1. Given vectors $\mathbf{a} = \mathbf{i} - 2\mathbf{j}$, $\mathbf{b} =< -2, 3 >$. Find
   (a) a unit vector $\mathbf{u}$ that has the same direction as $2\mathbf{b} + \mathbf{a}$.
   (b) angle between $\mathbf{a}$ and $\mathbf{b}$
   (c) $\text{comp}_{\mathbf{b}}\mathbf{a}$, $\text{proj}_{\mathbf{b}}\mathbf{a}$.

2. Find the work done by a force of 20 lb acting in the direction N50°W in moving an object 4 ft due west.

3. Find the distance from the point (-2,3) to the line $3x - 4y + 5 = 0$.

4. Find vector and parametric equations for the line passing through the points $A(1, -3)$ and $B(2, 1)$.

5. Find all points of discontinuity for the function

$$f(x) = \begin{cases} x^2 + 1 & , \quad \text{if } x < 2, \\ x + 2 & , \quad \text{if } x \geq 2. \end{cases}$$

6. Find the vertical and horizontal asymptotes of the curve $y = \dfrac{x^2 + 4}{3x^2 - 3}$.

7. Find $\dfrac{dy}{dx}$ for each function
   (a) $y = (\sin x)^x$.
   (b) $y = \dfrac{\sqrt[5]{2x - 1}(x^2 - 4)^2}{\sqrt[3]{1 + 3x}}$
   (c) $y(t) = \sin^{-1} t$, $x(t) = \cos^{-1}(t^2)$.
   (d) $2x^2 + 2xy + y^2 = x$.

8. Find the equation of the tangent line to the curve $y = x\sqrt{5 - x}$ at the point (1,2).

9. A particle moves on a vertical line so that its coordinate at time t is $y = t^3 - 12t + 3$, $t \geq 0$.
   (a) Find the velocity and acceleration functions.
   (b) When is the particle moving upward?
   (c) Find the distance that particle travels in the time interval $0 \leq t \leq 3$

10. The vector function $\mathbf{r}(t) =< t, 25t - 5t^2 >$ represents the position of a particle at time t. Find the velocity, speed, and acceleration at $t = 1$.

11. Find y'' if $y = \mathrm{e}^{-5x} \cos 3x$

12. Find $\dfrac{d^{50}}{dx^{50}} \cos 2x$

13. Use differentials to estimate $(1.09)^{10}$.

14. A balloon is rising at a constant speed 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. Evaluate each limit:
    (a) $\displaystyle\lim_{x \to 0} \frac{\sin x + \sin 2x}{\sin 3x}$

(b) $\lim_{x\to 0}(\cot x - \csc x)$

(c) $\lim_{x\to 0} x^{\sin x}$

16. A cup of coffee has a temperature of 200°F and is in a room that has a temperature of 70°F. After 10 min the temperature of the coffee is 150°F.

    (a) What is the temperature of the coffee after 15 min?

    (b) When will the coffee have cooled to 100°F?

17. Find the absolute maximum and absolute minimum values of $f(x) = x^3 - 2x^2 + x$ on [-1,1].

18. For the function $y = x^2 e^x$ find

    (a) All asymptotes.

    (b) Intervals on which the function is increasing/decreasing.

    (c) All local minima/local maxima.

    (d) Intervals on which the function is CU/CD.

    (e) Inflection points.

19. The top and the bottom margins of a poster are each 6 cm and the side margins are each 4 cm. If the area of the printed material on the poster is fixed at 384 cm^2, find the dimensions of the poster with the smallest total area.

20. Find the area under the curve $y = x^2 + 3x - 2$ from 1 to 4. Use equal subintervals and take x_i^* to be the right end-point of the i-th interval

21. Express the limit $\lim_{n\to\infty} \frac{1}{n} \sum_{i=1}^{n} \frac{1}{1+(i/n)^2}$ as a definite integral. Do not evaluate it.

22. Find the derivative of the function $f(x) = \int_0^{\sqrt{x}} \frac{t^2}{t^2+1} dt$

23. Find the integral:

    (a) $\int_1^2 \left(x + \frac{1}{x}\right)^2 dx$

    (b) $\int_1^2 \frac{x^2+1}{\sqrt{x}} dx$

    (c) $\int_0^{\pi/2} (\cos t + 2\sin t) dt$

    (d) $\int \sqrt[3]{1-x}\, dx$

    (e) $\int \frac{(1+\sqrt{x})^9}{\sqrt{x}} dx$

    (f) $\int \frac{e^x+1}{e^x} dx$

(g) $\displaystyle\int_0^4 \frac{x}{\sqrt{1+2x}}dx$ (HINT: do the substitution $u = 1 + 2x$)

(h) $\displaystyle\int_1^{1/2} \frac{\sin^{-1} x}{\sqrt{1-x^2}}dx$

24. Find the area under the curve $y = \sqrt{x}$ above the x-axis between 0 and 4.

25. A particle moves in a straight line and has acceleration given by $a(t) = t^2 - t$. Its initial velocity is $v(0) = 2$ cm/s and its initial displacement is $s(0) = 1$ cm. Find the position function $s(t)$.

26. Find the vector function $\mathbf{r}(t)$ that gives the position of a particle at time t having the acceleration $\mathbf{a}(t) = 2t\mathbf{i} + \mathbf{j}$, initial velocity $\mathbf{v}(0) = \mathbf{i} - \mathbf{j}$, and initial position $(1, 0)$.