HARARE INSTITUTE OF TECHNOLOGY

SCHOOL OF INFORMATION SCIENCES AND TECHNOLOGY

B. TECH IN INFORMATION SECURITY AND ASSURANCE

B. TECH DEGREE IN INFORMATION TECHNOLOGY

B. TECH DEGREE IN SOFTWARE ENGINEERING

B. TECH DEGREE IN COMPUTER SCIENCE

IIT 123/ISE 124/ICS 124/ISS 128: DATABASE DESIGN CONCEPTS

TIME: 3 HOURS

DATE: MAY/JUNE 2020

INSTRUCTIONS TO CANDIDATES:

- This question paper contains a total of FIVE questions.
- Each question carries 25 marks
- Answer **any FOUR** questions
- Start a new question on a fresh page

ADDITIONAL MATERIALS

- *None*

Question 1

a. A student can access a particular package for a maximum of 18 hours over a predefined period after which the package is unavailable to that particular group of students. Each course has a selection of different packages unique to a particular course. The same course can be offered to students many times for example if they wish to re study.

Using any standard ER modelling notation, produce a **complete** ER model that includes ***all*** the Entity Types highlighted in bold in the scenario resolving any many to many relationships. State any assumptions you made. **[13]**

b. Relational databases are very effective in situations for which they are appropriate. In other situations, simpler file-based solutions may be sufficient. Suppose you are required to implement a system for storing information about a library's books, borrowers, and loans. Give **four (4)** reasons why a database system is superior to a file-based system for this task. Illustrate the answer with suitable examples. **[8]**

c. Explain, using examples, the objectives of the following data modelling stages
   i. Logical **[2]**
   ii. Physical **[2]**

Question 2

a. The three-tier architecture is commonly used to a database management system.
   i. Draw a diagram to illustrate this architecture. **[5]**
   ii. Describe the role of each tier. **[3]**
   iii. Discuss three advantages of this architecture. **[3]**

b. For each of the following two relational concepts, explain using examples the key ideas behind them.
   i. Entity Integrity **[5]**
   ii. Referential Integrity **[5]**

c. List and explain any **two (2)** main functions of a database administrator. **[4]**

Question 3

An SQL developer is bidding for a new contract with a prestigious blue-chip organization. Part of the selection process is a technical interview. Answer the following questions from the interview panel:

a. For each of the following terms, explain what the term stands for, the essence of the functions it provides and a set of example SQL statements (at least **two** for each) that implement these functions:
   i. DDL **[4]**
   ii. DML **[4]**

b. Explain the differences between LEFT, RIGHT OUTER JOIN and INNER JOIN. **[3]**

c. Refer to the tables C3.1 and C3.2 below for the following question.

C3.1 transactions

transaction_id	account_id	transaction_date	Amount
7659897	93008	12/4/2017	3.67
7659898	93008	12/4/2017	12.99
7743433	93008	13/4/2017	-7.99
7935320	331449	13/4/2017	-14.76
8756571	93008	13/4/2017	-5.99

C3.2 accounts

account_id	sort_code	account_type	Balance
93008	30-54-87	Direct Debit	362.74
331449	31-12-54	Credit	320.26
57746	30-54-87	On-Line Saver	1295.60

16227	12-32-18	Direct Debit	-550.93

i. List the results of running both the following queries (Query A and Query B) and then describe in a few sentences how these results are produced. **[8]**

Query A:

```
SELECT COUNT(*), account_type
FROM accounts
WHERE balance < 4000
GROUP BY account_type
HAVING COUNT(*) > 1;
```

Query B:

```
SELECT SUM(AMOUNT), t.account_id, transaction_date
FROM transactions t
WHERE t.account_id IN (SELECT a.account_id FROM accounts a WHERE
                       account_type <> 'On-Line Saver')
GROUP BY t.account_id, transaction_date
ORDER BY SUM(amount) ASC;
```

d. Write a SQL query that produces the same output as query B, but instead uses an INNER JOIN operator. For guidance, the syntax of an INNER JOIN operator is:

INNER JOIN <tablea name> ON <tablea.columna> = <tableb.columna> where columna is the matching column in tablea and tableb **[6]**

Question 4

a. Explain the term candidate key [2]

b. List **three (3)** candidate keys from the following table [6]

A	B	C	D
a1	b1	c1	d1
a2	b3	c3	d1
a1	b2	c1	d2

c. Explain what is meant by a functional dependency and give an example. [3]

d. Identify **two (2)** functional dependencies in the following table [4]

A	B	C
a1	b1	c1
a1	b1	c3
a1	b2	c1

e. A company places orders for items. Each order is placed on a given date, and may include a variety of items in different quantities. The following table shows a sample of orders. The Primary Key is (OrderNo, ItemNo).

Orders

ORDERNO	ITEMNO	ITEMDESCRIPTION	DATE	QUANTITY
1	1	Screw	Jan 6th	100
1	2	Bolt	Jan 6th	50
2	3	Flange	Feb 2nd	10

2	2	Bolt	Feb 2nd	40
2	1	Screw	Feb 2nd	80

i. Describe **two (2)** types of anomalies that could be caused by update, insert or delete operations giving an example of each, with reference to the above table. **[6]**

ii. Transform the table into 2^{nd} normal form. Show the structures of the resultant tables. **[4]**

Question 5

a. Explain what is meant by a transaction and why it is an important unit of operation in a DBMS? **[3]**

b. Discuss how the log file is a fundamental feature in any database recovery mechanism. **[4]**

c. Describe, with an example, any type of problem that can occur in a multi-user environment when concurrent access to the database is allowed. **[6]**

d. Discuss the "ACID" properties of transactions. Give examples to illustrate your answer. **[12]**

**********END OF EXAMINATION*******