Strathmore
UNIVERSITY

FACULTY OF INFORMATION TECHNOLOGY
BACHELOR OF BUSINESS INFORMATION TECHNOLOGY
FINAL EXAM
BBT3104: ADVANCED DATABASE SYSTEMS

DATE: 19th July 2019 Time: 2 Hours

Instructions

1. This EXAM consists of **FIVE** questions.
2. Answer Question ONE (COMPULSORY) and any other TWO questions.
3. All SQL statements should be written to run on a **MySQL** or **MariaDB** DBMS unless stated otherwise.
4. Please **BE NEAT** and ensure your handwriting is **LEGIBLE**.

QUESTION ONE *(30 marks)*

SUPPOSE that the Payroll Office has requested for your services as the Database Administrator to compute the individual income tax for employees in the HR database. This computation is based on the pre-determined Pay-As-You-Earn (PAYE) formula that is already being used by the Payroll Office. PAYE is the process by which a government (through its Revenue Authority) collects employees' income tax directly from the employer. It is the employer's statutory duty to deduct income tax from the remuneration of all employees who earn a monthly salary of more than KES. 11,135. The company you work for applies the following tax rates stipulated by the government:

Monthly Taxable Income Range (KES)	**Taxable Income (KES)** *(i.e. the total amount in this income range)*	**Tax Rate (%)**	**Income Tax Charged**
0 - 12,298.99	$12{,}298 - 0 = 12{,}298.99$	10	$10\% \times 12{,}298.99$
12,299 - 23,885.99	$23{,}885.99 - 12{,}299 = 11{,}586.99$	15	$15\% \times 11{,}586.99$
23,886 - 35,472.99	$35{,}472.99 - 28{,}886 = 11{,}586.99$	20	$20\% \times 11{,}586.99$
35,473 - 47,059.99	$47{,}059.99 - 35{,}473 = 11{,}586.99$	25	$25\% \times 11{,}586.99$
47,060 and above	$< total\ taxable\ income > - 47{,}060 = x$	30	$30\% \times x$

For example, if an employee's taxable income is KES. 38,500 per month, then the total income tax the employee is expected to pay to the government is KES. 6,042.00 per month. This is computed as follows:

Monthly Taxable Income Range (KES)	Taxable Income (KES)	Tax Rate (%)	Income Tax Charged
0 - 12,298.99	12,298.99	10	1,229.80
12,299 - 23,885.99	11,586.99	15	1,738.05
23,886 - 35,472.99	11,586.99	20	2,317.40
35,473 - 47,059.99	3,027	25	756.75
47,060 and above	-	30	-
TOTAL	**≈38,500**		**6,042.00**

Through meetings between the Payroll Office and the IT Department's database team, the following algorithm has been stipulated as the formula used to calculate an individual employee's PAYE income tax in the organization you are working for.

Algorithm 1 BBIT Advanced DB July 2018 Exam - Compute Pay-As-You-Earn

```
1: function PAYE(employeeID)
2:     sal = salary of employeeID
3:     tax = 0.00
4:     if sal > 11,135 then
5:         if sal ≥ 12,298.99 then
6:             tax = tax + (0.1 * 12,298.99)
7:         else if sal < 12,298.99 then
8:             tax = tax + (0.1 * sal)
9:         end if
10:        if sal ≥ 23,885.99 then
11:            tax = tax + (0.15 * 11,586.99)
12:        else if sal < 23,885.99 and sal > 12,299 then
13:            tax = tax + (0.15 * (sal − 12,299))
14:        end if
15:        if sal ≥ 35,472.99 then
16:            tax = tax + (0.2 * 11,586.99)
17:        else if sal < 35,472.99 and sal > 23,886 then
18:            tax = tax + (0.2 * (sal − 23,886))
19:        end if
20:        if sal ≥ 47,059.99 then
21:            tax = tax + (0.25 * 11,586.99)
22:        else if sal < 47,059.99 and sal > 35,473 then
23:            tax = tax + (0.25 * (sal − 35,473))
24:        end if
25:        if sal ≥ 47,060 then
26:            tax = tax + (0.3 * (sal − 47,060))
27:        end if
28:        Return TOTAL monthly PAYE income tax of employeeID as tax
29:    end if
30: end function
```

a) Draw a flowchart to represent this algorithm *(2 marks)*

b) Create an SQL stored procedure called *proc_PAYE* to implement this algorithm. The stored procedure should accept the employee's ID as input and provide output as the tax that the individual employee is required to pay *(7 marks)*

c) Provide the code that the Payroll Office can use to call the stored procedure specified in (b) and to output the result *(3 marks)*

d) The company has 2,905 residential employees countrywide. Subsequently, a few days later the Payroll Office request for an easier way to get the income tax of all employees in the database using one command instead of a stored procedure that calculates the income tax for only one employee at a time. Create an SQL function called *func_PAYE* to compute the income tax of all the 2,905 employees. The function should be called only once to get the income tax for each of the 2,905 employees and its input should be the employee's salary. *(7 marks)*

e) SUPPOSE that the employee data is stored in a table called "*employee*". The attribute *emp_ID* stores the employee's ID and the attribute *emp_salary* stores the employee's salary. Provide the code that the Payroll Office can use to call the function specified in (d) so that the output has the following format: *(3 marks)*

Employee ID	Taxable Income	Income Tax Charged
1		
2		
3		
⋮		
2,905		

f) The Payroll Office is still not yet satisfied and has requested for an even simpler way to view the income tax of each of the 2,905 employees. The database team finally decides to create for them a simple view which they can invoke by executing the following statement:

```
SELECT * FROM view_PAYE;
```

The result should have the following format:

view_PAYE Employee ID	Employee Salary	Income Tax Charged
1		
2		
3		
⋮		
2,905		

Provide the code that can be used to create the view called "view_PAYE". The view can make use of the function called *func_PAYE* defined in (d). *(8 marks)*

QUESTION TWO *(15 marks)*

a) SUPPOSE that you are the team-leader of the database team in a project. A few of your team members are getting frustrated with the amount of repetition involved. They prefer to create the tables immediately and move on with other sections of the project. Explain to them the value of conducting database design in an iterative manner *(5 marks)*

b) SUPPOSE that a first-year student is working on a project to map units being taught to the lecturers who teach them as well as to the core reading materials for the unit based on the course outline. The main purpose of this system is to help students to know the most relevant reading materials for each unit when using the University library. The first-year student comes up with the following relation to store the data:

unit code	lecturer	core reading material

i. Explain to the first-year student what a Multi-Valued Dependency is *(2 marks)*

ii. Explain to the first-year student how the Multi-Valued Dependency has been formed in the proposed relation *(3 marks)*

iii. Normalize the relation to the fourth normal form (4NF) and show how the database will look if the relation is in 4NF. *(5 marks)*

QUESTION THREE *(15 marks)*

SUPPOSE that you are not satisfied with what current open-source Database Management Systems (DBMSs) have to offer. You therefore decide to embark on a project to create an entire DBMS that is customized to suite performance requirements in the context of a business.

a) Even though storing data in main memory (RAM) can increase the speed of data access, you opt to store the data in mass storage (the Hard Disk Drive). Explain factors that would lead you to make this decision. *(6 marks)*

b) The database contains data that is stored in sectors on the mass storage device. Noting that the performance of the DBMS is dependent on the underlying hardware capabilities, during the testing phase of the development, you decide to determine the total time it takes to access a sector that stores data. Explain, in detail, the components that constitute the total time it takes to access a sector. *(9 marks)*

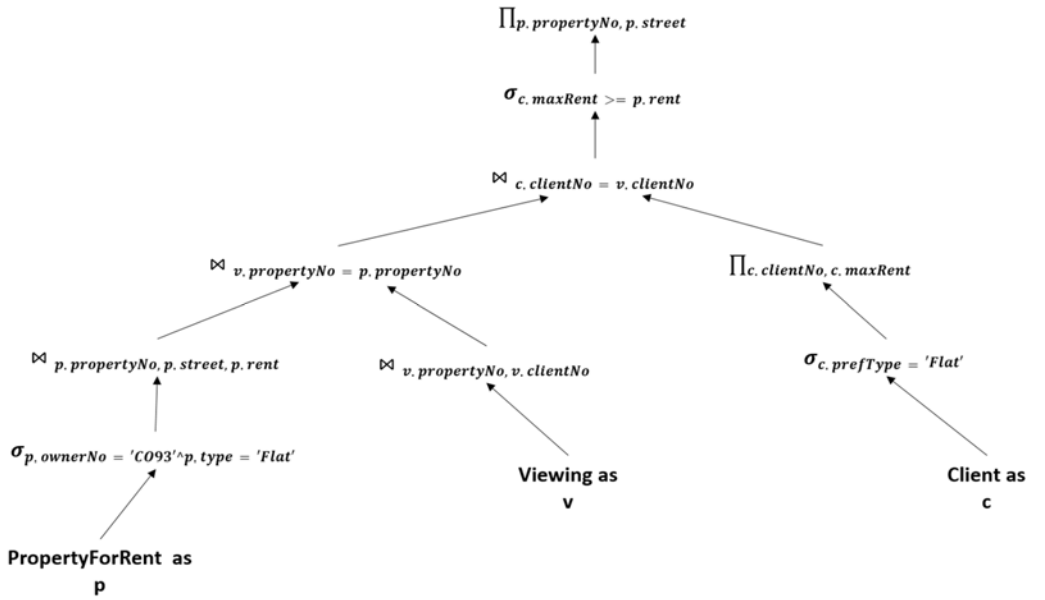
QUESTION FOUR *(15 marks)*

a) Which of the following statements is/are true?
   a. A relation can still be in BCNF if it is not in 4NF
   b. A relation is in BCNF if every determinant of the relation is a candidate key
   c. BCNF more strict than 3NF
   d. A relation can still be in BCNF if it is not in 4NF
   e. None

   (3 marks)

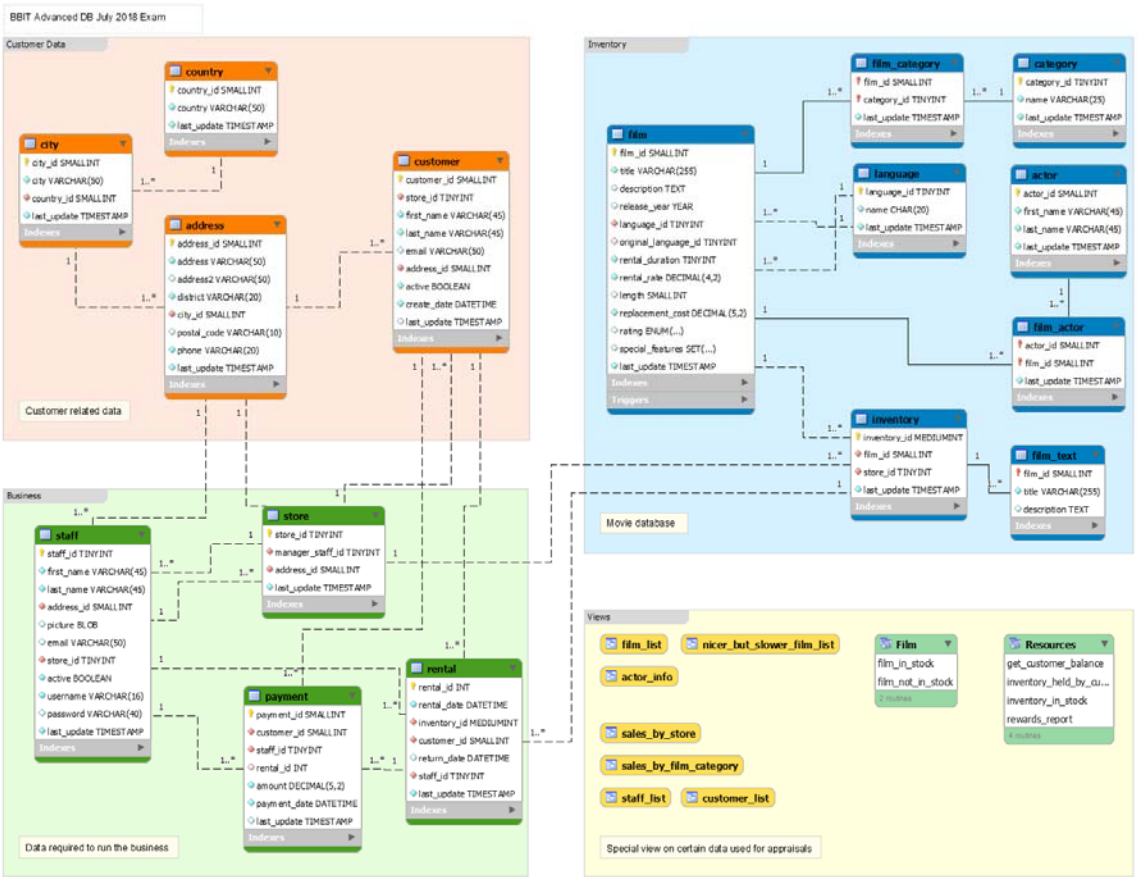
b) Use an appropriate, database-related example to differentiate between an intrarelational integrity constraint and an interrelational integrity constraint *(2 marks)*

c) Convert the following relational algebra tree into its equivalent SELECT statement *(10 marks)*



QUESTION FIVE *(15 marks)*

SUPPOSE that after finishing your third year of the prestigious Bachelor of Business Information Technology course, you start an internship at a company called "Sakila". One of your roles is to assist the Senior Database Administrator. The senior Database Administrator provides you with the following database schema during your third week at the company so that you can use it to understand the structure of the database.



a) The inventory management officer in the company requires a view that shows only the *film_id, title,* and *description*. One of your colleagues suggests that another table called *film_text* that contains these three attributes should be created.

   (i) Provide the code to create a trigger called "*trg_inv_film*" that duplicates INSERT operations on the *film* relation to the *film_text* relation. This duplication should be done after inserting a tuple into the *film* relation. For example, if the relation *film* has 6,000 tuples and the 6,001 tuple is inserted into *film*, immediately after it is inserted the trigger should be automatically fired in order to create a similar 6,001 tuple in the *film_text* relation. *(6 marks)*

   (ii) Explain to the senior Database Administrator why creating a view would be a better alternative than creating a trigger in this case *(4 marks)*

b) You realize that using an index can improve the performance of a query being processed. Create an index called "*ind_film_text_title*" that is of the type B-Tree on the *film_text.title* attribute *(5 marks)*