Monash University

FIT9132

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PART A Relational Model [Total: 10 Marks]

Q1 [3 Marks]
A company wishes to record the following attributes about their employees: employee ID, department number, name, home address, education qualifications and skills which the employee has.

A small sample of data is show below:

Employee ID	Department Number	Employee Name	Home Address	Qualification	Skill
101	21	Given name: Joe Family name: Bloggs	Street: 12 Wide Rd Town: Mytown Postcode: 1234	Bachelor of Commerce MBA	Project Management Hadoop R
102	13	Given name: Wendy Family name: Xiu	Street: 55 Narrow St Town: Mytown Postcode: 1234	Bachelor of Computer Science Master of IT Doctor of Philosophy	SQL HLSQL
103	13	Given name: Sarah Family name: Green	Street: 25 High St Rd Town: Mytown Postcode: 1234	Certificate IV in Business Administration	SQL Java Phyton

Use this data to explain the difference between a simple attribute, a composite attribute and a multivalued attribute. Your answer must include examples drawn from this data.

Simple - an attribute which cannot be subdivided eg. employeeid, department number

Composite - an attribute which can be subdivided into additional attributes eg. employee name, home address

Multivalued - an attribute which has many potential values eg. qualification, skill

Q2 [7 Marks]

The following relations represent a publications database:

author (author_id, first_name, last_name)

author_paper (author_id, paper_id, author_position)

paper (paper_id, paper_title, journal_id)

journal (journal_id, journal_title, month, year, editor)

* editor in journal references author(author_id) – this is an author acting as the journal editor

Authors write papers which are published in an edition of a journal. Each edition of a journal is assigned a journal id and appoints an editor. A given paper may be authored by several authors, in such cases each author is assigned a position representing their contribution to the paper:

Write the relational algebra for the following queries (your answer must show an understanding of query efficiency):

(a) Show the names of all authors who have been listed as first author (author_position = 1) in any paper (3 marks)

$$\pi_{\text{author\_fname, author\_lname}}(\text{AUTHOR} \bowtie (\pi_{\text{author\_id}}(\sigma_{\text{author\_position} = 1}(\text{AUTHOR\_PAPER}))))$$

OR

ANSWER1 = $\pi_{\text{author\_id}}(\sigma_{\text{author\_position} = 1}(\text{AUTHOR\_PAPER}))$

ANSWER2 = AUTHOR $\bowtie$ ANSWER1

ANSWER3 = $\pi_{\text{author\_fname, author\_lname}}$(ANSWER2)

(b) Show the paper title, journal title and month and year of publication for all papers published before 2012 (4 marks)

$$\pi_{\text{paper\_title, journal\_title, month, year}}((\pi_{\text{journal\_id, journal\_title, month, year}}(\sigma_{\text{year} < 2012}(\text{JOURNAL})) \bowtie (\pi_{\text{journal\_id, paper\_title}}(\text{PAPER}))))$$

OR

ANSWER1 = $\pi_{\text{journal\_id, journal\_title, month, year}}$ ($\sigma_{\text{year < 2012}}$ (JOURNAL))

ANSWER2 = $\pi_{\text{journal\_id, paper\_title}}$(PAPER)

ANSWER3 = ANSWER1 $\bowtie$ ANSWER2

ANSWER4 = $\pi_{\text{paper\_title, journal\_title, month, year}}$ (ANSWER3)

Here ANSWER1 could be done in two steps, a select and then a project.

PART B Database Design [Total: 20 Marks]

Q3 [20 marks]

Monash Computing Students Society (MCSS) is one of the student clubs at Monash University.

Students are welcome to join as a member. When a student joins MCSS, a member id is assigned, and the students first name, last name, date of birth, email and phone number will be recorded. This club has an annual membership fee. When a member has paid the membership fee for the current year, the current year is recorded against the year of membership as part of their membership details.

MCSS hosts several events throughout the year. The events are currently categorised into *Professional Events*, *General Events*, and *Social Events*. MCSS would like to be able to add further categories as they develop new events. When an event is scheduled, MCSS assigns an event id to the event. The event date and time, description, location, allocated budget, the ticket price and the discount rate (eg 5%) for members. Some events are organised as free events for members. In this situation, the discount rate is recorded as 100% for members. For all events, only members can purchase the tickets. However, members can buy additional tickets for their friends or family at full price. For each of the sales, the receipt number, number of tickets sold, total amount paid and the member id are recorded.

Some events attract some sponsorships. The sponsor may be an organisation or an individual. The sponsors provide financial support to the event. Some events may have several sponsors. The amount of financial support provided by each sponsor is recorded for the event. Each sponsor is identified by a sponsor id. The name, contact email and sponsor type are also recorded. A sponsor may support several events throughout the year.

For some events such as career night, MCSS may also invite some guest speakers to share their experience. The database records all guests' information, the guests full name, email and phone number are recorded. If a guest comes from an organisation or an individual that provides a sponsorship to any of the MCSS events (does not have to be at the event where the guest speaks), this fact will also be recorded. A guest may be invited to several events.

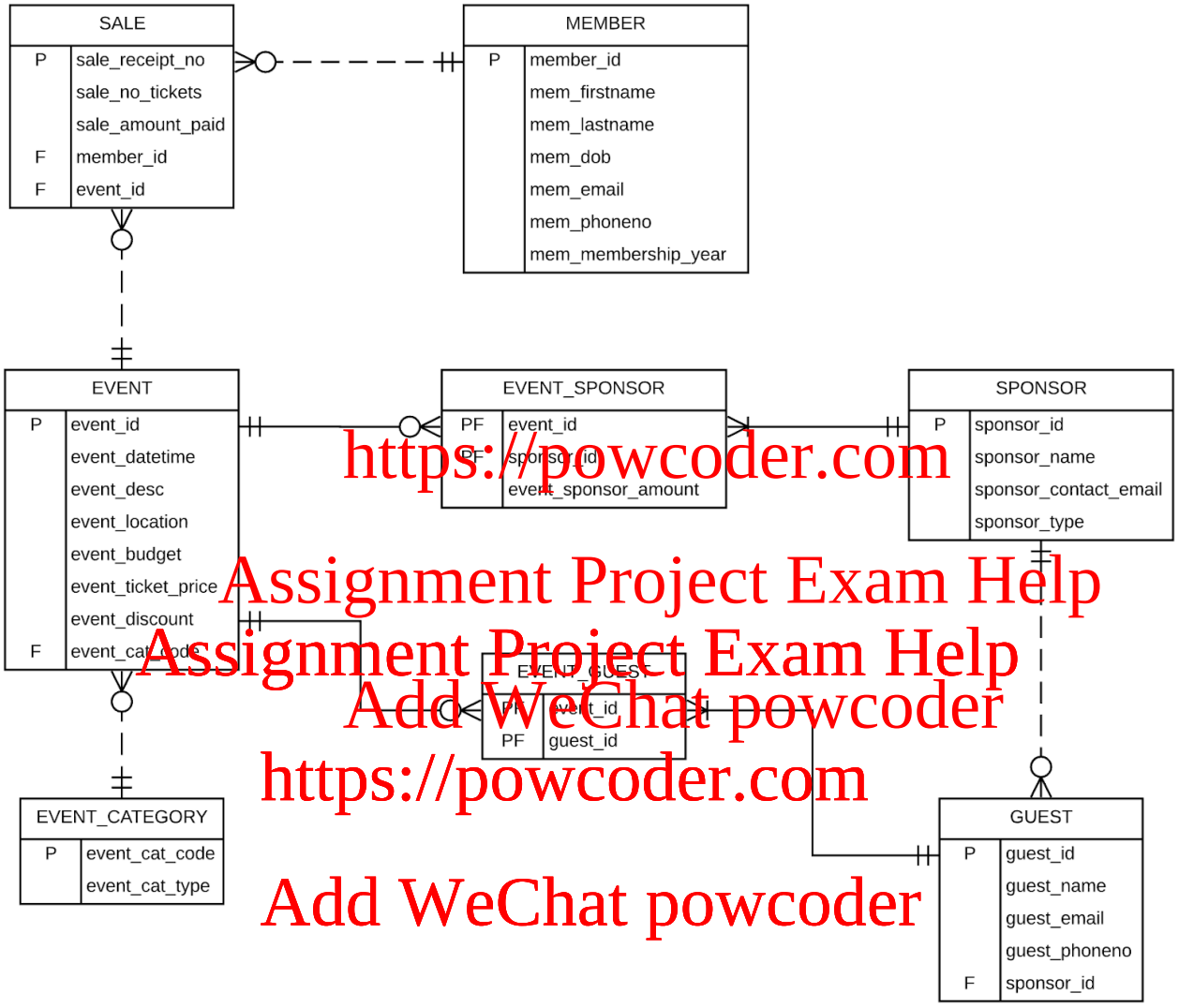
Create ***a logical level diagram using Crow's foot notations*** to represent the "Monash Computing Students Society" data requirements described above. Clearly state any assumptions you make when creating the model.

Please note the following points:

- Be sure to include all relations, attributes and relationships (unnecessary relationships must not be included)
- Identify clearly the Primary Keys (P) and Foreign Keys (F), as part of your design
- In building your model you must conform to FIT9132 modelling requirements
- The following are **NOT required** on your diagram
    - verbs/names on relationship lines
    - indicators (*) to show if an attribute is required or not
    - data types for the attributes

NOTE: Draw the model on a piece of paper.

Monash Computing Students Society (MCSS) Logical Model



PART C Normalisation [Total: 10 Marks]

Q3 [10 marks]

The Super Electronics Invoice shown below displays the details of an invoice for the client Alice Paul.

Super Electronics
INVOICE

Client Number: C3178713 **Invoice No.:** 132
Client Name: Alice Paul **Invoice Date:** 02/11/2018
Client Address: 43 High Street,
Caulfield, VIC 3162
Client Phone: 0411 245 718

ItemID	Item Name	Purchase Price	Expected Delivery Date	Quantity	Cost
316772	Sonic S55UV16B 55"	499.00	2 weeks	1	499.00
452550	Microsoft Surface Pro	1198.00	1-3 weeks	1	1198.00
48304A	Delboghi Digital Coffee	299.00	Same Day	2	598.00
				SUB TOTAL:	**$ 2295.00**
				DELIVERY:	**$145.00**
				ORDER TOTAL:	**$2440.00**

Represent this form in UNF. In creating your representation you should note that Super Electronics wish to treat the client name and address as simple attributes. Convert your UNF to first normal form (1NF) and then continue the normalisation to third normal form (3NF). At each normal form show the appropriate dependencies for that normal form, if there are none write "No Dependencies"

Do not add new attributes during the normalisation. Clearly write the relations in each step from the unnormalised form (UNF) to the third normal form (3NF). Clearly, indicate primary keys on all relations from 1NF onwards.

[**10 marks**]

UNF

INVOICE (invoice_nbr, inv_date, client_number, client_name, client_address, client_phone, (item_id, item_name, item_purchase_price, item_delivery_time, qty_ordered, line_cost) sub_total, delivery_fee, order_total)

ii) Remove repeating groups and identify the primary key for each relation

1NF

INVOICE (invoice_nbr, inv_date, client_number, client_name, client_address, client_phone, sub_total, delivery_fee, order_total)

INVOICE_LINE (invoice_nbr, item_id, item_name, item_purchase_price, item_delivery_time, qty_ordered, line_cost)

Partial Dependencies:

item_id -> item_name

iii) Remove partial dependency and identify the primary key for each relation

2NF

INVOICE (invoice_nbr, inv_date, client_number, client_name, client_address, client_phone, sub_total, delivery_fee, order_total)

INVOICE_LINE (invoice_nbr, item_id, item_purchase_price, item_delivery_time, qty_ordered, line_cost)

ITEM (item_id, item_name)

Transitive Dependencies:

client_number -> client_name, client_address, client_phone

iv) Remove transitive dependency and identify the primary key for each relation

3NF

INVOICE (invoice_nbr, inv_date, client_number, sub_total, delivery_fee, order_total)

CLIENT (client_number, client_name, client_address, client_phone)

INVOICE_LINE (invoice_nbr, item_id, item_purchase_price, item_delivery_time, qty_ordered, line_cost)

ITEM (item_id, item_name)

Full Dependencies:

invoice_nbr -> inv_date, client_number, sub_total, delivery_fee, total_cost

client_number -> client_name, client_address, client_phone

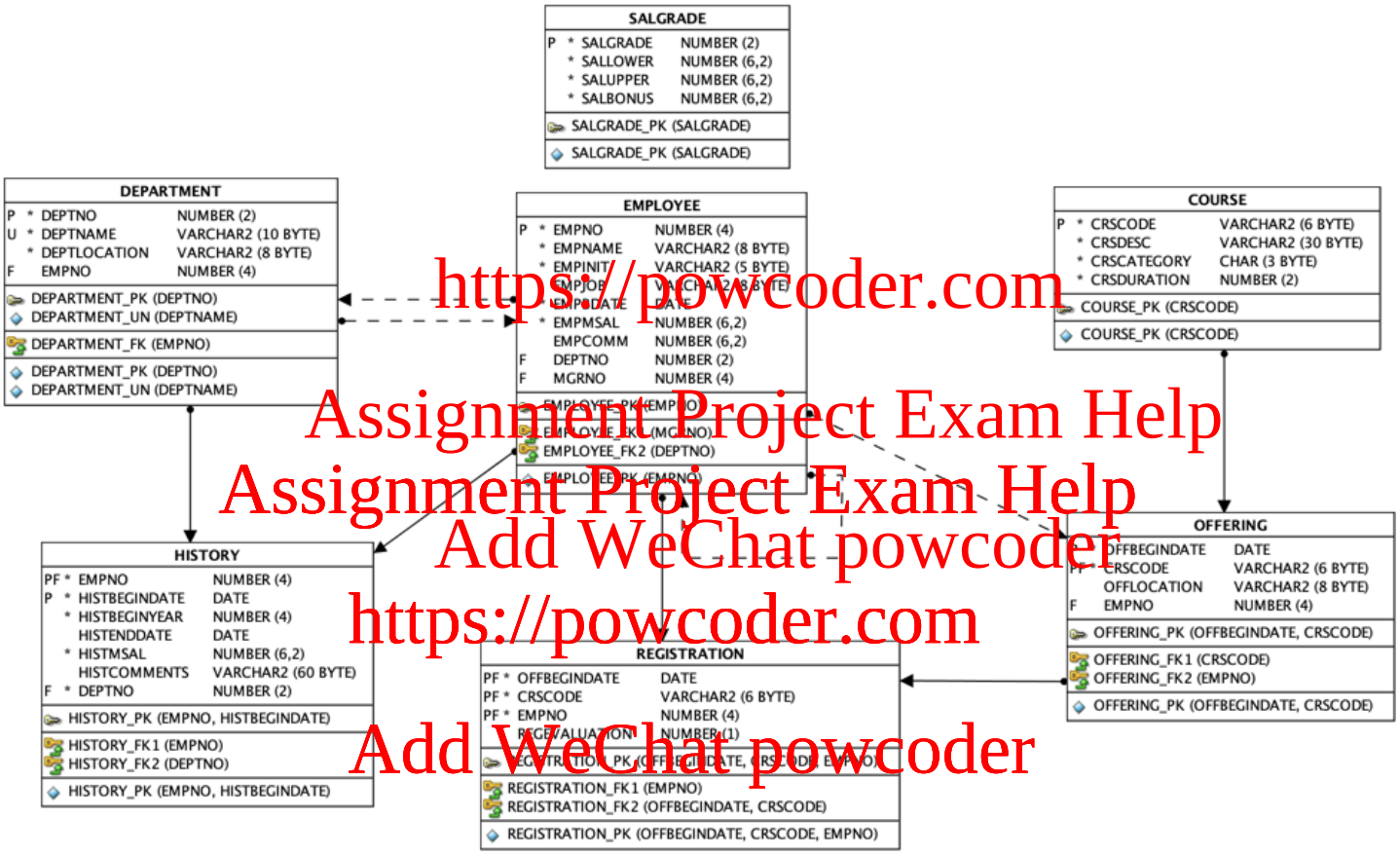
invoice_nbr, item_id -> item_purchase_price, item_delivery_time, qty_ordered, line_cost

item_id -> item_name

PART D SQL [Total: 40 Marks]

Employee System Model and Schema File for Part D

The following relational model depicts an employee system:



Given this model and assuming the tables have been created and populated in an Oracle database, provide the SQL statements for the following questions in Part D.

Note in coding your SQL each SELECT, FROM, WHERE, GROUP BY, HAVING and ORDER BY clause **must start on a new line**.

The schema file to create these tables is:

The schema file to create these tables is:

```
CREATE TABLE SALGRADE (

  salgrade NUMBER(2)    NOT NULL ,

  sallower NUMBER(6,2)    NOT NULL ,

  salupper NUMBER(6,2)    NOT NULL ,

  salbonus NUMBER(6,2)    NOT NULL    ,
```

```
CONSTRAINT salgrade_pk PRIMARY KEY (salgrade),
CONSTRAINT salgrade_chk1 CHECK (sallower >= 0),
CONSTRAINT salgrade_chk2 CHECK (sallower <= salupper));

COMMENT ON COLUMN salgrade.salgrade IS 'Salary Grade';
COMMENT ON COLUMN salgrade.sallower IS 'Salary Lower Limit';
COMMENT ON COLUMN salgrade.salupper IS 'Salary Upper Limit';
COMMENT ON COLUMN salgrade.salbonus IS 'Salary Bonus';

CREATE TABLE course (
  crscode VARCHAR(6)   NOT NULL ,
  crsdesc VARCHAR(30)   NOT NULL ,
  crscategory CHAR(3)   NOT NULL ,
  crsduration NUMBER(2)   NOT NULL ,
CONSTRAINT course_pk PRIMARY KEY (crscode),
CONSTRAINT course_chk1 CHECK (crscode = upper(crscode)),
CONSTRAINT course_chk2 CHECK (crscategory in ('GEN','BLD','DSG')));

COMMENT ON COLUMN course.crscode     IS 'Course Code',
COMMENT ON COLUMN course.crsdesc     IS 'Course Description';
COMMENT ON COLUMN course.crscategory IS 'Course Category';
COMMENT ON COLUMN course.crsduration IS 'Course Duration';

CREATE TABLE DEPARTMENT (
  deptno NUMBER(2)   NOT NULL ,
  deptname VARCHAR(10)   NOT NULL ,
  deptlocation VARCHAR(8)   NOT NULL ,
  empno NUMBER(4) ,
CONSTRAINT department_pk PRIMARY KEY (deptno),
CONSTRAINT department_un UNIQUE (deptname),
CONSTRAINT department_chk1 CHECK (deptname = upper(deptname)),
CONSTRAINT department_chk2 CHECK (deptlocation = upper(deptlocation)));
```

```
COMMENT ON COLUMN department.deptno       IS 'Department Number';

COMMENT ON COLUMN department.deptname     IS 'Department Name';

COMMENT ON COLUMN department.deptlocation IS 'Location of department';

COMMENT ON COLUMN department.empno        IS 'Employee who manages department';


CREATE TABLE EMPLOYEE (

  empno NUMBER(4)   NOT NULL ,

  empname VARCHAR(8)   NOT NULL ,

  empinit VARCHAR(5)   NOT NULL ,

  empjob VARCHAR(8)    ,

  empbdate DATE   NOT NULL ,

  empmsal NUMBER(6,2)   NOT NULL ,

  empcomm NUMBER(6,2) ,

  deptno NUMBER(2) ,

  mgrno NUMBER(4) ,
CONSTRAINT employee_pk PRIMARY KEY (empno),

CONSTRAINT employee_fk1 FOREIGN KEY (mgrno)

    REFERENCES EMPLOYEE (empno),

CONSTRAINT employee_fk2 FOREIGN KEY (deptno)

    REFERENCES DEPARTMENT (deptno));


COMMENT ON COLUMN employee.empno     IS 'Employee number';

COMMENT ON COLUMN employee.empname   IS 'Employee name';

COMMENT ON COLUMN employee.empinit   IS 'Employee initials';

COMMENT ON COLUMN employee.empjob    IS 'Employee job';

COMMENT ON COLUMN employee.empbdate  IS 'Employee birthdate';

COMMENT ON COLUMN employee.empmsal   IS 'Employee monthly salary';

COMMENT ON COLUMN employee.empcomm   IS 'Employee commission';

COMMENT ON COLUMN employee.deptno    IS 'Department Number';

COMMENT ON COLUMN employee.mgrno     IS 'Employees manager (empno of manager)';
```

```
ALTER TABLE DEPARTMENT

ADD (CONSTRAINT department_fk FOREIGN KEY (empno)

      REFERENCES employee (empno));


CREATE TABLE HISTORY (

  empno NUMBER(4)   NOT NULL ,

  histbegindate DATE   NOT NULL ,

  histbeginyear NUMBER(4)   NOT NULL ,

  histenddate DATE    ,

  histmsal NUMBER(6,2)   NOT NULL ,

  histcomments VARCHAR(60)    ,

  deptno NUMBER(2)    NOT NULL ,

CONSTRAINT history_pk PRIMARY KEY (empno, histbegindate),

CONSTRAINT history_chk CHECK (histbegindate < histenddate),

CONSTRAINT history_fk1 FOREIGN KEY (empno)

    REFERENCES EMPLOYEE (empno)

ON DELETE CASCADE,

CONSTRAINT history_fk2 FOREIGN KEY (deptno)

    REFERENCES DEPARTMENT (deptno));


COMMENT ON COLUMN history.deptno        IS 'Department Number';

COMMENT ON COLUMN history.histbegindate IS 'Date history record begins';

COMMENT ON COLUMN history.histbeginyear IS 'Year history record begins';

COMMENT ON COLUMN history.histenddate   IS 'Date history record ends';

COMMENT ON COLUMN history.histmsal      IS 'Monthly Salary for this history
record';

COMMENT ON COLUMN history.histcomments  IS 'Comments for this history record';

COMMENT ON COLUMN history.empno         IS 'Employee number';


CREATE TABLE OFFERING (

  offbegindate DATE   NOT NULL ,

  crscode VARCHAR(6)   NOT NULL ,
```

```
  offlocation VARCHAR(8) ,
  empno NUMBER(4) ,
CONSTRAINT offering_pk PRIMARY KEY (offbegindate, crscode),
CONSTRAINT offering_fk1 FOREIGN KEY (crscode)
    REFERENCES course(crscode),
CONSTRAINT offering_fk2 FOREIGN KEY (empno)
    REFERENCES EMPLOYEE (empno));

COMMENT ON COLUMN offering.offbegindate IS 'Begin date for offering';
COMMENT ON COLUMN offering.crscode      IS 'Course Code';
COMMENT ON COLUMN offering.offlocation  IS 'Location for offering';
COMMENT ON COLUMN offering.empno        IS 'Employee number for employee running
offering';

CREATE TABLE REGISTRATION (
  offbegindate DATE    NOT NULL ,
  crscode VARCHAR(6)   NOT NULL ,
  empno NUMBER(4) NOT NULL,
  regevaluation NUMBER(1) ,
CONSTRAINT registration_pk PRIMARY KEY (offbegindate, crscode, empno),
CONSTRAINT resgitration_chk CHECK (regevaluation in (1,2,3,4,5)),
CONSTRAINT registration_fk1 FOREIGN KEY (empno)
    REFERENCES EMPLOYEE (empno),
CONSTRAINT registration_fk2 FOREIGN KEY (offbegindate, crscode)
    REFERENCES OFFERING (offbegindate, crscode));


COMMENT ON COLUMN registration.offbegindate  IS 'Begin date for offering';
COMMENT ON COLUMN registration.crscode       IS 'Course Code';
COMMENT ON COLUMN registration.regevaluation IS 'Grade for course completed';
COMMENT ON COLUMN registration.empno         IS 'Employee number of employee
completing course';
```

Q5 [15 marks]

The company needs to record a new department. This new department's number will be 10 higher than the highest current department number and will be called EXAM and is located in BOSTON. The employee named KING who has a job as the only company DIRECTOR has been assigned to manage the new EXAM department.

The company has also decided that they wish to record, for each department, the number of employees currently working in the department (the employee count). For new departments the number of employees in the department should be set to 0. For those departments which currently have employees, the employee count should correctly reflect the current number of employees in the department.

Code the SQL statements to modify the database to meet these requirements.

```
INSERT INTO department VALUES (
    (
        SELECT
            MAX(deptno)
        FROM
            department
    ) + 10,
    'EXAM',
    'BOSTON',
    (
        SELECT
            empno
        FROM
            employee
        WHERE
            empname = 'KING'
            AND empjob = 'DIRECTOR'
    )
);

COMMIT;

ALTER TABLE department ADD deptcount NUMBER(3, 0) DEFAULT 0 NOT NULL;

UPDATE department d
SET
    deptcount = (
        SELECT
            COUNT(empno)
        FROM
            employee e
        WHERE
            e.deptno = d.deptno
    );

COMMIT;
```

Q6 [10 marks]

(a) Display the course code, course name and duration for all those courses which are from the course category "GEN" or "BLD", order the output with the course with the longest duration first. Where two courses have the same duration, order their output by the course code. (4 marks)

```
SELECT
    crscode,
    crsdesc,
    crsduration
FROM
    course
WHERE
    crscategory = 'GEN'
    OR crscategory = 'BLD'
ORDER BY
    crsduration DESC,
    crscode;
```


(b) For each department list the department name, the department location, the name of the manager and the number of employees in that department. The name of the manager must be output in a column called "MANAGERS NAME" and the number of employees must be output in a column called "TOTAL EMPLOYEES". Order the output by the number of employees in the department. (6 marks)


```
SELECT
    deptname,
    deptlocation,
    e1.empname AS "MANAGERS NAME",
    COUNT(*) AS "TOTAL EMPLOYEES"
FROM
    ( department   d
    JOIN employee     e1
    ON d.empno = e1.empno )
    JOIN employee     e2
    ON d.deptno = e2.deptno
GROUP BY
    deptname,
    deptlocation,
    e1.empname
ORDER BY
    COUNT(*);
```

Q7 [15 marks]

List ALL employees whose total course registrations are less than the average number of registrations for employees who have completed a course. Note that some employees may repeat a course, this repeat does not count as a different course. In the list, include the employee number, name, date of birth and the number of different courses they have registered for. Order the output by employee number.

```
SELECT
    e.empno,
    empname,
    to_char(empbdate, 'dd-Mon-yyyy') AS dob,
    COUNT(DISTINCT r.crscode) AS crscount
FROM
    employee       e
    LEFT JOIN registration   r ON e.empno = r.empno
GROUP BY
    e.empno,
    empname,
    to_char(empbdate, 'dd-Mon-yyyy')
HAVING
    COUNT(DISTINCT r.crscode) < (
        SELECT
            AVG(COUNT(DISTINCT r.crscode))
        FROM
            employee       e
            JOIN registration   r ON e.empno = r.empno
        GROUP BY
            e.empno
    )
ORDER BY
    e.empno;
```

PART E Big Data and No SQL [Total: 10 Marks]

Q8 [6 marks]

(a) Given this sample data:

	EMPNO	EMPNAME	EMPINIT	EMPJOB	EMPBDATE	CRSCODE	OFFBEGINDATE	REGEVALUATION
1	7876	ADAMS	AA	TRAINER	30/DEC/83	SQL	12/APR/16	2
2	7876	ADAMS	AA	TRAINER	30/DEC/83	PLS	11/SEP/17	(null)
3	7876	ADAMS	AA	TRAINER	30/DEC/83	JAV	13/DEC/16	5

and this select statement

```
SELECT
JSON_OBJECT( '_id' VALUE empno,
             'name' VALUE JSON_OBJECT(
                    'initial' VALUE empinit,
                    'familyName' VALUE empname
                    ),
                    'position' VALUE empjob,
                    'birthDate' VALUE to_char(empbdate,'dd-mm-yyyy'),
                    'courseInfo' VALUE JSON_ARRAYAGG(
                          JSON_OBJECT(
                                'code' VALUE crscode,
                                'date' VALUE
to_char(offbegindate,'dd-mm-yyyy'),
                                'evaluation' VALUE regevaluation
                          )
                    )
             FORMAT JSON)
             || ','

FROM PAYROLL.employee NATURAL JOIN payroll.registration
GROUP BY empno, empinit, empname, empjob,empbdate
ORDER BY empname;
```


Write the JSON formatted text for one of the employees listed in the table (4 marks)

```
{
   "_id": 7876,
    "name": {
      "initial": "AA",
      "familyName": "ADAMS"
    },
    "position": "TRAINER",
    "birthDate": "30-12-1983",
    "courseInfo": [
      {
        "code": "SQL",
        "date": "12-04-2016",
        "evaluation": 2
      },
      {
```

```
            "code": "PLS",
            "date": "11-09-2017",
            "evaluation": null
        },
        {
            "code": "JAV",
            "date": "13-12-2016",
            "evaluation": 5
        }
    ]
}
```

(b) Assume that the collection name is employee, write the MongoDB command to show all employees who have a surname of 'JONES' or 'SCOTT' (2 marks)

```
db.employee.find({$or:[{"name.familyName":"JONES"},{"name.familyNam
e":"SCOTT"}]})
```


Q9 [4 marks]

Explain and give example for each of these big data terms:

(a) scaling up

Keeping the same number of systems but migrating each one to a larger system. For example buying a new server with larger memory, bigger storage space and faster CPU.

(b) scaling out

When the workload exceeds server capacity, it is spread out across a number of servers. For example buying many common computers and using distributed systems for storage and processing.

PART F Transaction [Total: 10 Marks]

Q10. [5 marks]

Given two transactions:

T1 – R(X), W(X)

T2 – R(Y), W(Y), R(X), W (X)

Where R(X) means Read(X) and W(X) means Write(X).

(a) If we wish to complete both of these transactions, explain the difference between a *serial* and *non-serial* ordering of these two transactions. Provide an example of each as part of your answer.
(b) What transaction ACID property does a non-serial ordering of these two transactions potentially violate.

(a)

Serial – all of one transaction followed by all of the other

T1 R(X), T1 W(X), T2 R(Y), T2 W(Y), T2 R(X), T2 W(X)

Non-Serial – interleaving of the transactions

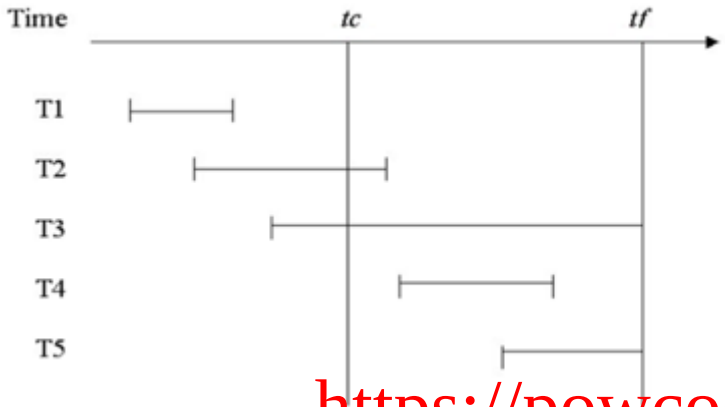
T1 R(X), T2 R(Y), T2 W(Y), T1 W(X), T2 R(X), T2 W(X)

(b)

Isolation or Consistency

Q11 [5 marks]

A *write through* database has five transactions running as listed below (the time is shown horizontally from left to right):



At time *tc* a checkpoint is taken, at time *tf* the database fails due to a power outage.

Explain for each transaction what recovery operations will be needed when the database is restarted and why.

T1 – nothing required, committed before checkpoint

T2 – ROLL FORWARD, committed after checkpoint and before fail

T3 – ROLL BACK, never reached commit

T4 – ROLL FORWARD, started after checkpoint committed before fail

T5 - ROLL BACK, never reached commit