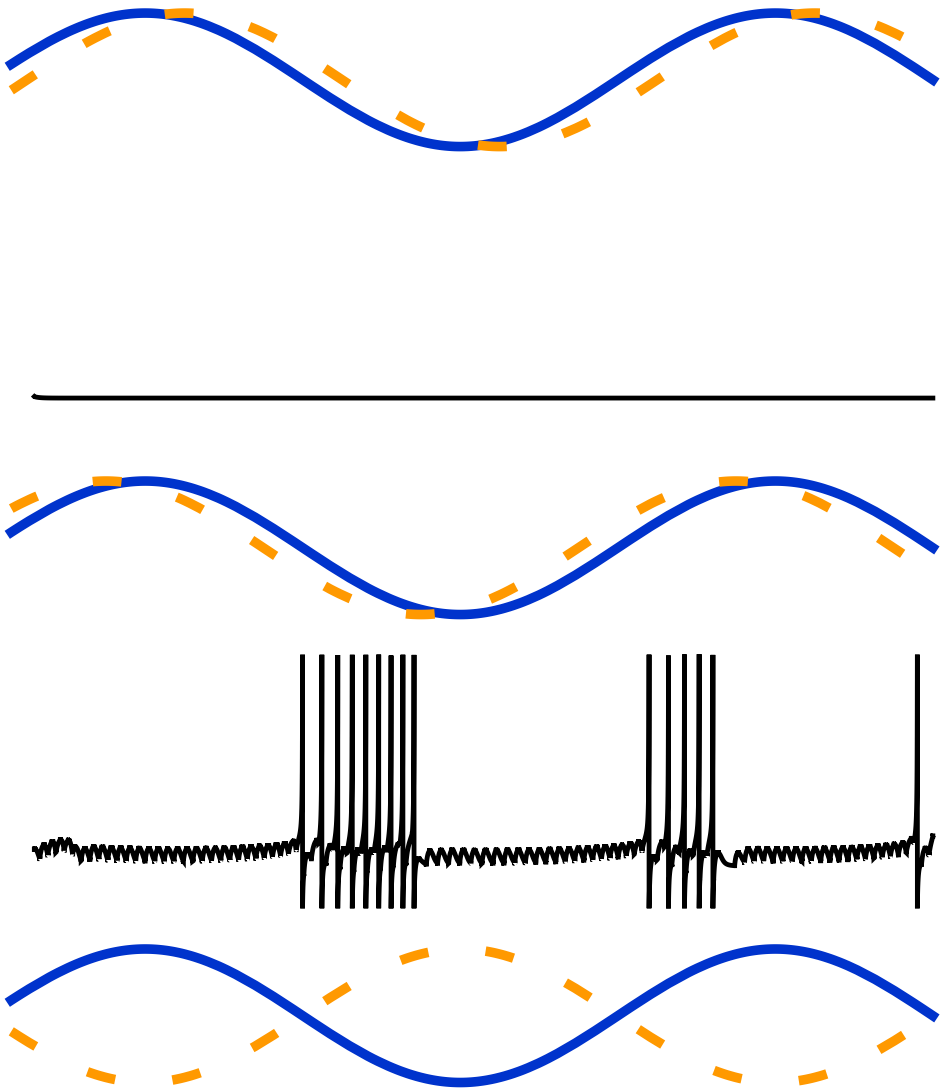
```
Plot[Vo[t] /. solLagNXOR, {t, 30, time}, ImageSize → 500, PlotRange → {0, 140},
 PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
 AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
Plot[{input1[t], inputLag[t]},
 {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
   {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
 ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False],
Plot[Vo[t] /. solAntiNXOR, {t, 30, time}, ImageSize → 500,
 PlotRange → {0, 140}, PlotPoints → 10 000, PlotStyle → {{Thickness[.005], Black}},
 AspectRatio → (1 / (2 GoldenRatio)), Axes → None],
Plot[{input1[t], inputAnti[t]},
 {t, 30, time}, PlotStyle → {{Thickness[.01], RGBColor[0, .2, .8]},
   {Thickness[.01], RGBColor[1, .6, 0], Dashing[{.03, .06}]}}, Exclusions → None,
 ImageSize → 500, AspectRatio → (1 / (4 GoldenRatio)), Axes → False]

}]
```

Out[ ]=

```
{2.99, 3.19, 3.5, 3.4, 0}
```

Out[ ]=





In[ ]:=
```
Export["/home/ns-cclolab/Desktop/OR.png", ORout]
Export["/home/ns-cclolab/Desktop/XOR.png", XORout]
Export["/home/ns-cclolab/Desktop/NOR.png", NOR2out]
Export["/home/ns-cclolab/Desktop/NXOR.png", NXORout]
Export["/home/ns-cclolab/Desktop/AND.png", ANDout]
Export["/home/ns-cclolab/Desktop/NAND.png", NANDout]
Export["/home/ns-cclolab/Desktop/IMP.png", IMPout]
Export["/home/ns-cclolab/Desktop/NIMP.png", NIMPout]
```

Out[ ]=
```
/home/ns-cclolab/Desktop/OR.png
```

Out[ ]=
```
/home/ns-cclolab/Desktop/XOR.png
```

Out[ ]=
```
/home/ns-cclolab/Desktop/NOR.png
```

Out[ ]=

/home/ns-cclolab/Desktop/NXOR.png

Out[ ]=

/home/ns-cclolab/Desktop/AND.png

Out[ ]=

/home/ns-cclolab/Desktop/NAND.png

Out[ ]=

/home/ns-cclolab/Desktop/IMP.png

Out[ ]=

/home/ns-cclolab/Desktop/NIMP.png