This exam consists of four exercises. The available points for each item are written in the margin. You need at least 50 points to pass.

Explain your answers!

$\boxed{1}$ Consider the formula φ^{UF}

$$F(F(x_1)) = G(x_1, F(x_2)) \wedge F(F(x_2)) \neq G(F(x_1), F(x_2)) \wedge G(x_1, x_2) = F(x_2)$$

in equality logic with uninterpreted functions.

[10] (a) Use Ackermann's reduction to transform φ^{UF} into an equivalent equality logic formula.

[10] (b) Use Bryant's reduction to transform φ^{UF} into an equivalent equality logic formula.

$\boxed{2}$ Consider the following equality logic formula φ^{E}:

$$a = b \wedge a \neq c \wedge (a \neq d \vee e = f \vee g = h) \wedge$$
$$g = i \wedge h = j \wedge (b = c \vee g \neq i \vee i = j)$$

[5] (a) Compute the equality graph of φ^{E} and list its contradictory cycles.

[5] (b) Compute the propositional skeletion of φ^{E}.

[5] (c) Compute a nonpolar chordal equality graph for φ^{E}.

[5] (d) Transform φ^{E} into an equisatisfiable propositional formula.

[10] (e) Compute an adequate domain for φ^{E} whose state space is smaller than 10!

3 Consider the following linear system S over the reals:

$$\begin{array}{rcrcrcr} 2x_1 & + & 2x_2 & + & 2x_3 & \leqslant & 2 \\ 4x_1 & - & 2x_2 & - & x_3 & \leqslant & -3 \\ x_1 & + & x_2 & & & \geqslant & 1 \end{array}$$

[10] (a) Use the generalized simplex method to find a solution for S.

[10] (b) Use Fourier-Motzkin variable elimination to find a solution for S.

[10] (c) Does S admit any integer solutions?

[20] 4 Group the following concepts in seven categories of four related concepts.

left-infinite projection — propositional skeleton — Fourier-Motzkin

Bryant's reduction — symmetric modulo — branch-and-bound

non-chronologic backtracking — Gomory — domain allocation

small-model property — relaxed problem — implication graph

uninterpreted function — Omega test — divisibility predicate

functional consistency — Danzig — Ackermann's reduction

VSIDS — quantifier elimination — Cooper — real shadow

pivot operation — equality graph — cutting planes

resolution graph — simplex method — Pugh