N(x)^T N(X) terms

In[1]:= `phis = {{p0 * p0, p0 * p1, p0 * p2, p0 * p3}, {p1 * p0, p1 * p1, p1 * p2, p1 * p3},`
`{p2 * p0, p2 * p1, p2 * p2, p2 * p3}, {p3 * p0, p3 * p1, p3 * p2, p3 * p3}};`

`MatrixForm[phis]`

`p0 = 1 - p1 - p2 - p3;`

`MatrixForm[phis]`

Out[2]//MatrixForm=

$$\begin{pmatrix} p0^2 & p0\,p1 & p0\,p2 & p0\,p3 \\ p0\,p1 & p1^2 & p1\,p2 & p1\,p3 \\ p0\,p2 & p1\,p2 & p2^2 & p2\,p3 \\ p0\,p3 & p1\,p3 & p2\,p3 & p3^2 \end{pmatrix}$$

Out[4]//MatrixForm=

$$\begin{pmatrix} (1-p1-p2-p3)^2 & p1\,(1-p1-p2-p3) & p2\,(1-p1-p2-p3) & (1-p1-p2-p3)\,p3 \\ p1\,(1-p1-p2-p3) & p1^2 & p1\,p2 & p1\,p3 \\ p2\,(1-p1-p2-p3) & p1\,p2 & p2^2 & p2\,p3 \\ (1-p1-p2-p3)\,p3 & p1\,p3 & p2\,p3 & p3^2 \end{pmatrix}$$

integrals

In[5]:= `f = Function[e, Integrate[e, {p1, 0, 1}, {p2, 0, 1 - p1}, {p3, 0, 1 - p1 - p2}]]`

Out[5]= $\text{Function}\left[e, \int_0^1 \int_0^{1-p1} \int_0^{1-p1-p2} e\, d p3\, d p2\, d p1\right]$

In[6]:= `MatrixForm[Map[f, phis]]`

Out[6]//MatrixForm=

$$\begin{pmatrix} \frac{1}{60} & \frac{1}{120} & \frac{1}{120} & \frac{1}{120} \\ \frac{1}{120} & \frac{1}{60} & \frac{1}{120} & \frac{1}{120} \\ \frac{1}{120} & \frac{1}{120} & \frac{1}{60} & \frac{1}{120} \\ \frac{1}{120} & \frac{1}{120} & \frac{1}{120} & \frac{1}{60} \end{pmatrix}$$