In[1]:=
```
(* Question 4 *)
ynp1 = y[tn] + h / 2 * (f[tn, y[tn]] + f[tn + h, y[tn + h]])
f = Function[{t, y}, A * y]
method = y[tn + h] == ynp1
```

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

Out[2]= $\text{Function}[\{t, y\}, A\ y]$

Out[3]= $y[h + tn] == y[tn] + \frac{1}{2} h (A\ y[tn] + A\ y[h + tn])$

In[4]:=
```
ceq = method /. y -> Function[s, rho^s]
ceq2 = ceq /. {tn -> 0, h -> 1}
S = Solve[ceq2, rho]
```

Out[4]= $\text{rho}^{h+tn} == \text{rho}^{tn} + \frac{1}{2} h \left(A\ \text{rho}^{tn} + A\ \text{rho}^{h+tn}\right)$

Out[5]= $\text{rho} == 1 + \frac{1}{2} (A + A\ \text{rho})$

Out[6]= $\left\{\left\{\text{rho} \to \frac{-2 - A}{-2 + A}\right\}\right\}$

In[7]:=
```
(* the linear stability region is all values of A such that |rho|<1 *)
Z1t = Abs[rho] /. S[[1]]
Z1 = Z1t /. {A -> a + I * b}
```

Out[7]= $\text{Abs}\left[\frac{-2 - A}{-2 + A}\right]$

Out[8]= $\text{Abs}\left[\frac{-2 - a - i\ b}{-2 + a + i\ b}\right]$

In[9]:=
```
(* the red area is linearly stable, the blue unstable *)
ContourPlot[Z1, {a, -2, 2}, {b, -2, 2}, Contours -> {1},
 ContourShading -> {Red, Blue}, PlotRange → All, Exclusions → None]
```

Out[9]=