In[1]:= `V = 1/2 (kζh ζh[t]^2 + kβh βh[t]^2 + kζb ζb[t]^2 + kβb βb[t]^2)`

General::spell1 : Possible spelling error: new symbol name "βh" is similar to existing symbol "ζh". More…

General::spell : Possible spelling error: new symbol name "ζb" is similar to existing symbols {ζ, ζh}. More…

General::spell : Possible spelling error: new symbol name "βb" is similar to existing symbols {β, βh, ζb}. More…

Out[1]= $$\frac{1}{2}\left(k_{\beta b}\,\beta_b(t)^2+k_{\beta h}\,\beta_h(t)^2+k_{\zeta b}\,\zeta_b(t)^2+k_{\zeta h}\,\zeta_h(t)^2\right)$$

In[2]:= `kζb = kζ/R`

Out[2]= $$\frac{k_\zeta}{R}$$

In[3]:= `kβb = kβ/R`

Out[3]= $$\frac{k_\beta}{R}$$

In[4]:= `kζh = kζ/(1 - R)`

Out[4]= $$\frac{k_\zeta}{1-R}$$

In[5]:= `kβh = kβ/(1 - R)`

Out[5]= $$\frac{k_\beta}{1-R}$$

In[6]:= `ζb[t] = Cos[θ[t]] (ζ[t] - ζh[t]) + Sin[θ[t]] (β[t] - βh[t])`

Out[6]= $$\sin(\theta(t))\,(\beta(t)-\beta_h(t))+\cos(\theta(t))\,(\zeta(t)-\zeta_h(t))$$

In[7]:= `βb[t] = -Sin[θ[t]] (ζ[t] - ζh[t]) + Cos[θ[t]] (β[t] - βh[t])`

Out[7]= $$\cos(\theta(t))\,(\beta(t)-\beta_h(t))-\sin(\theta(t))\,(\zeta(t)-\zeta_h(t))$$

In[8]:= `V = Simplify[V]`

Out[8]= $$\frac{1}{2}\left(\frac{k_\beta\,\beta_h(t)^2}{1-R}+\frac{k_\zeta\,(\sin(\theta(t))\,(\beta(t)-\beta_h(t))+\cos(\theta(t))\,(\zeta(t)-\zeta_h(t)))^2}{R}+\frac{k_\beta\,(\cos(\theta(t))\,(\beta(t)-\beta_h(t))-\sin(\theta(t))\,(\zeta(t)-\zeta_h(t)))^2}{R}+\frac{k_\zeta\,\zeta_h(t)^2}{1-R}\right)$$

In[9]:= `eqzeta = Simplify[Expand[∂ζh[t] V]]`

Out[9]= $$\frac{1}{(R-1)\,R}\big((R-1)\sin(\theta(t))\,k_\beta\,(\cos(\theta(t))\,\beta(t)-\sin(\theta(t))\,\zeta(t)-\cos(\theta(t))\,\beta_h(t)+\sin(\theta(t))\,\zeta_h(t))-k_\zeta\,((R-1)\,\zeta(t)\cos^2(\theta(t))-R\,\zeta_h(t)\cos^2(\theta(t))+\zeta_h(t)\cos^2(\theta(t))+(R-1)\sin(\theta(t))\,\beta(t)\cos(\theta(t))-R\sin(\theta(t))\,\beta_h(t)\cos(\theta(t))+\sin(\theta(t))\,\beta_h(t)\cos(\theta(t))+R\,\zeta_h(t))\big)$$

```
In[10]:= eqbeta = Simplify[Expand[∂_{β_h[t]} V]]
```

General::spell1 : Possible spelling error: new symbol name "eqbeta" is similar to existing symbol "eqzeta". More…

Out[10]= $$-\frac{1}{(R-1)R}((R-1)\sin(\theta(t))\,k_\zeta\,(\sin(\theta(t))\,\beta(t)+\cos(\theta(t))\,\zeta(t)-\sin(\theta(t))\,\beta_h(t)-\cos(\theta(t))\,\zeta_h(t))+ k_\beta\,((R-1)\,\beta(t)\cos^2(\theta(t))-R\,\beta_h(t)\cos^2(\theta(t))+\beta_h(t)\cos^2(\theta(t))- (R-1)\sin(\theta(t))\,\zeta(t)\cos(\theta(t))+R\sin(\theta(t))\,\zeta_h(t)\cos(\theta(t))-\sin(\theta(t))\,\zeta_h(t)\cos(\theta(t))+R\,\beta_h(t)))$$

```
In[11]:= sol = Solve[{eqzeta == 0, eqbeta == 0}, {ζ_h[t], β_h[t]}];

In[12]:= zrow = Simplify[∂_{ζ[t]} V /. sol[[1]]];

In[13]:= zrowbcol = Simplify[∂_{β[t]} zrow]
```

Out[13]= $$\frac{R\sin(2\,\theta(t))\,k_\beta\,(k_\beta-k_\zeta)\,k_\zeta}{2\,((R-1)\,R\sin^2(\theta(t))\,k_\beta^2+(-R^2+(R-1)\cos(2\,\theta(t))\,R+R-1)\,k_\zeta\,k_\beta+(R-1)\,R\sin^2(\theta(t))\,k_\zeta^2)}$$

```
In[14]:= zrowbcol = zrowbcol /. Cos[2 θ[t]] → 1 - 2 Sin[θ[t]]^2
```

Out[14]= $$\frac{R\sin(2\,\theta(t))\,k_\beta\,(k_\beta-k_\zeta)\,k_\zeta}{2\,((R-1)\,R\sin^2(\theta(t))\,k_\beta^2+(-R^2+(R-1)\,(1-2\sin^2(\theta(t)))\,R+R-1)\,k_\zeta\,k_\beta+(R-1)\,R\sin^2(\theta(t))\,k_\zeta^2)}$$

```
In[15]:= zrowbcolnum = Numerator[zrowbcol]
```

Out[15]= $R\sin(2\,\theta(t))\,k_\beta\,(k_\beta-k_\zeta)\,k_\zeta$

```
In[16]:= Δ = -1/(2 k_β k_ζ) (Simplify[Denominator[zrowbcol] /. Cos[2 θ[t]] → 1 - 2 Sin[θ[t]]^2])
```

Out[16]= $$-\frac{(R-1)\,R\sin^2(\theta(t))\,k_\beta^2-(2\,(R-1)\,R\sin^2(\theta(t))+1)\,k_\zeta\,k_\beta+(R-1)\,R\sin^2(\theta(t))\,k_\zeta^2}{k_\beta\,k_\zeta}$$

```
In[17]:= N[Δ] /. {R -> .5, k_β -> .1, k_ζ -> .5, θ[t] -> .1}
```

Out[17]= 1.00797

```
In[18]:= Δ = Expand[Δ]
```

Out[18]= $$2\,R^2\sin^2(\theta(t))-2\,R\sin^2(\theta(t))-\frac{R^2\,k_\zeta\sin^2(\theta(t))}{k_\beta}+\frac{R\,k_\zeta\sin^2(\theta(t))}{k_\beta}-\frac{R^2\,k_\beta\sin^2(\theta(t))}{k_\zeta}+\frac{R\,k_\beta\sin^2(\theta(t))}{k_\zeta}+1$$

```
In[19]:= Simplify[(Δ - 1)/(R (1 - R))]
```

Out[19]= $$\frac{\sin^2(\theta(t))\,(k_\beta-k_\zeta)^2}{k_\beta\,k_\zeta}$$

```
In[20]:= Δ = 1 + R (1 - R) %
```

Out[20]= $$\frac{(1-R)\,R\sin^2(\theta(t))\,(k_\beta-k_\zeta)^2}{k_\beta\,k_\zeta}+1$$

```
In[21]:= N[Δ] /. {R -> .5, k_β -> .1, k_ζ -> .5, θ[t] -> .1}
```

Out[21]= 1.00797

In[22]:= `zrowbcolnum = -Numerator[zrowbcol]/(2 kβ kζ)`

Out[22]= $-\frac{1}{2} R \sin(2\,\theta(t))\,(k_\beta - k_\zeta)$

In[23]:= `zrowbcol = zrowbcolnum/Δ`

Out[23]= $-\frac{R \sin(2\,\theta(t))\,(k_\beta - k_\zeta)}{2\left(\frac{(1-R) R \sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta k_\zeta} + 1\right)}$

In[24]:= `dzrowbcoldtheta = Simplify[∂θ[t] zrowbcol]`

Out[24]= $\frac{R\left(-\frac{(R-1) R \sin^2(2\,\theta(t))\,(k_\beta - k_\zeta)^2}{2 k_\beta k_\zeta} - \cos(2\,\theta(t))\left(1 - \frac{(R-1) R \sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta k_\zeta}\right)\right)(k_\beta - k_\zeta)}{\left(\frac{(R-1) R \sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta k_\zeta} - 1\right)^2}$

In[25]:= `N[dzrowbcoldtheta] /. {R -> .5, kβ -> .1, kζ -> .5, θ[t] -> .1}`

Out[25]= 0.191355

In[26]:= `numdzrowbcoldtheta = Numerator[dzrowbcoldtheta] / R / (kβ - kζ)`

Out[26]= $-\frac{(R-1) R \sin^2(2\,\theta(t))\,(k_\beta - k_\zeta)^2}{2 k_\beta k_\zeta} - \cos(2\,\theta(t))\left(1 - \frac{(R-1) R \sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta k_\zeta}\right)$

In[27]:= `numdzrowbcoldtheta = Expand[numdzrowbcoldtheta /.`
`{Cos[2 θ[t]] → 1 - 2 Sin[θ[t]]^2, Sin[2 θ[t]] -> 2 Sin[θ[t]] Cos[θ[t]]}]`

Out[27]= $4 R^2 \sin^4(\theta(t)) - 4 R \sin^4(\theta(t)) - \frac{2 R^2 k_\zeta \sin^4(\theta(t))}{k_\beta} + \frac{2 R k_\zeta \sin^4(\theta(t))}{k_\beta} - \frac{2 R^2 k_\beta \sin^4(\theta(t))}{k_\zeta} + \frac{2 R k_\beta \sin^4(\theta(t))}{k_\zeta} - 2 R^2 \sin^2(\theta(t)) + 4 R^2 \cos^2(\theta(t)) \sin^2(\theta(t)) - 4 R \cos^2(\theta(t)) \sin^2(\theta(t)) + 2 R \sin^2(\theta(t)) + \frac{R^2 k_\zeta \sin^2(\theta(t))}{k_\beta} - \frac{2 R^2 \cos^2(\theta(t)) k_\zeta \sin^2(\theta(t))}{k_\beta} + \frac{2 R \cos^2(\theta(t)) k_\zeta \sin^2(\theta(t))}{k_\beta} - \frac{R k_\zeta \sin^2(\theta(t))}{k_\beta} + \frac{R^2 k_\beta \sin^2(\theta(t))}{k_\zeta} - \frac{2 R^2 \cos^2(\theta(t)) k_\beta \sin^2(\theta(t))}{k_\zeta} + \frac{2 R \cos^2(\theta(t)) k_\beta \sin^2(\theta(t))}{k_\zeta} - \frac{R k_\beta \sin^2(\theta(t))}{k_\zeta} + 2 \sin^2(\theta(t)) - 1$

In[28]:= `numdzrowbcoldtheta = Expand[numdzrowbcoldtheta /. Cos[θ[t]]^2 → 1 - Sin[θ[t]]^2]`

Out[28]= $2 R^2 \sin^2(\theta(t)) - 2 R \sin^2(\theta(t)) - \frac{R^2 k_\zeta \sin^2(\theta(t))}{k_\beta} + \frac{R k_\zeta \sin^2(\theta(t))}{k_\beta} - \frac{R^2 k_\beta \sin^2(\theta(t))}{k_\zeta} + \frac{R k_\beta \sin^2(\theta(t))}{k_\zeta} + 2 \sin^2(\theta(t)) - 1$

In[29]:= `numdzrowbcoldthetap1 = Simplify[numdzrowbcoldtheta + 1]`

Out[29]= $-\frac{\sin^2(\theta(t))\,((R-1) R k_\beta^2 - 2 (R^2 - R + 1) k_\zeta k_\beta + (R-1) R k_\zeta^2)}{k_\beta k_\zeta}$

In[30]:= `Simplify[numdzrowbcoldthetap1 / Sin[θ[t]]^2]`

Out[30]= $-\frac{(R-1) R k_\beta^2 - 2 (R^2 - R + 1) k_\zeta k_\beta + (R-1) R k_\zeta^2}{k_\beta k_\zeta}$

In[31]:= **Simplify[% - 2]**

Out[31]= $-\frac{(R-1)\,R\,(k_\beta - k_\zeta)^2}{k_\beta\, k_\zeta}$

In[32]:= $\frac{\mathbf{((2 + \%)\ Sin[\theta[t]]^2 - 1)\ R\ (k_\beta - k_\zeta)}}{\mathbf{\Delta^2}}$

Out[32]= $\frac{R\left(\sin^2(\theta(t))\left(2 - \frac{(R-1)\,R\,(k_\beta - k_\zeta)^2}{k_\beta\, k_\zeta}\right) - 1\right)(k_\beta - k_\zeta)}{\left(\frac{(1-R)\,R\,\sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta\, k_\zeta} + 1\right)^2}$

In[33]:= **N[%] /. {R -> .5, k$_\beta$ -> .1, k$_\zeta$ -> .5, θ[t] -> .1}**

Out[33]= 0.191355

In[34]:= **zrowzcol = $\partial_{\zeta[t]}$ zrow;**

General::spell1 : Possible spelling error: new symbol name "zrowzcol" is similar to existing symbol "zrowbcol". More…

In[35]:= **zrowzcol = Simplify[zrowzcol];**

In[36]:= **zrowzcolnum = $-\frac{\mathbf{Numerator[zrowzcol]}}{\mathbf{2\ k_\beta\ k_\zeta}}$**

General::spell1 : Possible spelling error: new symbol name "zrowzcolnum" is similar to existing symbol "zrowbcolnum". More…

Out[36]= $\frac{1}{2}\,(2\,R\,k_\beta\,\sin^2(\theta(t)) + (\cos(2\,\theta(t))\,R - R + 2)\,k_\zeta)$

In[37]:= **zrowzcolnum = Expand[zrowzcolnum /. Cos[2 θ[t]] → 1 - 2 Sin[θ[t]]^2]**

Out[37]= $R\,k_\beta\,\sin^2(\theta(t)) - R\,k_\zeta\,\sin^2(\theta(t)) + k_\zeta$

In[38]:= **zrowzcol = $\frac{\mathbf{zrowzcolnum}}{\mathbf{\Delta}}$**

Out[38]= $\frac{R\,k_\beta\,\sin^2(\theta(t)) - R\,k_\zeta\,\sin^2(\theta(t)) + k_\zeta}{\frac{(1-R)\,R\,\sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta\, k_\zeta} + 1}$

In[39]:= **dzrowzcoldtheta = Simplify[$\partial_{\theta[t]}$ zrowzcol]**

General::spell1 : Possible spelling error: new symbol name "dzrowzcoldtheta" is similar to existing symbol "dzrowbcoldtheta". More…

Out[39]= $\frac{R\,\sin(2\,\theta(t))\,k_\beta\,(k_\beta - k_\zeta)\,k_\zeta^2\,(R\,k_\beta - (R-1)\,k_\zeta)}{((R-1)\,R\,\sin^2(\theta(t))\,k_\beta^2 + (-R^2 + (R-1)\cos(2\,\theta(t))\,R + R - 1)\,k_\zeta\,k_\beta + (R-1)\,R\,\sin^2(\theta(t))\,k_\zeta^2)^2}$

In[40]:= **N[dzrowzcoldtheta] /. {R -> .5, k$_\beta$ -> .1, k$_\zeta$ -> .5, θ[t] -> .1}**

Out[40]= −0.117323

In[41]:= **numdzrowzcoldtheta = Simplify[Δ^2 dzrowzcoldtheta / R / (k$_\beta$ - k$_\zeta$)]**

General::spell1 : Possible spelling error: new symbol name "numdzrowzcoldtheta" is similar to existing symbol "numdzrowbcoldtheta". More…

Out[41]= $\frac{\sin(2\,\theta(t))\,(R\,k_\beta - (R-1)\,k_\zeta)}{k_\beta}$

In[42]:= $\frac{R\,(k_\beta - k_\zeta)}{\Delta^2}$ %

Out[42]= $$\frac{R\sin(2\,\theta(t))\,(k_\beta - k_\zeta)\,(R\,k_\beta - (R-1)\,k_\zeta)}{k_\beta\left(\frac{(1-R)\,R\sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta\,k_\zeta} + 1\right)^2}$$

In[43]:= `N[%] /. {R -> .5, kβ -> .1, kζ -> .5, θ[t] -> .1}`

Out[43]= -0.117323

In[44]:= `brow = Simplify[∂β[t] V /. sol[[1]]];`

General::spell1 : Possible spelling error: new symbol name "brow" is similar to existing symbol "zrow". More…

In[45]:= `browbcol = ∂β[t] brow;`

General::spell1 : Possible spelling error: new symbol name "browbcol" is similar to existing symbol "zrowbcol". More…

In[46]:= `browbcol = Simplify[browbcol];`

In[47]:= browbcolnum = $-\frac{\text{Numerator[browbcol]}}{2\,k_\beta\,k_\zeta}$

General::spell1 : Possible spelling error: new symbol name "browbcolnum" is similar to existing symbol "zrowbcolnum". More…

Out[47]= $$\frac{1}{2}\,(2\,R\,k_\zeta\,\sin^2(\theta(t)) + (\cos(2\,\theta(t))\,R - R + 2)\,k_\beta)$$

In[48]:= browbcolnum = Expand[browbcolnum /. Cos[2 θ[t]] → 1 - 2 Sin[θ[t]]^2]

Out[48]= $$-R\,k_\beta\,\sin^2(\theta(t)) + R\,k_\zeta\,\sin^2(\theta(t)) + k_\beta$$

In[49]:= browbcol = $\frac{\text{browbcolnum}}{\Delta}$

Out[49]= $$\frac{-R\,k_\beta\,\sin^2(\theta(t)) + R\,k_\zeta\,\sin^2(\theta(t)) + k_\beta}{\frac{(1-R)\,R\sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta\,k_\zeta} + 1}$$

In[50]:= dbrowbcoldtheta = $\partial_{\theta[t]}$ browbcol

General::spell1 : Possible spelling error: new symbol name "dbrowbcoldtheta" is similar to existing symbol "dzrowbcoldtheta". More…

Out[50]= $$\frac{2\,R\cos(\theta(t))\sin(\theta(t))\,k_\zeta - 2\,R\cos(\theta(t))\sin(\theta(t))\,k_\beta}{\frac{(1-R)\,R\sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta\,k_\zeta} + 1} - \frac{2\,(1-R)\,R\cos(\theta(t))\sin(\theta(t))\,(k_\beta - k_\zeta)^2\,(-R\,k_\beta\,\sin^2(\theta(t)) + R\,k_\zeta\,\sin^2(\theta(t)) + k_\beta)}{k_\beta\left(\frac{(1-R)\,R\sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta\,k_\zeta} + 1\right)^2 k_\zeta}$$

In[51]:= `N[dbrowbcoldtheta] /. {R -> .5, kβ -> .1, kζ -> .5, θ[t] -> .1}`

Out[51]= 0.0234646

In[52]:= **numdbrowbcoldtheta = Simplify[** Δ^2 **dbrowbcoldtheta / R / (** $k_\beta - k_\xi$ **)]**

General::spell1 : Possible spelling error: new symbol name "numdbrowbcoldtheta" is similar to existing symbol "numdzrowbcoldtheta". More…

Out[52]= $$\frac{\sin(2\,\theta(t))\,((R-1)\,k_\beta - R\,k_\zeta)}{k_\zeta}$$

In[53]:= $$\frac{R\,(k_\beta - k_\xi)}{\Delta^2}\ \%$$

Out[53]= $$\frac{R\sin(2\,\theta(t))\,(k_\beta - k_\zeta)\,((R-1)\,k_\beta - R\,k_\zeta)}{\left(\frac{(1-R)\,R\sin^2(\theta(t))\,(k_\beta-k_\zeta)^2}{k_\beta\,k_\zeta}+1\right)^2 k_\zeta}$$

In[54]:= **N[%] /. {R -> .5,** k_β **-> .1,** k_ξ **-> .5,** θ**[t] -> .1}**

Out[54]= 0.0234646

In[55]:= $$R_w = \text{Simplify}\left[\frac{1}{\Delta}\,\partial_{\theta[t]}\,\Delta\right]$$

Out[55]= $$\frac{2\,(1-R)\,R\cos(\theta(t))\sin(\theta(t))\,(k_\beta-k_\zeta)^2}{k_\beta\left(1-\frac{(R-1)\,R\sin^2(\theta(t))\,(k_\beta-k_\zeta)^2}{k_\beta\,k_\zeta}\right)k_\zeta}$$

In[56]:= **N[** R_w **] /. {R -> .5,** k_β **-> .1,** k_ξ **-> .5,** θ**[t] -> .1}**

Out[56]= 0.157678

In[57]:= **Denominator[** R_w **]**

Out[57]= $$k_\beta\left(1-\frac{(R-1)\,R\sin^2(\theta(t))\,(k_\beta-k_\zeta)^2}{k_\beta\,k_\zeta}\right)k_\zeta$$

In[58]:= **N[%] /. {R -> .5,** k_β **-> .1,** k_ξ **-> .5,** θ**[t] -> .1}**

Out[58]= 0.0503987

In[59]:= $k_\beta\ k_\xi\ \Delta$

Out[59]= $$k_\beta\left(\frac{(1-R)\,R\sin^2(\theta(t))\,(k_\beta-k_\zeta)^2}{k_\beta\,k_\zeta}+1\right)k_\zeta$$

In[60]:= **N[%] /. {R -> .5,** k_β **-> .1,** k_ξ **-> .5,** θ**[t] -> .1}**

Out[60]= 0.0503987

In[61]:= **(*Stiffness matrix w/o** θ_ξ ***)**

In[62]:= **kmatpe0 = {{zrowzcol, zrowbcol}, {zrowbcol, browbcol}}**

Out[62]= $$\begin{pmatrix} \frac{R\,k_\beta\sin^2(\theta(t)) - R\,k_\zeta\sin^2(\theta(t)) + k_\zeta}{\frac{(1-R)\,R\sin^2(\theta(t))\,(k_\beta-k_\zeta)^2}{k_\beta\,k_\zeta}+1} & -\frac{R\sin(2\,\theta(t))\,(k_\beta-k_\zeta)}{2\left(\frac{(1-R)\,R\sin^2(\theta(t))\,(k_\beta-k_\zeta)^2}{k_\beta\,k_\zeta}+1\right)} \\ -\frac{R\sin(2\,\theta(t))\,(k_\beta-k_\zeta)}{2\left(\frac{(1-R)\,R\sin^2(\theta(t))\,(k_\beta-k_\zeta)^2}{k_\beta\,k_\zeta}+1\right)} & \frac{-R\,k_\beta\sin^2(\theta(t)) + R\,k_\zeta\sin^2(\theta(t)) + k_\beta}{\frac{(1-R)\,R\sin^2(\theta(t))\,(k_\beta-k_\zeta)^2}{k_\beta\,k_\zeta}+1} \end{pmatrix}$$

In[65]:= **kmatpe0 = FullSimplify[{{zrowzcol, 0}, {zrowbcol, 0}}]**

Out[65]=
$$\begin{pmatrix} \dfrac{R\,(k_\beta - k_\zeta)\sin^2(\theta(t)) + k_\zeta}{1 - \dfrac{(R-1)\,R\sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta\, k_\zeta}} & 0 \\ -\dfrac{R\sin(2\,\theta(t))\,(k_\beta - k_\zeta)}{2\left(1 - \dfrac{(R-1)\,R\sin^2(\theta(t))\,(k_\beta - k_\zeta)^2}{k_\beta\, k_\zeta}\right)} & 0 \end{pmatrix}$$

In[66]:= **Clear[Δ]**

In[95]:= **kmatpe0[[1, 1, 1, 1]] = Δ**

Out[95]= Δ

In[96]:= **kmatpe0[[2, 1, 4, 1]] = Δ**

Out[96]= Δ

In[98]:= **kmatpe0 /. {$k_\zeta \to \omega_\zeta{}^2$, $k_\beta \to \omega_\beta{}^2$}**

Out[98]=
$$\begin{pmatrix} \dfrac{R\left(\omega_\beta^2 - \omega_\zeta^2\right)\sin^2(\theta(t)) + \omega_\zeta^2}{\Delta} & 0 \\ -\dfrac{R\sin(2\,\theta(t))\left(\omega_\beta^2 - \omega_\zeta^2\right)}{2\,\Delta} & 0 \end{pmatrix}$$