Product of two multivariate gaussians is again gaussian.

$$N_x(a,A)N_x(b,B) = N_x(c,C)\frac{N_a(0,A)N_b(0,B)}{N_c(0,C)}$$

for $C^{-1} = A^{-1} + B^{-1}$ and $c = C\left[A^{-1}a + B^{-1}b\right]$

Etc.:

$$\prod_i N_x(c_i,C_i) = N_x(t,T)\frac{\prod_i N_{c_i}(0,C_i)}{N_t(0,T)}$$

with $T^{-1} = \sum_i C_i^{-1}$ and $t = T\sum_i C_i^{-1}c_i$