Department of Computer Science and Engineering
Indian Institute of Technology Patna

Course Name: Database
MidSem Paper

Course Code: CS354
Autumn 2020

Full Marks: 50+50

Answer all the questions. You may answer the questions in any order. However, all parts of the same question must be answered together. Clearly state any reasonable assumptions you make.

1. Consider the following functional dependency (FD) sets-
   $F : \{A \to C, AC \to D, E \to AD, E \to H\}$
   $G : \{A \to CD, E \to AH\}$

   (a) What is $\{E\}^+$ w.r.t FD F?
      i. $\{E\}$
      ii. $\{A, D, E, H\}$
      iii. $\{A, C, D, E, H\}$
      iv. none of the above

      Justify your answer

   (b) Which of the following(s) is/are true?
      i. A is an extra attribute in $AC \to D$ of FD set F
      ii. C is an extra attribute in $AC \to D$ of FD set F
      iii. C is an extra attribute in $A \to CD$ of FD set G
      iv. none of the above

      Justify your answer

   (c) Which of the following(s) is/are true?
      i. F is equivalent to G
      ii. F is not equivalent to G
      iii. only G can be derived from F
      iv. none of the above

      Justify your answer

   $3 \times 5 = 15$ **Marks**

2. Information about a collection of students is given using the relation **studInfo**(*studId*, *name*, *sex*, *height*). The relation **enroll**(*studId*, *courseId*) gives which student has enrolled for what course(s). Assume underlined attributes are key attributes and every course is taken by atleast one male and one female student.

   (a) What the following relational algebra expression will return?
      $t1 \leftarrow \pi_{studId,height}(\sigma_{sex='girl'}(studInfo))$
      $\pi_{studId}(t1) - \pi_{studId}(\sigma_{t1.height<d.height}(t1 \times \rho_d(t1)))$
      i. Lists the Id(s) of the girl student(s) with lowest height
      ii. Lists the Id(s) of the girl student(s) with highest height
      iii. Lists the Id(s) of the non-girl student(s) with highest height
      iv. not a correct a relational algebra expression

Give brief justification

(b) Consider the following relational algebra expressions. Which of them will return the list of courses taken by all male students?

- **I:** $\pi_{enroll.courseId}(\sigma_{sex='male'}(enroll \bowtie studInfo))$
- **II:** $enroll \div \pi_{studId}(\sigma_{sex='male'}(studInfo))$

i. Only I

ii. Only II

iii. Both I and II

iv. None of them

Justify your answer

$2 \times 5 = 10$ **Marks**

3. Let $R = (A, B)$ and $S = (A, C)$, and let $r(R)$ and $s(S)$ be relations.

(a) Consider the following expressions (I), (II) and (III). Which of them is/are true?

- **I:** $\pi_A(\sigma_{B=17}(r))$
- **II:** $\{t \mid \exists u \in r(u[B] = 17 \wedge t[A] = u[A])\}$
- **III:** $\{< a > \mid \exists b(< a, b > \in r \wedge b = 17)\}$

i. I & II are equivalent only

ii. II & III are equivalent only

iii. I, II & III are equivalent

iv. none of the above

Justify your answer

(b) Consider the following expressions (I), (II) and (III). Which of them is/are true?

- **I:** $\{< a, b, c > \mid (< a, b > \in r \wedge < a, c > \in s)\}$
- **II:** $\{t \mid \exists u \in r, \exists v \in s(u[A] = v[A] \wedge t[A] = u[A] \wedge t[B] = u[B] \wedge t[C] = v[C])\}$
- **III:** $\sigma_{r.A=s.A}(r \times s)$

i. I & II are equivalent only

ii. II & III are equivalent only

iii. I, II & III are equivalent

iv. none of the above

Justify your answer

$2 \times 5 = 10$ **Marks**

4. Consider the following instance of relation r.

A	B	C
a_1	b_1	c_1
a_1	b_1	c_2
a_1	b_2	c_1
a_2	b_3	c_3

(a) What would be a possible candidate key for this relation r?

i. AB

ii. BC

iii. AC

iv. none of the above

Justify your answer

(b) Is this relation in
    i. 2NF
    ii. 3NF
    iii. BCNF
    iv. none of the above

    Justify your answer

(c) Let's consider two decomposed components AC and BC. The decompositions are
    i. lossless
    ii. lossy
    iii. dependency preserving
    iv. non dependency preserving

    Justify your answer

$3 \times 5 = 15$ **Marks**

5. (Assignment) Let's assume that you are hired for creating a database system for Indian Premier League (IPL) which is a professional Twenty20 cricket league in India. If you are not aware of IPL then you can check [1] and [2].

References

[1] www.ipl20.com

[2] https://en.wikipedia.org/wiki/Indian_Premier_League