There are 10 problems. Each problem is worth 10 points. SHOW your work. $\boxed{\textit{CIRCLE}}$ your answer. **NO CALCULATORS!**

1. Show that $\boldsymbol{c}(t) = (\sin t, \cos t, e^t)$ is a flow line of the vector field $\overrightarrow{\boldsymbol{F}}(x, y, z) = (y, -x, z)$.

2. Find the divergence of the vector field $\overrightarrow{\boldsymbol{V}}(x, y, z) = x\,\overrightarrow{\boldsymbol{i}} + (y + \cos x)\,\overrightarrow{\boldsymbol{j}} + (z + e^{xy})\,\overrightarrow{\boldsymbol{k}}$.

3. Compute the curl of the vector field $\overrightarrow{\boldsymbol{F}}(x, y, z) = yz\,\overrightarrow{\boldsymbol{i}} + xz\,\overrightarrow{\boldsymbol{j}} + xy\,\overrightarrow{\boldsymbol{k}}$.

4. Find the equations of the line tangent to the curve traced out by $\boldsymbol{c}(t) = (t^3 + 1, e^{-t}, \cos(\frac{\pi t}{2}))$ at $t = 1$.

5. Express as an integral the arc length of the curve $x^2 = y^3 = z^5$ between $x = 1$ and $x = 4$ using a suitable parametrization. (Do not evaluate the integral.)

6. Find $\displaystyle\int_0^1 \int_1^{e^x} (x + y)\, dy\, dx$.

7. Find the volume of the region between $z = x^2 + y^2$ and $z = 50 - x^2 - y^2$.

8. Prove $\displaystyle\int_0^x \int_0^t F(u)\, du\, dt = \int_0^x (x - u)F(u)\, du$.

9. Find $\displaystyle\int_0^1 \int_x^1 e^{y^2}\, dy\, dx$.

10. Let D^* be the parallelogram, in the xy-plane, with vertices $(0, 0)$, $(2, -1)$, $(3, 2)$, and $(1, 3)$. Let D be the square

$$\{(u, v) \mid 0 \le u \le 1 \text{ and } 0 \le v \le 1\}.$$

Find a one-to-one function T from the xy-plane to the uv-plane such that D is the image of D^* under T.