

In[1]:= **yp = y[xn - h] + 2 * h * f[xn, y[xn]]**

Out[1]= $2 h f[xn, y[xn]] + y[-h + xn]$

In[2]:= **ynp1 = y[xn] + h / 2 * (f[xn, y[xn]] + f[xn + h, yp])**

Out[2]= $\frac{1}{2} h (f[xn, y[xn]] + f[h + xn, 2 h f[xn, y[xn]] + y[-h + xn]]) + y[xn]$

In[3]:= **f = Function[{xi, eta}, A * eta]**

Out[3]= $\text{Function}[\{xi, eta\}, A eta]$

In[4]:= **method = y[xn + h] == ynp1**

Out[4]= $y[h + xn] == y[xn] + \frac{1}{2} h (A y[xn] + A (2 A h y[xn] + y[-h + xn]))$

In[5]:= **ceq = method /. y -> Function[s, rho ^ s]**

Out[5]= $\text{rho}^{h+xn} == \text{rho}^{xn} + \frac{1}{2} h \left(A \text{rho}^{xn} + A \left(2 A h \text{rho}^{xn} + \text{rho}^{-h+xn} \right) \right)$

In[6]:= **ceq2 = ceq /. {xn -> 0, h -> 1}**

Out[6]= $\text{rho} == 1 + \frac{1}{2} \left(A + A \left(2 A + \frac{1}{\text{rho}} \right) \right)$

In[7]:= **S = Solve[ceq2, rho]**

Out[7]= $\left\{ \left\{ \text{rho} \rightarrow \frac{1}{4} \left(2 + A + 2 A^2 - \sqrt{4 + 12 A + 9 A^2 + 4 A^3 + 4 A^4} \right) \right\}, \right.$
 $\left. \left\{ \text{rho} \rightarrow \frac{1}{4} \left(2 + A + 2 A^2 + \sqrt{4 + 12 A + 9 A^2 + 4 A^3 + 4 A^4} \right) \right\} \right\}$

In[8]:= **# the linear stability region is all values of A such that | rho | < 1**

In[8]:= **Z1t = Abs[rho] /. S[[1]]**

Z1 = Z1t /. {A -> a + I * b}

Out[8]= $\frac{1}{4} \text{Abs} \left[2 + A + 2 A^2 - \sqrt{4 + 12 A + 9 A^2 + 4 A^3 + 4 A^4} \right]$

Out[9]= $\frac{1}{4} \text{Abs} \left[2 + a - \sqrt{4 + 12 (a + i b) + 9 (a + i b)^2 + 4 (a + i b)^3 + 4 (a + i b)^4} + 2 (a + i b)^2 + i b \right]$

In[10]:= **Z2t = Abs[rho] /. S[[2]]**

Z2 = Z2t /. {A -> a + I * b}

Out[10]= $\frac{1}{4} \text{Abs} \left[2 + A + 2 A^2 + \sqrt{4 + 12 A + 9 A^2 + 4 A^3 + 4 A^4} \right]$

Out[11]= $\frac{1}{4} \text{Abs} \left[2 + a + \sqrt{4 + 12 (a + i b) + 9 (a + i b)^2 + 4 (a + i b)^3 + 4 (a + i b)^4} + 2 (a + i b)^2 + i b \right]$

In[12]:= `ContourPlot[Max[Z1, Z2], {a, -3, 1}, {b, -2, 2}, Contours -> {1}, ContourShading -> {Red, Blue}]`

