4   **Computer Vision (JGD)**
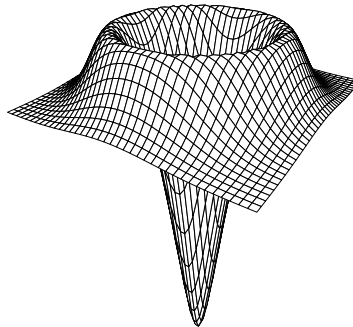
(a) Define the gradient vector field $\vec{\nabla} f(x, y)$ over an image $f(x, y)$, and explain what makes it useful. Contrast its features and capabilities with the $\nabla^2 G_\sigma(x, y)$ (Laplacian of a Gaussian) operator shown below. Identify their respective orders as differential operators, explain how they can be implemented, and discuss any neurobiological analogues for both.   [8 marks]

(b) Define a "hypercolumn" of neurones in the brain's primary visual cortex. Explain what are the main coding variables being spanned by a hypercolumn, roughly how many neurones it encompasses, how much of visual space it processes, and make a drawing of its architectural organisation.   [7 marks]

(c) Explain the Retinex Algorithm, starting with the problem it seeks to solve and why the problem arises.   [5 marks]