Directions: Be sure to follow the guidelines for writing up projects as specified in the course information sheet (passed out on the first day of class). Whenever appropriate, use in-line citations, including page numbers and people consulted when you present information obtained from discussion, a text, notes, or technology. Only write on one side of each page.

“I never know how much of what I say is true.” — Bette Midler

0.1 Project Description

Do one (1) of the following. All problems are “computational” but the last one requires more attention to details.

1. Do both of the following:

   (a) Assume that all functions are differentiable. If \( z = f(x, y) \), where \( x = r \cos \theta \), and \( y = \sin \theta \), find
   \[
   \frac{\partial z}{\partial r}, \quad \frac{\partial z}{\partial \theta} \quad \text{and} \quad \frac{\partial^2 z}{\partial r \partial \theta}.
   \]

   (b) Assume that all functions are differentiable. Show that any function of the form
   \[
   z = f(x + at) + g(x - at)
   \]
   is a solution of the wave equation
   \[
   \frac{\partial^2 z}{\partial t^2} = a^2 \frac{\partial^2 z}{\partial x^2}
   \]

2. Suppose \( z = f(x, y) \) is a function on two intermediate variables and \( x = x(s, t), \ y = y(s, t) \) are functions on two independent variables \( s, t \). Derive the formula for
   \[
   \frac{\partial^2 z}{\partial t \partial s}
   \]
   [Recall that \( \frac{\partial^2 z}{\partial t \partial s} = f_{st}(x, y) \).]