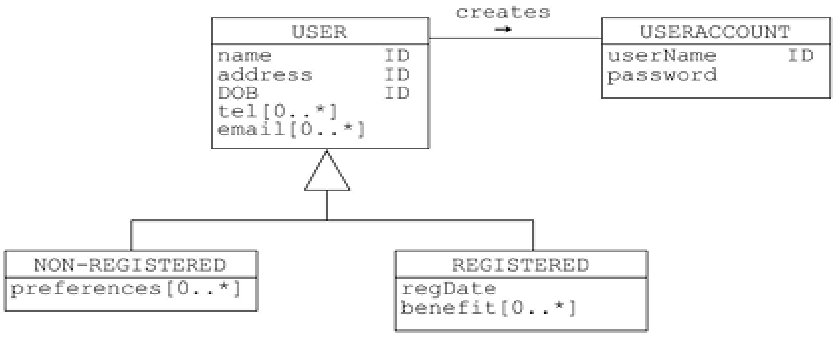
Task 2 (3.0 marks)
Analysis of relational schemas and normalization

Consider the following conceptual schema of a sample database domain that contains information about users, the type of users and the user's account of an application.



The following are partially completed collection of relational schemas.

$\boldsymbol{USER(name, address, DOB, tel[0..*], email[0..*])}$

$\boldsymbol{USERACCOUNT(userName, password)}$

$\boldsymbol{NON-REGISTERED(preferences[0..*])}$

$\boldsymbol{REGISTERED(regDate, benefit[0..*])}$

Schemas Provided

1. USER(name, address, DOB, tel[0..], email[0..])
2. USERACCOUNT(userName, password)
3. NON-REGISTERED(preferences[0..*])
4. REGISTERED(regDate, benefit[0..*])

(i)Find all functional and multivalued dependencies in the relational schemas USER, USERACCOUNT, NON-REGISTERED, and REGISTERED.

USER:

FD: ID → name, address, DOB

MVDs:

ID ↠ tel
ID ↠ email
Because a user can have multiple telephone numbers and multiple emails.

USERACCOUNT:
FD: userName → password, ID
(Each userName is unique; 1:1 mapping to USER)

NON-REGISTERED:
MVD: ID ↠ preferences
(Each non-registered user can have multiple preferences)

REGISTERED:
FD: ID → regDate
MVD: ID ↠ benefit
(A registered user can receive multiple benefits)

(ii)Find all minimal keys in the relational schemas USER, USERACCOUNT, NON-REGISTERED, and REGISTERED. List the derivations of all minimal keys.

USER:
Candidate Key: ID
(From ID, we get name, address, DOB, and also MVDs for tel and email)

USERACCOUNT:
Candidate Key: userName
(userName is unique → gives password, and associated ID)

NON-REGISTERED:
Candidate Key: ID
(MVD ID ↠ preferences → uniquely identifies preferences for each user)

REGISTERED:
Candidate Key: ID
(FD ID → regDate and ID ↠ benefit)

(iii)For each one of the relational schemas find the highest normal form a schema is in. List the justifications for each highest normal form found.

USER:
1NF: Not satisfied unless tel and email are represented in separate rows
2NF/3NF: Doesn’t apply due to multivalued attributes
4NF: Violates 4NF due to:

ID ↠ tel (non-trivial MVD, ID is key)
ID ↠ email
Not in 4NF

USERACCOUNT:
1NF: Atomic values
2NF: All fields depend on full key
3NF: No transitive dependencies
4NF: No MVDs
In 4NF

NON-REGISTERED:
MVD: ID ↠ preferences
No other attributes involved
Not in 4NF

REGISTERED:
ID ↠ benefit
ID → regDate
Not in 4NF (MVD present, ID ↠ benefit)

(iv)Decompose all relational schemas that are not in 4NF into 4NF. List all relational schemas obtained from the decompositions. Remember to indicate the primary key and foreign keys (if any).

USER (decompose MVDs):
USER_MAIN(ID, name, address, DOB)
PK: ID

USER_TEL(ID, tel)
PK: ID + tel
FK: ID → USER_MAIN

USER_EMAIL(ID, email)
PK: ID + email

FK: ID → USER_MAIN

NON-REGISTERED:

NON_REGISTERED_MAIN(ID)
PK: ID

NON_REGISTERED_PREF(ID, preference)
PK: ID + preference
FK: ID → NON_REGISTERED_MAIN

REGISTERED:

REGISTERED_MAIN(ID, regDate)
PK: ID

REGISTERED_BENEFIT(ID, benefit)
PK: ID + benefit
FK: ID → REGISTERED_MAIN