

## CS251 homework 2

name: \_\_\_\_\_

Due: 10/15/19

1. last week we showed that nand  $\odot$  is a universal operator. That is, we can write all operators in terms of nand. Show that  $\rightarrow$  is a universal operator by writing  $\neg$ ,  $\wedge$ , and  $\vee$  with only  $\rightarrow$ .

2. Convert the following into CNF

(a)  $(c \wedge a) \vee (b \wedge c)$

(b)  $(a \wedge \neg a) \vee (b \wedge \neg b)$

(c)  $a \rightarrow (b \equiv c)$

(d)  $(a \rightarrow b) \wedge (b \rightarrow c)$

(e)  $\neg(a \vee b)$

(f)  $(a \equiv b) \equiv c$

3. Prove the following theorems using inference rules from lecture 3. After you're done proving these, check them with the proof checker from class.

<https://github.com/slibby05/proofs>

Put these proof in hw2.py file, and turn that in on D2L.

(a)  $a \vee b \vdash b \vee a$ :

(b)  $(a \vee b), \neg b \vdash a$ :

(c)  $\neg a \vee \neg b \vdash \neg(a \wedge b)$ :

(d) DL1:  $\neg(\neg a \vee \neg b) \vdash a$

(e)  $\neg(a \wedge b) \vdash \neg a \vee \neg b$ :

(Hint: you can use the previous problem, and a theorem from class.

$$\frac{\neg(\neg a \vee \neg b)}{a} DL1 \quad \frac{\neg(\neg a \vee \neg b)}{b} DL2 \quad \frac{\neg\neg a}{a} \neg\neg E$$