```
m={{0, 0,0, 5.12963}, {0.4508671, 0.6428571, 0,0},{0, 0.0208333, 0.8,0},{0,0,0.08,0.981
```

```
{{0, 0, 0, 5.12963}, {0.450867, 0.642857, 0, 0},
 {0, 0.0208333, 0.8, 0}, {0, 0, 0.08, 0.981482}}
```

```
N[m,4]//MatrixForm
```

$$\begin{pmatrix} 0 & 0 & 0 & 5.12963 \\ 0.450867 & 0.642857 & 0 & 0 \\ 0 & 0.0208333 & 0.8 & 0 \\ 0 & 0 & 0.08 & 0.981482 \end{pmatrix}$$

```
Eigenvalues[m]
```

Population growth rate

```
{1.02516 + 0. i, 0.7033 + 0.108865 i, 0.7033 - 0.108865 i, -0.00742379 + 0. i}
```

```
Eigenvectors[m]
```

```
{{0.639832 + 0. i, 0.754579 + 0. i, 0.0698181 + 0. i, 0.127871 + 0. i},
 {0.127925 + 0.230408 i, 0.954238 + 0. i, -0.0906679 - 0.102075 i,
  0.0126493 + 0.0343051 i}, {0.127925 - 0.230408 i, 0.954238 + 0. i,
  -0.0906679 + 0.102075 i, 0.0126493 - 0.0343051 i},
 {-0.821705 + 0. i, 0.569723 + 0. i, -0.0147001 + 0. i, 0.0011892 + 0. i}}
```

Right eigenvector

```
u=%[[1]]
```

```
{0.639832 + 0. i, 0.754579 + 0. i, 0.0698181 + 0. i, 0.127871 + 0. i}
```

```
totalu=Sum[u[[i]],{i,1,4}]
```

```
1.5921 + 0. i
```

```
frequency=u/totalu
```

```
{0.401879 + 0. i, 0.473952 + 0. i, 0.0438528 + 0. i, 0.080316 + 0. i}
```

Stable stage distribution

```
lm=Transpose[m]
```

```
{{0, 0.450867, 0, 0}, {0, 0.642857, 0.0208333, 0},
 {0, 0, 0.8, 0.08}, {5.12963, 0, 0, 0.981482}}
```

```
Eigenvectors[lm]
```

```
{{-0.00802229 + 0. i, -0.0182407 + 0. i, -0.334729 + 0. i, -0.942104 + 0. i},
 {-0.0473146 + 0.0185164 i, -0.0782761 + 0.017459 i,
  -0.318333 - 0.358382 i, 0.872475 + 0. i}, {-0.0473146 - 0.0185164 i,
  -0.0782761 - 0.017459 i, -0.318333 + 0.358382 i, 0.872475 + 0. i},
 {0.188407 + 0. i, -0.00310223 + 0. i, 0.0968315 + 0. i, -0.977301 + 0. i}}
```

```
v=%[[1]]
```

```
{-0.00802229 + 0. i, -0.0182407 + 0. i, -0.334729 + 0. i, -0.942104 + 0. i}
```

Left eigenvector

```
%/-0.008022
```

```
{1.00004 + 0. i, 2.27384 + 0. i, 41.7264 + 0. i, 117.44 + 0. i}
```

Normalized reproductive value

```
bunbo=u.v
```

```
-0.162735 + 0. i
```

```
eiu={{v[[1]],0,0,0},{v[[2]],0,0,0},{v[[3]],0,0,0},{v[[4]],0,0,0}}
```

```
{{-0.00802229 + 0. i, 0, 0, 0}, {-0.0182407 + 0. i, 0, 0, 0},
 {-0.334729 + 0. i, 0, 0, 0}, {-0.942104 + 0. i, 0, 0, 0}}
```

```
eiv={u,{0,0,0,0},{0,0,0,0},{0,0,0,0}}
```

```
{{0.639832 + 0. i, 0.754579 + 0. i, 0.0698181 + 0. i, 0.127871 + 0. i},
 {0, 0, 0, 0}, {0, 0, 0, 0}, {0, 0, 0, 0}}
```

```
eiu.eiv
```

```
{{-0.00513292 + 0. i, -0.00605345 + 0. i, -0.000560101 + 0. i, -0.00102582 + 0. i},
 {-0.011671 + 0. i, -0.0137641 + 0. i, -0.00127353 + 0. i, -0.00233246 + 0. i},
 {-0.214171 + 0. i, -0.25258 + 0. i, -0.0233702 + 0. i, -0.0428022 + 0. i},
 {-0.602788 + 0. i, -0.710892 + 0. i, -0.0657759 + 0. i, -0.120468 + 0. i}}
```

```
sensitivity=%/bunbo
```

```
{{0.0315416 + 0. i, 0.0371982 + 0. i, 0.0034418 + 0. i, 0.00630362 + 0. i},
 {0.0717179 + 0. i, 0.0845797 + 0. i, 0.00782581 + 0. i, 0.0143329 + 0. i},
 {1.31607 + 0. i, 1.55209 + 0. i, 0.143609 + 0. i, 0.263018 + 0. i},
 {3.70411 + 0. i, 4.3684 + 0. i, 0.40419 + 0. i, 0.74027 + 0. i}}
```

```
N[sensitivity,4]//MatrixForm
```

$$\begin{pmatrix} 0.0315416 + 0.\,i & 0.0371982 + 0.\,i & 0.0034418 + 0.\,i & 0.00630362 + 0.\,i \\ 0.0717179 + 0.\,i & 0.0845797 + 0.\,i & 0.00782581 + 0.\,i & 0.0143329 + 0.\,i \\ 1.31607 + 0.\,i & 1.55209 + 0.\,i & 0.143609 + 0.\,i & 0.263018 + 0.\,i \\ 3.70411 + 0.\,i & 4.3684 + 0.\,i & 0.40419 + 0.\,i & 0.74027 + 0.\,i \end{pmatrix}$$

Sensitivity matrix

```
elasticity=sensitivity*m/1.02516//MatrixForm
```

$$\begin{pmatrix} 0. + 0.\,i & 0. + 0.\,i & 0. + 0.\,i & 0.0315416 + 0.\,i \\ 0.0315416 + 0.\,i & 0.0530382 + 0.\,i & 0. + 0.\,i & 0. + 0.\,i \\ 0. + 0.\,i & 0.0315416 + 0.\,i & 0.112067 + 0.\,i & 0. + 0.\,i \\ 0. + 0.\,i & 0. + 0.\,i & 0.0315416 + 0.\,i & 0.70873 + 0.\,i \end{pmatrix}$$

Elasticity matrix