1. Find the maximizer of \( f(x, y) = x^2 + y^2 \) subject to the constraints that \( 2x + y \leq 2, \ x \geq 0, \) and \( y \geq 0. \)

2. Determine if the following functions are convex, concave, or neither:
   (a) \[ f(x) = 3e^x + 5x^4 - \ln x \]
   (b) \[ f(x, y) = -3x^2 + 2xy - y^2 + 3x - 4y + 1 \]
   (c) \[ f(x, y, z) = 3e^x + 5y^4 - \ln z \]

3. Determine which of the following functions are homogeneous. For the homogeneous functions, identify the degree of homogeneity.
   (a) \[ f(x, y) = 3x^5y + 2x^2y^4 - 3x^3y^3 \]
   (b) \[ f(x, y) = 3x^5y + 2x^2y^4 - 3x^3y^4 \]
   (c) \[ f(x, y) = x^{1/2}y^{-1/2} + 3xy^{-1} + 7 \]

4. Write down the degree-one homogenization of each of the following functions:
   (a) \[ f(x) = e^x \]
(b) \[ f(x) = \ln x \]

(c) \[ f(x) = 5 \]

(d) \[ f(x, y) = x^2 + y^3 \]

5. Find the following integrals:

(a) \[ \int (x^3 + 2x - 3) \, dx \]

(b) \[ \int (x - 1)^2 \, dx \]

(c) \[ \int (x - 1)(x + 2) \, dx \]

(d) \[ \int (x + 2)^3 \, dx \]

(e) \[ \int (e^{3x} - e^{2x} + e^x) \, dx \]

(f) \[ \int \frac{x^3 - 3x + 4}{x} \, dx \]

6. Evaluate the following integrals:

(a) \[ \int_1^3 \frac{3x}{10} \, dx \]
7. Evaluate the following integrals:

(a) \[ \int_{0}^{5} (x + x^2) \, dx \]

(b) \[ \int_{-3}^{-1} x^2 \, dx \]

(c) \[ \int_{0}^{1} \alpha e^{\beta x} \, dx, \beta \neq 0 \]

(d) \[ \int_{-2}^{-1} \frac{1}{y} \, dy \]

(e) \[ \int_{-4}^{4} (x - 1)^3 \, dx \]

(f) \[ \int_{1}^{2} (x^5 + x^{-5}) \, dx \]
8. Find:
   (a) \[ \frac{d}{dt} \int_0^t x^2 \, dx \]
   (b) \[ \frac{d}{dt} \int_1^3 e^{-x^2} \, dx \]
   (c) \[ \frac{d}{dt} \int_{-t}^t \frac{1}{\sqrt{x^4 + 1}} \, dx \]

9. Evaluate the following:
   (a) \[ \int_{-1}^1 x \ln(x + 2) \, dx \]
   (b) \[ \int_0^2 x^2 \, dx \]
   (c) \[ \int_0^1 x^2 e^x \, dx \]

10. Find the following integrals by means of an appropriate substitution:
    (a) \[ \int x(2x^2 + 3)^5 \, dx \]
    (b) \[ \int x^2 e^{x^3 + 2} \, dx \]
    (c) \[ \int \frac{2x - 1}{x^2 - x + 8} \, dx \]
(d) \[
\int x\sqrt{1+xdx}
\]

(e) \[
\int \frac{x^3}{(1+x^2)^3} dx
\]

(f) \[
\int x^5\sqrt{4-x^2}dx
\]

11. Find an expression for \(F'(x)\) when

(a) \[
F(x) = \int_1^2 \frac{e^{xt}}{t} dt, x \neq 0
\]

(b) \[
F(x) = \int_1^e \ln(xt) dt, x > 0
\]

(c) \[
F(x) = \int_0^1 \frac{e^{-t}}{1+xt} dt, x > -1
\]

(d) \[
F(x) = \int_3^8 \frac{t^2}{(1-xt)^2} dt, x > 1/3
\]

12. Use Leibniz’s Formula to find an expression for \(F'(x)\) when

(a) \[
F(x) = \int_0^{2x} t^3 dt
\]

(b) \[
F(x) = \int_0^x (x^2 + t^3)^2 dt
\]