There are 10 problems on this exam. Carefully read and follow all directions. In order to receive credit show all necessary work. No credit will be given for an answer I cannot find or cannot read. Unless specified otherwise, all answers should be exact.

Use the vector field $\vec{F}(x, y, z) = <2xz - \sin y, 2y - x \cos y, x^2 - z^2>$ in problems 1-5.

1. This vector field is conservative. Determine a function $f$ such that $\vec{F} = \nabla f$. (8 points)

2. Determine curl($\vec{F}$). (6 points)

3. Determine div($\vec{F}$). (6 points)
4. Evaluate the line integral \[ \int_C \vec{F} \cdot d\vec{r} \] where \( C \) is the path made up of the line segment from \((-2, 0, 4)\) to \((3, 1, 5)\) followed by the line segment from \((3, 1, 5)\) to \((5, 0, -2)\). THINK BEFORE YOU DO ANY UNNECESSARY WORK. (6 points)

5. Rewrite \[ \int_7^3 3y \, dx + \int_{13}^3 3y \, dy \] as a double integral in terms of \( u \) and \( v \) using the transformation given by \( u = 3x + 3y - 24 \) and \( v = -x + 3y + 4 \). (15 points)
Use the vector field \( \mathbf{G} = <2xy, 2yz, 2xz> \) for problems 6-7.

6. Show that \( \mathbf{G} \) is not conservative. (5 points)

7. Evaluate the line integral \( \int_C \mathbf{G} \cdot d\mathbf{r} \) where C is the line segment from (2, 3, 6) to (2, 7, 6). (8 points)
8. Use Green’s Theorem to evaluate the line integral $\int_C \mathbf{H} \cdot d\mathbf{r}$ where $\mathbf{H} = < x^2 - 2y, 3x >$ and $C$ is the circle of radius 4 centered at the origin. (8 points)

9. On the grid below, draw the vectors associated with the vector field $< y, \frac{1}{x} >$ at the points on the coordinate axes for circles of radius 1 and 2 centered at the origin. (6 points)
10. We want to integrate \( \iiint_R xz \, dV \) where \( R \) is defined to be the set of all points with \( z \geq 0 \) that are inside the cone \( z^2 = x^2 + y^2 \) and inside the sphere \( x^2 + y^2 + z^2 = 18 \).

(a) Set up this integral if the differentials are ordered as \( dz \, dy \, dx \). (8 points)

(b) Set up this integral if the differentials are ordered as \( dx \, dy \, dz \). This will require two triple integrals. (8 points)

(c) Set up this integral using cylindrical coordinates. (8 points)

(d) Set up this integral using spherical coordinates. (8 points)