

## Quiz Section 2: Circuits and Predicate Logic

### Task 1 – Translate to English

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Translate these system specifications into English where  $F(p)$  is “Printer  $p$  is out of service”,  $B(p)$  is “Printer  $p$  is busy”,  $L(j)$  is “Print job  $j$  is lost,” and  $Q(j)$  is “Print job  $j$  is queued”. Let the domain be all printers and all print jobs.

a)  $\exists p (F(p) \wedge B(p)) \rightarrow \exists j L(j)$

b)  $(\forall j B(j)) \rightarrow (\exists p Q(p))$

c)  $\exists j (Q(j) \wedge L(j)) \rightarrow \exists p F(p)$

d)  $(\forall p B(p) \wedge \forall j Q(j)) \rightarrow \exists j L(j)$

### Task 2 – Equivalences

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Prove that each of the following pairs of propositional formulas are equivalent using the specified method(s).

a)  $(p \rightarrow \neg p) \wedge (\neg p \rightarrow p)$  vs. F

Use cozy at the following url (<https://tinyurl.com/CSE311S21a>) to complete the problem online.

b)  $\neg p \rightarrow (q \rightarrow r)$  vs.  $q \rightarrow (p \vee r)$  using (i) truth tables and (ii) propositional equivalences.

Use cozy at the following url (<https://tinyurl.com/CSE311S21b>) to complete the problem online.

### Task 3 – Non-equivalence

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Prove that the following pairs of propositional formulas are not equivalent using a truth table and specifying an input they differ on.

a)  $p \rightarrow r$  vs.  $r \rightarrow p$

**b)**  $a \rightarrow (b \wedge c)$  vs.  $(a \rightarrow b) \wedge c$

#### Task 4 – More Circuits

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**a)** Let  $Q$  be defined by  $Q(p, q) = (\neg p) \oplus q$ . Using only NOT, OR and  $Q$  gates express the logical expression  $(a \wedge b) \oplus c$ .

**b)** Draw a circuit that represents the logical expression from part a.

#### Task 5 – Boolean Algebra

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For each of the following parts, write the logical expression using boolean algebra operators. Then, simplify it using axioms and theorems of boolean algebra.

**a)**  $\neg p \vee (\neg q \vee (p \wedge q))$

**b)**  $\neg(p \vee (q \wedge p))$

## Task 6 – Canonical Forms

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Consider the boolean functions  $F(A, B, C)$  and  $G(A, B, C)$  specified by the following truth table:

$A$	$B$	$C$	$F(A, B, C)$	$G(A, B, C)$
1	1	1	1	1
1	1	0	1	1
1	0	1	0	1
1	0	0	0	0
0	1	1	1	1
0	1	0	1	0
0	0	1	0	1
0	0	0	1	0

- Write the DNF and CNF expressions for  $F(A, B, C)$ .
- Write the DNF and CNF expressions in boolean algebra for  $G(A, B, C)$ .
- Simplify your CNF form for  $G(A, B, C)$ .