

1. To plot a phase portrait of the van der Pol oscillator (both numerical solution and analytics for the limit cycle) in mathematica, use the following commands:

```
sol[t_] =  
  NDSolve[{x''[t] + 0.1*(x[t]^2 - 1)* x'[t] + x[t] == 0,  
    x[0] == 1., x'[0] == 0}, x[t], {t, 0, 50}][[1, 1, 2]]  
  
ParametricPlot[{2*Cos[t], -2*Sin[t]}, {sol[t], sol'[t]}],  
  {t, 0, 50}]
```

2. To plot the numerical solution of a boundary value problem for an ordinary differential equation in mathematica, use the following commands:

```
sols = NDSolve[{0.1*y''[x] + 2* y'[x] + Exp[y[x]] == 0, y[0] == 0,  
  y[1] == 0}, y, {x, 0, 1}]  
  
Plot[{Evaluate[y[x] /. sols], x*(1 - x)}, {x, 0, 1}]
```