Q. 1 (A) Attempt any Two of the following:

(i) Discuss the continuity of the following function at \( x = 1 \).

\[
f(x) = \begin{cases} 
\frac{1}{x-1} - \frac{3}{1-x^3 + \frac{7}{4}}, & \text{when } x < 1 \\
3 & \text{when } x = 1 \\
\frac{\log x}{x-1} - \frac{1}{4}, & \text{when } x > 1 
\end{cases}
\]

(ii) Evaluate:\n\[
\lim_{x \to 0} \frac{(4^x - 1)(1 - \cos 4x)}{3 \sin x - \sin 3x}
\]

(iii) If \( f(x) = \frac{\sqrt{3} - \tan x}{\pi - 3x} \)

\[
\text{when } x \neq \frac{\pi}{3}
\]

\[
= \frac{4}{3} \text{ when } x = \frac{\pi}{3}
\]

discuss the continuity of the function at \( x = \frac{\pi}{3} \).

(B) Attempt any One of the following:

(i) If \( f'(x) = 4x^3 - 3x^2 + 2x + k \), find \( f(x) \) given that \( f(0) = 1 \) and \( f(1) = 4 \).

(ii) Evaluate:\n\[
\int \frac{x^e - 1 + e^{x-1}}{x^e + e^x} \, dx
\]

Q. 2 (A) Attempt any Two of the following:

(i) Find the derivative of \( x \sin x \) with reference to \( x \) by first principle.

(ii) If \( (x^2 + y)^{17} = x^8 y^{13} \), prove that \( \frac{dy}{dx} = \frac{2y}{x} \).

(iii) A man of 2 metres height walks at a uniform speed of 6 km/hr away from a lamp post of 6 metres high. Find the rate at which the length of his shadow increases.

(B) Attempt any One of the following:

(i) Form the differential equation by eliminating the arbitrary constants from the equation \( y = a \cos (\log x) + b \sin (\log x) \).

(ii) Verify that \( y = ae^{-bx} \) is a solution of \( \frac{d^2y}{dx^2} = \frac{1}{y} \left( \frac{dy}{dx} \right)^2 \)

Q. 3 (A) (a) Attempt any One of the following:

(i) Evaluate:\n\[
\int \frac{\log x}{(1 + \log x)^2} \, dx
\]

(ii) Evaluate:\n\[
\int \frac{dx}{\cos x(2 + \sin x)}
\]

(b) Attempt any One of the following:

(i) Evaluate:\n\[
\int_0^x x^2 (3 - x)^{1/2} \, dx
\]

(ii) Find the volume of a cone of height 'h' and base radius 'r'.

(B) Attempt any One of the following:

(i) Find the Boolean function representing the following circuit:

Also find an equivalent circuit.
(ii) Construct the input-output table for the following Boolean function:
\[ f(x_1, x_2) = x_1 \cdot x_2 \]

Q. 4 (A) (a) Attempt any One of the following:
(i) Find the 7th term of a sequence 3, 9, 20, 38, 65, ….. using operators E and \( \Delta \).
(ii) Evaluate: \( \left( \frac{\Delta^3}{E^2} \right) (x^3) \)

(b) Attempt any One of the following:
(i) Solve the differential equation: \( \frac{dy}{dx} = \frac{y}{x} + \tan \left( \frac{y}{x} \right) \), using \( y = ux \).
(ii) The growth of a population is proportional to the number present. If the population of a colony doubles in 50 years, in how many years will the population become triple?

(B) Attempt any One of the following:
(i) If \( B \) is Boolean Algebra, then for any \( x \in B \) prove that, \( x + x = x \).
(ii) Write the Boolean expression for the following circuits:

(a) 

(b) 

Q. 5 (A) (a) Attempt any One of the following:
(i) If \( y \) is a differentiable function of \( u \) and \( u \) is a differentiable function of \( x \), then prove that,
\[
\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}.
\]
(ii) Prove that every differentiable function is continuous.

(b) Attempt any One of the following:
(i) If \( u \) and \( v \) are differentiable functions of \( x \), then prove that:
\[
\int uv \, dx = u \int v \, dx - \int \left[ \frac{du}{dx} \cdot \int v \, dx \right] \, dx.
\]
(ii) Prove that:
\[
\int_{-a}^{a} f(x) \, dx = \begin{cases} 
2 \int_{0}^{a} f(x) \, dx & \text{if } f(x) \text{ is even.} \\
0 & \text{if } f(x) \text{ is odd.}
\end{cases}
\]

(B) Attempt any One of the following:
(i) Find \( \frac{dy}{dx} \) if \( y = \sin^{-1} \left( \frac{2x}{1 + x^2} \right) \)
(ii) If \( y = \frac{(\tan x)^x}{1 + x^2} \), find \( \frac{dy}{dx} \).