```
> restart:
  #Ben Hoobler
  #Math 435
  #Maple Code
  #The Mathematics of Rumor Propagation

> with(Student[NumericalAnalysis]):
  with(DynamicSystems):
  with(VectorCalculus):
  with(LinearAlgebra):
  with(linalg):
  with(Student[LinearAlgebra]):

> Ldot:= -lambda*kappa*L*S:
> Sdot:= lambda*kappa*L*S-alpha*kappa*S*(S+R):
> Rdot:= alpha*kappa*S*(S+R):
> solve({Ldot=0,Sdot=0,Rdot=0},{L,S,R});
  Equil1 := {L = L, R = R, S = 0};
  Equil2 := {L = 0, R = -S, S = S};
```

$$\{L = L, R = R, S = 0\}, \{L = 0, R = -S, S = S\}$$

$$Equil1 := \{L = L, R = R, S = 0\}$$

$$Equil2 := \{L = 0, R = -S, S = S\} \quad (1)$$

```
> J0 := Jacobian([Ldot,Sdot,Rdot], [L, S, R]);
```

$$J0 := \begin{bmatrix} -\kappa S \lambda & -\lambda \kappa L & 0 \\ \kappa S \lambda & \lambda \kappa L - \alpha \kappa (S + R) - \alpha \kappa S & -\alpha \kappa S \\ 0 & \alpha \kappa (S + R) + \alpha \kappa S & \alpha \kappa S \end{bmatrix} \quad (2)$$

```
> J0_EQUIL1 := subs(L = L, R = R, S = 0,J0);
```

$$J0\_EQUIL1 := \begin{bmatrix} 0 & -\lambda \kappa L & 0 \\ 0 & \lambda \kappa L - \alpha \kappa R & 0 \\ 0 & \alpha \kappa R & 0 \end{bmatrix} \quad (3)$$

```
> EIGEN_JEQ1:= eigenvalues(J0_EQUIL1);
```

$$EIGEN\_JEQ1 := 0, 0, \lambda \kappa L - \alpha \kappa R \quad (4)$$

```
> J0_EQUIL2 := subs(L = 0, R = -S, S = S,J0);
```

$$J0\_EQUIL2 := \begin{bmatrix} -\kappa S \lambda & 0 & 0 \\ \kappa S \lambda & -\alpha \kappa S & -\alpha \kappa S \\ 0 & \alpha \kappa S & \alpha \kappa S \end{bmatrix} \quad (5)$$

```
> EIGEN_JEQ2:= eigenvalues(J0_EQUIL2);
```

$$EIGEN\_JEQ2 := -\kappa S \lambda, 0, 0 \quad (6)$$

```
> Num_Eigen_JEQ1:= subs(lambda=.8,alpha=.3,kappa=.3, L=.99,S=.01,
  R=0,J0_EQUIL1);
  Num_Eigen_JEQ2:= subs(lambda=.8,alpha=.3,kappa=.3, L=.99,S=.01,
  R=0,J0_EQUIL2);
```

$$Num\_Eigen\_JEQ1 := \begin{bmatrix} 0 & -0.2376 & 0 \\ 0 & 0.2376 & 0 \\ 0 & 0. & 0 \end{bmatrix}$$

$$Num\_Eigen\_JEQ2 := \begin{bmatrix} -0.0024 & 0 & 0 \\ 0.0024 & -0.0009 & -0.0009 \\ 0 & 0.0009 & 0.0009 \end{bmatrix} \quad (7)$$

```
> eigenvalues(Num_Eigen_JEQ1);
```

$$0., 0.237600000000000, 0. \quad (8)$$

```
> eigenvalues(Num_Eigen_JEQ2);
```

$$0., 0., -0.00240000000000000 \quad (9)$$

```
> (-Rdot - Ldot) - Sdot; #Spreaders are a linear combination of
  ignorants                                and stiflers
```

$$0 \quad (10)$$

```
>
```