SOLUTION of 3:

3.1

a) Angry(I) ⟹ ∀x(¬MakesHappy(x,I)⟺¬Cake(x))

b) ∀x(WentToParty(x)⟺x≠I)

c) ∀x(¬AllowedOnFloor(x)⟺(¬Manager(x)∨¬SeniorResearcher(x)))

If an object x is an exception to a property P, this means that being x is equivalent to not enjoying property P, or that not being x is equivalent to enjoying property P.

Modelling a sentence like this:

Angry(I) ⟹ ∀x(¬MakesHappy(x,I)⟹¬Cake(x)), with a simple conditional instead of a double conditional is a mistake, because the formula has models where there is something which is not a cake and yet it makes me happy.

3.2

If I catch the train, then either I'm on time or the train is late.

CT ⟹ (OT ∨TL) (hyp 1)

If I wake up late, I must run to be on time.

WL ⟹(OT⟹R) (hyp 2) (running is necessary for being on time, if I wake up late)

I'm out of shape

OS (hyp 3)

which [being out of shape] means that if I run I end up heavy breathing

OS ⟺ (R⟹HB) (hyp 4)

Today the train was on time, while I woke up late, but I managed to catch it.

¬TL ∧ WL ∧CT (hyp 5)

That's why I'm heavy breathing.

HB (thesis)

Proof:

OS ⟹ (R⟹HB) (6: from 4 with ⟺-elim and ∧-elim)

R⟹HB (7: from 3 and 6 with MP)

WL (8: from 5 with ∧-elim)

OT⟹R (9: from 2 and 8 with MP)

CT (10: from 5 with ∧-elim)

OT ∨TL (11: from 1 and 10 with MP)

¬TL (12: from 5 with ∧-elim)

OT (13: from 11 and 12 with resolution)

R (14: from 9 and 13 with MP)

HB (thesis: from 7 and 14 with MP).