

## L2 practice problems

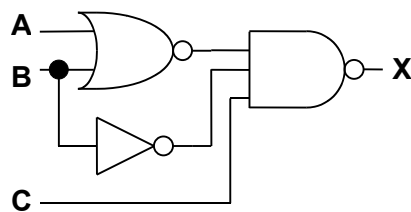
### Answers:

$$\begin{aligned}
 1. \quad x &= (M + N)(M' + P)(N' + P') \\
 &= (M + N)(M'N' + M'P' + PN' + PP') \\
 &= (M + N)(M'N' + M'P' + PN' + 0) \\
 &= (M + N)(M'N' + M'P' + PN') \\
 &= MM'N' + MM'P' + MPN' + NM'N' + NM'P' + NPN' \\
 &= 0 + 0 + MPN' + 0 + NM'P' + 0 \\
 &= MN'P + M'NP'
 \end{aligned}$$

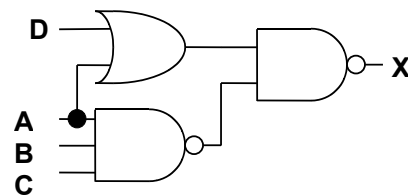
$$\begin{aligned}
 2. \quad z &= A'BC' + ABC' + BC'D \\
 &= BC'(A' + A + D) \\
 &= BC'(1 + D) \\
 &= BC'
 \end{aligned}$$

3. a)  $(A'BC')' = A'' + B' + C'' = A + B' + C$
- (b)  $(A' + B'C)' = A''(B'C)' = A(B'' + C') = A(B + C')$
- (c)  $(ABC'D)' = A' + B' + C + D'$
- (d)  $(A + B')' = A'B$
- (e)  $(A'B')' = A + B$
- (f)  $(A' + C' + D')' = ACD$
- (g)  $[A(B + C')'D]' = A' + (B + C')'' + D' = A' + B + C' + D'$
- (h)  $[(M + N')(M' + N)]' = (M + N')' + (M' + N)' = M'N + MN'$
- (i)  $\{[(AB)'C]'D\}' = [(AB)'C]'' + D' = (AB)'C + D' = (A' + B')C + D'$

4. Note that this question does not restrict to NAND or NOR only:

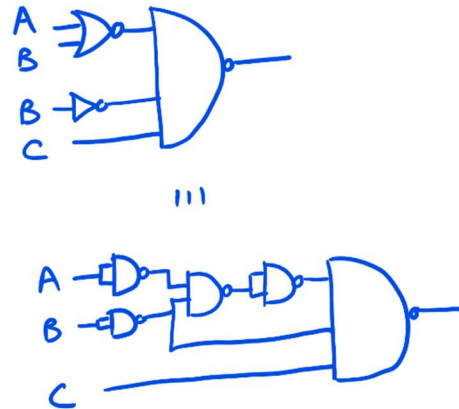


$$X = [(A+B)'(B'C)]'$$



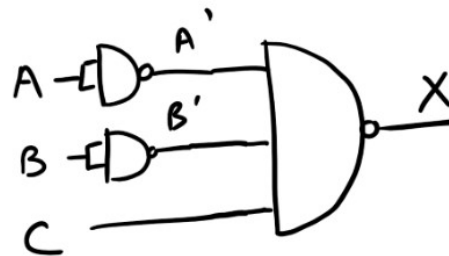
$$X = [(ABC)'(A+D)]'$$

If 4(a) must use only NAND:



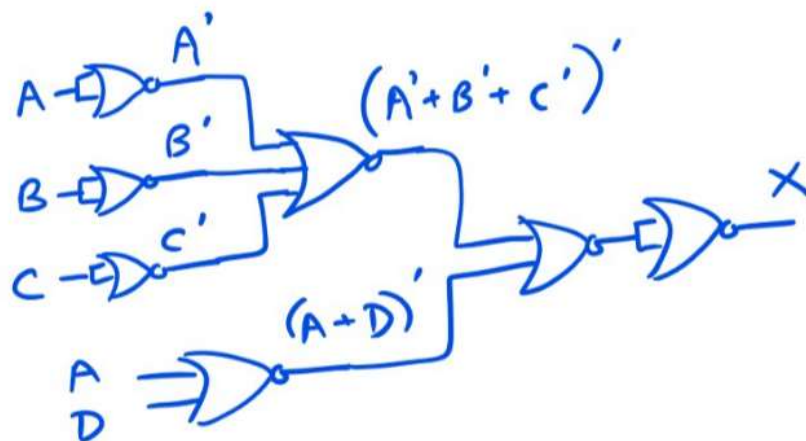
Alternatively

$$X = [(A+B)'(B'C)]' = [(A')(B')(B'C)]' = (A'B'C)'$$



If 4(b) must use only NOR:

$$X = [(ABC)'(A+D)]' = [(A'+B'+C')(A+D)]' = [(A'+B'+C')' + (A+D)]''$$



Other ways of drawing may also be acceptable.