Please work the problems in the white space provided and clearly box your solutions. You are allowed one $3'' \times 5''$ notecard. Enjoy! This quiz has 3pts of bonus credit.

Problem 1 (9pts) Let $f(x,y) = x + x^2y^2$. Find the following:

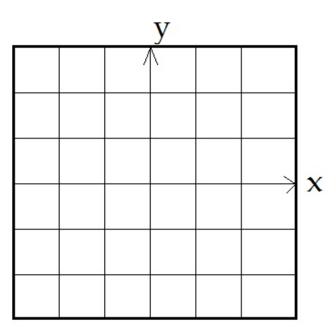
(a.) $\frac{\partial f}{\partial x}$

(b.) $\frac{\partial f}{\partial y}$

(c.) the equation of the tangent plane at $(1,2)$.

Problem 2 (6pts) Let $f(x,y) = \dfrac{1}{1+x^2+y^3}$. Find the rate of change in f at $(1,0)$ in the $\langle 8,-6\rangle$ direction.

Problem 3 (6pts) Let $f(x,y) = x^2 + y^2$. Plot level curves $f(x,y) = k$ for $k = 1,2,9$ on the graph template given below. Furthermore, find (with calculus) the direction in which f is locally constant at $(1,1)$ and indicate why it is reasonable in view of your plotted level curves.



Problem 4 (10pts) Let $z = \sin(xy^2)$. Furthermore, $x = \alpha + \beta^2$ and $y = \beta^2 \sin(\beta)$. Use the multivariate chain rule to calculate $\dfrac{\partial z}{\partial \alpha}$ and $\dfrac{\partial z}{\partial \beta}$.

Problem 5 (6pts) Suppose $h_x(1,2) = 3$ and $h_y(1,2) = 7$. In addition, $x(u,v) = uv^2$ and $y(u,v) = u^2 - v$. Let $g(u,v) = h(x(u,v),\, y(u,v))$ and calculate $\dfrac{\partial g}{\partial u}(1,-1)$.

Problem 6 (9 pts) Let $\vec{r}(s,t) = \langle t\cos 3s,\ t\sin 3s,\ 4s\rangle$ be the parametrization of a surface M. Find the normal vector field to M.

Problem 7 (6pts) A surface $Ax^2 + By^3 + Cz^4 = 5$ has a normal line at $(1, -1, 1)$ with direction vector $\langle 12, 12, 12 \rangle$. Find the values of the constants A, B and C.

Problem 8 (6 pts) Calculate the limit below (if it doesn't exist then explain why)

$$\lim_{(x,y)\to(0,0)} \frac{y - x^2}{x^2 + y^2}$$

Problem 9 (6pts) You are stuck on the surface $xy^2z^3 = 1$. At the point $(1, 1, 1)$ you measure your x-velocity to be $2ft/s$ and your y-velocity is $-3ft/s$. Assuming units of ft and s find $\frac{dz}{dt}$.

Problem 10 (6pts) Imagine yourself a pig. Ron Swanson is holding a barbeque of epic size in a heavily misty park. At the same time a bagpipe club is playing at an embarrassing volume. You can't see or hear in effect. The smell of meat is measured to roughly follow $M(x, y) = x^2 - 2xy$ at $(1, 1)$. In which direction should you travel to **get away** from the feast?

Problem 11 (6pts) Suppose $w = x^2 + yz^3$ where $\cos(xyz) = y^2 + z^2$. Calculate $\left(\dfrac{\partial w}{\partial x}\right)_y$.

Problem 12 (6pts) Calculate dF for $F(x, y, z) = \ln\left[e^x z^{z^2}[\cosh^2(xyz) - \sinh^2(xyz)]\sqrt{\sec(y^2)}\right]$. Simplify your answer.

Problem 13 (10 pts) Solve $(2xy^2 + e^x)dx + (2x^2y + y\cos(y^2))dy = 0$.

Problem 14 (3pts) Let $\omega = -ydx + xdy$. Is this form closed? Is this form exact?

Problem 15 (5pts) Suppose f, g are smooth real-valued functions of n-variables. Show that

$$\nabla(fg) = (\nabla f)g + f(\nabla g).$$

Problem 16 (4pts) Let $\vec{A}(x, y, z) = \left\langle 2x,\ -2y,\ \dfrac{1}{z^2+1} \right\rangle$. If possible, find Φ such that $\nabla\Phi = \vec{A}$.

Problem 17 (4pts) Let $\vec{B}(x, y, z) = \langle 2x + z,\ x^3,\ y \rangle$. If possible, find Ψ such that $\nabla\Psi = \vec{B}$.