The earthquake source is represented by the point force $\boldsymbol{f}$, which may be written in terms of a moment tensor $\boldsymbol{M}$ as (omitting the source time function)

$$\boldsymbol{f} = -\boldsymbol{M} \cdot \nabla \delta(\boldsymbol{x} - \boldsymbol{x}_s) \tag{1}$$

The point force $\boldsymbol{f}$ in 3D:

$$\begin{cases} f_x = -\left[M_{xx}\delta'(x-x_s)\delta(y-y_s)\delta(z-z_s) + M_{xy}\delta(x-x_s)\delta'(y-y_s)\delta(z-z_s)\right. \\ \qquad\qquad \left. + M_{xz}\delta(x-x_s)\delta(y-y_s)\delta'(z-z_s)\right] \\ f_y = -\left[M_{xy}\delta'(x-x_s)\delta(y-y_s)\delta(z-z_s) + M_{yy}\delta(x-x_s)\delta'(y-y_s)\delta(z-z_s)\right. \\ \qquad\qquad \left. + M_{yz}\delta(x-x_s)\delta(y-y_s)\delta'(z-z_s)\right] \\ f_z = -\left[M_{xz}\delta'(x-x_s)\delta(y-y_s)\delta(z-z_s) + M_{yz}\delta(x-x_s)\delta'(y-y_s)\delta(z-z_s)\right. \\ \qquad\qquad \left. + M_{zz}\delta(x-x_s)\delta(y-y_s)\delta'(z-z_s)\right] \end{cases}, \tag{2}$$

Multiplying equations (2) by the time-independent test functions, we can obtain

$$\begin{cases} F_x = -\int\left[M_{xx}\delta'(x-x_s)\delta(y-y_s)\delta(z-z_s) + M_{xy}\delta(x-x_s)\delta'(y-y_s)\delta(z-z_s)\right. \\ \qquad\qquad \left. + M_{xz}\delta(x-x_s)\delta(y-y_s)\delta'(z-z_s)\right]\varphi_x(x,y,z)d\Omega \\ F_y = -\int\left[M_{xy}\delta'(x-x_s)\delta(y-y_s)\delta(z-z_s) + M_{yy}\delta(x-x_s)\delta'(y-y_s)\delta(z-z_s)\right. \\ \qquad\qquad \left. + M_{yz}\delta(x-x_s)\delta(y-y_s)\delta'(z-z_s)\right]\varphi_y(x,y,z)d\Omega \\ F_z = -\int\left[M_{xz}\delta'(x-x_s)\delta(y-y_s)\delta(z-z_s) + M_{yz}\delta(x-x_s)\delta'(y-y_s)\delta(z-z_s)\right. \\ \qquad\qquad \left. + M_{zz}\delta(x-x_s)\delta(y-y_s)\delta'(z-z_s)\right]\varphi_z(x,y,z)d\Omega \end{cases}, \tag{3}$$

where φ_x, φ_y and φ_z are the test functions, respectively.

Applying the identity of the Dirac delta function

$$\begin{cases} F_x(x_s,y_s,z_s) = \left(M_{xx}\dfrac{\partial\varphi_x(x_s,y_s,z_s)}{\partial x} + M_{xy}\dfrac{\partial\varphi_x(x_s,y_s,z_s)}{\partial y} + M_{xz}\dfrac{\partial\varphi_x(x_s,y_s,z_s)}{\partial z}\right) \\ F_y(x_s,y_s,z_s) = \left(M_{xy}\dfrac{\partial\varphi_y(x_s,y_s,z_s)}{\partial x} + M_{yy}\dfrac{\partial\varphi_y(x_s,y_s,z_s)}{\partial y} + M_{yz}\dfrac{\partial\varphi_y(x_s,y_s,z_s)}{\partial z}\right) \\ F_z(x_s,y_s,z_s) = \left(M_{xz}\dfrac{\partial\varphi_z(x_s,y_s,z_s)}{\partial x} + M_{yz}\dfrac{\partial\varphi_z(x_s,y_s,z_s)}{\partial y} + M_{zz}\dfrac{\partial\varphi_z(x_s,y_s,z_s)}{\partial z}\right) \end{cases}, \tag{4}$$

If we can find the dimensionless parameters $(\xi_s, \eta_s, \gamma_s)$ satisfying

$$\begin{cases} x_s = \sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N} \ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)x_{pqr} \\ y_s = \sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N} \ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)y_{pqr} \\ z_s = \sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N} \ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)z_{pqr} \end{cases}, \tag{5}$$

or,

$$\begin{cases} \xi_s = \sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N} \ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\xi_{pqr} \\ \eta_s = \sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N} \ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\eta_{pqr} \\ \gamma_s = \sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N} \ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\gamma_{pqr} \end{cases}, \tag{6}$$

Applying the chain rule, (4) can be written

$$\begin{cases} F_x(x_s,y_s,z_s) = M_{xx}\left(\frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\xi}\frac{\partial\xi_s}{\partial x} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\eta}\frac{\partial\eta_s}{\partial x} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\gamma}\frac{\partial\gamma_s}{\partial x}\right) \\ \qquad M_{xy}\left(\frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\xi}\frac{\partial\xi_s}{\partial y} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\eta}\frac{\partial\eta_s}{\partial y} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\gamma}\frac{\partial\gamma_s}{\partial y}\right) \\ \qquad M_{xz}\left(\frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\xi}\frac{\partial\xi_s}{\partial z} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\eta}\frac{\partial\eta_s}{\partial z} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\gamma}\frac{\partial\gamma_s}{\partial z}\right) \\ F_y(x_s,y_s,z_s) = M_{xy}\left(\frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\xi}\frac{\partial\xi_s}{\partial x} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\eta}\frac{\partial\eta_s}{\partial x} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\gamma}\frac{\partial\gamma_s}{\partial x}\right) \\ \qquad M_{yy}\left(\frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\xi}\frac{\partial\xi_s}{\partial y} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\eta}\frac{\partial\eta_s}{\partial y} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\gamma}\frac{\partial\gamma_s}{\partial y}\right) \\ \qquad M_{yz}\left(\frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\xi}\frac{\partial\xi_s}{\partial z} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\eta}\frac{\partial\eta_s}{\partial z} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\gamma}\frac{\partial\gamma_s}{\partial z}\right) \\ F_z(x_s,y_s,z_s) = M_{xz}\left(\frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\xi}\frac{\partial\xi_s}{\partial x} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\eta}\frac{\partial\eta_s}{\partial x} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\gamma}\frac{\partial\gamma_s}{\partial x}\right) \\ \qquad M_{yz}\left(\frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\xi}\frac{\partial\xi_s}{\partial y} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\eta}\frac{\partial\eta_s}{\partial y} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\gamma}\frac{\partial\gamma_s}{\partial y}\right) \\ \qquad M_{zz}\left(\frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\xi}\frac{\partial\xi_s}{\partial z} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\eta}\frac{\partial\eta_s}{\partial z} + \frac{\partial\varphi_x(\xi_s,\eta_s,\gamma_s)}{\partial\gamma}\frac{\partial\gamma_s}{\partial z}\right) \end{cases}, \tag{7}$$

where,

$$\begin{cases} \varphi_x(\xi_s,\eta_s,\gamma_s) = \sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N} \ell_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\varphi_{xklm} \\ \varphi_y(\xi_s,\eta_s,\gamma_s) = \sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N} \ell_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\varphi_{yklm} \\ \varphi_z(\xi_s,\eta_s,\gamma_s) = \sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N} \ell_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\varphi_{zklm} \end{cases}, \tag{8}$$

Substituting (6) and (8) into (7), we can obtain

$$
\begin{aligned}
F_x(x_s,y_s,z_s) = {} & M_{xx}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial x} \\
& + M_{xx}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial x} \\
& + M_{xx}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial x} \\
& + M_{xy}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial y} \\
& + M_{xy}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial y} \\
& + M_{xy}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial y} \\
& + M_{xz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial z} \\
& + M_{xz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial z} \\
& + M_{xz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial z},
\end{aligned}
\tag{9a}
$$

$$
\begin{aligned}
F_y(x_s,y_s,z_s) = {} & M_{xy}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial x} \\
& + M_{xy}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial x} \\
& + M_{xy}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial x} \\
& + M_{yy}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial y} \\
& + M_{yy}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial y} \\
& + M_{yy}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial y} \\
& + M_{yz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial z} \\
& + M_{yz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial z} \\
& + M_{yz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial z},
\end{aligned}
\tag{9b}
$$

$$
\begin{aligned}
F_z(x_s,y_s,z_s) = {} & M_{xz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\xi_{pqr}}{\partial x} \\
& + M_{xz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\eta_{pqr}}{\partial x} \\
& + M_{xz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\gamma_{pqr}}{\partial x} \\
& + M_{yz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\xi_{pqr}}{\partial y} \\
& + M_{yz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\eta_{pqr}}{\partial y} \\
& + M_{yz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\gamma_{pqr}}{\partial y} \\
& + M_{zz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\xi_{pqr}}{\partial z} \\
& + M_{zz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\eta_{pqr}}{\partial z} \\
& + M_{zz}\sum_{k=1}^{N}\sum_{l=1}^{N}\sum_{m=1}^{N}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\gamma_{pqr}}{\partial z}
\end{aligned} \quad . \tag{9c}
$$

Therefore, the source force at each GLL node can be written:

$$
\begin{aligned}
F_x(k,l,m) = {} & M_{xx}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\xi_{pqr}}{\partial x} \\
& + M_{xx}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\eta_{pqr}}{\partial x} \\
& + M_{xx}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\gamma_{pqr}}{\partial x} \\
& + M_{xy}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\xi_{pqr}}{\partial y} \\
& + M_{xy}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\eta_{pqr}}{\partial y} \\
& + M_{xy}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\gamma_{pqr}}{\partial y} \\
& + M_{xz}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\xi_{pqr}}{\partial z} \\
& + M_{xz}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\eta_{pqr}}{\partial z} \\
& + M_{xz}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial\gamma_{pqr}}{\partial z}
\end{aligned} \quad , \tag{10a}
$$

$$
\begin{aligned}
F_y(k,l,m) = {} & M_{xy}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial x} \\
& + M_{xy}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial x} \\
& + M_{xy}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial x} \\
& + M_{yy}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial y} \\
& + M_{yy}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial y} \\
& + M_{yy}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial y} \\
& + M_{yz}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial z} \\
& + M_{yz}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial z} \\
& + M_{yz}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial z},
\end{aligned}
\tag{10b}
$$

$$
\begin{aligned}
F_z(k,l,m) = {} & M_{xz}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial x} \\
& + M_{xz}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial x} \\
& + M_{xz}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial x} \\
& + M_{yz}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial y} \\
& + M_{yz}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial y} \\
& + M_{yz}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial y} \\
& + M_{zz}\ell'_k(\xi_s)\ell_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \xi_{pqr}}{\partial z} \\
& + M_{zz}\ell_k(\xi_s)\ell'_l(\eta_s)\ell_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \eta_{pqr}}{\partial z} \\
& + M_{zz}\ell_k(\xi_s)\ell_l(\eta_s)\ell'_m(\gamma_s)\sum_{p=1}^{N}\sum_{q=1}^{N}\sum_{r=1}^{N}\ell_p(\xi_s)\ell_q(\eta_s)\ell_r(\gamma_s)\frac{\partial \gamma_{pqr}}{\partial z},
\end{aligned}
\tag{10c}
$$