1. Find the limit:
   (a) $\lim_{x\to\infty} \sqrt[x]{x}$ (b) $\lim_{x\to 1^+} \frac{1}{\ln(x)} - \frac{1}{x-1}$ (c) $\lim_{x\to-\infty} x^2 e^x$ (d) $\lim_{x\to 1} \frac{2-x}{(x-1)^2}$
   (e) $\lim_{x\to 5^-} \frac{-6}{x-5}$ (f) $\lim_{x\to\infty} \frac{x^3-2x+3}{5x^2-2x^3}$ (g) $\lim_{x\to 4} \frac{x-4}{|4-x|}$

2. Find y':
   (a) $y = \ln(\sinh(x))$ (b) $y = \sqrt{x}e^{\cosh(3x)}$ (c) $y = (1+x^2)\arctan(x)$ (d) $y = x\ln(\tan^{-1}(x))$
   (e) $y = 5^{-1/x}$ (f) $y = x^{\sin(x)}$ (g) $y = \log_{10}(x^2-4)$ (h) $y = \sqrt{1+2e^{3x}}$
   (i) $y = \ln(x^2+y^2)$ (j) $y = \int_{1/x^2}^{0} \sin^3(t)\,dt$ (k) $y = \frac{\ln(x)}{e^x}$

3. Find the exact value of: (a) $\arcsin(-1/\sqrt{2})$ (b) $\cos(\sin^{-1}(x))$

4. A bacteria culture initially contains 10 cells and grows at a rate proportional to its size. After an hour the population has increased to 106. (a) Find an expression for the number of bacteria after t hours. (b) When will the population reach 10,000 cells?

5. (a) Find f^{-1} given $f(x) = \frac{1-\sqrt{x}}{1+\sqrt{x}}$ (b) Find $(f^{-1})'(1)$ given $f(x) = x^3 + x + 1$.

6. Evaluate the integral:
   (a) $\int \frac{e^x}{e^{2x}+1}\,dx$ (b) $\int \frac{dx}{x+\sqrt{x}}$ (c) $\int \sec(x)\,dx$ (d) $\int \frac{dx}{\sec(x)+\tan(x)}$
   (e) $\int_{-1}^{1} e^{|x|}\,dx$ (f) $\int \frac{x}{\sqrt{x^2+1}}\,dx$ (g) $\int \frac{dx}{x\cos(\ln(x))}$

7. (a) Find an approximation to the integral $\int_1^2 x^2\,dx$ using a Riemann sum with a regular partition with left endpoints and $n = 4$.
   (b) Given that
   $$\sum_{i=1}^{n} i = \frac{n(n+1)}{2}, \qquad \sum_{i=1}^{n} i^2 = \frac{n(n+1)(2n+1)}{6}, \quad \text{and} \quad \sum_{i=1}^{n} i^3 = \left[\frac{n(n+1)}{2}\right]^2.$$
   Use the limit definition of the integral, with right endpoints and a regular partition, to find the exact value of $\int_1^2 x^2\,dx$.

8. If 1200 cm^2 of material is available to make a box with a square base and an open top, find the largest possible volume of the box.

9. Complete two iterations of Newton's Method to approximate a root of $y = 3x^2 - 2$ using an initial guess of $x_1 = 1$.

10. Given that $y = x - 3x^{1/3}$, $y' = 1 - \frac{1}{x^{2/3}}$, $y'' = \frac{2}{3x^{5/3}}$
    (a) State the domain of the function, does the function have any vertical or horizontal asymptotes?
    (b) Determine the intervals where y is increasing and decreasing.
    (c) Determine the intervals where y is concave up and concave down.
    (d) Find any local maximum or minimum values.
    (e) Sketch the graph of the function.

11. Given that $f(x) = \dfrac{x^2 - x}{x^2 + x - 2}$, $f'(x) = \dfrac{2}{(x+2)^2}$, $f''(x) = \dfrac{-4}{(x+2)^3}$

    (a) State the domain of the function, does the function have any vertical or horizontal asymptotes?

    (b) Determine the intervals where y is increasing and decreasing.

    (c) Determine the intervals where y is concave up and concave down.

    (d) Find any local maximum or minimum values.

    (e) Sketch the graph of the function.

12. (a) State the Intermediate Value Theorem

    (b) State Rolle's Theorem.

    (c) State the Mean Value Theorem.

    (d) Find all numbers c that satisfy the conclusion of the Mean Value Theorem for $f(x) = \ln(x)$ on the interval $[e, e^2]$

13. Find the absolute maximum and absolute minimum values of $f(x) = \cosh(x)$ over the interval $[\ln(1/2), \ln(3)]$.

14. A balloon is rising at a constant rate of 5 ft/s. A boy is cycling along a straight road at a speed of 15 ft/s. When he passes under the balloon, it is 45 ft above him. How fast is the distance between the boy and the balloon increasing 3 s later?

15. The radius of a circular disk was found to be 24 cm with a possible error in measurement of 0.2 cm. Use differentials to estimate the error, relative error, and percentage error in computing the area of the disk

16. Find the linearization of $f(x) = e^x$ at the point $a = 1/2$, and then use this linearization to approximate e. (Hint: $\ln(1.6) \approx 1/2$)

17. If a particle has position function $s(t) = t^3 - 12t + 3$, where $t \geq 0$ is measured in seconds and s in feet.

    (a) Find the velocity and acceleration function.

    (b) When is the particle moving forward and when is it moving backward?

    (c) Find the total distance traveled in the first 3 seconds.

18. Use the limit definition of the derivative to find $f'(x)$ given $f(x) = \sqrt{1 + 2x}$.

19. Find a and b so that

$$f(x) = \begin{cases} ax^3, & x \leq 2 \\ x^2 + b, & x > 2 \end{cases}$$

    is differentiable everywhere.

20. Given $f(x) = \dfrac{1}{x^2}$ and $g(x) = \sqrt{x}$ find g/f, $f \circ f$ and $g \circ f$ and state their domains.