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Math 290 - Group Assignment I
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2a.

P	Q	R	(P $\vee$ R)	(P $\wedge$ Q)	(P $\wedge$ R)	(P $\wedge$ (Q $\vee$ R))	(P $\wedge$ Q) $\vee$ (P $\wedge$ R)
F	F	F	F	F	F	F	F
F	F	T	T	F	F	F	F
F	T	F	T	F	F	F	F
F	T	T	T	F	F	F	F
T	F	F	F	F	F	F	F
T	F	T	T	F	T	T	T
T	T	F	T	T	F	T	T
T	T	T	T	T	T	T	T

2b. Not possible for this problem since the problem statement is the definition of the distributive property of and over or

2c. In order to show that P $\wedge$ (Q $\vee$ R) is equivalent to

(P $\wedge$ Q) $\vee$ (P $\wedge$ R) we must show two things.

(1) P $\wedge$ (Q $\vee$ R) then (P $\wedge$ Q) $\vee$ (P $\wedge$ R)
(2) (P $\wedge$ Q) $\vee$ (P $\wedge$ R) then P $\wedge$ (Q $\vee$ R)

(1) Suppose P $\wedge$ (Q $\vee$ R) is true. In this case we must also show that (P $\wedge$ Q) $\vee$ (P $\wedge$ R) is true. For (P $\wedge$ Q) $\vee$ (P $\wedge$ R) to be true either (P $\wedge$ Q) must be true OR (P $\wedge$ R) must be true. Since P $\wedge$ (Q $\vee$ R) is true, P must be true and either Q OR R must be true. Since P must be true and either Q OR R must be true, then it follows that at least (P $\wedge$ Q) is true OR (P $\wedge$ R) is true.

(2) assume (P $\wedge$ R) is true. If (P $\wedge$ R) is true then it must be the case that P AND R are both true. Since P AND R are both true, since P AND R must be true, then (Q $\vee$ R) must be true since R is true. and the statement P $\wedge$ (Q $\vee$ R) must also be true since P is also true. Therefore, P $\wedge$ (Q $\vee$ R) and (P $\wedge$ Q) $\vee$ (P $\wedge$ R) must be equivalent.

4a.

P	Q	R	$(Q \land R)$	$(P \implies R)$	$(P \implies Q)$	$(P \implies (Q \land R))$	$(P \implies Q) \land (P \implies R)$
F	F	F	F	F	F	F	F
F	F	T	T	F	F	F	F
F	T	F	T	F	F	F	F
F	T	T	T	F	F	F	F
T	F	F	F	F	F	F	F
T	F	T	T	F	T	T	T
T	T	F	T	T	F	T	T
T	T	T	T	T	T	T	T

4b $(P \implies (Q \land R)) \equiv$ (Implcation removal)
$\neg P \lor (Q \land R) \equiv$ (Distribute)
$(\neg P \lor Q) \land (\neg P \lor R) \equiv$ (Introduce implications)
$(P \implies Q) \land (P \implies R)$

4c In order to show that $(P \implies (Q \land R))$ is equivalent to $(P \implies Q) \land (P \implies R)$ we must show two things.

(1) $(P \implies (Q \land R))$ then $(P \implies Q) \land (P \implies R)$

(2) $(P \implies Q) \land (P \implies R)$ then $(P \implies (Q \land R))$

(1) Assume $(P \implies (Q \land R))$ is true since the statement is true it follows that Q AND R must both be true. This says nothing about P however, since Q AND R both must be true it is not possible for either $(P \implies Q)$ OR $(P \implies R)$ to ever be false since the only way for the implication to be false is if either Q OR R is also false. Since both $(P \implies Q)$ AND $(P \implies R)$ must be true it must be true when $(P \implies (Q \land R))$ is true.

(2) Assume $(P \implies Q) \land (P \implies R)$ is true. Which means P, Q AND R can be all false, OR Q AND R can be true. When P, Q, AND R are false. $(Q \land R)$ is false, which means since P is false $(P \implies (Q \land R))$ must be true. Which is consistent with $(P \implies Q) \land (P \implies R)$. When Q AND R are true, it is not possible for $(P \implies Q) \land (P \implies R)$ to ever be false since the implication can only evaluate to false when either Q OR R are false. Additionally, since Q AND R are both true, $(Q \land R)$ must also be true, forcing $(P \implies (Q \land R))$ to also always be true. Therefore, $(P \implies (Q \land R))$ must be equivalent to $(P \implies Q) \land (P \implies R)$