APPENDIX

// Newton Rapson method for two variables (q, r) in R Programming for chapter 2 //

```
AC=function(x)
{
 q=x[1]
 r=x[2]
 k=10; h=5; d=20; theata=5; c=5
 mu=2.5; lemda=0.25; pic=25; pi=250
 de=0; theata=d+theata; ie=0.08
 ic=0.15; T0=0.6; R=0.05; t1=6
 p0=mu/(lemda+mu)
 p1=lemda/(lemda+mu)
 u=exp((-mu*r)/dtheata)
 v=exp((mu*r)/dtheata)
 w=exp(R*t1)
 C10=(u*w/(mu^2))*((h*v*(mu*r-(dtheata))+((pi*mu*d)+(h*dtheata)+pic)
-(theata*c*mu)))+((theata*c)/mu)
 w1=exp(-(lemda+mu)*(q/dtheata))
 P01=p1-p1*w1
 A0=k+((.5*h*q^2*w)/dtheata)+((h*r*q*w)/dtheata)+((theata*c*q*w)/dtheata)
 T00=(q/dtheata)+((1/mu)*P01)
 Ie1=d*c*T00*T0*Ie
 Ie2=((d*c*T00+Ie1)*(T00-T0)*Ie)
 Ic=de*d*c*ic*(T00-T0)
 A=A0/T00
 B0=C10*P01
 B=B0/T00
 C0=(Ie1+Ie2)
 C=C0/T00
 D=Ic/T00
 return(A+B-C+D)
}
```

Output of R-code

```
nlm(AC, p=c(8, 9))
$minimum
[1] 260.3604
$estimate
[1] 18.56644  14.14799
```

// Newton Rapson method for two variables (q, r) in R Programming for chapter 3 //

```
AC=function(x)
{
 q=x[1]
 r=x[2]
 k=10; h=5; d=20;  theata=5; c=5;  mu=2.5; lemda=0.25;  pic=25;  pi=250
 T1=0.3; T=0.6; alpha=0.5; Ie=0.08; Ic=0.15; R=0.05; t1=6; U=0; V=1
 dtheata=d+theata
 p0=mu/(lemda+mu)
 p1=lemda/(lemda+mu)
 a=exp((-mu*r)/dtheata)
 b=exp((mu*r)/dtheata)
 w=exp(R*t1)
 C10=(a*w/(mu^2))*((h*b*(mu*r-(dtheata))+((pi*mu*d)+(h*dtheata)+pic)
- (theata*c*mu)))+((theata*c*w)/mu)
w1=exp(-(lemda+mu)*(q/dtheata))
 P01=p1-p1*w1
 A0=k+((.5*h*w*q^2)/dtheata)+((h*r*w*q)/dtheata)+((theata*c*w*q)/dtheata)
 T00=(q/dtheata)+((1/mu)*P01)
 E1=(-c*d*w*T00*T1*Ie)-((1-alpha)*c*d*w*T00*(T-T1)*Ie)
- (U*d*c*w*alpha*T00*(T-T1)*Ie)+(U*d*c*w*alpha*T00*(T-T1)*Ic)
-(c*d*w*T00*T1*Ie*(T-T1)*Ie)
 E2=(-V*(((1-alpha)*c*d*w*T00*(T00-T)*Ie)+(c*d*w*T00*T1*Ie*(T-T1)
*Ie*(T00-T)*Ie)+(c*d*w*T00*T1*Ie*(T00-T)*Ie)+((1-alpha)*c*d*w*T00*(T-T1)
*Ie*(T00-T)*Ie)))
 E3=(-V*(U*(d*c*w*alpha*T00*Ie*(T-T1)*(T00-T)
*Ie)))+(V*(U*((d*c*w*alpha*T00*Ic*(T00-T))+((1-alpha)*c*d*w*T00*Ic*(T00-T)))))
 A=A0/T00
 B0=C10*P01
 B=B0/T00
 D=(E1+E2+E3)
 E=D/T00
 return(A+B+E)
}
```

Output of R-code

```
nlm(AC, p=c(8,9))
$minimum
[1] 260.9979

$estimate
[1] 17.83440 14.41302
```

// Newton Rapson method for four variables (q_0, q_1, q_2, r) in R Programming for chapter 4 //

```
AC = function(x)
{
 q0 = x[1]
 q1 = x[2]
 q2 = x[3]
 r  = x[4]
 k=5; h=5; d=20; theata=4; c=1; mu1=3.4; mu2=2.5; lemda1=0.58; lemda2=0.45;
pi=350; T01=.6; T02=.8 Ie1=0.02; Ie2=0.04; ic1=0.11; ic2=0.13; alpha1=0; alpha2=0
delta=mu1+mu2
dtheata=d+theata
row1=mu1/delta
row2=mu2/delta
Tbar=1/(mu1+mu2)
p0=(mu1*mu2)/((lemda1+mu1)*(lemda2+mu2))
p1=(lemda2*mu1)/((lemda1+mu1)*(lemda2+mu2))
p2=(lemda1*mu2)/((lemda1+mu1)*(lemda2+mu2))
p3=(lemda1*lemda2)/((lemda1+mu1)*(lemda2+mu2))
u=exp(-(delta*r)/dtheata)
v=exp((delta*r)/dtheata)
cbar=(u/(delta^2))*((h*v*(delta*r-dtheata)+((pi*delta*d)+(h*dtheata)+pic)-
(theata*c*delta)))+(theata*c)/delta
w1=exp(-(lemda1+mu1)*(q0/dtheata))
w2=exp(-(lemda2+mu2)*(q0/dtheata))
w3=exp(-(lemda1+mu1+lemda2+mu2)*(q0/dtheata))
P01=p1+(p3*w1)-(p1*w2)-(p3*w3)
P02=p2-(p2*w1)+(p3*w2)-(p3*w3)
P03=p3-(p3*w1)-(p3*w2)+(p3*w3)
y1=exp(-(lemda1+mu1)*(q1/dtheata))
y2=exp(-(lemda2+mu2)*(q1/dtheata))
y3=exp(-(lemda1+mu1+lemda2+mu2)*(q1/dtheata))
P11=p1+(p3*y1)+(p0*y2)+(p2*y3)
P12=p2-(p2*y1)-(p2*y2)+(p2*y3)
P13=p3-(p3*y1)+(p2*y2)-(p2*y3)
z1=exp(-(lemda1+mu1)*(q2/dtheata))
z2=exp(-(lemda2+mu2)*(q2/dtheata))
z3=exp(-(lemda1+mu1+lemda2+mu2)*(q2/dtheata))
P21=p1-(p1*z1)-(p1*z2)+(p1*z3)
```

```
P22=p2+(p0*z1)+(p3*z2)+(p1*z3)
P23=p3+(p1*z1)-(p3*z2)-(p1*z3)
A0=k+((.5*h*q0^2)/dtheata)+((h*r*q0)/dtheata)+((theata*c*q0)/dtheata)
A1=k+((.5*h*q1^2)/dtheata)+((h*r*q1)/dtheata)+((theata*c*q1)/dtheata)
A2=k+((.5*h*q2^2)/dtheata)+((h*r*q2)/dtheata)+((theata*c*q2)/dtheata)
Nu=((A2+P23*cbar)*(1-P11-P13*row1))+((P21+P23*row1)*(A1+P13*cbar))
Den=((1-P22-P23*row2)*(1-P11-P13*row1))-((P21+P23*row1)*(P12+P13*row2))
C20=Nu/Den
Num1=(A1+P13*cbar)+((P12+P13*row2)*C20)
Den1=(1-P11-P13*row1)
C10=Num1/Den1
C30=cbar+(row1*C10+row2*C20)
Num2=((q2+P23*Tbar)*(1-P11-P13*row1))+((P21+P23*row1)*(q1+P13*Tbar))
Den2=((1-P22-P23*row2)*(1-P11-P13*row1))-((P21+P23*row1)*(P12+P13*row2))
T20=Num2/Den2
Num3=(q1+P13*Tbar)+((P12+P13*row2)*T20)
Den3=(1-P11-P13*row1)
T10=Num3/Den3
T30=Tbar+(row1*T10+row2*T20)
T00=(q0/dtheata)+(P01*T10)+(P02*T20)+(P03*(Tbar+row1*T10+row2*T20))
Ie11=(d*c*T00*T01*Ie1)
Ie12=(d*c*T00*T02*Ie2)
Ie21=((d*c*T00+Ie11)*(T00-T01)*Ie1)
Ie22=((d*c*T00+Ie12)*(T00-T02)*Ie2)
Ic1=(alpha1*d*c*ic1*(T00-T01))
Ic2=(alpha2*d*c*ic2*(T00-T02))
C101=C10-(Ie11+Ie21)+Ic1
C201=C20-(Ie12+Ie22)+Ic2
C301=cbar+(row1*C101+row2*C201)
B0=P01*C101
C0=P02*C201
D0=P03*C301
A=A0/T00
B=B0/T00
C=C0/T00
D=D0/T00
return (A+B+C+D)
}
```

Output of R-code

```
nlm(AC, p=c(8,9,1,4))
$minimum
[1] 5.900553
$estimate
[1]  9.216337 41.8218088 41.9396503  0.7624755
```

// Newton Rapson method for four variables (q_0, q_1, q_2, r) in R Programming for chapter 5 //

```
AC = function(x)
{
q0 = x[1]
 q1 = x[2]
 q2 = x[3]
  r  = x[4]
 k=5; h=5; d=20; theata=4; c=1; mu1=3.4; mu2=2.5; lemda1=.58; lemda2=.45
 pic=25; pi=350; T01=.6; T02=.8; ie1=0.02; ie2=0.04; ic1=.11 ; ic2=.13 R=0.05
 t1=6; alpha1=0; alpha2=0
 delta=mu1+mu2
 dtheata=d+theata
 row1=mu1/delta
 row2=mu2/delta
 Tbar=1/(mu1+mu2)
 p0=(mu1*mu2)/((lemda1+mu1)*(lemda2+mu2))
 p1=(lemda2*mu1)/((lemda1+mu1)*(lemda2+mu2))
 p2=(lemda1*mu2)/((lemda1+mu1)*(lemda2+mu2))
 p3=(lemda1*lemda2)/((lemda1+mu1)*(lemda2+mu2))
u=exp(-(delta*r)/dtheata)
v=exp((delta*r)/dtheata)
w=exp(R*t1)
cbar=(u*w/(delta^2))*((h*v*(delta*r-dtheata)+((pi*delta*d)+(h*dtheata)+pic)-
(theata*c*delta)))+(theata*c*w)/delta
w1=exp(-(lemda1+mu1)*(q0/dtheata))
w2=exp(-(lemda2+mu2)*(q0/dtheata))
w3=exp(-(lemda1+mu1+lemda2+mu2)*(q0/dtheata))
P01=p1+(p3*w1)-(p1*w2)-(p3*w3)
P02=p2-(p2*w1)+(p3*w2)-(p3*w3)
P03=p3-(p3*w1)-(p3*w2)+(p3*w3)
y1=exp(-(lemda1+mu1)*(q1/dtheata))
y2=exp(-(lemda2+mu2)*(q1/dtheata))
```

```
y3=exp(-(lemda1+mu1+lemda2+mu2)*(q1/dtheata))
P11=p1+(p3*y1)+(p0*y2)+(p2*y3)
P12=p2-(p2*y1)-(p2*y2)+(p2*y3)
P13=p3-(p3*y1)+(p2*y2)-(p2*y3)
z1=exp(-(lemda1+mu1)*(q2/dtheata))
z2=exp(-(lemda2+mu2)*(q2/dtheata))
z3=exp(-(lemda1+mu1+lemda2+mu2)*(q2/dtheata))
P21=p1-(p1*z1)-(p1*z2)+(p1*z3)
P22=p2+(p0*z1)+(p3*z2)+(p1*z3)
P23=p3+(p1*z1)-(p3*z2)-(p1*z3)
A0=k+((.5*h*q0^2*w)/dtheata)+((h*r*q0*w)/dtheata)+((theata*c*q0*w)/dtheata)
A1=k+((.5*h*q1^2*w)/dtheata)+((h*r*q1*w)/dtheata)+((theata*c*q1*w)/dtheata)
A2=k+((.5*h*q2^2*w)/dtheata)+((h*r*q2*w)/dtheata)+((theata*c*q2*w)/dtheata)
Nu=((A2+P23*cbar)*(1-P11-P13*row1))+((P21+P23*row1)*(A1+P13*cbar))
Den=((1-P22-P23*row2)*(1-P11-P13*row1))-((P21+P23*row1)*(P12+P13*row2))
C20=Nu/Den
Num1=(A1+P13*cbar)+((P12+P13*row2)*C20)
Den1=(1-P11-P13*row1)
C10=Num1/Den1
C30=cbar+(row1*C10+row2*C20)
Num2=((q2+P23*Tbar)*(1-P11-P13*row1))+((P21+P23*row1)*(q1+P13*Tbar))
Den2=((1-P22-P23*row2)*(1-P11-P13*row1))-((P21+P23*row1)*(P12+P13*row2))
T20=Num2/Den2
Num3=(q1+P13*Tbar)+((P12+P13*row2)*T20)
Den3=(1-P11-P13*row1)
T10=Num3/Den3
T30=Tbar+(row1*T10+row2*T20)
T00=(q0/dtheata)+(P01*T10)+(P02*T20)+(P03*(Tbar+row1*T10+row2*T20))
Ie11=(d*c*T00*w*T01*ie1)
Ie12=(d*c*T00*w*T02*ie2)
Ie21=((d*c*w*T00+Ie11)*(T00-T01)*ie1)
Ie22=((d*c*w*T00+Ie12)*(T00-T02)*ie2)
Ic1=(alpha1*d*c*w*ic1*(T00-T01))
Ic2=(alpha2*d*c*w*ic2*(T00-T02))
C101=C10-(Ie11+Ie21)+Ic1
C201=C20-(Ie12+Ie22)+Ic2
C301=cbar+(row1*C101+row2*C201)
B0=P01*C101
C0=P02*C201
D0=P03*C301
```

```
 A=A0/T00
 B=B0/T00
 C=C0/T00
 D=D0/T00
 return (A+B+C+D)
}
```

Output of R-code

```
nlm(AC, p=c(8,9,3,2))
$minimum
[1] 7.750814
$estimate
[1] 6.106851 33.977701 33.857779 1.026171
```

// Newton Rapson method for four variables (q_0, q_1, q_2, r) in R Programming for chapter 6//

```
 AC = function(x)
{
q0 = x[1]
q1 = x[2]
q2 = x[3]
 r  = x[4]
 k=5; h=5; d=20; theata=4; c=1; mu1=3.4; mu2=2.5; lemda1=0.58; lemda2=0.45
 pic=25; pi=350; T11=0.6; T12=0.8; Ie1=0.02; Ie2=0.04; Ic1=0.11; Ic2=0.13;
T1=0.9; T2=1.1; alpha1=0.5; alpha2=0.6; U1=1; U2=1; V1=0; V2=0
delta=mu1+mu2
dtheata=d+theata
row1=mu1/delta
row2=mu2/delta
Tbar=1/(mu1+mu2)
p0=(mu1*mu2)/((lemda1+mu1)*(lemda2+mu2))
p1=(lemda2*mu1)/((lemda1+mu1)*(lemda2+mu2))
p2=(lemda1*mu2)/((lemda1+mu1)*(lemda2+mu2))
p3=(lemda1*lemda2)/((lemda1+mu1)*(lemda2+mu2))
u=exp(-(delta*r)/dtheata)
v=exp((delta*r)/dtheata)
cbar=(u/(delta^2))*((h*v*(delta*r-dtheata)+((pi*delta*d)+(h*dtheata)+pic)-
(theata*c*delta)))+(theata*c)/delta
w1=exp(-(lemda1+mu1)*(q0/dtheata))
w2=exp(-(lemda2+mu2)*(q0/dtheata))
w3=exp(-(lemda1+mu1+lemda2+mu2)*(q0/dtheata))
```

```
P01=p1+(p3*w1)-(p1*w2)-(p3*w3)
P02=p2-(p2*w1)+(p3*w2)-(p3*w3)
P03=p3-(p3*w1)-(p3*w2)+(p3*w3)
y1=exp(-(lemda1+mu1)*(q1/dtheata))
y2=exp(-(lemda2+mu2)*(q1/dtheata))
y3=exp(-(lemda1+mu1+lemda2+mu2)*(q1/dtheata))
P11=p1+(p3*y1)+(p0*y2)+(p2*y3)
P12=p2-(p2*y1)-(p2*y2)+(p2*y3)
P13=p3-(p3*y1)+(p2*y2)-(p2*y3)
z1=exp(-(lemda1+mu1)*(q2/dtheata))
z2=exp(-(lemda2+mu2)*(q2/dtheata))
z3=exp(-(lemda1+mu1+lemda2+mu2)*(q2/dtheata))
P21=p1-(p1*z1)-(p1*z2)+(p1*z3)
P22=p2+(p0*z1)+(p3*z2)+(p1*z3)
P23=p3+(p1*z1)-(p3*z2)-(p1*z3)
A0=k+((.5*h*q0^2)/dtheata)+((h*r*q0)/dtheata)+((theata*c*q0)/dtheata)
A1=k+((.5*h*q1^2)/dtheata)+((h*r*q1)/dtheata)+((theata*c*q1)/dtheata)
A2=k+((.5*h*q2^2)/dtheata)+((h*r*q2)/dtheata)+((theata*c*q2)/dtheata)
Nu=((A2+P23*cbar)*(1-P11-P13*row1))+((P21+P23*row1)*(A1+P13*cbar))
Den=((1-P22-P23*row2)*(1-P11-P13*row1))-((P21+P23*row1)*(P12+P13*row2))
C20=Nu/Den
Num1=(A1+P13*cbar)+((P12+P13*row2)*C20)
Den1=(1-P11-P13*row1)
C10=Num1/Den1
C30=cbar+(row1*C10+row2*C20)
Num2=((q2+P23*Tbar)*(1-P11-P13*row1))+((P21+P23*row1)*(q1+P13*Tbar))
Den2=((1-P22-P23*row2)*(1-P11-P13*row1))-((P21+P23*row1)*(P12+P13*row2))
T20=Num2/Den2
Num3=(q1+P13*Tbar)+((P12+P13*row2)*T20)
Den3=(1-P11-P13*row1)
T10=Num3/Den3
T30=Tbar+(row1*T10+row2*T20)
T00=(q0/dtheata)+(P01*T10)+(P02*T20)+(P03*(Tbar+row1*T10+row2*T20))
E1=(c*d*T00*T11*Ie1)-((1-alpha1)*c*d*T00*(T1-T11)*Ie1)-
(U1*d*c*alpha1*T00*(T1-T11)*Ie1)+(U1*d*c*alpha1*T00*(T1-T11)*Ic1)-
(c*d*T00*T11*Ie1*(T1-T11)*Ie1)
E2=(-V1*(((1-alpha1)*c*d*T00*(T00-T1)*Ie1)+(c*d*T00*T11*Ie1*(T1- T11)
*Ie1*(T00-T1)*Ie1)+(c*d*T00*T11*Ie1*(T1-T11)*Ie1*(T00-
T1)*Ie1)+(c*d*T00*T11*Ie1*(T00-T1)*Ie1)+((1-alpha1)*c*d*T00*(T1- T11)
*Ie1*(T00-T1)*Ie1)))
```

```
E3=(-V1*(U1*(d*c*alpha1*T00*Ie1*(T1-T11)*(T00- T1)
*Ie1)))+(V1*(U1*((d*c*alpha1*T00*Ic1*(T00-T1))+((1- alpha1) *c*d*T00*Ic1*
(T00-T1)))))
F1=(c*d*T00*T12*Ie2)-((1-alpha2)*c*d*T00*(T2-T12)*Ie2)-
(U2*d*c*alpha2*T00*(T2-T12)*Ie2)+(U2*d*c*alpha2*T00*(T2-T12)*Ic2)-
(c*d*T00*T12*Ie2*(T2-T12)*Ie2)
F2=(-V2*(((1-alpha2)*c*d*T00*(T00-T2)*Ie2)+(c*d*T00*T12*Ie2*(T2- T12)
*Ie2*(T00-T2)*Ie2)+(c*d*T00*T12*Ie2*(T2-T12)*Ie2*(T00-
T2)*Ie2)+(c*d*T00*T12*Ie2*(T00-T2)*Ie2)+((1-alpha2)*c*d*T00*(T2- T12)
*Ie2*(T00-T2)*Ie2)))
F3=(-V2*(U2*(d*c*alpha2*T00*Ie2*(T2-T12)*(T00- T2)
*Ie2)))+(V2*(U2*((d*c*alpha2*T00*Ic2*(T00-T2))+((1- alpha2)*c*d*T00*Ic2*
(T00-T2)))))
C101=C10-(E1+E2+E3)
C201=C20-(F1+F2+F3)
C301=cbar+(row1*C101+row2*C201)
B0=P01*C101
C0=P02*C201
D0=P03*C301
A=A0/T00
B=B0/T00
C=C0/T00
D=D0/T00
return (A+B+C+D)
}
```

Output of R-code

```
nlm(AC, p=c(8,9,4,3))
$minimum
[1] 6.37324
$estimate
[1]  3.3466827 30.1547987 29.5618813  0.7667965
```

// Newton Rapson method for four variables (q_0, q_1, q_2, r) in R Programming for chapter 7 //

```
AC = function(x)
{
 q0 = x[1]
 q1 = x[2]
 q2 = x[3]
 r  = x[4]
 k=5; h=5; d=20; theata=4; c=1; mu1=3.4; mu2=2.5; lemda1=0.58; lemda2=0.45
 pic=25; pi=350; T11=0.6; T12=0.8; Ie1=0.02; Ie2=0.04; Ic1=0.11; Ic2=0.13
 T1=0.9; T2=1.1; alpha1=0.5; alpha2=0.6; R=0.05; t1=6; U1=1; U2=1; V1=0; V2=0
 delta=mu1+mu2
```

```
dtheata=d+theata
row1=mu1/delta
row2=mu2/delta
Tbar=1/(mu1+mu2)
p0=(mu1*mu2)/((lemda1+mu1)*(lemda2+mu2))
p1=(lemda2*mu1)/((lemda1+mu1)*(lemda2+mu2))
p2=(lemda1*mu2)/((lemda1+mu1)*(lemda2+mu2))
p3=(lemda1*lemda2)/((lemda1+mu1)*(lemda2+mu2))
u=exp(-(delta*r)/dtheata)
v=exp((delta*r)/dtheata)
w=exp(R*t1)
cbar=(u*w/(delta^2))*((h*v*(delta*r-dtheata)+((pi*delta*d)+(h*dtheata)+pic)-
(theata*c*delta)))+(theata*c*w)/delta
w1=exp(-(lemda1+mu1)*(q0/dtheata))
w2=exp(-(lemda2+mu2)*(q0/dtheata))
w3=exp(-(lemda1+mu1+lemda2+mu2)*(q0/dtheata))
P01=p1+(p3*w1)-(p1*w2)-(p3*w3)
P02=p2-(p2*w1)+(p3*w2)-(p3*w3)
P03=p3-(p3*w1)-(p3*w2)+(p3*w3)
y1=exp(-(lemda1+mu1)*(q1/dtheata))
y2=exp(-(lemda2+mu2)*(q1/dtheata))
y3=exp(-(lemda1+mu1+lemda2+mu2)*(q1/dtheata))
P11=p1+(p3*y1)+(p0*y2)+(p2*y3)
P12=p2-(p2*y1)-(p2*y2)+(p2*y3)
P13=p3-(p3*y1)+(p2*y2)-(p2*y3)
z1=exp(-(lemda1+mu1)*(q2/dtheata))
z2=exp(-(lemda2+mu2)*(q2/dtheata))
z3=exp(-(lemda1+mu1+lemda2+mu2)*(q2/dtheata))
P21=p1-(p1*z1)-(p1*z2)+(p1*z3)
P22=p2+(p0*z1)+(p3*z2)+(p1*z3)
P23=p3+(p1*z1)-(p3*z2)-(p1*z3)
A0=k+((.5*h*q0^2*w)/dtheata)+((h*r*q0*w)/dtheata)+((theata*c*q0*w)/dtheata)
A1=k+((.5*h*q1^2*w)/dtheata)+((h*r*q1*w)/dtheata)+((theata*c*q1*w)/dtheata)
A2=k+((.5*h*q2^2*w)/dtheata)+((h*r*q2*w)/dtheata)+((theata*c*q2*w)/dtheata)
Nu=((A2+P23*cbar)*(1-P11-P13*row1))+((P21+P23*row1)*(A1+P13*cbar))
Den=((1-P22-P23*row2)*(1-P11-P13*row1))-((P21+P23*row1)*(P12+P13*row2))
C20=Nu/Den
Num1=(A1+P13*cbar)+((P12+P13*row2)*C20)
Den1=(1-P11-P13*row1)
C10=Num1/Den1
C30=cbar+(row1*C10+row2*C20)
Num2=((q2+P23*Tbar)*(1-P11-P13*row1))+((P21+P23*row1)*(q1+P13*Tbar))
Den2=((1-P22-P23*row2)*(1-P11-P13*row1))-((P21+P23*row1)*(P12+P13*row2))
```

```
 T20=Num2/Den2
 Num3=(q1+P13*Tbar)+((P12+P13*row2)*T20)
 Den3=(1-P11-P13*row1)
 T10=Num3/Den3
 T30=Tbar+(row1*T10+row2*T20)
 T00=(q0/dtheata)+(P01*T10)+(P02*T20)+(P03*(Tbar+row1*T10+row2*T20))
 E1=(c*d*w*T00*T11*Ie1)-((1-alpha1)*c*d*w*T00*(T1-T11)*Ie1)
- (U1*d*c*w*alpha1*T00*(T1-T11)*Ie1)+(U1*d*c*w*alpha1*T00*(T1-T11)*Ic1)
-(c*d*w*T00*T11*Ie1*(T1-T11)*Ie1)
 E2=(-V1*(((1-alpha1)*c*d*w*T00*(T00-T1)*Ie1)+(c*d*w*T00*T11*Ie1*(T1- T11)
*Ie1*(T00-T1)*Ie1)+(c*d*w*T00*T11*Ie1*(T00-T1)*Ie1)+((1- alpha1)
*c*d*w*T00*(T1-T11)*Ie1*(T00-T1)*Ie1)))
 E3=(-V1*(U1*(d*c*w*alpha1*T00*Ie1*(T1-T11)*(T00- T1)
*Ie1)))+(V1*(U1*((d*c*w*alpha1*T00*Ic1*(T00-T1))+((1- alpha1)
*c*d*w*T00*Ic1*(T00-T1)))))
 F1=(c*d*w*T00*T12*Ie2)-((1-alpha2)*c*d*w*T00*(T2-T12)*Ie2)
- (U2*d*c*w*alpha2*T00*(T2-T12)*Ie2)+(U2*d*c*w*alpha2*T00*(T2-T12)*Ic2)
-(c*d*w*T00*T12*Ie2*(T2-T12)*Ie2)
 F2=(-V2*(((1-alpha2)*c*d*w*T00*(T00-T2)*Ie2)+(c*d*w*T00*T12*Ie2*(T2- T12)
*Ie2*(T00-T2)*Ie2)+(c*d*w*T00*T12*Ie2*(T00-T2)*Ie2)+((1- alpha2)
*c*d*w*T00*(T2-T12)*Ie2*(T00-T2)*Ie2)))
 F3=(-V2*(U2*(d*c*w*alpha2*T00*Ie2*(T2-T12)*(T00- T2)
*Ie2)))+(V2*(U2*((d*c*w*alpha2*T00*Ic2*(T00-T2))+((1- alpha2)
*c*d*w*T00*Ic2*(T00-T2)))))
 C101=C10-(E1+E2+E3)
 C201=C20-(F1+F2+F3)
 C301=cbar+(row1*C101+row2*C201)
 B0=P01*C101
 C0=P02*C201
 D0=P03*C301
 A=A0/T00
 B=B0/T00
 C=C0/T00
 D=D0/T00
 return (A+B+C+D)
}
```

Output of R-code

```
nlm (AC, p=c(4,7,8,2))
$minimum
[1] 8.144696
$estimate
[1]  2.8538783 28.7990363 28.0153335  0.7395786
```