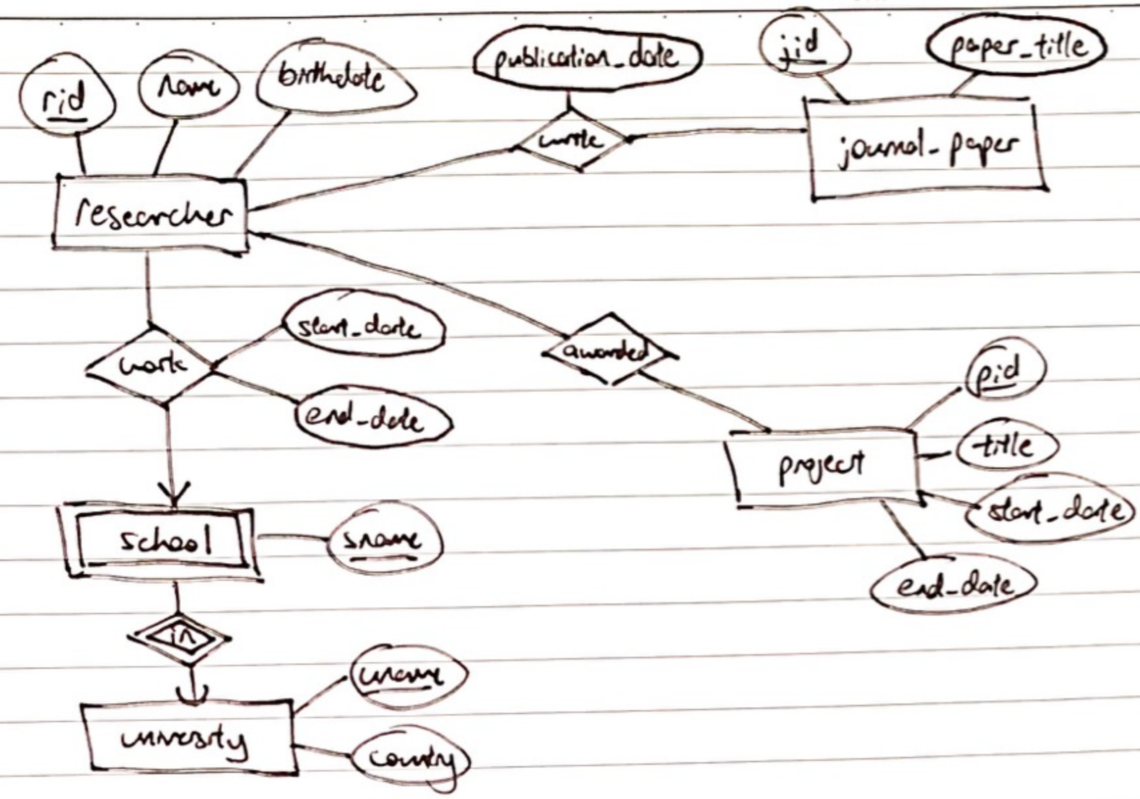
1. a)



b) (i)

$R_1 := \pi_{bid,\ pid}\ (buy)$

$R_2 := \pi_{sid}\ (\sigma_{sname = 'Shopee'}\ shop)$

$R_3 := \pi_{pid}\ (\sigma_{sid = R2.sid}\ product)$

$R_4 := R_1 \div R_4$

$R_5 := \pi_{bid, sid, price}\ (R_1 \bowtie_{R_1.pid = product.pid}\ product)$

$R_6 := \gamma_{bid,\ sid,\ sum(price) \rightarrow SpentInShop}\ (\sigma_{R5.bid = R_4.bid}\ R_5)$ //

(ii)

$R_1 := \pi_{bid,\ sid,\ price}\ (buy \bowtie product)$

$R_2 := \gamma_{bid,\ sid,\ sum(price) \rightarrow SpentInShop}\ R_1$

$R_3 := (\pi_{bid}\ buyer \times \pi_{sid}\ shop) - (\pi_{bid, sid}\ R_2)$

$\rho\ R_4\ (bid, sid, SpentInShop) := R_3 \times 0$

$R_5 := R_2 \cup R_4$ //

2. a) keys of R: {A}, {B}, {C}, {D}, {E}, {F}, {G}

b) Already in BCNF.

c) A key should be in its minimal form and since each attribute in R is a key already, any key with 2 or more attributes would not be minimal.

3. a) (i)
```
SELECT *
FROM q
WHERE NOT EXISTS (
    SELECT *
    FROM r );
```

(ii)
```
SELECT r.A, r.C, s.D
FROM r, s
WHERE r.C = s.C ;
```

b) (i)
```
SELECT employee-name
FROM works
GROUP BY company-name
HAVING salary > AVG(salary) ;
```

(ii)
```
SELECT e1.employee-name      INNER JOIN                          AS e1
FROM   employee e2, employee e ^ manages M ON e.employee-name = M.employeename ^
WHERE  e2.employee-name IN (SELECT M1.manager-name
                            FROM manages M1)
  AND  e1.employee-name NOT IN (SELECT M2.manager-name
                                FROM manages M2)
  AND  e2.employee-name = e1.manager-name
  AND  e2.street = e1.street
  AND  e2.city = e1.city ;
```

3. c) Average marks not grouped by subject code

```
SELECT    subject-code,  AVG(Marks)
FROM      Students
GROUP BY   subject-code
HAVING     AVG(marks) > 75 ;
```

4. a)

```
CREATE  ASSERTION  appointmentCheck  CHECK (
      NOT EXISTS (
            SELECT   doctorID, date
            FROM     appointments
            GROUP BY   doctorID, date
            HAVING    SUM ( patientID) > 50
      )
);
```

b) 4400

4400

4400

4400

c) view cannot be updated , error occurs.

Ambigious query.

d) Index occupies space on disk and memory thus it would be disadvantage if space is a concern. Also, when data is inserted / updated / deleted, index needs to be maintained by re-indexing, on top of maintaining relational table, thus incurring additional overhead.

4. e) customerInfo (Cid , name , address Country)
customerContact (Cid , phonetype , phoneNum)
customerAddress (Cid , address Country , street, city, prov-state, pcode-zip)