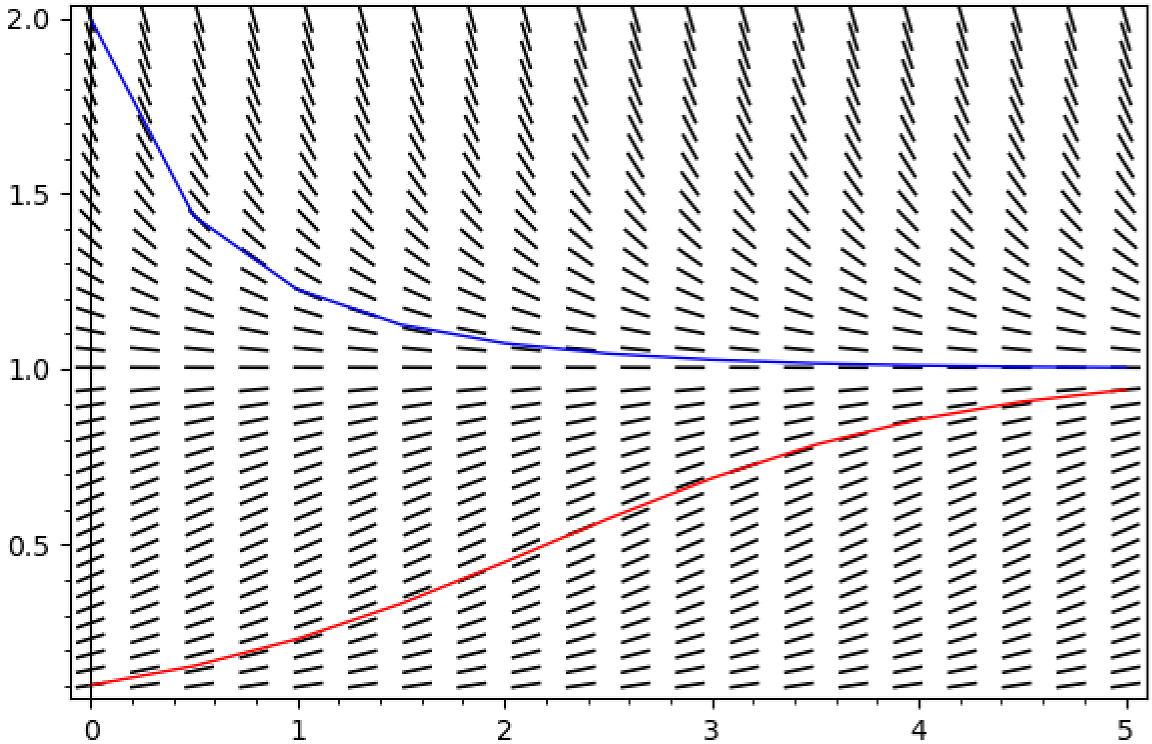
In [1]:
```
### 1.
reset()

# Declaram variabilele t si r
t = var('t')
r = var('r')

# Declaram functia x
x = function('x')(t)

# Declaram ecuatia dx/dt = rx(1 - x)
eq = diff(x, t) == r * x * (1 - x)

# Rezolvam ecuatia folosind desolve
sol = desolve(eq, [x, t])

# Afisam solutia
show(sol)
```

$$-\frac{\log(x(t) - 1) - \log(x(t))}{r} = C + t$$

In [3]:
```
### 2.1.
reset()

# Declaram variabila t
t = var('t')

# Declaram functia x
x = function('x')(t)

# Declaram ecuatia dx/dt = x(1 - x)
eq = diff(x, t) == x * (1 - x)

# Rezolvam pentru x1, x1(0) = 0.1
sol1 = desolve_rk4(eq, x, [0, 0.1], step=0.5, end_points=[0, 5])
show(sol1)

# Rezolvam pentru x2, x2(0) = 2
sol2 = desolve_rk4(eq, x, [0, 2], step=0.5, end_points=[0, 5])
show(sol2)

### 2.2.

# Rezolvam pentru x1, x1(0) = 0.1, grafic
graf1 = desolve_rk4(eq, x, [0, 0.1], step=0.5, end_points=[0, 5], output='slope_

# Rezolvam pentru x2, x2(0) = 2, grafic
graf2 = desolve_rk4(eq, x, [0, 2], step=0.5, end_points=[0, 5], output='slope_fi

show(graf1 + graf2)
```

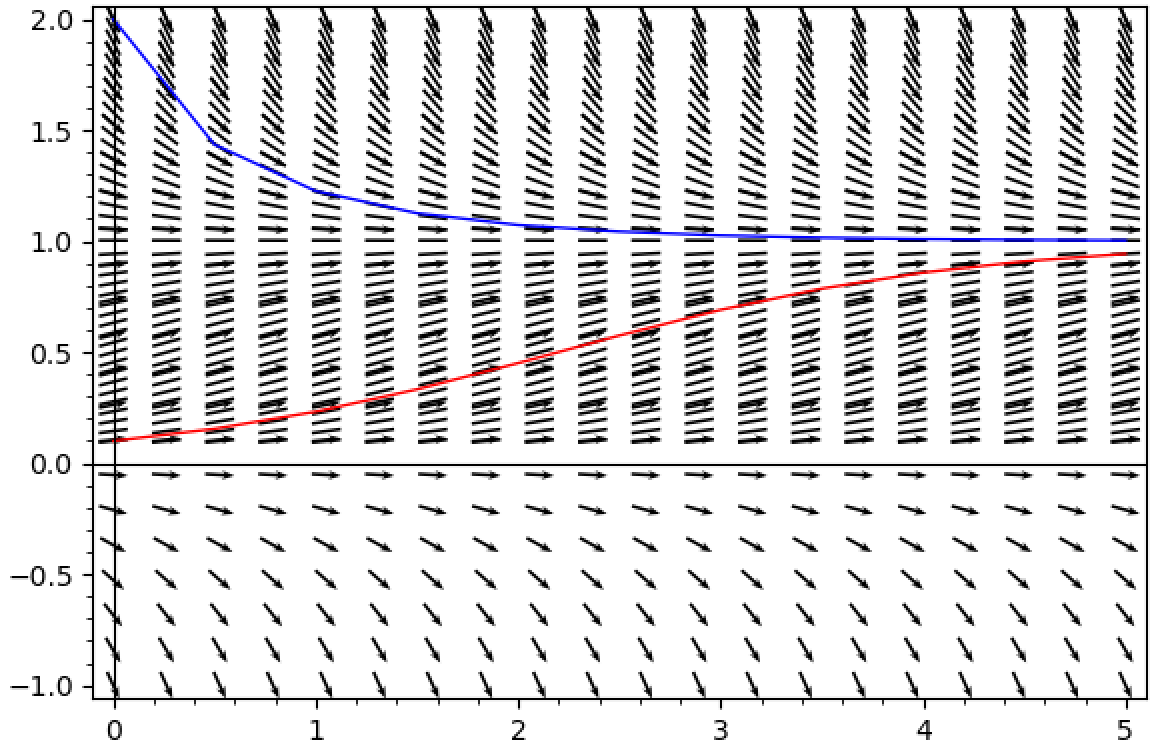
$$[[0, 0.100000000000000], [0.5, 0.1548152835027005], [1.0, 0.2319390433613608], [1.5, 0.332$$

$[[0, 2], [0.5, 1.435124397277832], [1.0, 1.225742412718555], [1.5, 1.125877218964766], [2.0$



In [8]:

```
### 3

# Declaram functia f
f(s) = s * (1 - s)

# Reprezentam grafic portretul fazic al functiei f in intervalul dat
graf3 = plot_slope_field(f(s), (t, 0, 5), (s, -1, 2), headaxislength=3, headleng

# Afisam toate cele 3 grafice
show(graf1 + graf2 + graf3)
```



In [29]:

```
### 4

# Declaram functia f
f(s) = s * (1 - s) * (2 - s)

# Declaram ecuatia pentru care trebuie gasite punctele de echilibru
eq = f(s) == 0

# Rezolvam ecuatia, obtinem punctele de echilibru
eqp = solve(eq, s)
show(eqp)

# Extragem punctele de echilibru din rezolvare
s1 = eqp[0].rhs()
s2 = eqp[1].rhs()
s3 = eqp[2].rhs()

# Calculam derivata functiei in punctele de echilibru
d1 = diff(f, s)(s1)
d2 = diff(f, s)(s2)
d3 = diff(f, s)(s3)

# Afisam
print('s: {}, f\'(s): {}'.format(s1, d1))
print('s: {}, f\'(s): {}'.format(s2, d2))
print('s: {}, f\'(s): {}'.format(s3, d3))

# Observam ca f'(1) < 0 => 1 punct de echilibru stabil
# f'(0) si f'(2) > 0 => {0, 2} puncte de echilibru instabile
```

$$[s = 0, s = 1, s = 2]$$

```
s: 0, f'(s): 2
s: 1, f'(s): -1
```

```
s: 2, f'(s): 2
```