96/100

UNIVERSITY OF EDINBURGH

COLLEGE OF SCIENCE AND ENGINEERING

SCHOOL OF INFORMATICS

INFR10080 INTRODUCTION TO DATABASES

December 2020

13:00 to 15:00

INSTRUCTIONS TO CANDIDATES

1. **Note that ALL QUESTIONS ARE COMPULSORY.**
2. **DIFFERENT QUESTIONS MAY HAVE DIFFERENT NUMBERS OF TOTAL MARKS. Take note of this in allocating time to questions.**
3. **This is an OPEN BOOK examination.**

Year 3 Courses

Convener: D.Armstrong

External Examiners: S.Rogers, H.Vandierendonck

THIS EXAMINATION WILL BE MARKED ANONYMOUSLY

Question 1. Consider the following set of functional dependencies:

$$\Sigma = \{AB \to C,\ B \to D, C \to A, AD \to E\}$$

Give a formal proof (written as a sequence of numbered and appropriately justified derivation steps) that:

(a) $\Sigma \models CB \to E$ $(n = 7)$ [*6 marks*]

(b) $\Sigma \models AB \to EC$ $(n = 8)$ [*6 marks*]

Marks are awarded as follows:

- 4 marks for a correct proof that may use the reflexivity, augmentation, transitivity, decomposition and union axioms;
- 5 marks if, in addition to the above requirements, the proof does *not* use the decomposition and union axioms;
- 6 marks if, in addition to the above requirements, the length (that is, number of steps) of the proof is at most n, where n is specified for each point above.

Question 2. Consider the following schedule:

	1	2	3	4	5	6	7	8	9	10	11
T_1					r(B)					w(D)	
T_2			r(C)				w(C)				
T_3	r(A)			w(A)							r(B)
T_4		r(B)							w(B)		
T_5						r(D)		r(C)			

where r denotes a read operation and w denotes a write operation.

(a) Draw the precedence graph of the schedule, and justify the presence of each edge. [*6 marks*]

(b) Is the schedule conflict-serializable? Justify your answer, and indicate all of the serial schedules that are equivalent to the given one (including the case when there are none). [*2 marks*]

Question 3. Given a schema consisting of a relation R over attributes A, B, C (in this order) and a relation S over attributes A, B, C, D (in this order), translate the following relational calculus query into an equivalent relational algebra expression (on sets):

$$\{\, x, x, y, w, z \mid S(x, y, w, z) \land \forall u\ \neg R(y, w, u) \,\}$$

You can use Adom_N (for any attribute name N) to denote the relational algebra expression that computes the active domain, over attribute N. Only the translation rules presented in class are allowed. Detail all the steps of the translation. [*10 marks*]

Question 4. Given a schema consisting of a relation R over attributes A, B, C (in this order), translate the following relational algebra expression (on sets) into an equivalent relational calculus query:

$$\pi_{A,B,C}(\sigma_{A=D \wedge B=E \wedge C \neq F}(R \times \rho_{A \to D, B \to E, C \to F}(R)))$$

Only the translation rules presented in class are allowed. Detail all the steps of the translation.

[8 marks]

Question 5. Assuming set semantics, consider a database schema consisting of relations R over attributes A, B, C (in this order) and S over attributes A, B, C, D (in this order).

w/o $\forall$

(a) Write a Boolean query in Relational Calculus, without universal quantifiers in its body, that returns true if and only if the functional dependency $A, B \to C$ is satisfied by R.

[6 marks]

(b) Write a Relational Algebra query that, using only primitive operations, returns all of the tuples in S for which the inclusion dependency $S[B, C] \subseteq R[A, B]$ is not satisfied.

[6 marks]

$\sigma_{B=A' \wedge C=B'} (S \times \rho_{B \to B'}(R))$

R: A' B' C

S: A B C D

σ $\quad \pi_{A', B'}(R) \quad \pi_{B,C}(S)$

$\pi_{A', B'}(R) \times S$

$\pi_{A,B,C,D}(\sigma$