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Question One [10 Marks]

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A) Simplify the following statement form to an equivalent expression:

$\sim(p \vee \sim q) \vee (p \wedge q) \equiv q$

$\sim(p \vee \sim q) \vee (p \wedge q) \equiv (\sim p \wedge \sim(\sim q)) \vee (p \wedge q)$ De Morgan Law
 $\equiv (\sim p \wedge q) \vee (p \wedge q)$ Double Negation Law
 $\equiv (q \wedge \sim p) \vee (q \wedge p)$ Commutative Law (5)
 $\equiv q \wedge (\sim p \vee p)$ Distributive Law
 $\equiv q \wedge (p \vee \sim p)$ Commutative Law
 $\equiv q \wedge 1$ Universal Bound Law
 $\equiv q$ Identity Law

B) Verify the following logical equivalence by constructing a truth table and comparing the truth values of both expressions for all possible truth values of p, q, r

$p \rightarrow (q \rightarrow r) \equiv (p \wedge q) \rightarrow r$

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p	q	r	$p \rightarrow r$	$p \rightarrow (q \rightarrow r)$	$p \wedge q$	$(p \wedge q) \rightarrow r$
T	T	T	T	T	T	T
T	T	F	F	F	T	F
T	F	T	T	T	F	T
T	F	F	F	F	F	T
F	T	T	T	T	F	T
F	T	F	T	T	F	T
F	F	T	T	T	F	T
F	F	F	T	T	F	T

$p \rightarrow (p \rightarrow r)$ and $(p \wedge q) \rightarrow r$ have different truth value (in row 4) so, they are not logical equivalence

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Question Two [15 Marks]

A) Write the contrapositive, converse, inverse, and negation of each of the following statements:

a. If a figure is a square, then it has four equal sides and four right angles.

Inverse	If a figure is not a square, then it is not has four equal sides or not four right angles.
Converse	If a figure has four equal sides and four right angles, then it is square.
Contrapositive	If a figure is not has four equal sides and or not four right angles, then it is not square.
Negation	is a figure is a square and and it has not four equal sides and not four right angles.

b. If x is nonnegative, then x is positive or x is 0.

Inverse	If x is not nonnegative, then x is not positive and x is not 0.
Converse	If x is positive or x is 0, then x is nonnegative.
Contrapositive	If x is not positive and x is not 0, then x is not nonnegative.
Negation	is x is nonnegative or x is not positive and x is not 0.

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Birzeit University
 Computer Science Department
 Discrete Math (Comp 233)
 First Semester 2024/2025
 Quiz One

B) Formalize the following statements in propositional logic and use inference rules to determine if "the project will be completed on time."

- If the team meets daily, then the project will progress smoothly.
- If the project progresses smoothly, then any issues will be resolved quickly.
- If any issues are resolved quickly, then the project will be completed on time.
- The team is meeting daily.
- If the team does not meet daily, then additional resources will be needed.

x : team meets daily

y : the project will progress smoothly

z : any issues will be resolved quickly

w : the project will be completed on time

A : additional resources will be needed

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① $x \rightarrow y$
 $y \rightarrow z$
 $\therefore x \rightarrow z$
 by transitivity

② $x \rightarrow z$
 $z \rightarrow w$
 $\therefore x \rightarrow w$
 by transitivity

③ $x \rightarrow w$
 ~~x~~
 $\therefore w$
 by Modus ponens

④ w
 x
 $\therefore w \wedge x$
 by Conjunction

⑤ $\neg x \rightarrow A$
 ~~$\neg x$~~