1. Evaluate: \[ \int \frac{(5x+15)}{\sqrt{x^2 + 6x}} \, dx \]

2. Find the function \( f \) whose graph passes through the point \((0, 5)\) and whose derivative is given by \( f'(x) = xe^{-\frac{x}{2}} \).

3. Determine the demand function for a product when its rate of change of the unit price is given by \( p'(x) = \frac{-600x}{(3x^2 + 25)^{\frac{3}{2}}} \) if the demand is 5 when the price is $27.

4. Evaluate: \[ \int x^2 (\ln x) \, dx \]

5. Evaluate: \[ \int \frac{x}{\sqrt{x+1}} \, dx \]

6. Evaluate: \[ \int_1^9 \frac{3x}{\sqrt{10-x}} \, dx \]

7. Evaluate: \[ \int \sqrt{x} (\ln \sqrt{x}) \, dx \]

8. The marginal revenue for the sale of a product can be modeled by \( \frac{dR}{dx} = 50 - 0.02x + \frac{100}{x+1} \), where \( x \) is the quantity demanded and \( \frac{dR}{dx} \) is measured in units of a dollar. Find the total revenue realized from the sale of the first 200 units.

9. Find the *average* price of a product as its demand increases from 59 to 99 units if its demand function is given by \( p = 400 + \frac{1000}{x+1} \), where \( p \) is the price in dollars and \( x \) is the number of units demanded.

10. Find the present value and future value of an income stream at the rate of \( R(t) = 10,000 - 500t \) dollars for 5 years at 10% per year compounded continuously.

11. Using integration tables, evaluate \[ \int_2^4 \frac{dx}{\sqrt{16x^2 - 64}} \]
12. Using the Trapezoidal Rule with \( n = 3 \), approximate \( \int_{1}^{4} (2x - 5)^3 \, dx \).

13. Using Simpson’s Rule with \( n = 4 \), approximate \( \int_{0}^{2} 2xe^{-x} \, dx \).

14. It was found that the demand function for a product can be represented by \( p = \sqrt{25 - 0.1x} \) and \( x \) units will be available if the unit price is \( p = \sqrt{0.1x + 9} - 2 \), where \( p \) is measured in dollars. If the market unit price is set at market equilibrium, find its consumers’ and producers’ surplus.

15. Find the present and the future value of an annuity of $2000 deposited monthly into an account for 10 years at 4.25% compounded continuously.

16. Evaluate: \( \int_{-\infty}^{0} \frac{6}{(1-3x)^2} \, dx \)

17. Evaluate: \( \int_{-\infty}^{0} \frac{1}{\sqrt{6-x}} \, dx \)

18. Evaluate: \( \int_{\frac{1}{2}}^{\infty} \frac{1}{x \ln x} \, dx \)

19. The productivity units of a company are given by the function \( f(x, y) = 300x^{\frac{2}{3}}y^{\frac{1}{3}} \), where \( x \) represents the worker-hours per week and \( y \) represents the capital in hundreds of dollars per week.
   a) Determine the productivity for the week when 125 worker-hours and $6400 in capital are available.
   b) Determine the marginal productivity of labor and the marginal productivity of capital at the levels of labor and capital used in part a above.
   c) Interpret your results for part b above.
   d) What would be the approximate effect of decreasing labor from 125 to 124 worker-hours while keeping capital fixed at $6400?

20. Determine, if any exists, the relative extrema of \( f(x, y) = x^4 - 8xy + 2y^2 - 3 \).

21. Determine, if any exists, the relative extrema of \( f(x, y) = \frac{1}{x} + \frac{1}{y} + xy \).

22. A manufacturing company produces two products—product A & product B—that sell for $10 and $9 per unit, respectively. The cost of producing \( x \) units of product A and \( y \) units of product B is \( C(x) = 400 + 2x + 3y + 0.01(3x^2 + xy + 3y^2) \).
   a) Give the profit function \( P(x, y) \).
   b) Determine the number of units of each product and the prices that should be charged in order to maximize profit.
   c) Find the maximum profit.
23. The amount of space required by a manufacturer of computer chips is \( f(x, y) = 1000\sqrt{6x^2 + y^2} \), where \( x \) and \( y \) are the number of units of labor and capital utilized, respectively. Suppose that labor costs $480 per unit and capital costs $40 per unit and the firm has $5000 to spend. Use Lagrange multipliers to determine the amounts of labor and capital that should be utilized in order to minimize the amount of space required.

24. Given the function \( z = f(x, y) = y^3 + xe^{xy} \).
   a) Find the approximate change in \( z \) as a point \((x, y)\) goes from \((1, 2)\) to \((1.05, 1.95)\).
   b) Find the exact change in \( z \).

25. The market research consultant for a major computer distributor traced the selling price and the corresponding demand for a new computer for a 3-month period. The information is provided below, where \( x \) represents the selling price per computer (in thousands) and \( y \) represents the number (in thousands) of computers purchased that month.

<table>
<thead>
<tr>
<th>( x )</th>
<th>2.5</th>
<th>3.2</th>
<th>4.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y )</td>
<td>3</td>
<td>1.4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

   a) Find the least square regression line that best fits the above information.
   b) Estimate the demand if the price per computer is $2,900.

26. Set up and evaluate the double integral for \( f(x, y) = \frac{\ln x}{xy} \) and the rectangular region \( R \), where \( R \) is bounded by \( 1 \leq x \leq 2 \) and \( 2 \leq y \leq 3 \).

27. Find the volume of the solid bounded above by \( f(x, y) = 2xy \) and below by the plane region \( R \) bounded by \( x = 0, \ x = 1, \ y = x + 1, \) and \( y = \sqrt{x} \).

28. Find the average value of \( f(x, y) = 6 - \frac{1}{2} x - \frac{1}{2} y \) over the plane region bounded by the graphs of \( y = x \) and \( y = 0 \) from \( x = 1 \) to \( x = 4 \).

29. Find the equation of the function \( f \) given that the slope of the tangent line to the graph of \( y = f(x) \) at any point \( P(x, y) \) is given by \( y' = 2x - 2xy \) and the graph of \( f \) passes through the point \((0,4)\).

30. Find the particular solution to \( y' = xy - x \) if \( y(0) = 4 \).

31. The resale value of a car decreases at a rate proportional to the car’s purchase price. The car was purchased at $23,000 and was worth $18,000 two years later.
   a) Using \( S \) to represent the value of the car, give the differential equation that describes this relationship at any time \( t \).
   b) Find the value of the car after 8 years.
32. The management of an investment company has decided that the level of investment should not exceed $500,000. Furthermore, management has decided that the rate of change of the total capital should be proportional to the difference between $500,000 and the total capital invested.
   a) Using $A$ as the amount invested, give the differential equation that describes this relation at any time $t$.
   b) If $200,000$ was invested initially and the amount increased $150\%$ at the end of two years, find the amount at the end of five years.

33. Find the value of the constant $k$ that will make $f(x) = k(4x - x^2)$ a probability density function on $[0,4]$.

34. Given the probability density function $f(x) = \frac{1}{10} e^{-\frac{x}{10}}$ defined on $[0,\infty)$. Find
   a) $P(0 \leq x \leq 1)$
   b) $P(5 \leq x \leq 10)$
   c) $P(x = 6)$
   d) $P(x \geq 4)$

35. For the probability density function $f(x) = 12x^2(1-x)$ on the interval $[0,1]$, find the
   a) mean
   b) variance
   c) standard deviation

36. For the probability density function $f(x) = \frac{64}{x^3}$ on the interval $[2,\infty)$, find the
   a) mean
   b) variance
   c) standard deviation

37. The number of years when a new business will start to turn a profit is a random variable with probability density function $f(x) = \frac{1}{2} x(2 - x)$ on $[0,2]$.
   a) Find the expected numbers of years that it will begin realizing a profit.
   b) Find the variance and standard deviation.
   c) Find the probability that the business will turn a profit within the first six months.

38. The grades on a recent math exam were found to be normally distributed with a mean of 73 and a standard deviation of 8. Find the probability that a student selected at random in the class will have a score of
   a) 90 or higher
   b) less than 60
   c) between 70 and 90
   d) Give the percentage of the class that might have a score of 90 or higher.
   e) Give the percentage of the class that might have a score of less than 60.
   f) Give the percentage of the class that would have a score between 70 and 90.

39. Evaluate: $\int \frac{1}{x(5-x)} \, dx$

40. Find the particular solution of the linear differential equation subject to the initial condition
   \[ \frac{dy}{dx} - y = \frac{1}{1+e^{-x}}; \quad y(0) = 0 \]

41. Find the expected value, variance, standard deviation, and median of the random variable $X$ for the probability density function $f(x) = \frac{x}{8} - \frac{1}{4}$ on the interval $[2,6]$.

42. Find the capital value of property that can be rented at $10,000 annually when the prevailing continuous interest rate is 12\% per year.