a) Figure 1 shows a small part of an Extended-Entity-Relationship model describing the personnel department of a research company.

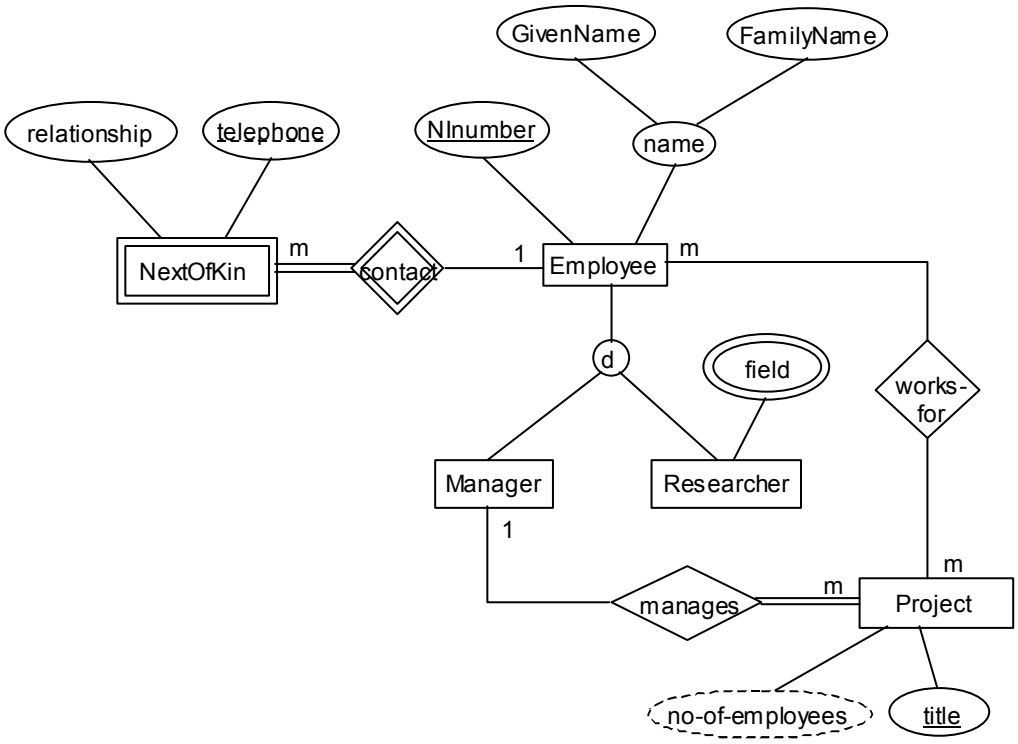


Figure 1

Explain the meanings of the following terms, illustrating your explanations by referring to examples in Figure 1.

i)	Key attribute.	[1 mark]
ii)	Multivalued attribute.	[1 mark]
iii)	Composite attribute.	[1 mark]
iv)	Derived attribute.	[1 mark]
v)	Discriminator (partial key) attributes.	[1 mark]
vi)	Mandatory (total) participation of an entity in a relationship.	[1 mark]
vii)	Specialisation and attribute inheritance.	[2 marks]
viii)	Weak entity types and identifying relationship types.	[2 marks]

a) Figure 3 shows a fragment of an Extended-Entity-Relationship model describing customer orders.

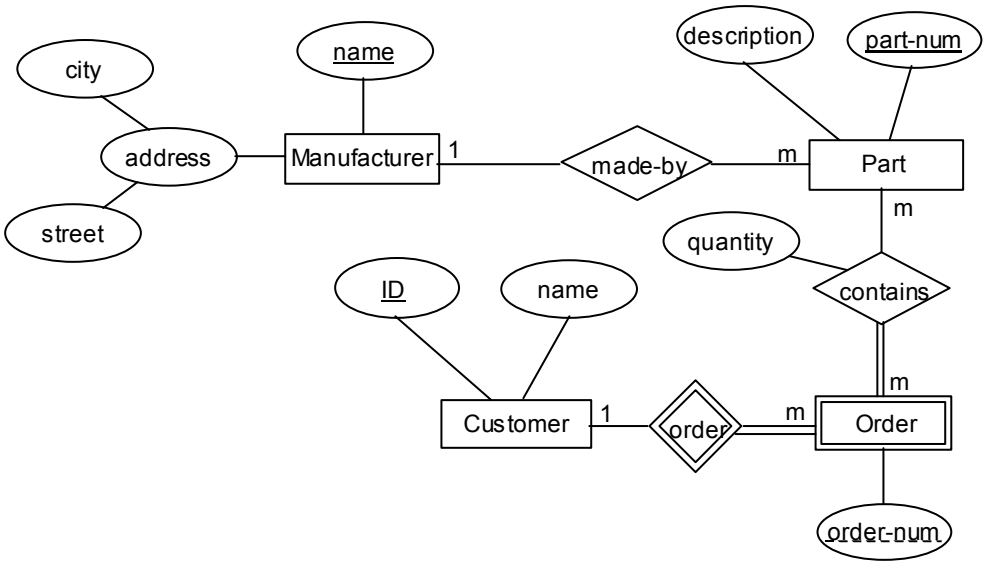


Figure 3

The EER model can be mapped into a relational schema consisting of the following relations:

Manufacturer( )
Part( )
Customer( )
Order( )
Contains( )

Complete the relational schema by adding the appropriate attributes to each relation. In each case clearly indicate the primary key and any foreign keys (also stating into which relations they are keys). [8 marks]

b) Consider the following relational schema for a (very simplified) university database:

Student(<u>ID</u>, name, tutor)	tutor is a foreign key into Staff
Module(<u>number</u>, name, lecturer)	lecturer is a foreign key into Staff
Staff(<u>ID</u>, name, room, telephne)	
Takes(<u>student</u>, <u>module</u>)	student is a foreign key into Student, module is a foreign key into Module

i) Write SQL to create a view called "Tutors" that selects all members of Staff who tutor at least one Student. State whether or not this view is updatable, and why. [3 marks]

ii) Use the Tutors view created in part (i) above to write an SQL query that returns a list of the ID, name and room of all members of staff who tutor Students and who share the same room with some other member of staff who also tutors students. The list should be duplicate free and in ascending alphabetical order of tutor's names, i.e., names beginning with "A" should come first in the list. [3 marks]

iii) Consider the following relational algebra expressions:

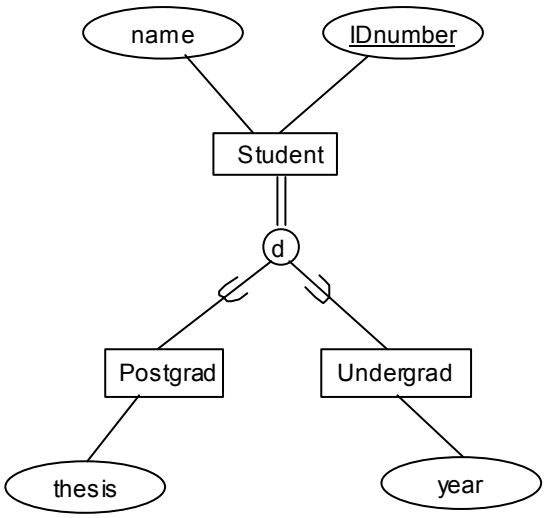
$$R1 \leftarrow \sigma_{name='compilers'}(Module)$$
$$R2 \leftarrow \pi_{studemt,\ module}(Takes \bowtie_{module=number} R1)$$
$$R3 \leftarrow \pi_{tutor}(Student \bowtie_{ID=student} R2)$$
$$R4 \leftarrow \pi_{name}(Staff \bowtie_{ID=tutor} R3)$$

Describe (in English) the information returned in the relation R4. [3 marks]

iv) Write an SQL query that returns the same information as the relation R4 in part (iii) above. [3 marks]

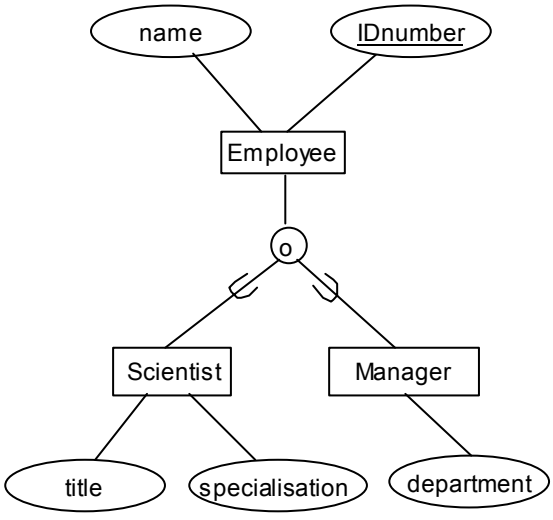
b) When mapping an EER schema to a relational schema, class/sub-class hierarchies can be mapped in several different ways. In each of the following scenarios, give a suitable mapping, *and discuss its advantages and disadvantages*.

a. A schema dealing with students:



[4 marks]

b. A schema dealing with employees:



[4 marks]

Figure 2 shows a fragment of an Extended-Entity-Relationship model describing part of an Estate Agency database that stores details of properties for sale and contact information for clients.

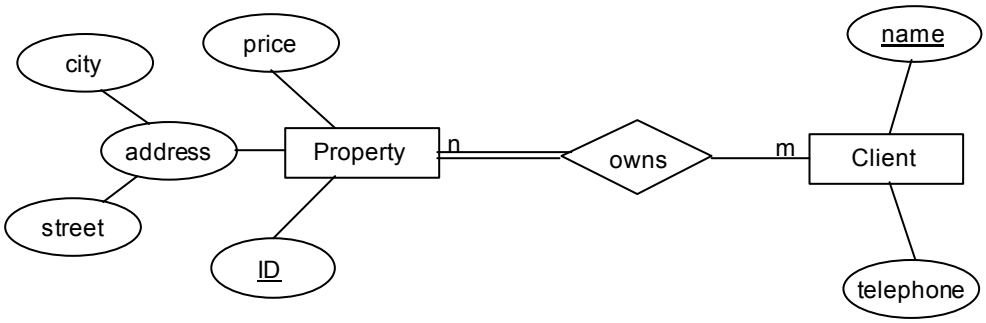


Figure 2

The EER model can be mapped into a single relation as follows:

Properties(ID, city, street, price, name, telephone)

Functional dependencies are as follows:

ID → ID, city, street, price
name → name, telephone
telephone → telephone, name

i) Explain why this relation is not in Boyce-Codd normal form (BCNF).
[2 marks]

ii) Describe two update operations illustrating problems that derive from the non-normalised form of the relation.
[3 marks]

iii) Convert the relation into BCNF, justifying why the resulting relations are in BCNF.
[3 marks]

iv) Discuss how the normalised form addresses the problems you described in part ii) above.
[2 marks]

a. In a banking system three transactions are started at the same time:

Tx1: Move £20 from account 123 to account 456
Tx2: Move £40 from account 456 to account 789
Tx3: Move £60 from account 789 to account 123

Describe, using this example, how the transaction management system is used to:

i. preserve any constraints which are imposed on the database;
[2 marks]
ii. prevent conflicts between transactions;
[5 marks]
iii. deal with problems of recovering from a system crash that happens during the processing of the transactions
[5 marks]

Consider the following relational schema:

LECTURER(LCode, FirstName, LastName)
STUDENT(SCode, FirstName, LastName)
TOPIC(TCode, Description)
LECTURE(TCode, Date, LCode, StudNumber)
Tcode FK into TOPIC
LCode FK into LECTURER
(StudNumber is the number of students attending the lecture)
ASSESSMENT(Tcode, Date, Scode, Mark)
Tcode, Date FK into LECTURE
Scode FK into STUDENT
(Assessments are done during lectures)

Write the SQL expressions for the following queries:

(a) Select the code number, the first name and the last name of the students who where never assessed on a topic with a description "Logic". (4 Marks)
(b) Select the code number, of the lecturer who gave lectures on all the topics with description "Logic". (4 Marks)
(c) Select the code number of the lecturer who made continuous assessments, i.e. who made at least an assessment for each of her/his lectures. (4 Marks)
(d) Select, for each topic, the average of the marks assessed on the topic, considering only the students who where assessed at least three times on the topic. (4 Marks)
(e) Select, for each student, the code number of the lecturer with whom she/he got the greatest number of assessments. (4 Marks)