In[•]:=
```
NLODEs =
 {D[x[t], t] == V0 + V1 β - V2 + V3 + kf y[t] - k x[t], D[y[t], t] == V2 - V3 - kf y[t],
  D[z[t], t] == β V4 - V5 - ∈ z[t]} /. {V2 → VM2 x[t]^2 / (k2^2 + x[t]^2),
  V3 → VM3 x[t]^m / (kx^m + x[t]^m) y[t]^2 / (ky^2 + y[t]^2) z[t]^4 / (kz^4 + z[t]^4),
  V5 → VM5 z[t]^p / (k5^p + z[t]^p) x[t]^n / (kd^n + x[t]^n)}
```

Out[•]=

$$\left\{x'[t] == V0 + V1\,\beta - k\,x[t] - \frac{VM2\,x[t]^2}{k2^2 + x[t]^2} + kf\,y[t] + \frac{VM3\,x[t]^m\,y[t]^2\,z[t]^4}{(kx^m + x[t]^m)\,(ky^2 + y[t]^2)\,(kz^4 + z[t]^4)},\right.$$

$$y'[t] == \frac{VM2\,x[t]^2}{k2^2 + x[t]^2} - kf\,y[t] - \frac{VM3\,x[t]^m\,y[t]^2\,z[t]^4}{(kx^m + x[t]^m)\,(ky^2 + y[t]^2)\,(kz^4 + z[t]^4)},$$

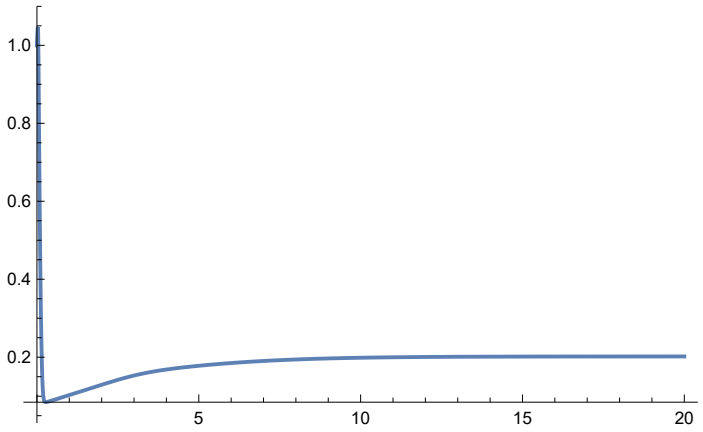
$$\left.z'[t] == V4\,\beta - \in z[t] - \frac{VM5\,x[t]^n\,z[t]^p}{(kd^n + x[t]^n)\,(k5^p + z[t]^p)}\right\}$$

In[•]:=
```
tmax = 20;
```

Steady State

In[•]:=
```
VvalsSS = {V0 → 2, V1 → 2 , V4 → 5, kf → 1, k → 10, β → 0.01, ∈ → 0.1 , VM2 → 6, k2 → 0.1,
   VM3 → 20, m → 2, kx → 0.5, ky → 0.2, kz → 0.2, VM5 → 30, k5 → 0.3, kd → 0.5, p → 2, n → 4};
solSS = NDSolve[Join[NLODEs /. VvalsSS, {x[0] == 1, y[0] == 1, z[0] == 1}],
   {x[t], y[t], z[t]}, {t, 0, tmax}];
Plot[x[t] /. solSS[[1]], {t, 0, tmax}, PlotRange → All]
```

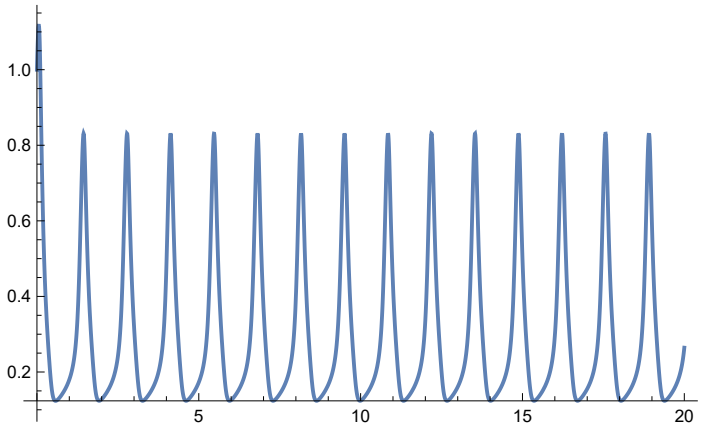
Out[•]=



Simple Periodic Oscillations

In[•]:=
```
VvalsSPO = {V0 → 2, V1 → 2 , V4 → 2, kf → 1, k → 10, β → 0.5, ϵ → 0.1 , VM2 → 6, k2 → 0.1,
    VM3 → 20, m → 2, kx → 0.5, ky → 0.2, kz → 0.2, VM5 → 5, k5 → 1, kd → 0.4, p → 2, n → 4};
solSPO = NDSolve[Join[NLODEs /. VvalsSPO, {x[0] == 1, y[0] == 1, z[0] == 1}],
    {x[t], y[t], z[t]}, {t, 0, tmax}];
Plot[x[t] /. solSPO[[1]], {t, 0, tmax}, PlotRange → All]
```

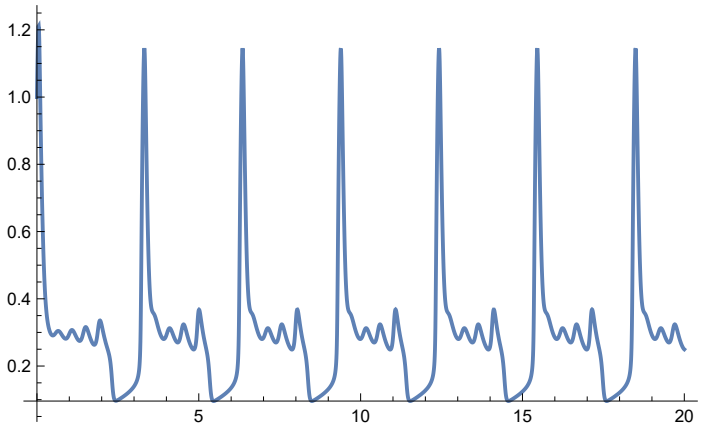
Out[•]=



Bursting

In[•]:=
```
VvalsB = {V0 → 2, V1 → 2 , V4 → 2.5, kf → 1, k → 10, β → 0.46, ϵ → 0.1 , VM2 → 6, k2 → 0.1,
    VM3 → 20, m → 4, kx → 0.3, ky → 0.2, kz → 0.1, VM5 → 30, k5 → 1, kd → 0.6, p → 1, n → 2};
solB = NDSolve[Join[NLODEs /. VvalsB, {x[0] == 1, y[0] == 1, z[0] == 1}],
    {x[t], y[t], z[t]}, {t, 0, tmax}];
Plot[x[t] /. solB[[1]], {t, 0, tmax}, PlotRange → All]
```

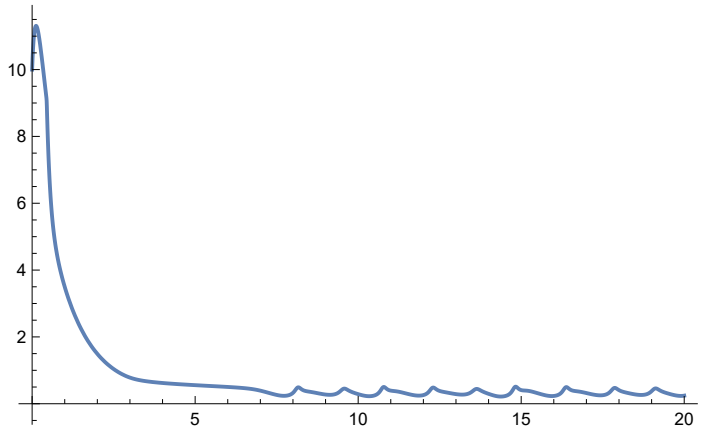
Out[•]=



Chaos

```
In[•]:= VvalsC = {V0 → 2, V1 → 2 , V4 → 3, kf → 1, k → 10, β → 0.65, ϵ → 13 , VM2 → 6, k2 → 0.1, VM3 → 30,
          m → 2, kx → 0.6, ky → 0.3, kz → 0.1, VM5 → 50, k5 → 0.3194, kd → 1, p → 1, n → 4};
        solC = NDSolve[Join[NLODEs /. VvalsC, {x[0] == 10, y[0] == 100, z[0] == 1000}],
          {x[t], y[t], z[t]}, {t, 0, tmax}];
        Plot[x[t] /. solC[[1]], {t, 0, tmax}, PlotRange → All]
```

Out[•]=



Period Doubling Sequences

```
In[•]:= VvalsPDS = {V0 → 2, V1 → 2 , V4 → 3, kf → 1, k → 10, β → 0.7, ϵ → 13 , VM2 → 6, k2 → 0.1,
          VM3 → 30, m → 2, kx → 0.6, ky → 0.3, kz → 0.1, VM5 → 50, k5 → 0.3194, kd → 1, p → 1, n → 4};
        solPDS = NDSolve[Join[NLODEs /. VvalsPDS, {x[0] == 1, y[0] == 1, z[0] == 1}],
          {x[t], y[t], z[t]}, {t, 0, tmax}];
        Plot[x[t] /. solPDS[[1]], {t, 0, tmax}, PlotRange → All]
```

Out[•]=