$$\mathbb{E}\left[g(t)g(s)^T\right]$$

$$g(s) = g(t) + \nabla g\,(s-t) + \nabla^2 g(s-t, s-t)$$

$$\Rightarrow \mathbb{E}\left[g(t)g(s)^T\right]$$

$$= \mathbb{E}\left[g(t)g(t)^T\right] + \mathbb{E}\left[g(t)\,(s-t)^T(\nabla g)^T\right] + \cdots$$

and $\mathbb{E}\left[g(t)\,(s-t)^T(\nabla g)^T\right]_{ij}$

$$= \mathbb{E}\left[g_i\left((s-t)^T(\nabla g^T)\right)_j\right]$$

$$= \mathbb{E}\left[g_i \sum_n (s-t)_n (\nabla g)^T_{nj}\right] = \mathbb{E}\left[g_i \sum_n (s-t)_n \frac{\partial g_j}{\partial t_n}\right]$$

and the ijth element of the transpose for $\mathbb{E}\,g(s)g(t)^T$

is $\mathbb{E}\left[g_j \sum_n (s_n - t_n)\frac{\partial g_i}{\partial t_n}\right]$

$$\Rightarrow \text{sum} = \mathbb{E}\left[\sum_n (s_n - t_n)\left(\frac{\partial g_j}{\partial t_n} g_i + \frac{\partial g_i}{\partial t_n} g_j\right)\right]$$

but $\mathbb{E}[g_i g_j] = \delta_{ij} \Rightarrow \mathbb{E}\left[\frac{\partial g_j}{\partial t_n} g_i + \frac{\partial g_i}{\partial t_n} g_j\right] = 0!$

So the first term is 0!

also need the $\left(\nabla g(s-t)\right)(\nabla g(s-t))^T$ term

but this is clearly true details