Your exam should consist of this cover sheet, followed by 7 problems. Check that you have a complete exam.

Unless otherwise indicated, show all your work and justify your answers.

Unless otherwise indicated, your answers should be exact values rather than decimal approximations. For example, $\frac{\pi}{4}$ is an exact answer and is preferable to 0.7854.

You may use a scientific calculator and one double-sided 8.5×11-inch sheet of handwritten notes. All other electronic devices, including graphing or programmable calculators, and calculators which can do calculus, are forbidden.

The use of headphones or earbuds during the exam is not permitted.

Show your work, unless instructed otherwise.

If you need more space, write on the back and indicate this. If you still need more space, raise your hand and I’ll give you some extra paper to staple onto the back of your test.

Academic misconduct will guarantee a score of zero on this exam. DO NOT CHEAT.

Turn your cell phone OFF and put it AWAY for the duration of the exam.

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<th>Problem</th>
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1. (10 points) Consider the function

\[ f(x, y, z) = x^2 + y^2 + z^2. \]

Take \( \mathbf{n} = \langle 1/3, 2/3, 2/3 \rangle \) and calculate \( f_\mathbf{n}(0, 1, -2) \).
2. (10 points) Write parametric equations of the plane that passes through the points

\[ P(1, 0, 0), \ Q(2, 1, 0), \ R(0, 0, -1). \]
3. (10 points) Calculate the integral

\[ \int_C z^2 \, ds, \]  
where \( C \) is the curve \( \mathbf{r}(t) = \cos t \mathbf{i} + \sin t \mathbf{j} + t \mathbf{k}, \) \( 0 \leq t \leq 2\pi. \)
4. (10 points) Calculate the integral
\[ \iiint_E xy^2 \, dV, \]
where $E$ is the solid region between the planes
\[ y = x, \quad y = -x, \quad x = 0, \quad x = 1, \quad z = 1, \quad z = -1. \]
5. (10 points) Calculate the integral

\[ \iiint_E \sqrt{x^2 + y^2 + z^2} \, dV, \]

where \( E \) is the part of the unit ball that lies in the first octant above the half-cone \( z = \sqrt{x^2 + y^2} \).
6. (10 points) Using the Divergence Theorem, calculate

$$\iint_{\Sigma} \mathbf{F} \cdot d\mathbf{S},$$

where

$$\mathbf{F} = xyz(i + j + k),$$

and $\Sigma$ is the boundary of the region

$$E = \{-x - y \leq z \leq x + y, \ x \geq 0, \ y \geq 0, \ x + y \leq 1\}$$

with the standard outward orientation.
7. (10 points) Using Stokes’ Theorem, calculate

\[ \int_C \mathbf{F} \cdot d\mathbf{r}, \]

where

\[ \mathbf{F} = y\mathbf{j} + yz\mathbf{k}, \]

and \( C \) is the triangular contour between \( P(1, 0, 0), Q(0, 1, 0), R(0, 0, 1) \) (traversed counterclockwise, if you look from above).