1. Compute the following integral,\[ \int_0^\infty \frac{\sin(x)}{x} \, dx. \]

2. Let \( f : S^2 \to S^1 \) be a continuous map: Show that there is no continuous map \( g : S^1 \to S^2 \) so that \( f \circ g \) is the identity map on \( S^1 \).

3. Let \( \pi(x) = e^{2\pi i x} \) denote the covering space map from \( \mathbb{R} \) to \( S^1 \). Suppose that \( \varphi : S^1 \to S^1 \) is a continuous map. Show that there exists a continuous map \( \tilde{\varphi} : \mathbb{R} \to \mathbb{R} \) so that \( \pi \tilde{\varphi} = \varphi \pi \). Explain how the degree of the map \( \varphi \) is reflected in the behavior of the function \( \tilde{\varphi} \) and use this construction to show that if \( \varphi \) has degree 1 it is homotopic to the identity map on \( S^1 \).

4. If \( M \) is a compact orientable \( n \)-manifold show that the deRham cohomology, \( H^n(M) \), is not 0.

5. Determine the deRham cohomology for \( \mathbb{R}^n \setminus \text{pt} \) and for \( \mathbb{R}^n \setminus \text{ln} \), where pt = point and ln = line. Use your result for \( \mathbb{R}^3 \setminus \text{ln} \) to say what the deRham cohomology is for \( S^3 \setminus S^1 \) (\( S^1 \) can be taken to be \( S^3 \cap \{x_1 = x_2 = 0\} \)).

6. Consider \( \mathbb{R}^3 \) with coordinates \( (x, y, z) \). Write down explicit formulas for the vector fields \( X \) and \( Y \) which represent the infinitesimal generators of rotations about the \( x \)- and \( y \)-axes respectively and compute their Lie bracket.

7. Let \( \Omega = dx \wedge dy \wedge dz \) be the standard volume form on \( \mathbb{R}^3 \). Consider the one form \( \alpha = xdx + ydy + zdz \) and find a two form \( \beta \) on \( \mathbb{R}^3 \setminus \{0\} \) such that \( \Omega = \alpha \wedge \beta \) on \( \mathbb{R}^3 \setminus \{0\} \). Also show that there is no such two form \( \gamma \) defined on all of \( \mathbb{R}^3 \) so that \( \Omega = \alpha \wedge \gamma \).