1. Integrate.
   a. $\int 5x^8 \, dx$
   b. $\int 25x^4 \, e^{x+5} \, dx$
   c. $\int 3x^8(2x^3 - 1)^5 \, dx$
   d. $\int \cos(4x) \, dx$
   e. $\int 5x \, dx$
   f. $\int 4x \, dx$
   g. $\int x^3 e^{-x^5} \, dx$
   h. $\int 6x^2(2x^3 - 1)^5 \, dx$

2. Integrate using Integration by Parts.
   a. $\int 8x^2 e^{2x} \, dx$
   b. $\int 6x^2 \ln x \, dx$

3. Find the value of “k” that makes each equation true.
   a. $\int 2^x^2 \, dx = 6$
   b. $\int 4x + 2 \, dx = 56$

4. Find the area between the curves $f(x) = 4x + 2$ and $g(x) = 14 - 2x$ from $x = 0$ to $x = 6$. (Make sure to graph your functions first to find where they intersect. Then set up two integrals – one for each area.)

5. Find the average value of the function over the given interval.
   a. $f(x) = (2x - 1)^{1/2}$ on $[1, 13]$
   b. $f(x) = e^{0.1x}$ on $[0, 10]$

6. Determine whether each improper integral converges or diverges. Find the value if it converges.
   a. $\int_0^\infty \frac{8}{x^3} \, dx$
   b. $\int_0^\infty 5e^{-0.1x} \, dx$
   c. $\int_0^\infty 4e^{0.2x} \, dx$

7. Solve each differential equation.
   a. $y' = \frac{10x}{y^4}$
   b. $y' = 3x^2 \, y$, $y(0) = 5$

8. Let x represent the amount of time (in hours) needed by a student to complete a calculus final exam for which 2 hours is allowed. Past records show the probability density function for $x$ can be approximated by $f(x) = \frac{1}{8} x^2 + \frac{3}{8}$, $0 \leq x \leq 2$. What is the probability that Garrett needs between 1 and 1.5 hours to complete the exam? What is the average length of time needed by students to complete the 2-hour exam?

9. The amount of time needed to wait for an appointment at Coggins House of Curl is given by the probability density function $f(x) = 0.02e^{-0.02x}$ minutes, $x \geq 0$.
   a. Nicoletta Nichols needs her haircut and stops in. What is the probability Nicoletta will wait less than 20 minutes for an appointment.
   b. Karole-Ann Gill stops by to get an appointment and is told there are no more slots open for the day. She is disappointed but decides to stop by tomorrow. What is the expected amount of time Karole-Ann will wait for an appointment tomorrow? (i.e. find the expected value for this exponential pdf)

10. Evaluate.
    a. $\int_0^2 \int_0^2 6x - 2xy \, dxdy$
    b. $\int_0^1 \int_0^1 4xy + 3 \, dydx$

11. Find the indicated partial derivatives:
    a. $f_x$ for $f(x, y) = \ln(xy - 3)$
    b. $f_y$ for $f(x, y) = e^{3xy}$
12. Find and classify the critical points for the function \( f(x, y) = 3x^2 - 24x + \frac{2}{3}y^3 + \frac{9}{2}y^2 - 5y + 2 \).

13. A certain type of cruise missile has a remote guidance device. Pete O’Brien and his team of army engineers have found that the distance (in thousands of miles) at which the missile can be controlled by the device is given by the function \( R(t, h) = 12,000 - t^2 - 2ht - 2h^2 + 200t + 260h \) miles, where \( t \) is the temperature in degrees Fahrenheit and \( h \) is the humidity as a %. Find the optimal conditions for controlling the missile. What is the maximum distance the missile can be controlled under the optimal conditions?

14. Use the method of Lagrange Multipliers to Maximize \( f(x, y) = 2 - x^2 - y^2 \) subject to \( x + 2y = 20 \).

15. Find the value of an annuity in which $2000 is deposited at 8% compounded semiannually for 10 years.

Answer Key:

1. a. \(-2x^{-4} + C\)  
b. \(2e^{2x+5} + C\)  
c. \((2x + 1)^4 + C\)  
d. \(\frac{1}{4}\sin(4x) + C\)  
e. \(5\ln x + C\)  
f. \(2(4x + 1)^{1/2} + C\)  
g. \(\frac{1}{5}e^{x^4} + C\)  
h. \(\frac{1}{6}(2x^3 - 1)^6 + C\)  

2. a. \(4x^2 e^{2x} - 4xe^{2x} + 2e^{2x} + C\)  
b. \(2x^3 \ln x - \frac{2}{3}x^3 + C\)

3. a. \(k = \frac{1}{2}\)  
b. \(k = 5\) (\(k = -6\) is also a solution — I would give credit for either or both)

4. 60 square units (12 square units from \(x = 0\) to \(x = 2\) and 48 square units from \(x = 2\) to \(x = 6\))

5. a. \(31/9 = 3.44\)  
b. \((1/10)(10e - 10) = 1.718\)

6. a. \(1/16\)  
b. \(50\)  
c. Diverges

7. a. \(y = \sqrt{25x^2 + C}\)  
b. \(y = 5e^{x^3}\)

8. The probability a student will need between 1 hour and 90 minutes is 0.307. The students will need, on average, approximately 1.389 hours (1 hour 23 minutes) to complete the exam.

9. a. Probability Nicoletta will wait 20 minutes or less is .33  
b. Expected waiting time is 50 minutes (1/0.02).  

10. a. 12  
b. 10

11. a. \(f_x = \frac{y}{xy - 3}\)  
b. \(f_y = 12xy^3e^{3xy^4}\)

12. (4, \(\frac{1}{2}\)) relative minimum, (4, -5) saddle point

13. Maximum distance of 22.9 thousand miles when a temperature of 70 degrees and 30% humidity.

14. \(x = 4, y = 8\) and a Maximum of -78

15. $59,556.16 (Note i = .04 and n = 20)