UNIT 5 Part 2
PREDICATE SYMBOLIZATION:
COMPLEX PARTICULAR TERMS AND IDENTITY

5.11 E1 Let's try a few:

a^0: Tom b^0: Ontario c^0: Mary d^0: 3 e^0: 4 f: Sarah

a^1: the square of *a*. b^1: the capital city of *a*. c^1: the father of *a*.

a^2: the product of *a* and *b* b^2: the oldest child of *a* and *b* c^2: the sum of *a* and *b*

a^3: the sum of *a* and *b* and *c*

Symbolize the following noun phrases using operation letters:

a) the capital city of Ontario
b(b)

b) the father of Tom
c(a)

c) Mary's father.
c(c)

d) 4 squared
a(e)

e) the product of 3 and 4.
a(de)

f) the oldest child of Tom and Mary.
b(ac)

g) the oldest child of Tom's father and Mary.
b(c(a)c)

h) the sum of 3 and 4.
c(de)

i) the sum of 4 and 3 and 3
a(edd)

j) the sum of the square of 3 and the square of four.
c(a(d)a(e))

k) the oldest child of Mary's father and Sarah and Tom's oldest child.
b(c(c)b(fa))

l) the sum of the square of three, the sum of three and four, and four.
a(a(d)c(de)e)

m) the sum of three squared, four squared and the square of the sum of three and four
a(a(d)a(e)a(c(de)))

5.11 E2 Symbolize the following sentences using operation letters:

F^1: *a* is a person. G^2: *a* is the spouse of *b*. L^2: *a* loves *b.* M^2: *a* is less than *b*

a^0: Tom b^0: Sarah c^0: Mary d^0: 3 e^0: 4

a^1: the square of *a* b^1: the father of *a* c^2: the product of *a* and *b*

d^2: the oldest child of *a* and *b* e^2: the sum of *a* and *b* f^3: the sum of *a* and *b* and *c*

a) Mary's father is Sarah's spouse.
ST1=b(c) ST2 =b (Sarah)
G(st1 st2)
G(b(c)b)

b) Sarah loves Tom's father.
L(bb(a))

c) Mary's spouse is the oldest child of Tom and Sarah.
G(d(ab)c) d(ab)

d) The sum of three squared and four squared is less than the square of the sum of three and four. ST1: a(d) ST2: a(e) ST3: a(e(de))
M(e(ST1 ST2) ST3)
M(e(a(d)a(e)) a(e(de)))

e) The product of three and four is not less than the sum of three plus four.
ST1: c(de) ST2: e(de)
~M(c(de)e(de))

f) Tom and Mary's oldest child has no spouse.
ST1: d(ac)
~∃xG(xST1)
~∃xG(xd(ac))

g) Not everybody loves Mary's father.
ST1: b(c)
~∀x(Fx → L(xb(c)))

h) No spouse of Sarah is the father of Mary.
ST1:b ST2:b(c)
~G(bb(c))

i) Anything less than the sum of 4 plus 4 is less than the square of 3.
∀x(M(xe(ee)) → M(xa(d)))

j) Mary's father is not the spouse of the spouse of Sarah's father.
~∃x(G(b(c)x) ∧ G(xb(b)))

5.14 EG 1 Let's try a few examples:

a) Adam's sister's husband doesn't own a car.

b) Any friend of Adam is a friend of Adam's sister.

c) Adam's sister's husband is Daniella's husband's brother.

d) Adam introduces all of his friends to his sister, but his sister doesn't introduce some of her friends to him.

C^1: *a* is a car	F^2: *a* is a friend of *b*.	O^2: *a* owns *b*	I^3: *a* introduces *b* to *c*.
a^1: Adam	d^1: Daniella	b^1: *a*'s brother	
c^1: *a*'s sister	h^1: *a*'s husband.	e^2: the person sitting between *a* and *b*.	

a) Adam's sister's husband doesn't own a car.

Step 1: Find all the primary singular terms in the sentence, abbreviate and symbolize them: .

ST1: Adam's sister's husband. h(c(a))

Step 2: Paraphrase the sentence using the abbreviations

ST1 doesn't own a car. (There is no car that ST1 owns.)

Step 3: Sketch your symbolization of step 2.

$\sim\exists x(Cx \wedge O(\underset{ST1}{\_\_}\ x))$

Step 4: Put the results of step 3 together with the results of step 1.

$\sim\exists x(Cx \wedge O(h(c(a))x))$

b) Any friend of Adam is a friend of Adam's sister.

Step 1: Find all the primary singular terms in the sentence, abbreviate and symbolize them: .

ST1=Adam a ST2=Adam's sister. c(a)

Step 2: Paraphrase the sentence using the abbreviations

For all x, if x is a friend of ST1 then x is a friend of ST2.

Step 3: Sketch your symbolization of step 2.

$\forall x(F(x\ \underset{ST1}{\_\_\_}) \rightarrow F(x\ \underset{ST2}{\_\_\_}))$

Step 4: Put the results of step 3 together with the results of step 4.

$\forall x(F(xa) \rightarrow F(xc(a))$

c) Adam's sister's husband is Daniella's husband's brother.

Step 1: Find all the primary singular terms in the sentence, abbreviate and symbolize them: .

ST1 = Adam's sister's husband $h(c(a))$ ST2= Daniella's husband's brother. $b(h(d))$

Step 2: Paraphrase the sentence using the abbreviations

ST1 is ST2.

Step 3: Sketch your symbolization of step 2.

$$\underset{ST1}{\underline{\quad}} = \underset{ST2}{\underline{\quad}}$$

Step 4: Put the results of step 3 together with the results of step 1.

$h(c(a)) = b(h(d))$

d) Adam introduces all of his friends to his sister, but his sister doesn't introduce some of her friends to him.

Step 1: Find all the primary singular terms in the sentence, abbreviate and symbolize them: .

ST1=Adam a ST2=Adam's sister. $c(a)$

Step 2: Paraphrase the sentence using the abbreviations

For all x, if x is a friend of ST1 then ST1 introduces x to ST2, <u>and</u> there is some y such that y is a friend of ST2 and it is not the case that ST2 introduces y to ST1.

Step 3: Sketch your symbolization of step 2.

$$\forall x(F(x \underset{ST1}{\underline{\quad}}) \rightarrow I(\underset{ST1}{\underline{\quad}} x \underset{ST2}{\underline{\quad}})) \;\wedge\; \exists y(F(y \underset{ST2}{\underline{\quad}}) \wedge {\sim}I(\underset{ST2}{\underline{\quad}} y \underset{ST1}{\underline{\quad}})$$

Step 4: Put the results of step 3 together with the results of step 4.

$\forall x(F(xa) \rightarrow I(axc(a))) \wedge \exists y(F(yc(a)) \wedge {\sim}I(c(a)ya))$

5.14 E1 Symbolize:

A^2:	a is taller than b.	B^1:	a is a baseball player.	D^2:	a is a daughter of b.
E^2:	a is a son of b.	F^1:	a is a person	G^1:	a is a physician
H^1:	a is a marine biologist.	L^2:	a is a brother of b.	L^1:	a lives in town.
M^2:	a is married to b.	O^2:	a is older than b.		
a^1:	the boss of a.	b^1:	the ex-husband of a.	a^0:	Adam.
b^0:	Bryan.	c^0:	Carrie	d^0:	Doreen.

a) Bryan is Carrie's son.

$E(bc)$

b) None of Adam's sons are baseball players, but some of his daughters are.

$\sim\exists x(E(xa) \wedge Bx) \wedge \exists y\exists z(y \neq z \wedge D(ya) \wedge D(za) \wedge By \wedge Bz)$

(If we interpret 'some of his daughters' to be at least two, we need to use inequality.)

c) Bryan is Carrie's only son.

$\forall x(E(xc) \leftrightarrow x{=}b)$

d) Adam is the only person in town taller than Bryan.

$\forall x(Fx \wedge Lx \wedge A(xb) \leftrightarrow x{=}a)$ OR $Fa \wedge La \wedge A(ab) \wedge \forall x(Fx \wedge Lx \wedge A(xb) \rightarrow x{=}a)$

e) Adam's boss's ex-husband is married to Doreen's ex-husband's boss.

$M(b(a(a))a(b(d)))$

f) Adam is Carrie's ex-husband's boss's ex-husband.

$a{=}b(a(b(c)))$

g) Carrie is not Adam's boss's ex-husband's boss.

$\sim c{=}\ a(b(a(a)))$

h) Doreen's only daughter is a physician.

$\exists x(\forall y(D(yd) \leftrightarrow y{=}x) \wedge Gx)$

i) Although Carrie and Bryan have at least one son together, Carrie is married to somebody else.

$\exists x(E(xc) \wedge E(xb)) \wedge \exists y(y{\neq}b \wedge M(cy))$

j) All of Carrie's sons and daughters live in town.

$\forall x(D(xc) \vee E(xc) \rightarrow Lx)$

k) Doreen's ex-husband is married to Carrie only if Doreen is married to one of Carrie's brothers.

$M(b(d)c) \rightarrow \exists x(L(xc) \wedge M(dx))$

l) Bryan's sons and Adam's daughters are baseball players.

$\forall x(E(xb) \vee D(xa) \rightarrow Bx)$

m) Carrie is married to Adam's only son.

$\exists x(\forall y(E(ya)\leftrightarrow x=y) \wedge M(cx))$

n) There is only one physician in town other than Bryan.

$\exists x\forall y(Gy \wedge Ly \wedge y\neq b \leftrightarrow x=y) \wedge Gb \wedge Lb$

o) Carrie and Adam have one son

$\exists x\forall y(E(yc) \wedge E(ya) \leftrightarrow x=y)$

p) Carrie and Adam each have exactly one son.

$\exists x\forall y(E(yc) \leftrightarrow x=y) \wedge \exists x\forall y(E(ya) \leftrightarrow x=y)$

q) Carrie's ex-husband is married to Doreen.

$M(b(c)d)$

r) Carrie's boss's ex-husband is the person who is married to Bryan's boss.

$\forall y(M(ya(b)) \leftrightarrow b(a(c))=y)$

s) Just one of Doreen's daughters is a physician.

$\exists x\forall y(D(yd) \wedge Gy \leftrightarrow x=y)$

t) The physician who lives in town is also a marine biologist.

$\exists x(\forall y(Gy \wedge Ly) \leftrightarrow x=y) \wedge Hx)$

u) Bryan's daughter is a baseball player.

$\exists x(\forall y(D(yb) \leftrightarrow x=y) \wedge Bx)$

v) Adam's son has one son.

$\exists x(\forall y(E(ya) \leftrightarrow x=y) \wedge \exists w\forall z(E(zx) \leftrightarrow w=z))$

w) One of Adam's sons is a baseball player, but none of his other children are.

$\exists x(\forall y(E(ya) \wedge By \leftrightarrow x=y) \wedge \forall z(E(za) \wedge z\neq x \rightarrow {\sim}Bz))$

x) The oldest person in town is not married to anybody. NOTE: the oldest person in town is the person in town who is older than everyone else in town.

$\exists x(Fx \wedge Lx \wedge \forall y(x\neq y \wedge Fy \wedge Ly \rightarrow O(xy)) \wedge {\sim}\exists z(Fz \wedge M(xz)))$

y) The only marine biologist in town is married to one of Doreen's sons.

$\exists x(\forall y(Hy \wedge Ly \leftrightarrow x=y) \wedge \exists z(E(zd) \wedge M(xz)))$