

Name (5 points): _____ Section (5 points): _____

Section I: True / False questions (4 points each)

1. T Any valid argument with a false conclusion must have a false premise.
2. F Some wffs are both conjunctions and disjunctions.
3. F If a wff does not contain any parentheses, then it is atomic.
4. F Every denial is a negation.
5. F Every invalid argument has only one invalidating assignment.

Section II: Mark the correct completion (4 points each)

1. The conclusion of a valid argument ...
 - (a) _____ cannot be true unless all the premises are true.
 - (b) X cannot be false unless at least one of the premises is false.
 - (c) _____ cannot be false unless all the persimmons are false.
 - (d) _____ cannot be false unless all the premises are false.
 - (e) _____ cannot be true if all the premises are false.

2. The main connective of $(\sim ((R \vee Q) \rightarrow \sim S) \leftrightarrow (T \& \sim U))$ is ...
 - (a) _____ the wedge
 - (b) _____ the hedge
 - (c) _____ the arrow
 - (d) X the double-arrow
 - (e) _____ the ampersand

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3. $((P \leftrightarrow Q) \rightarrow \sim (R \& S)) \vee T$ is a ...
- (a) _____ biconditional
 - (b) _____ conditional
 - (c) _____ negation
 - (d) _____ conjunction
 - (e) X disjunction
4. $(P \rightarrow Q) \leftrightarrow \sim (R \vee T)$ is a ...
- (a) _____ conditional
 - (b) _____ biconditional
 - (c) _____ negation
 - (d) X not a WFF
 - (e) _____ disjunction
5. $(D \rightarrow (B \& \sim C))$ could be used as a translation of ...
- (a) _____ I can have my dessert and not eat my brussels sprouts if I complain.
 - (b) X I can have my dessert only if I eat my brussels sprouts and do not complain about it.
 - (c) _____ If I have my dessert and eat my brussels sprouts, then I have nothing to complain about.
 - (d) _____ I can not have my dessert if I eat my brussels sprouts and complain.
 - (e) _____ none of the above.

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Section III Translations (5 points each)

Using the provided translation schemes, construct a strictly correct translation that includes all parentheses.

1. If Argentina mobilizes, then Brazil will protest to the UN only if Chile calls for a meeting of all Latin American states.

A - Argentina mobilizes
B - Brazil protests to the UN
C - Chile calls for a meeting of all Latin American states

$$(A \rightarrow (B \rightarrow C))$$

2. Neither Bill nor Fred will attend if both Mary and Jane do not attend.

B - Bill attends
F - Fred attends
J - Jane attends
M - Mary attends

$$((\sim M \ \& \ \sim J) \rightarrow \sim (B \vee F))$$

or

$$((\sim M \ \& \ \sim J) \rightarrow (\sim B \ \& \ \sim F))$$

3. Nancy can not attend unless Bob attends, and Bob can attend only if he doesn't have to work.

B - Bob attends
N - Nancy attends
W - Bob has to work

$$((\sim N \vee B) \ \& \ (B \rightarrow \sim W))$$

or

$$((\sim B \rightarrow \sim N) \ \& \ (B \rightarrow \sim W))$$

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4. Rick will win the election if and only if he is the best candidate and outspends his opponent in advertising.

- B - Rick is the best candidate
- O - Rick outspends his opponent
- W - Rick wins the election

$$(W \leftrightarrow (B \ \& \ O))$$

Section IV Proofs (5 points each)

Give a proof for each of the following sequents. Unless otherwise indicated, use only the primitive rules, (that is, no derived rules).

1. $(Q \vee (R \ \& \ P)), (\sim R \vee (P \rightarrow S)), \sim Q \vdash (P \ \& \ S)$

1	(1)	$(Q \vee (R \ \& \ P))$	A
2	(2)	$(\sim R \vee (P \rightarrow S))$	A
3	(3)	$\sim Q$	A $\vdash (P \ \& \ S)$
1,3	(4)	$(R \ \& \ P)$	1,3 $\vee E$
1,3	(5)	R	4 $\& E$
1,3	(6)	P	4 $\& E$
1,2,3	(7)	$(P \rightarrow S)$	2,5 $\vee E$
1,2,3	(8)	S	6,7 $\rightarrow E$
1,2,3	(9)	$(P \ \& \ S)$	6,8 $\& I$

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2. $(Q \rightarrow \sim P), ((\sim P \vee R) \rightarrow \sim S) \vdash (S \rightarrow \sim Q)$

1	(1)	$(Q \rightarrow \sim P)$	A	
2	(2)	$((\sim P \vee R) \rightarrow \sim S)$	A	$\vdash (S \rightarrow \sim Q)$
3	(3)	S	A (for \rightarrow I)	
4	(4)	Q	A (for RAA)	
1,4	(5)	$\sim P$	1,4 \rightarrow E	
1,4	(6)	$\sim P \vee R$	5 vI	
1,2,4	(7)	$\sim S$	2, 6 \rightarrow E	
1,2,3	(8)	$\sim Q$	3,7 RAA (4)	
1,2	(9)	$(S \rightarrow \sim Q)$	8 \rightarrow I (3)	

3. $(Q \vee T), (T \rightarrow (P \& R)), ((P \vee Q) \rightarrow S) \vdash S$

(For this one you may use the derived rules if you wish)

1	(1)	$(Q \vee T)$	A	
2	(2)	$(T \rightarrow (P \& R))$	A	
3	(3)	$((P \vee Q) \rightarrow S)$	A	$\vdash S$
4	(4)	$\sim S$	A (for RAA)	
3,4	(5)	$\sim(P \vee Q)$	3,4 MTT	
3,4	(6)	$(\sim P \& \sim Q)$	5 DM	
3,4	(7)	$\sim Q$	6 &E	
1,3,4	(8)	T	1,7 vE	
1,2,3,4	(9)	$(P \& R)$	2,8 \rightarrow E	
1,2,3,4	(10)	P	9 &E	
3,4	(11)	$\sim P$	6 &E	
1,2,3	(12)	S	10, 11 RAA (4)	

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3. Is the following sequent valid? Provide an invalidating assignment if it is not.

$$(((A \rightarrow B) \rightarrow C) \rightarrow D), (D \rightarrow (C \rightarrow (B \rightarrow A))) \vdash (A \leftrightarrow D)$$

(((A	→	B)	→	C)	→	D),	(D	→	(C	→	(B	→	A)))	⊢	(A	↔	D)
T	T	T	F	F	T	F	F	T	F	T	T	T	T		T	F	F

This argument is invalid on the following invalidating assignment:

- A - T
- B - T
- C - F
- D - F