1 Potential Due to a Ring of Charge–Limiting Cases

The potential due to a ring of charge is given by:

$$V(s,\phi,z) = \frac{1}{4\pi\epsilon_0}\frac{Q}{2\pi}\int_0^{2\pi}\frac{d\phi'}{\sqrt{s^2+R^2-2sR\cos(\phi-\phi')+z^2}}$$

Expand this potential in a power series to fourth order, in the plane of the ring, for $s < R$. Make sure to integrate. Warning: Make sure you keep all of the terms up to fourth order and none of the terms of higher order. Figuring out which terms to keep is tricky and is the most important lesson from this homework problem.