Problem discussion :-

A full adder circuit is central to most digital circuits that perform addition or subtraction. It is called so because it adds together two binary digits, plus a carry-in digit to ~~provide~~ produce a sum and carry-out digit. Actually the full adder extends the concept of half-adder by providing an additional carry-in input.

Variable Identification :-

A full adder circuit provide three inputs where ~~two~~ two's are "A" and "B" and the other is carry-in or "Cin". This adder produces two outputs Sum ~~or~~ or "Sum" and carry-out or "Cout".

Truth Table :-

A	B	Cin	Sum	Cout
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Equation Simplification :-

Here, $Sum = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$

$= \bar{A}\bar{B}C_{in} + ABC_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in}$

$= C_{in}(\bar{A}\bar{B} + AB) + \bar{C}_{in}(\bar{A}B + A\bar{B})$

$= C_{in}(\overline{A \oplus B}) + \bar{C}_{in}(A \oplus B)$

$= C_{in}\bar{X} + \bar{C}_{in}X$ [Let, $A \oplus B = X$]

$= C_{in} \oplus X$

$= C_{in} \oplus (A \oplus B)$ [Adding the value of X]

Here, $C_{out} = \bar{A}BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in} + ABC_{in}$

$= C_{in}(\bar{A}B + A\bar{B}) + AB(\bar{C}_{in} + C_{in})$

$= (C_{in}(A \oplus B)) + AB$ [$\because \bar{A} + A = 1$]

Drawing the Full-Adder Circuit :-