1. Given vectors $\vec{a} = \vec{\imath} - 2\vec{\jmath}$, $\vec{b} = < -2, 3 >$. Find

   (a) a unit vector $\vec{u}$ that has the same direction as $2\vec{b} + \vec{a}$.

   (b) angle between $\vec{a}$ and $\vec{b}$

   (c) $\text{comp}_{\vec{b}}\vec{a}$, $\text{proj}_{\vec{b}}\vec{a}$.

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 $\vec{r}(t) =< t, 25t - 5t^2 >$ 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. 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?

14. Find the quadratic approximation of $1/x$ for x near 4.

15. If $f(x) = x + x^2 + \mathrm{e}^x$ and $g(x) = f^{-1}(x)$, find $g'(1)$.

16. Solve the equation $\ln(x + 6) + \ln(x - 3) = \ln 5 + \ln 2$

17. Find $\cos^{-1}\left(\sin\dfrac{5\pi}{4}\right)$.

18. Evaluate each limit:

(a) $\lim_{x \to 0} \frac{\sin x + \sin 2x}{\sin 3x}$

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

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

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

20. 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?

21. 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.

22. A cylindrical can without a top is made to contain V cm^3 of liquid. Find the dimensions that will minimize the cost of the metal to make the can.

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

24. Evaluate the integral:

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

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

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

25. 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

26. 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.

27. 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 $s(t)$.

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