(Date): e.g. Wednesday, May 21, 2008
(Time): e.g. 2.30p.m. – 3.45p.m.
Duration: **2 hours**

University of Glasgow

EXAMINATION FOR

MSC & POSTGRADUATE DIPLOMA IN INFORMATION TECHNOLOGY

&

MRES IN BIOINFORMATICS

INFORMATION SYSTEMS AND DATABASES

(Answer Question 1 from Question A and Two Questions from Section B)

Any special instructions

This examination paper is worth a total of 70 marks

Section A

1.   Write a short description with examples of **two** of the following:
Bookwork - marks for these issues + examples

   (a) Number formatting in spreadsheets
single number type – formatting distinguishing numeric types – better than adding text – e.g. for currency – makes conversion easier

   (b) Formulae in spreadsheets
expressions involving constants and other cells – acyclic - functions

   (c) Cascading Style Sheets
separation of format and content – selectors – style properties

   (d) Fonts
glyphs – types of font – organisation of character sets

   (e) Compression techniques for multimedia data
run length encoding – Huffman and other dictionary techniques -

   (f) Uniform Resource Indicators
URL structure – URIs involve local files – not just web pages

   (g) XML Schema and DTDs
description of structure of XML documents – XML Schema in XML and allowing a more detailed representation – DTDs different syntax and less powerful

   (h) Accessibility techniques for the web.
Use of validated content description – use of alt tags – etc.

[5 marks each]

Section B

2. Given the following relational database which describes the data held by a company concerning the in-house training of their staff and which comprises details of courses, the individual running of these courses and the employees who take and give these courses:

```
Course( CourseID, Subject, Length)

Offering( CourseID, OfferingNbr, Date, Location)

Prequisites( CourseID, PreCourseID )

Employee( EmpID, Name, Dept, Salary )

Teaches( CourseID, OfferingNbr, EmpID )

Attends( CourseID, OfferingNBR, EmpID, Mark, Grade )
```

(a) What kind of element of an ER diagram gives rise to the tables `Offering` and `Teaches`?

[2]

Offering is a weak entity type
Teaches is a many-many relationship

Provide queries which return the following in SQL and the Relational Algebra:

(b) The subjects of courses which are longer than 3 sessions.

[2]

select subject **from** Course **where** length > 3

LongCourse = Course, length > 3
result = **project** subject **from** LongCourse

(c) The names of the courses attended by the teachers of Database courses.

[4]

select c1.name **from** Course c1, Course c2, Employee e, Attends a, Teaches t
   where c1.CourseID = a.CourseID **and** a.EmpID = e.EmpID **and**
     e.EmpID = t.EmpID **and** t.CourseID = c2.CourseID **and**
      cd.Name = 'Databases'

DBcourse = **select** Course, name = 'Database'
Join DBcourse, Teaches then with Employee then with Attends then with
   Course
project grade from the result of this

(d) The grades of all employees who have attended courses but not taught any of them.

[4]

select grade **from** Employee e, Attends a
   where e.EmpID = a.empID **and** e.empId **not in**
     (**select** EmpID **from** Teaches)

Teachers = **project** EmpID **from** Teaches
Attenders = **project** EmpID **from** Attenders
AnotT = Attenders – Teachers
AnoTdata = **join** AnotT, Employee
result = **project** grade **from** AnotTdata

Give SQL for the following:

(e)   A **query** which, for each location, returns the average salary of employees who have taught in that location.

[4]

select location, average(salary)
from Offering o, Employee e, Teaches t
where o.courseID = t.courseID **and** t.empID = e.empID
group by location

(f)   The **addition** of a new course on Nanotechnology which is three sessions long and requires course C123 as a pre-requisite.

[4]

insert into Course **values**(C345, 'Nanotechnology', 3)
insert into PreRequisites **values**(C345, C123)

(g)   Describe three **user roles** for this database and indicate what kind of access each would be given to the data. In your answer, describe some useful views (but you need not give the SQL for these).

[6]

Employee (who can select data from courses, perhaps with a view of future offerings).
Teacher, who can set grades
Administrator who can set up everything

(h)   Describe one technique with which a database system **recovers from a crash**.

[4]

Description of logging with write-ahead or ????.

3.   (a)   In the Entity Relationship Diagram below, explain what is meant by the following (i.e. explain the structure, don't just name it):

the double oval around "degrees";
Multivalued attribbute – a teacher can have more than one degree

the double box around "Exam"
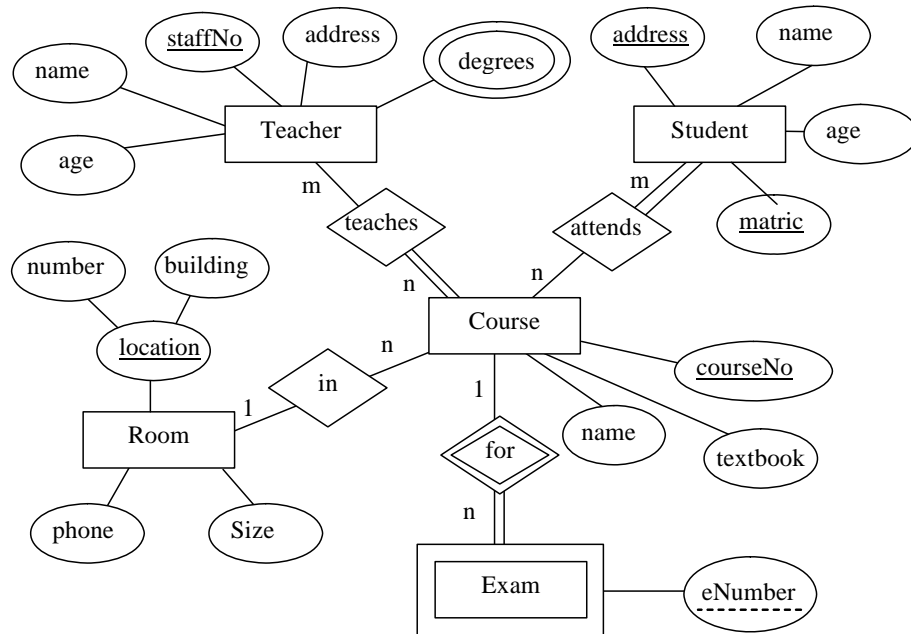Weak entity – excams can't exist on their own and have no unique key

the double line between "Course" and "Teaches"
Total Participation – every course has a teacher

the broken line under "Enumber"

[5]

Partial Key – this will form part of the primary key of exam, along with the primary key of the owning entity – i.e. courseNo

Teacher — name, staffNo, address, degrees, age

Student — address, name, age, matric

teaches (m ... n) attends (m ... n)

Course — courseNo, name, textbook

location — number, building

Room (1 ... in ... n)

for (1 ... n)

Exam — eNumber

phone, Size

(b) Turn this into a set of tables giving the domains of the columns and the foreign keys.

Teacher(staffNo: Number(4), name: Varchar2(20), age Number(2),
    address: Varchar2(30))
Degrees(teacher: Number(4), degree: Varchar2(20))
Teaches(teacher: Number(4), course: Number(2))
Student(matric: Number(4), name: Varchar2(20), age Number(2),
    address: Varchar2(30))
Attends(student: Number(4), course: Number(2))
Course(courseNo: Number(2), name: Varchar2(20), textBook: Varchar2(30),
    roomNumber: Number(2), roomBuilding Varchar2(20))
Exam(course: Number(2), examNumber: Number(2))
Room(number Number(2), building Varchar2(20), phone Varchar2(20),
    Size Number(2))

Foreign Keys: Degrees.teacher refers to Teacher.staffNo
    Teaches.teacher refers to Teacher.staffNo
    Teaches.course refers to Course.courseNo
    Attends.course refers to Course.courseNo
    Attends.student refers to Student.matric
    Course.roomNumner, Course.roomBuilding refers to
        Room.number, Room.building
    Exam.course refers to Course.courseNo

[10]

(c) A spreadsheet and a relational database system both manage rectangular data structures. List **five** main difference between them.

SS orders rows and columns
SS has no types
SS has expressions

[5]

(d) In a banking system, three transactions start at the same time which are intended to:

Tx1: Move £20 from account 1234 to account 4321

Tx2: Move £40 from account 4321 to account 5678

Tx3: Move £60 from account 5678 to account 1234

Describe how a transaction system is used to:

preserve any **constraints** which are imposed on the database;

prevent conflicts between the transactions
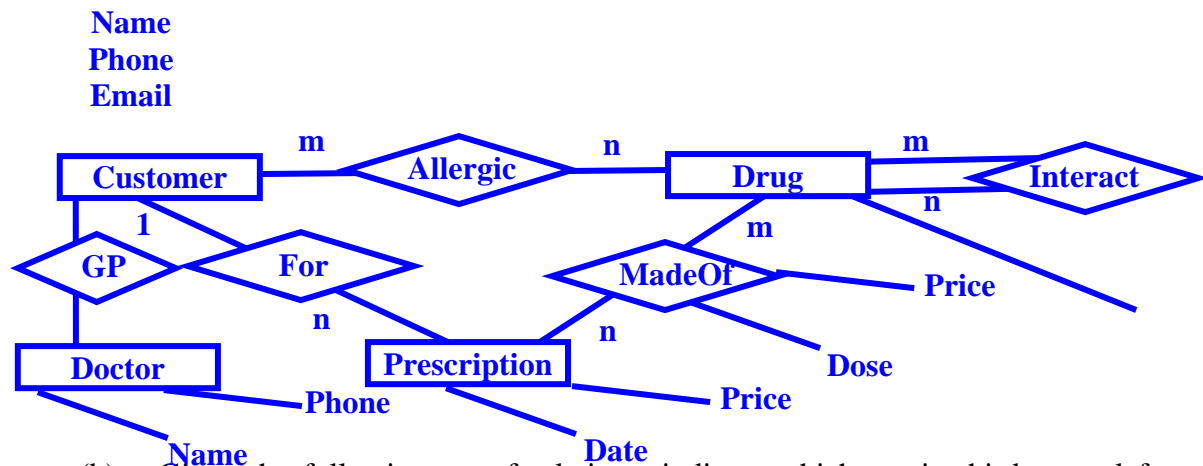
ensure that the transactions eventually **complete**

[10]

4. (a) Create an **ER diagram** which describes the schema of a database to hold data for the following application:

> *A chemist wishes to store the information about prescriptions and customers. The database must hold the names and contact information about the customers as well as which drugs they are allergic to and the name and phone number of their doctor. The part of the database dealing with drugs stores the manufacturer, the name of illnesses for which they are commonly prescribed and which other drugs they may not be taken with. Each prescription may be for more than one drug and includes the date and total price together with the individual prices and doses of each drug.*

[12]

Name
Phone
Email

Customer — m — Allergic — n — Drug — m — Interact
n

GP — 1 — For — MadeOf — m — Price

Doctor — n — Prescription — n — Dose

Phone

Price

Name **Date**

(b) Given the following set of relations, indicate which are in third normal form, which only in second and which are only in first normal form:

      Student(<u>Matric</u>, Name, HallName, HallAddress, Faculty)

      Course(CourseID, CourseName)

      EnrolledIn(<u>StudentMatric, ClassName</u>, ClassHeadStaffNumber)

      Teaches(<u>CourseID, TeacherStaffNumber</u>)

      Teacher(<u>StaffNumber</u>, Name, Department, Faculty)

      StudiesOn(<u>StudentMatric, CourseID</u>, grade)

[3]

3NF – Course, Teaches, StudiesOn
2NF – Student, Teacher
1NF – EnrolledIn

(c) What needs to be done to put the whole database into third normal form?

[5]

EnrolledIn needs to be split into:
    EnrolledIn(StudentMatric, ClassName)
    Class(ClassName, ClassHeadStaffNumber)
Student needs to be split into:
    Student(Matric, Name, HallName, Faculty)
    Hall(HallName, HallAddress)
Teacher needs to be split into:
    Teacher(StaffNumber, Name, Department)
    Department(Name, Faculty)

(d) There are eight courses in the database. Draw a B+ tree for an index created on the course name.

[6]

Bookwork: