ASSIGNMENT

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1 Question

(GATE CS-2021)
Q.7. Let p and q be two proportions. Consider the following two formulae in propositional logic.

$$\text{S1: } (\neg p \wedge (p \vee q)) \longrightarrow q$$
$$\text{S2: } q \longrightarrow (\neg p \wedge (p \vee q))$$

S1 and S2 in terms of boolean expression.
S1: $A'(A+B) \longrightarrow B = (A'(A+B))' + B$
S2: $q \longrightarrow p'(p+q) = q' + p'(p+q)$
Which one of the following choices is correct?

1) Both S1 and S2 are tautologies.
2) S1 is a tautology but S2 is not a tautology.
3) S1 is not a tautology but S2 is a tautology.
4) Neither S1 nor S2 is a tautology.

2 Components

Component	Values	Quantity
ArduinoUNO		1
JumperWires	M-M	10
Breadboard		1
LED		2
Resistor	220ohms	2

Figure.a

3 formulae

A tuatology is a compound statement in Maths which always results in Truth(True) value.
Tuatology formula:

$$p \longrightarrow q = \neg p \vee q$$

where:
$\neg$ = Not operation
$\wedge$ = and operation
$\vee$ = or opreation

a) Therefore the two propositional logics S1 and S2 formulae are:

S1: $(\neg p \wedge (p \vee q)) \longrightarrow q = \neg((\neg p \wedge (p \vee q))) \vee q$
S2: $q \longrightarrow (\neg p \wedge (p \vee q)) = \neg q \vee (\neg p \wedge (p \vee q))$

4 Truth table

TABLE I: Truth table for expression S1

p	q	$\neg((\neg p \wedge (p \vee q))) \vee q$
false	false	true
false	true	true
true	false	true
true	true	true

From the above truth table it is seen that all the outputs are true. Therefore the expression "S1 is a tuatology".

From the above truth table it is seen that one

TABLE II: Truth table for expression S2

p	q	$\neg q \vee (\neg p \wedge (p \vee q))$
false	false	true
false	true	true
true	false	true
true	true	false

of the output is false, to meet the tuatology

condition all the outputs must be true. Therefore the expression "S2 is not a tuatology".

5 Boolean epressions

Consider the propositional logic S1:
Assume the variables p and q as A and B(as there are two expressions with same variables we assume one of the expression with variables A and B).
Therefore the expression S1 becomes as
S1: $(\neg A \wedge (A \vee B)) \longrightarrow B = \neg((\neg A \wedge (A \vee B))) \vee B$
The boolean expression for the propositional expression can be written as:
S1: $A'(A+B) \longrightarrow B = (A'(A+B))' + B$ Consider

TABLE III: Logical Truth table for expression S1

A	B	(A'(A+B))'+B
0	0	1
0	1	1
1	0	1
1	1	1

the propositional logic S2:
S2: $q \longrightarrow (\neg p \wedge (p \vee q)) = \neg q \vee (\neg p \wedge (p \vee q))$ The boolean expression for the proportional expression can be written as
S2: $q \longrightarrow p'(p+q) = q' + p'(p+q)$

TABLE IV: Logical Truth table for expression S2

p	q	q'+p'(p+q)
0	0	1
0	1	1
1	0	1
1	1	0

6 Implementation

TABLE V: connections

Arduino pin	INPUT	OUTPUT
2	A	
3	B	
4	p	
5	q	
6		C
8		R

a) Procedure

1. Connect the circuit as per the above table.
2. Connect the Output pins C and R to the LED's.
3. Connect the other end of the LED's o the Ground terminal.
4. Connect inputs to Vcc for logic 1,ground for logic 0.
5. Execute the circuits using the below codes for S1 and S2.

https://github.com/BharathMorri/CS72021/blob/main/code/assignS1.asm

https://github.com/BharathMorri/CS72021/blob/main/code/assignS2.asm

6. Change the values of A,B,P,Q in the code and verify the Truth tables respectively.
Answer is : **Option2 : S1 is a tautology but S2 is not a tautology.**