1. Some doctors use the body mass index (BMI) to determine a patient’s ideal weight. The BMI is defined as \( B = \frac{m}{h^2} \), where \( m \) is the person’s mass (in kilograms), and \( h \) is the height (in meters). A person with a BMI above 25 is considered to be overweight.
   a) Find \( \frac{\partial B}{\partial h} \).
   b) What is the sign of your answer in part a (positive, negative, or zero)?
   c) Explain the significance of your answer in part b in practical terms.

2. A) Find the directional derivative of the function \( z = e^x \sin(\pi y) \) at the point \((0,0)\) in the direction of the vector \( 3i + 4j \).
   b) Find a normal vector to the surface \( z = e^x \sin(\pi y) \) at the point \((0,0,0)\).

3. Find \( \int_R x^2 y^2 dA \) for the region \( R \) bounded by the curves \( y = x \) and \( y = x^2 \).

4. Find the equation of the plane through points \((1,0,2)\), \((0,2,1)\), and \((2,1,0)\).

5. A successful Colby alumna pledges an annual donation of $100,000 to her Alma Mater, with the first payment being made right away, and the payments going on indefinitely. What is the present value of this gift, assuming an annual effective interest rate of 10%. Note: The present value \( P \) of a payment \( B \) made \( t \) years from now is \( P = B/(1.1)^t \).

6. Find all the local extrema of the function \( f(x,y) = x^3 - 3xy + y^3 \).

7. Consider the function \( f(x) \) such that \( f(0) = 2 \) and \( f'(x) = \frac{1}{1+x^2} \). Find the Taylor polynomial of degree 3 of \( f(x) \).

8. Two bugs are sitting at the point \((2,3)\) on a metal plate whose temperature at the point \((x,y)\) is \( T(x,y) = 100 - x^2 - 4y^2 \).
   a) One of the bugs wishes to move in the direction in which the temperature is increasing most rapidly. Find this direction.
   b) The other bug wishes to take a direction in which the directional derivative is 24. Is there such a direction? If so, how many choices does the bug have?

9. It’s 1 am and you have a final exam at 9 am that morning. Based on (torturous) experience you expect your score \( s \) in the final to be \( s = \frac{1}{6}a^3b \) if you spend \( a \) hours of the remaining time studying and \( b \) hours sleeping. (No time will be left for eating, grooming, and other pursuits.) How many hours should you study? Will you pass the exam?

10. Let \( L \) be the line through the points \((0,1,0)\) and \((1,0,1)\). Find the shortest distance between line \( L \) and the \( z \)–axis.