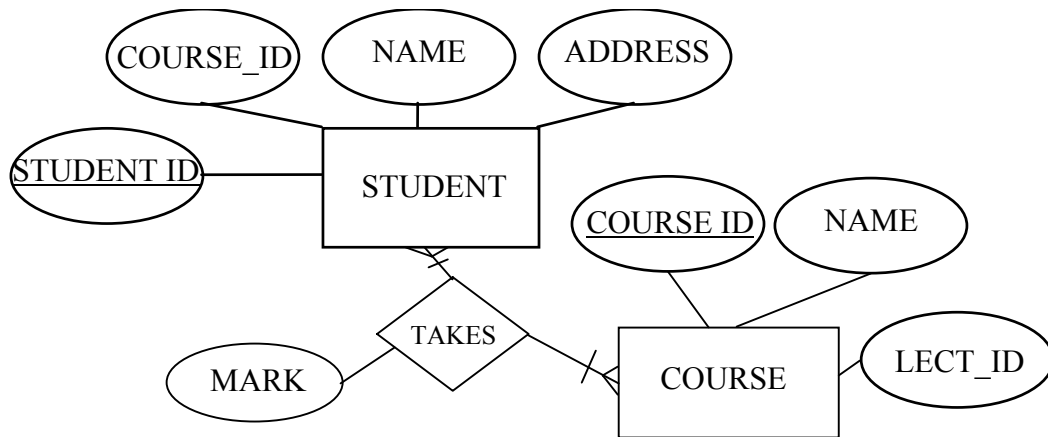# CS_219 DATABASE SYSTEMS
(Answer 2 questions out of 3)

Question 1
(a)   Given the following ER diagram:

What specific conversion rules would be followed to convert this into relations in a database? Give the resulting tables. What other rules apply when converting ER diagrams to relational tables?

[**6 marks**]

(b)   Give the definitions for functional dependence and full functional dependence. Describe both with the use of an example. Give the definition for a candidate key.

[**6 marks**]

(c)   Define the *Entity Integrity Rule* and the *Referential Integrity Rule*. Show the impact of these rules on a database with the use of an example such as the EMPLOYEE table which has attributes for the employee's number, name, salary and manager number which is a foreign key to the EMPLOYEE table.

Describe the *Foreign Key Rules* that can be applied for updates and deletions. Why do we have to take care when using the cascades rule?

[**7 marks**]

(d)   What is a multi-valued dependency?

Give an example of a relational table that is in Boyce-Codd normal form, but is not in fourth normal form. Show an insertion, an update and a deletion problem on this table. Why does the table suffer from these problems?

From what problem do tables not in fifth normal form (but in fourth normal form) suffer?

[**6 marks**]

Question 2

(a)   You have been asked to computerise the records of an online CD sales company. The following is the preliminary information you have been given.

A CD sales company has records of each CD it sells in the form of a unique CD identifier and the CD's title. Each CD has a number of tracks for which the track title and a filename of an mp3 preview of the track are stored. The company also keeps records of each artist's name, and their date of birth, and the CD's they have authored. Customers and the CDs they have bought are also recorded. For customers, the company is interested in their name, current address and credit card details. Past purchasing history concerning the date, quantity and price of each CD they have purchased is kept.

  (i) Draw a complete ER diagram for the above problem. Include the **cardinality** of all relationships. The cardinality of some relationships cannot be deduced from the above passage. Assume sensible values, indicate them on your diagram by placing a star next to them, and write down the question you would have to ask to determine if you are correct.
  (ii) Indicate the **primary key** of each entity (by underlining it).
  (iii) How could we ensure that the tracks of each CD are displayed in the correct order?
  (iv) Select one relationship from your diagram that would use the conversion rule *relation to relationship relation with two foreign keys*, and show how it would be represented by a table in the database. You should indicate any primary key and foreign key constraints.
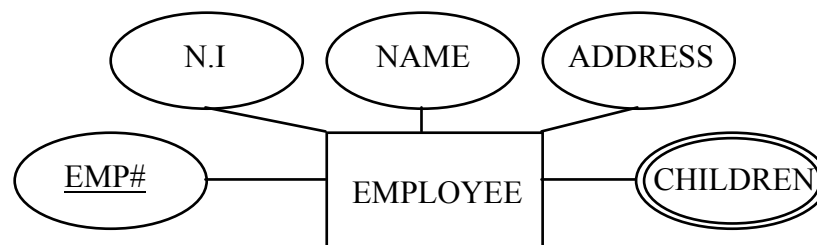
[**15 marks**]

(b)   Thinking about transaction processing, draw and describe a diagram showing the five possible states a transaction can be in during the period surrounding a system failure. Describe how implementing a log file and checkpoint record can aid recovery. Which two commands are used in transaction processing, and what do they both mean? What procedure should be followed during recovery and why? (You should indicate how each transaction state is dealt with).

[**10 marks**]

Question 3

(a)   In the diagram below, employees have a multi-valued attribute called *children*. The resulting relational table for the employee entity is not even in first normal form. What do we introduce into the *ER diagram* to ensure the resulting relational table is in second normal form?

What is a weak entity? What primary key do we use for such entities, and which two benefits does this introduce?

[**5 marks**]

(b)   Many database management systems use B+-Trees to organise the data within the database.
(i)   What is a B+-Tree (also how does it differ from a B-Tree)?
(ii) Explain, with the use of a diagram, how data is stored in a B+-Tree.
(iii) How is the tree traversed to find an item of data?
(iv) What happens to an already full leaf node if we try to insert a new item of data?
(v)   What benefits do B+-Trees offer for locating data quickly (in terms of disk access, search path length, and the order of the B+-Tree)?

[**8 marks**]

(c) (i) Given a first normal form relation R(A,B,C,D) with a composite primary key of (A,B), give a situation where R is not in second normal form. What do you have to do to place relation R in second normal form?

Given the relation:

StudentNo	Student Name	CourseNo	Course Name	Course Mark
1	Jones	CS_217	Computer Graphics	40
1	Jones	CS_219	Database Systems	56
2	Evans	CS_217	Computer Graphics	72

which describes the mark a student gets on a particular course and has the following non-trivial functional dependencies:
StudentNo→Student Name
CourseNo→Course Name
(StudentNo, CourseNo)→Course Mark

(ii) Determine the primary key of this relation.
(iii) Draw a functional dependency diagram for this relation.
(iv) Identify an update, an insert and a deletion problem for this relation.
(v)   Does the relation conform to second normal form? If not, place the relation into second normal form.

[**7 marks**]

(d) (i) Given a second normal form relation R(A,B,C) with a primary key of A, give a situation where R is not in third normal form. What do you have to do to place relation R in third normal form?

This relation:

StudentNo	TutorNo	Tutor Name
1	1	Jack Daniels
2	1	Jack Daniels
3	2	Philip Morris
4	3	Harley Davidson

which describes the tutor for each student has the following non-trivial functional dependencies:
StudentNo→TutorNo
StudentNo→Tutor Name
TutorNo→Tutor Name
(ii) Draw the functional dependency diagram for this relation.
(iii) Give the relations that result when this relation is placed into third normal form.

[**5 marks**]