1. For the parametric curve \( x = t^3 + t, \ y = 1 + t + \sin t \), find \( \frac{dy}{dx} \) as a function of \( t \). Now find the equation of the line which is tangent to the curve at the point when \( t = 0 \).
(10) 2. Calculate the arc length of the curve

\[ x = \frac{1}{2} t^2, \quad y = \frac{1}{3} t^3, \quad 1 \leq t \leq 2. \]

(20) 3. A particle is moving in the plane according to the parametric equations

\[ x = t^2, \quad y = t^3 - 3t \] where \( t \) is the time. Find, as functions of \( t \),

a) position vector \( \vec{r}(t) = \)

b) velocity vector \( \vec{v}(t) = \)

c) acceleration vector \( \vec{a}(t) = \)

d) speed \( \frac{ds}{dt} = \)
4. An object is moving in the plane in such a way that its acceleration vector as a function of time $t$ is $\vec{a} = (\cos t) \vec{i} + 2\vec{j}$. Suppose we know that at time $t = 0$ the velocity vector is $\vec{v}(0) = \vec{j}$ and the position vector is $\vec{r}(0) = \vec{i} + \vec{j}$. Find the velocity vector and the position vector as functions of $t$. Now write the parametric equations of the motion.
5. Given the 3-dimensional vectors

\[ \vec{a} = 2\vec{i} - \vec{j} + 3\vec{k} \]
\[ \vec{b} = \vec{i} + \vec{j} - 2\vec{k} \]
\[ \vec{c} = 3\vec{i} + \vec{j} - 2\vec{k} \]

Find

a) the cosine of the angle between \( \vec{a} \) and \( \vec{b} \)

b) \( \vec{a} \times \vec{b} \)

c) the area of the parallelogram determined by \( \vec{a} \) and \( \vec{b} \)

d) the volume of the parallelepiped determined by \( \vec{a} \), \( \vec{b} \) and \( \vec{c} \).
(10) 6. Find the parametric equations for each of the following lines.

a) line through the points \((1, 3, 2)\) and \((2, 1, 4)\)

b) line through \((2, -1, 0)\) and perpendicular to the plane \(3x + 4y - 2z = 10\).
(10) 7. Find the equation for each of the following planes

a) plane containing \((3, 2, -1)\) and perpendicular to the line \(x = 1 - t, y = 1 + 4t, z = 3t\)

b) plane containing the points \((1, 0, 0), (2, 1, -1), (1, 2, 1)\)