CS 353 Spring 2024
Homework 5
Due: April 16, Tuesday till midnight
You will use the Moodle course page for submission of this assignment

Q.1 [10 pts] Consider the following instance of relation R(A, B, C, D, E):

A	B	C	D	E
a1	b1	c1	d1	e1
a2	b2	c2	d2	e2
a3	b3	c2	d1	e1
a4	b2	c1	d1	e1
a1	b1	c3	d1	e1

Which of the following functional dependencies are **violated** by this instance?

(a) A → B
(b) AB → C
(c) CD → A
(d) BC → D
(e) C → DE
(f) DE → A
(g) ADE → B
(h) ADE → C

Q.2 [14 pts] Given a relation R (A, B, C, D) with the following functional dependencies:
{ A → BC, B → D, C → D }

(a) [3 pts] Determine if A → D holds on R.
(b) [3 pts] Determine if C → B holds on R.
(c) [8 pts] Determine if R in BCNF. If not, decompose it into BCNF relations using the BCNF decomposition algorithm.

Q.3 [20 pts, 10 pts each] Given a relation R(A, B, C, D) with the following functional dependencies:
{ A → B, C → A, BC → D}

(a) Is the decomposition of R into R1(A, B, C) and R2(C, D) lossless? Explain why or why not. If it is not lossless, show this through an example instance of R.

(b) Is the decomposition of R into R1(A, B) and R2(B, C, D) lossless? Explain why or why not. If it is not lossless, show this through an example instance of R.

Q.4 [36 pts] Given a relation R(A, B, C, D, E, F) and its functional dependencies:

{ A → BC, AD → F, AF → E }

(a) [4 pts] Show that R in not in BCNF.

(b) [8 pts] Decompose R into BCNF relations using the BCNF decomposition algorithm.

(c) [6 pts] Find the candidate key(s) of R.

(d) [4 pts] Show that R in not in 3NF.

(e) [6 pts] Find the canonical cover of the given functional dependency set.

(f) [8 pts] Decompose R into 3NF relations using the lossless and dependency preserving 3NF decomposition algorithm which makes use of the canonical cover.

Q.5 [20 pts] Given a relation R(A, B, C, D, E) and its functional dependencies:

A → B, B → E,

and multivalued dependencies:

A $\twoheadrightarrow$ C, A $\twoheadrightarrow$ D.

Check if R is in 4NF. If not, decompose it into 4NF relations.