C 3 (0	1 h	w 7	7PVL	7PVQ
(.	P	Q	P=> Q	7(0=>

		. 0	
P	Q	P => Q	7Q=>7P
talse	false	true	the
false	true	true	true
true	false	fortse	false
true	true	true	true

70=7P= QV7P=7PVQ 1. P=>Q=7Q=>7p.

Thus, P= 12 and 70 => 7P are equivalent.

P	Q	P=>-1Q	((2019/12/1/(2))
false	false	false	false
false	true	true	tme
true	false	true	true
true	tru	talre	falle

PE77Q=(P⇒7Q)∧(7Q⇒P) = (7PV7Q)∧(QVP)

Thus, PE>70 and ((PA70)V(7PA0)) are equivalent.

2.

		smolee VI Tire
Smoke	Fire	(Smole => Fine) => (75 moke => 7 Fine)
false		true
false	true	folse
true	false	true
true	true	true

Thus, (Smoke => fire) => (7 Smoke => 7 Fire) is satisfiable.

Sproke	Fine	Heat	(Smoke ⇒ Fire) ⇒ ((Smoke VHeat) => fire)	Smoke > Fine	(Smile V Heat) => Fine
fulse	fulse	false	true	true	true
false	false	true	false	true	false
fulre	frue	false	true	true	true
false	true	true	true	true	true
true	false	false	trne	false	false
true	false	true	true	false	false
true	+me	false	true	true	trne
true	true	true	true	true	true

Thus, (smoke) Five) => (15 moleev Heat) => Five) is satisfiable.

Snoke	Heat	Fire	(Smake Alteat) > Fire	Smolei 7) Tire	Heat=Fire	((Smake 1 Heat) > fire ((Smake > five) V (Heat > fire))
talse	false	false	frue	true	true	true
false	false	true	true	truc	true	true
false	true	false	true	true	false	true
false	true	true	true	true	true	true
true	false	-Palse	true	false	true	true
true	false	true	true	true	true	true
true	true	false	false	false	false	true
true	true	true	true	true	true	trne

Thus, (15 moke 1 Heat) => Fine) => (15 moke => Fine) V (Heat => Fine)) is valid

3. (a)

(knowledge base)

7 Mythical => (7 Immortal A Mammal)

(Immortal V Mammal)=> Horned

Horned => Magical

Mythical the unicorn is mythical.

Immortal the unicorn is immortal.

Mammal the unicorn is mammal.

Horned the unicorn is horned.

Magical the unicorn is magical.

- (b) Clauses of knowledge base (KB):
 - 1. 7 Mythical V Immortal
 - 2. Mythical V 7 Immortal
 - 3. Mythical V Mammal
 - 4. 7 mmortal VHorned
 - J. 7 Manual V Horned
 - 6. THorned V Magical

7 Mythiad => (7 Immortal / Mammal)

= Mythical V (7 Immortal 1 Mammal)

= (Mythical V7 Immortal) (Mythical V Mammal)

(Immortal V Mahmad) => Horned

- = 7 (Immortal V Mammal) V Horned
- = (7/mmortal 17 Manunal) V Hornel
- = (71mmortal VHorned) A 17Mammal VHorned)

(NF of knowledge base:

(7Mythical V Immortal) 1 (Mythical V 7 Immortal) 1 (Mythical V Mammal) 1

[7Immortal V Horned) 1 (7 Mammal V Horned) 1 (7 Horned V Magical)

```
(x: Mythical)
   1° clause of 7x:
(c) 7. 7 Mythical
     Applying the resolution rule to the clauses, ne get
     8. 71 mmortal I from 2,7)
     9. Mammal I from 3,7)
     10. Horned (from 5,9)
                                     :. There's no contradiction anywhere.
     11. Magical I from 6,10)
    .. We cannot use the knowledge base to prove that the unicorn is mythical
  2 clause of 7/3 (B: Magical)
     12. 7 Magical Applying the resolution rule to the clauses, we get 13. 7 Horned (from 6,12)
     14. 7 Manual (from 5, 13)
     11. 7 mmortal (from 4,13)
     16. 7 Mythical (from 1,15)
     17. Mythical (from 3, 14)
     18. Empty clause I from 16,17)
                                          1. KBFB
    Therefore, we can use the knowledge barse to prove that the unicorn is magical
 3° clause of 78: (8: Horned)
    19. 7 Horned
     Applying the resolution rule to the clauser, we get
    20. 7 Mammal (from 5, 19)
    21. 7 Immortal (from 4, 19)
    22. 7 Mythical (from 1,21)
    23. Mythical (from ), 20)
    24. Empty clause (from 22,23)
                                           - KB = X
   Therefore, we can use the knowledge base to prove that the unicorn is horned
4. Figure 1:
  Figure 1 is decomposable because the subcircuits feeding into an and-gate share
  no variables for all and-gates in Figure 1.
  Figure 1 is not smooth because we can look at the second or-gate from left to
  right on the lower level; it's left input contains variable c, but it's right input
  Lowtains variable cand d. Since this or-gate's input variables are not the same, Figure 1
  is not smooth
  Figure 1 is not deterministic because a counter example would be we assign A=true,
  B= false , C= true, D= false, and in this care both inputs for the or-gate at the
 root node would be high.
```

Figure 2 is <u>decomposable</u> because the subcircuits feeding into an and-gate share no variables for all and-gates in Figure 2.

Figure 2 is <u>smooth</u> because the substituits feeding into an or-gate contain the same variables for all or-gates in Figure 2.

Figure 2 is not deterministic became a counterexample would be the third or gate from left to right on the lower level; both of this or gate's inputs are TAAB, if we set A=false and B= true, then (7AAB) will evaluate to true, and this or-gate will have two high inputs.

7	la)

A	B	17813)	(7 B ^ A)	(7A N B) V (7 BNA)
false	false	folse	false	folse
fortse	true	true	false	true
true	false	fatre	true	true
true	true	false	falre	false

 $W(7A,B) = W(7A)W(B) = 0.8 \times 6.4 = 0.32$ $W(A,7B) = W(A)W(7B) = 0.2 \times 0.6 = 0.12$ W(7A,B) + W(A,7B) = 0.32 + 0.12 = 0.44

16). For the decomposable, deterministic and smooth NNF circuit in Figure 3, the count on the root is the same as the Weighted Model Count for the formula.

The count on the root is 0.8x0.4+0.6x0.2=0.44 = W(7A,B)+W(A,7B)=0.44

0.8 0.4 0.6 0.2

(c)
$$(W(7A,B)+W(7B,A))\times(W(C,D)+W(7D,7C))+(W(7A,7B)+W(B,A))\times(W(C,7D)+W(D,7C))$$

= $(0.8\times0.4+0.6\times0.2)\times(0.6\times0.8+0.2\times0.4)+(0.8\times0.6+0.4\times0.2)\times(0.6\times0.2+0.8\times0.4)$
= $0.44\times0.56+0.56\times0.44$