ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2020
EXAMINATION CATEGORY: <u>TECHNICAL</u>

PAPER III: SUBJECT SPECIALISATION PAPER FOR ICT

Date	: February 27, 2021
Total Marks	: 100
Writing Time	: 150 minutes (2.5 hours)
Reading Time	: 15 minutes (prior to writing time)

GENERAL INSTRUCTIONS:

1. Write your Registration Number clearly and correctly on the Answer Booklet.

2. The first 15 minutes is being provided to check the number of pages of the Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.

3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:

   - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions

     Part II - 4 Short Answer Questions

     All questions under SECTION A are COMPULSORY.

   - **SECTION B** consists of two Case Studies. Choose only **ONE** case study and answer the questions of your choice.

4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.

5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.

6. Begin each Section and Part on a fresh page of the Answer Booklet.

7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.

8. Use of any other paper including paper for rough work is not permitted.

9. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**

10. This paper has **11 printed pages**, including this instruction page.

GOOD LUCK!

SECTION A

### PART I: Multiple Choice Questions [30 marks]

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. Data warehouse architecture is based on
    a) DBMS
    b) RDBMS
    c) SQL
    d) ORACLE

2. Which of the following is NOT one of the standard message exchanges between a DHCP client and a DHCP server?
    a) Acknowledge
    b) Offer
    c) Discover
    d) Sync

3. What are the attributes of good software?
    a) Software maintainability and functionality.
    b) Software maintainability and development.
    c) Software functionality and development.
    d) All of the above.

4. In C programming, the output of the following code will be

```
#include <stdio.h>
main( )
{
        int n = 0, m = 0;
        if ( n > 0)
           if (m > 0)
              printf("True");
        else
           printf("False");
}
```

    a) True
    b) False
    c) No output will be printed
    d) Run Time Error

5. What is the default size of the Maximum Transmission Unit (MTU) for Ethernet?

    a) 64,000 bytes
    b) 1500 bytes
    c) 2900 bytes
    d) 9000 bytes

6. Key to represent relationship between tables in database is called

    a) Primary key
    b) Secondary key
    c) Foreign key
    d) Derived key

7. In the diagram shown below, L1 is an Ethernet LAN and L2 is a Token-Ring LAN. An IP packet originates from sender S and traverses to R, as shown. The link within each ISP, and across two ISPs, are all point to point optical links. The initial value of TTL is 32. The maximum possible value of TTL field when R receives the datagram is:
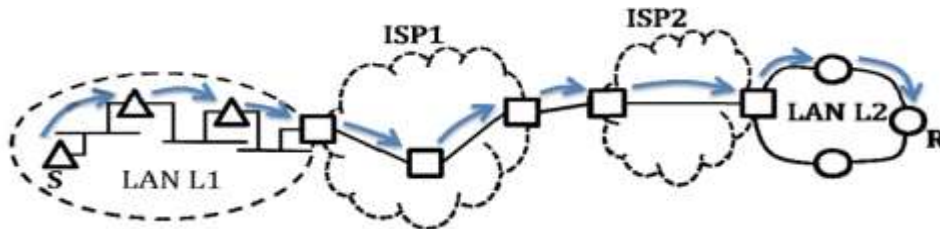
    a) 24
    b) 25
    c) 26
    d) 28

8. What is java bytecode?

    a) Machine-specific code
    b) Java code
    c) Machine-independent code
    d) None of the above

9. A digital signature is

    a) A scanned signature
    b) Signature in binary form
    c) Encrypting information
    d) Signature stored in cloud

10. Which one of the following statements is FALSE?

    a) TCP guarantees a minimum communication rate.
    b) TCP ensures in-order delivery.
    c) TCP reacts to congestion by reducing sender window size.
    d) TCP employs retransmission to compensate for packet loss.

11. During a team meeting, a team member suggests an enhancement to the scope of work that is beyond the scope of the project chart. The project manager points out that the team needs to concentrate on completing all the work and only the work requires. This is an example of
    a) Change management process
    b) Scope management
    c) Quality analysis
    d) Scope decomposition

12. Assume that source "S" and destination "D" are connected through two intermediate routers labelled R as show in the diagram. Determine how many times each packet has to visit the network layer and the data link layer during a transmission from S to D.

    a) Network layer – 4 times and Data link layer – 4 times
    b) Network layer – 4 times and Data link layer – 3 times
    c) Network layer – 4 times and Data link layer – 6 times
    d) Network layer – 2 times and Data link layer – 6 times

13. A network of physical objects or things embedded with electronics or software is
    a) Artificial Intelligence (AI)
    b) Machine Learning (ML)
    c) Internet-of-Thing (IOT)
    d) Internet

14. Bit stuffing refers to
    a) inserting a '0' in flag stream to avoid ambiguity.
    b) appending a nibble to the flag sequence.
    c) inserting a '0' in user stream to differentiate it with a flag.
    d) appending a nibble to the use data stream.

15. _____ represents a particular instance of a class in object-oriented programming (OOP).
    a) Module
    b) Block
    c) Object
    d) Token

16. One of the header fields in an IP datagram is the Time to Live (TTL) field. Which of the following statements best explains the need for this field?
    a) It can be used to prioritize packets.
    b) It can be used to reduce delays.
    c) It can be used to optimize throughput.
    d) It can be used to prevent packet looping.

17. What are the notations for the Use case Diagrams?
    a) Use case
    b) Actor
    c) Prototype
    d) Use case and Actor

18. Identify the correct sequence in which the following packets are transmitted on the network by a host when a browser requests a webpage from a remote server, assuming that the host has just been restarted.
    a) HTTP GET request, DNS query, TCP SYN
    b) DNS query, HTTP GET request, TCP SYN
    c) DNS query, TCP SYN, HTTP GET request
    d) TCP SYN, DNS query, HTTP GET request

19. What does a simple name in UML Class and objects consist of?
    a) Letters
    b) Digits
    c) Punctuation Characters
    d) All of the above

20. The network protocol which is used to get MAC address of a node by providing IP address is
    a) SMTP
    b) RIP
    c) BOOTP
    d) ARP

21. Which one of the following is used to define the structure of the relation, deleting relations and relating schemas?
    a) Data Manipulation Language – DML
    b) Data Definition Language – DDL
    c) Query
    d) Relational Schema

22. Which protocol will be used to automate the IP configuration mechanism which includes IP address, subnet mask, default gateway, and DNS information?
    a) SMTP
    b) DHCP
    c) ARP
    d) TCP/IP

23. Which one of the following is the most complete cloud computing service model?
    a) PaaS
    b) IaaS
    c) CaaS
    d) SaaS

24. TCP/IP model does not have _____ but OSI model have this layer.
    a) session layer
    b) transport layer
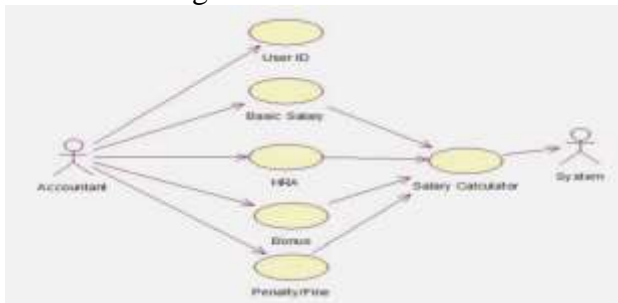   c) application layer
    d) network layer

25. Tables in Second Normal Form (2NF)
    a) eliminate all hidden dependencies.
    b) eliminate the possibility of an insertion anomalies.
    c) have composite key.
    d) have all non-key fields depend on the whole primary key.

26. How many /64 networks can be build from a /48 IPv6 allocation?
    a) 2^{64}
    b) 2^{8}
    c) 2^{16}
    d) 2^{80}

27. Which UML diagram is shown below?

    a) Use Case Diagram
    b) Collaboration Diagram
    c) Class Diagram
    d) Object Diagram

28. Which one of the following is not provided as a service in cloud computing?
    a) Infrastructure as a service
    b) Architecture as a service
    c) Software as a service
    d) Platform as a service

29. An Internet Service Provider (ISP) has the following chunk of CIDR-based IP addresses available with it: 245.248.128.0/20. The ISP wants to give half of this chunk of addresses to Organisation A, and a quarter to Organisation B, while retaining the remaining with itself. Which of the following is a valid allocation of addresses to A and B?
    a) 245.248.136.0/21 and 245.248.128.0/22
    b) 245.248.128.0/21 and 245.248.128.0/22
    c) 245.248.132.0/22 and 245.248.132.0/21
    d) 245.248.136.0/24 and 245.248.132.0/21

30. What are the first two hexadecimal characters in an IPv6 Multicast address?
    a) FE
    b) FF
    c) 20
    d) 1F

PART II – Short Answer Questions [20 marks]

This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks. Mark for each sub-question is indicated in the brackets.

1. Superclass called **Animal** have a method called animalSound() as shown below. Subclasses of Animals could be **Pigs, Cats** and **Dogs** with their own sound as "the pig oinks", "the cat meows" and "the dog barks". Using Polymorphism, write the subclasses and complete the main function to print all their sounds. (5 marks)

```
//Superclass
class Animal {
        public void animalSound( ) {
                System.out.println("The animal makes a sound");
        }
}

//Subclasses
……..
……..
……..

class Main {
        public static void main (String[] args) {
                ……
                …….
                …….
        }
}
```

2. What is e-Governance? Describe four types of e-Governance. (1+4 marks)

3. Illustrate IPv4 Header Format. List down and explain any five IP header fields. (5 marks)

4. A central office is maintaining the record of their employees as follows:

ID	FirstName	MiddleName	LastName	Department	Position	Salary
1	Sonam		Dorji	IT	Chief	30000
2	Pema	Dorji	Tshering	Accounts	DCFO	25000
3	Sangay	Lhamo	Dorji	ADM	Adm	20000
4	Tshering		Dema	IT	ITO	20000

Based on the above record, answer the following questions:

a) Write SQL query to create above table (1.5 marks)

b) Write SQL query to insert new record with the following details. (1.5 marks)

Name: Sangay Penjor
Department: ADM
Position: Chief Adm
Salary: 30000

c) Write SQL query to fetch the records whose salary is more than 20000 and belongs to IT department. (2 marks)

SECTION B: CASE STUDY [50 marks]

Choose either CASE I or CASE II from this section. Each case study carries 50 marks. Mark for each sub-question is indicated in the brackets.

CASE I

Jigme Dorji Wangchuk Public Library (JDWPL) has been a place for the public and student to get access to the public library for reading and/or to borrow the books for certain duration. With the increasing number of interested visitors, the JDWPL management is looking forward to the adoption of ICT system for the better management.

For the task, you are hired to design and develop Library Management System.

The Library management system is to manage asset collections as well as relationships with their members. Library management system helps librarians keep track of the books and their checkouts, as well as members' subscriptions and profiles.

Library management system also involve maintaining the database for entering new books and recording books that have been borrowed with their respective due dates.

You should consider the following set of requirements while designing the Library Management System:

- Any library member should be able to search books by their title, author, subject category as well by the publication date.

- Each book will have a unique identification number and other details including a rack number which will help to physically locate the book.

- There could be more than one copy of a book, and library members should be able to check-out and reserve any copy. We will call each copy of a book, a **book item**.

- The system should be able to retrieve information like who has taken the particular book or what are the books checked-out by a specific library member.

- There should be a maximum limit (5) on how many books a member can check-out.

- There should be a maximum limit (10) on how many days a member can keep a book.

- The system should be able to collect fines for books returned after the due date.

- Members should be able to reserve books that are not currently available.

- The system should be able to send notifications whenever the reserved books become available, as well as when the book is not returned within the due date.

- Each book and member card will have a unique barcode. The system will be able to read barcodes from books and members' library cards.

1. Identify the actors and design use case diagram for the following use cases:
   a) Add/Remove/Edit book: To add, remove or modify a book. (2 marks)
   b) Search catalog: To search books by title, author, subject or publication date. (2 marks)
   c) Librarian Issue book, and Member or Librarian checkout book. (2 marks)
   d) Mention applicable Use case relationships to demonstrate <<include>> and <<extend>>.
   (2 marks)

2. Draw a Class Diagram for the User class, Book class and other related classes to implement following methods checkoutStatus( ), getAuthorName( ), getBookTitle( ), getReturnDate( ).
   (2+2+2+2 marks)

3. Draw Activity Diagram for the "Check-out a book". (8 marks)

4. What is Software Development Life Cycle (SDLC)? Explain briefly five major phases of SDLC.
   (1+5 marks)

5. State two advantages and two disadvantages of Waterfall Model. (4 marks)

6. Differentiate between function and non-functional requirements. Specify two non-functional requirements from the above case study. (4+2 marks)

7. Differentiate Entity Relationship Diagram (ERD) from Class Diagram. Draw ER-Diagram in relation to Q2. (2+8 marks)

CASE II

Network Design

You are an ICT Officer at the Jigme Dorji Wangchuck National Referral Hospital (JDWNRH) and is responsible for managing the network. The hospital is growing and the management is moving towards digitalizing health system including introduction of electronic Patience Information System (e-PIS). The management of the hospital has released funds for network improvements. You are therefore asked to propose a network solution that will meet the hospital's requirements.

The hospital has two buildings – Building-I and Building-II. There are 4 departments, namely Dentistry (60 Computers), Dermatology (100 Computers), Forensic Medicine (90 Computers) and ENT (40 Computers) in Building-I. All the departments are required to operate in a separate network segments and are located in different floors. Dentistry is in the Ground Floor, Dermatology department in the 1st Floor, Forensic Medicine and ENT departments are in the 2nd and 3rd Floors respectively. Building-II has an Emergency department on 1st Floor with 200 Computers and has a data center located in the ground floor. Patient rooms are on floors 2 through 4 of the hospital Building-II.

The hospital has purchased 10 new servers to host 20 health services and 10 other Financial/Human Resource administration related services. All servers are placed in the data center and must have high availability. Only 10 health services should be made available to public over Internet while all the services should be made available for staffs accessing it from within hospital's local area network.

The hospital's border router located in the data center is connected to its upstream Internet Service Provider called Druk Research and Education Network (DrukREN). DrukREN has assigned 103.197.176.0 /28 IPv4 and 2001:DB8:8::/48 IPv6 addresses.

The hospital wants to provide Internet access to all its staffs. Additionally, the medical staff would like to be able to access Internet and medical systems hosted in the data center using their portable devices from any of the patient rooms. Doctors and nurses should be able to access patient medical records, x-rays, prescriptions, and recent patient information. The wireless LAN (WLAN) has approximately 200 portable devices (laptops, Tablets and mobile devices). A radio-frequency report mentions that a single access point located in each communication closet can reach all the patient rooms on each floor.

1. What is the network's technical requirements? (2 marks)

2. Prepare a logical network diagram of JDWNRH based on the information given in the case study. (5 marks)

3. What do you mean by CIDR in IP Addressing? Give one example. (2 marks)

4. A Network Engineer in the Ministry of Information and Communications has suggested you to implement NAT in your network.

   a) What does NAT stand for? (1 mark)

   b) What does NAT do? (1 mark)

   c) Explain three types of NAT. (3 marks)

5. State three differences between IPv4 and IPv6 Addresses. (3 marks)

6. A computer in the Dentistry Department has auto-generated a Link Local IPv6 Address – "*FE80::C800:0EFF:FE74:0008*" using EUI-64 method. Calculate the MAC address of the computer. (5 marks)

7. Prepare IPv4 Address Plan for JDWNRH. In addition to DrukREN Public IP Addresses, you are provided with 172.16.7.0/22 private IPv4 Address space to design your LAN. (10 marks)

8. Prepare IPv6 Address Plan for JDWNRH. (10 marks)

9. The management of the hospital has decided to provide Internet access to all the patients admitted in the patient rooms of the hospital. What changes would you make in your network and why? (5 marks)

10. JDWNRH Hospital Management has decided to extend e-PIS system access to doctors and nurses in Mongar Regional Referral Hospital over DrukREN. Explain how you would ensure secure connection between the two hospitals. (3 marks)

TASHI DELEK