620-231 semester 2, 2005 Exam

$\boxed{Q1}$ (a) $\underline{\underline{D}}(f \circ g)\Big|_{(2,0,-1)} = \begin{bmatrix} -1 & 1 & 2 \\ 0 & -2 & 0 \end{bmatrix}$

(b) Minimum $f = -1$ at $(1, -4, 2)$

Maximum $f = 9$ at $(-1, 12, -2)$

$\boxed{Q2}$ (a) $k = \frac{2}{5}$

(b) $\underline{u}''' \times \underline{u}' \cdot \underline{u}$

$\boxed{Q3}$ (a) Put $\underline{F} = F_1 \underline{i} + F_2 \underline{j} + F_3 \underline{k}$ and expand. $\nabla \cdot \nabla \times \underline{F}$

(b) (i) $6r^3$

(ii) 0

$\boxed{Q4}$ (b) $\frac{1}{6}(\sin 1 + \sin 2)$

$\boxed{Q5}$ Total mass $= \iiint_D (x^2+y^2)^3 \, dV = \frac{7\pi}{90}$

$\boxed{Q6}$ (a) normal $= (4uv, -2v, 1)$

(b) area of surface $= \int_{-2}^{2} \int_{-2}^{2} \sqrt{16u^2v^2 + 4v^2 + 1} \, du \, dv$

(c) $4x - 2y - z = 3$

$\boxed{Q7}$ -54

$\boxed{Q8}$ -4π

$\boxed{Q9}$ Both integrals equal $\pi/2$

$\boxed{Q10}$ (a) $h_u = \sqrt{v^2+u^2}$, $h_v = \sqrt{v^2+u^2}$, $h_\phi = uv$

(b) $\underline{e}_u = \frac{1}{\sqrt{v^2+u^2}}(v\cos\phi, v\sin\phi, u)$

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$$\underline{e_v} = \frac{1}{\sqrt{v^2+u^2}} (u\cos\phi, \ u\sin\phi, -v)$$

$$\underline{e_\phi} = (-\sin\phi, \ \cos\phi, \ 0)$$

(c) $dV = uv(v^2+u^2)\,du\,dv\,d\phi$

(d) $\nabla^2(u^2\cos\phi) = \frac{1}{uv(u^2+v^2)}\left[4uv\cos\phi - \frac{u}{v}(u^2+v^2)\cos\phi\right]$