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ROYAL GOVERNMENT OF BHUTAN
ROYAL CIVIL SERVICE COMMISSION

BHUTAN CIVIL SERVICE EXAMINATION 2024

MAIN EXAMINATION

OCTOBER 4, 2024

CATEGORY: TECHNICAL (ENGINEERING)

PAPER II: GENERAL SUBJECT KNOWLEDGE

ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2024
EXAMINATION CATEGORY: <u>TECHNICAL</u>
PAPER II: GENERAL SUBJECT KNOWLEDGE PAPER FOR <u>ENGINEERING</u>

Date   : October 4, 2024
Total Marks   : 100
Examination Time   : 90 minutes (1.5 hours)
Reading Time   : 15 Minutes (prior to examination time)

GENERAL INSTRUCTIONS:

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

2. The first 15 minutes is 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 parts: Part I & Part II.**

    Part I consists of 70 multiple choice questions of 1 (one) mark each, and
    Part II consists of 10 short answer questions of 3 (three) marks each.

4. All questions are COMPULSORY

5. 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.

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

7. Begin each Part on a fresh page of the Answer Booklet.

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

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

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

11. The Question paper has **16 printed pages,** including this Instruction Page.

GOOD LUCK!

PART I
Multiple Choice Questions [70 marks]

Choose the correct answer and write down the letter of the correct answer chosen in the Answer Booklet against the question number. e.g. 71 (a). Each question carries ONE mark. Any double writing, smudgy answer or writing more than one choice shall not be evaluated.

SECTION A: MATHEMATICS

1) Let N be the set of natural numbers and R be the relation in N defined as R = {(a, b) : a = b – 2, b > 6}. Then which of the following is correct?

    a) $(2, 4) \in R$
    b) $(3, 8) \in R$
    c) $(6, 8) \in R$
    d) $(8, 7) \in R$.

2) The range of the function $f(x) = \tan^{-1}(x)$ is:
    a) $[-\infty, \infty]$
    b) $[0, \pi/2]$
    c) $[-\pi/2, \pi/2]$
    d) $(-\pi/2, -\pi/2)$

3) The value of $\cot^{-1}9 + \csc^{-1}(41\sqrt{4})$ is given by

    a) 0
    b) $\pi/4$
    c) $\tan^{-1}2$
    d) $\pi/2$

4) If $A = [a_{ij}]$ is a square matrix of order 2 such that $a_{ij} = 1$, when $i \neq j$ and $a_{ij} = 0$, when $i = j$, then A^2 is

    a) $\begin{bmatrix} 1 & 0 \\ 1 & 0 \end{bmatrix}$

    b) $\begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix}$

    c) $\begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix}$

    d) $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

5) If $A = \begin{bmatrix} x & 2 \\ 4 & 3 \end{bmatrix}$ and $A^{-1} = \begin{bmatrix} \frac{1}{8} & -\frac{1}{12} \\ -\frac{1}{6} & \frac{4}{9} \end{bmatrix}$, then find the value of 'x'.

 a) 28/3
 b) 32/3
 c) 34/3
 d) 10

6) The number of distinct real roots of $= \begin{vmatrix} sinx & cosx & cosx \\ cosx & sinx & cosx \\ cosx & cosx & sinx \end{vmatrix} = 0$ in the interval $-\pi/4 \le x \le \pi/4$ is

 a) 0
 b) 2
 c) 1
 d) 3

7) If the function $f(x) = (2x - \sin^{-1}x) / (2x + \tan^{-1}x)$ is continuous at each point of its domain, then the value of f(0) is

 a) 1/3
 b) -1/3
 c) 2/3
 d) 2

8) The point(s) on the curve $y = x^2$, at which y-coordinate is changing six times as fast as x-coordinate is

 a) (6, 2)
 b) (2, 4)
 c) (3, 9)
 d) (9, 3)

9) If $\int sec^2(7 - 4x)dx = a \tan (7 - 4x) + C$, then value of a is

 a) -4
 b) -1/4
 c) 3
 d) 7

10) The area bounded by the curves y=cosx, y=sinx, Y-axis and $0 \le x \le \pi/4$ is _____.

   a) $2(\sqrt{2}-1)$
   b) $\sqrt{2}-1$
   c) $\sqrt{2}+1$
   d) $\sqrt{2}$

11) The area bounded by the lines y = |x| - 1 and y = -|x| + 1 is

   a) 1 sq. unit
   b) 2 sq. unit
   c) $2\sqrt{2}$ sq. unit
   d) 4 sq. unit

12) The order and degree of the differential equation are

$$(\frac{d^2y}{dx^3})^2 - 3\frac{d^2y}{dx^2} + 2(\frac{dy}{dx})^4 = y^4$$

   a) (1,4)
   b) (3,4)
   c) (2,4)
   d) (3,2)

13) If $\vec{a} = 2\hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{b} = -\hat{i} + 2\hat{j} + \hat{k}$ and $\vec{c} = 3\hat{i} + \hat{j}$ are such that $\vec{a} + \gamma\vec{b}$ is perpendicular to $\vec{c}$, then determine the value of γ.

   a) 3
   b) 0
   c) 4
   d) 8

14) Minimize $Z = 20x_1 + 9x_2$, subject to $x_1 \ge 0$, $x_2 \ge 0$, $2x_1 + 2x_2 \ge 36$, $6x_1 + x_2 \ge 60$.

   a) 360 at (18, 0)
   b) 336 at (6, 4)
   c) 540 at (0, 60)
   d) 0 at (0, 0)

15) A person writes 4 letters and addresses 4 envelopes. If the letters are placed in the envelopes at random, then the probability that all letters are not placed in the right envelope is

   a) 23/24
   b) 15/24
   c) 11/24
   d) 1/4

16) $\int_0^{2/3} \frac{dx}{4+9x^2}$ equals to

a) $\frac{\pi}{6}$

b) $\frac{\pi}{12}$

c) $\frac{\pi}{24}$

d) $\frac{\pi}{4}$

17) If $6\sin^{-1}(x^2-6x+8.5) = \pi$, then x is equal to
   a) 1
   b) 2
   c) 3
   d) 8

18) The area of the square that can be inscribed in a circle of 8 cm is

   a) 256 cm^2
   b) 128 cm^2
   c) 64√2 cm^2
   d) 64 cm^2

19) Find the limit of the function $\lim_{x \to 0} \frac{tanx-sinx}{x^3}$.
   a) 1
   b) 2
   c) $\frac{1}{2}$
   d) π

20) For the following probability distribution, E(X) is equal to

X	-4	-3	-2	-1	0
PX	0.1	0.2	0.3	0.2	0.2

   a) 0
   b) -1
   c) -2
   d) -1.8

SECTION B: CHEMISTRY

21) $P_4 + 3NaOH + 3H_2O \longrightarrow$ "A" $+ 3NaH_2PO_2$. "A" is_____.
   a) NH_3
   b) PH_3
   c) H_3PO_4
   d) H_3PO_3

22) Lead is soluble in _____.
   a) CH_3COOH
   b) H_2SO_4
   c) HCl
   d) HNO_3

23) Modern periodic table is based on the atomic number of the elements. The experiment which proved the significance of the atomic number was
   a) Millikan's oil drop experiment
   b) Moseley's work on -ray spectra
   c) Bragg's work on -ray diffraction
   d) Discovery of -rays by Rontgen

24) If the difference in electronegativities of two elements is very large, then
   a) The bond is 50% ionic
   b) The bond is 100% covalent
   c) The bond is more covalent than ionic
   d) The bond is more ionic than covalent

25) The boiling point of benzene is 353.23 K. When 1.80 gm of a nonvolatile solute was dissolved in 90 gm of benzene, the boiling point is raised to 354.11 K. The molar mass of the solute is [K_b for benzene= $2.53Kmol^{-1}$]
   a) $5.8gmol^{-1}$
   b) $0.58mol^{-1}$
   c) $58mol^{-1}$
   d) $88\ mol^{-1}$

26) Leaching of silver and gold ores are done by
   a) NaCN/KCN
   b) $NaOH/Na_2CO_3$
   c) NaCl/KCl
   d) C/CO

27) Which of the following aqueous solutions have the highest boiling point?
   a) 1.0 M NaOH
   b) 1.0 M Na_2SO_4
   c) 1.0 M NH_4NO_3
   d) 1.0 M KNO_3

28) The set with the correct order of acidity is
   a) $HClO < HClO_2 < HClO_3 < HClO_4$
   b) $HClO_4 < HClO_3 < HClO_2 < HClO$
   c) $HClO_4 < HClO_3 < HClO < HClO_2$
   d) $HClO_3 < HClO_2 < HClO < HClO_4$

29) The most basic compound amongst the following is
   a) benzylamine
   b) aniline
   c) acetanilide
   d) p-nitroaniline

30) What is the hybridization of Xe in $XeOF_4$?
   a) sp^3d
   b) sp^3d^2
   c) sp^2
   d) sp^3

31) The value of Henry's constant KH is
   a) greater for gases with higher solubility
   b) greater for gases with lower solubility
   c) constant for all gases
   d) not related to the solubility of gases

32) A 100 ml solution of 0.1N HCl was titrated with 0.2N NaOH solution. The titration was discontinued after adding 30 ml of NaOH solution. The titration was completed by adding 0.25N KOH solution. The volume of KOH required for completing the titration is
   a) 70 ml
   b) 32 ml
   c) 35 ml
   d) 16 ml

33) A number of ionic compounds are insoluble in water. This is due to
   a) Ionic compounds do not dissolve in water
   b) Water has a high dielectric constant
   c) Water is not a good ionizing solvent
   d) These molecules have exceptionally high attractive forces in lattice

34) For the formation of 5 mol of water, which reaction uses the most nitric acid?
   a) $3Cu + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$
   b) $Al2O_3 + 6HNO_3 \longrightarrow 2Al(NO_3)_3 + 3H_2O$
   c) $4Zn + 10HNO_3 \longrightarrow 4Zn(NO_3)_2 + NH_4NO_3 + 3H_2O$
   d) $Cu + 4HNO_3 \longrightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

35) A zero-order reaction is one whose rate is independent of
    a) the temperature of the reaction
    b) the concentration of the reactants
    c) the concentration of the products
    d) the material of the vessel in which the reaction is carried out

36) Molecular formula of chloropicrin is
    a) $CHCl_3NO_2$
    b) CCl_3NO_3
    c) CCl_2NO_2
    d) CCl_3NO_2

37) Sulphur does not exist as S_2 molecule because
    a) it is less electronegative
    b) it does not form $p\pi$-$p\pi$ bond
    c) it has ability to exhibiting catenation
    d) it has tendency to show variable oxidation

38) Which set of conditions represents easiest way to liquefy a gas?
    a) low temperature and high pressure
    b) high temperature and low pressure
    c) low temperature and low pressure
    d) high temperature and high pressure

39) 100 mL of aqueous solution is mixed with 100 mL of 0.02 N NaOH solution. The pH of the resulting solution is
    a) 1.0
    b) 1.7
    c) 2.0
    d) 2.3

40) Liquid ammonia is used in refrigeration because of its
    a) High dipole moment
   b) High heat of vaporisation
    c) High basicity
    d) All of these

SECTION C: PHYSICS

41) Two-point charges are placed at a distance "d" apart. If a copper plate is placed between the charges the effective force will be

a) F
b) 2F
c) √F
d) zero

42) A body is sliding down an inclined plane having coefficient of friction 0.5. If the normal reaction is twice that of the resultant downward force along the incline, the angle between the inclined plane and the horizontal is

a) 15°
b) 30°
c) 45°
d) 30°

43) The work done by the external force in bringing the charge "q" from infinity to a point is called as
a) Electric field due to charge q at that point
b) Potential energy due to charge q at that point
c) Both a and b
d) None

44) Five elements A, B, C, D and E have work functions 1.2 eV, 2.4 eV, 3.6 eV, 4.8 eV and 6 eV respectively. If light of wavelength 4000 Å is allowed to fall on these elements, then photoelectrons are emitted by
a) A, B and C
b) A, B, C, D and E
c) A and B
d) Only E

45) The shortest wavelength of X-rays emitted from an X-ray tube depends on
a) the current in the tube
b) the voltage applied to the tube
c) the nature of the gas in tube
d) the atomic number of the target material

46) Two identical p-n junctions may be connected in series with a battery in three ways. The potential drops across the two p-n junctions are equal in

Circuit–1   Circuit–2   Circuit–3
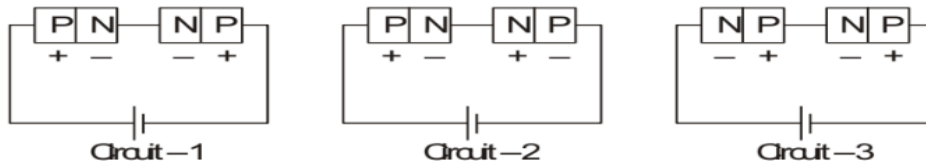
a) circuit 1 and circuit 2
b) circuit 2 and circuit 3
c) circuit 3 and circuit 1
d) circuit 1 only

47) A ball is dropped from a spacecraft revolving around the earth at a height of 120 km. What will happen to the ball?
a) It will continue to move with velocity v along the original orbit of spacecraft
b) It will move with the same speed tangentially to the spacecraft
c) It will fall down to the earth gradually
d) It will go very far in the space

48) The diagram showing the variation of gravitational potential of earth with distance from the centre of earth is

a)

b)

c)

d)
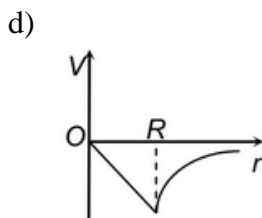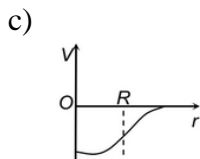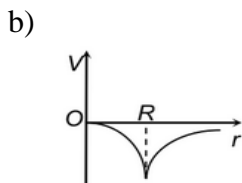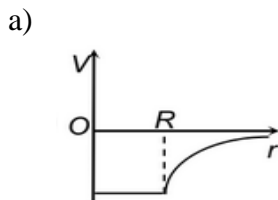
49) The escape velocity for a rocket from earth is 11.2 km/sec. What will the value be on a planet where acceleration due to gravity is double that on the earth and diameter of the planet is twice that of earth?
   a) 11.2
   b) 5.6
   c) 22.4
   d) 53.6

50) Select the pair whose dimensions are same.
   a) Work, energy, force
   b) Velocity, momentum, impulse
   c) Potential energy, kinetic energy, momentum
   d) Pressure, stress, coefficient of elasticity

51) The potentiometer wire shown in figure has length 100 cm and resistance 500 W. Balanced length for cell having emf 12V is found to be 40 cm. Then R is
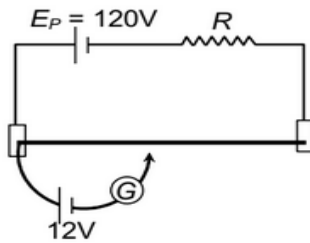
   a) 4000 W
   b) 3000 W
   c) 1500 W
   d) 1000 W

52) Which of the following statement(s) is/are true about magnetic field?
   (i) A stationary charged particle does not experience any force in presence of magnetic field only.
   (ii) magnetic field lines are always perpendicular to magnetic force lines.
   (iii) force on a moving charged particle due to magnetic field cannot do any work.
   (iv) a moving charged particle does not experience any magnetic force while travelling in the direction of magnetic field.

   a) (i) only
   b) (ii) and (iii) only
   c) (i) and (iii) only
   d) (i), (ii), (iii) and (iv)

53) A diminished image of an object is to be obtained on a screen 1.0 m from it. This can be achieved by appropriate placing
   a) a concave mirror of suitable focal length
   b) a convex mirror of suitable focal length
   c) a convex lens of focal length less than 0.25 m
   d) a convex lens of suitable focal length

54) An average emf of 20V is induced in an inductor when the current in it changed from 2.5A in one direction to the same value in opposite direction in 0.1s, the self-inductance of inductor is
   a) 0.4 H
   b) 1 H
   c) 2 H
   d) 0.6 H

55) A slab is introduced between the plates of a parallel plate air capacitor having dielectric constant k = 4 and then connected across a cell having emf E = 100V with the cell remaining connected. Find work done to slowly take the slab out of the capacitor. The capacitance of the parallel plate air capacitor is C = 2µF.
   a) 10 mJ
   b) 20 mJ
   c) 30 mJ
   d) 60 mJ

56) A 20 N metal block is suspended by a spring balance. A beaker containing some water is placed on a weighing machine which reads 40 N. The spring balance is now lowered so that the block gets immersed in the water. The spring balance now reads 16 N. The reading of the weighing machine will be
   a) 36 N
   b) 60 N
   c) 44 N
   d) 56 N

57) A body moves a distance of 10 m along a straight line under the action of a force of 5 N. If the work done is 25 joules, the angle which the force makes with the direction of motion of the body is
   a) 0°
   b) 30°
   c) 60°
   d) 90°

58) Potential energy associated with a conservative force is given by $U = Ax^2$ where A is a constant then
   a) force always tends to accelerate the particle towards origin
   b) force always tends to accelerate the particle away from origin
   c) force always tends to accelerate the particle towards the origin if A is positive
   d) force always tends to accelerate the particle towards the origin if A is negative

59) A body of mass 'm' having an initial velocity 'v', makes head on collision with a stationary body of mass 'M'. After the collision, the body of mass 'm' comes to rest and only the body having mass 'M' moves. This will happen only when
   a) m >> M
   b) m << M
   c) m = M
   d) m = ½ M

60) An engine generates 10 kW of power. How much time will it take to lift a mass of 200 kg to a height of 40 m?
   a) 4 sec
   b) 5 sec
   c) 8 sec
   d) 10 sec

SECTION D: GENERAL IT KNOWLEDGE

61. Which of the following natural element is the primary element in computer chips?
    a) Silicon
    b) Carbon
    c) Iron
    d) Uranium

62. What is the speed of computer measured in?
    a) Nanoseconds
    b) Kilo-seconds
    c) Gigahertz
    d) Megabytes

63. Credit card, debit card and smart card is called as
    a) deposited money
    b) plastic money
    c) instant money
    d) stored money

64. The main memory of a computer system is
    a) volatile
    b) non-volatile
    c) unrestricted
    d) restricted

65. C is a_____ type of high level language.
    a) procedural language
    b) non-procedural language
    c) business language
    d) scientific language

66. Which of the following algorithms is used for public key encryption?
    a) AES
    b) DES
    c) RSA
    d) MD5

67. In cloud computing, what does IaaS stand for?
    a) Infrastructure as a Service
    b) Information as a Service
    c) Integration as a Service
    d) Internet as a Service

68. Which of the following is the most secure form of authentication?
    a) Passwords
    b) Biometrics
    c) Two-Factor Authentication
    d) Security Questions

69. What does the term "phishing" refer to?
    a) A type of firewall
    b) A method used to protect data
    c) A technique used to obtain sensitive information by disguising as a trustworthy entity
    d) A process for encrypting data

70. Which of the following is a key concept of social engineering attacks?
    a) Exploiting software vulnerabilities
    b) Tricking people into revealing confidential information
    c) Encrypting data to prevent access
    d) Brute-force password cracking

PART II
SHORT ANSWER QUESTIONS   [30 MARKS]

This part consists of 10 Short Answer Questions. Answer all questions. Each question carries THREE marks.

1. Show that the following equations are consistent. **(3 marks)**

    $2x + 3y + 4 = 0$

    $x + 2y + 3 = 0$

    $3x + 4y + 5 = 0$

2. Write the first five terms of the following sequence and obtain the corresponding series:
    $a_1 = 3, a_n = 3a_{n-1} + 2$ for all $n > 1$. **(3 marks)**

3. Find the distance between $P(x_1, y_1)$ and $Q(x_2, y_2)$ when: i) PQ is parallel to the y-axis, ii) PQ is parallel to the x-axis. **(3 marks)**

4. Analysis of water in a place shows that the water contains Calcium Chloride. The people in that place are advised to use detergents for washing clothes. State at least two reasons. **(3 marks)**

5. Dry air was passed successively through a solution of 5 g of a solute in 180 g of water and then through pure water. The loss in weight of solution was 2.50 g and that of pure solvent 0.04 g. What is the molecular weight of the solute? **(3 marks)**

6. A reaction is of second order with respect to a reactant. How will the rate of reaction be affected if the concentration of this reactant is (i) doubled and (ii) reduced to half? **(3 marks)**

7. Which gate does the following truth table represent and why? **(3 marks)**

Input		Output
A	**B**	**Y**
0	**0**	**0**
0	**1**	**0**
1	**0**	**0**
1	**1**	**1**

8. Answer the following questions.
    a) When a glass rod is rubbed with a silk cloth, charges appear on both. A similar phenomenon is observed with many other pairs of bodies. Explain how this observation is consistent with the law of conservation of charge. **(1.5 marks)**
    b) Explain why two field lines never cross each other at any point. **(1.5 marks)**

9. The storage battery of a car has an emf of 12V. If the internal resistance of the battery is 0.4Ω, what is the maximum current that can be drawn from the battery? **(3 marks)**

10. Explain the concept of Big Data and its impact on business decision-making. **(3 marks)**

TASHI DELEK