1. Evaluate the 1-form \( dx + 2dy + 3dz \) on the oriented line segment \( PQ \) where \( P(3, 4, 5) \) and \( Q(6, -1, 7) \).

2. Find the pull-back of the 1-form \( \frac{xdx + ydy}{x^2 + y^2} \) under the map \( x = r \cos \theta \) and \( y = r \sin \theta \) (i.e. express the form in polar coordinates). Simplify as much as you can.

3. Evaluate one of the integrals.

\[
\int_0^\pi \int_y^\pi \frac{\sin x}{x} \, dx \, dy, \quad \int \int_R e^{-(x^2 + y^2)} \, dA, \quad R = \{(x, y), x^2 + y^2 \leq 4\}.
\]

4. Calculate the integral of the 1-form \( y^2dx + x^2dy \) along the square with vertices \((0, 0), (3, 0), (3, 3), (0, 3)\) oriented counterclockwise.

5. Do either:

(a) Find the 2-form describing flow in the three dimensional space from a source at \((0, 0, 0)\), assuming that the flow is outward at all points with a magnitude depending only on \( r \) (radial flow) and assuming there are no sources between spheres around the origin.

Hint: The surface area of the sphere of radius \( r \) is \( 4\pi r^2 \).

(b) Evaluate the integral \( \int_S \mathbf{F} \cdot \mathbf{n} \, dS \) (surface integral or flow) of the vector field

\[
\mathbf{F}(x, y, z) = xi + yj + zk,
\]

where \( S \) is the hemisphere \( z = \sqrt{a^2 - x^2 - y^2} \) oriented counterclockwise as seen from the outside.