

# 104

QUESTION PAPER  
SERIES CODE

## A

Registration No. :

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Centre of Exam. :

Name of Candidate :

Signature of Invigilator

**ENTRANCE EXAMINATION, 2018**  
**M.Sc. COMPUTATIONAL AND INTEGRATIVE SCIENCES**  
**[ Field of Study Code : CISM (232) ]**

Time Allowed : 3 hours

Maximum Marks : 80

**INSTRUCTIONS FOR CANDIDATES**

- Candidates must read carefully the following instructions before attempting the Question Paper :
- Write your Name and Registration Number in the space provided for the purpose on the top of this Question Paper and in the Answer Sheet.
  - Please darken the appropriate Circle of Question Paper Series Code on the Answer Sheet.**
  - The Question Paper consists of two Parts : **Part—A** and **Part—B**.
  - Part—A** contains twenty (20) questions. Answer **all** questions. Each correct answer carries 1 mark and **0.25 mark will be deducted for every wrong answer.**
  - Part—B** : There will be thirty (30) subject-specific questions in each section of the two tracks, i.e., Track 1 [Physics, Chemistry, Mathematics, Engineering/Computer Sciences] and Track 2 [Biology]. Candidates are required to attempt any **ONE** Section only. Candidates will be separately shortlisted in each track. Each correct answer will be awarded 2 marks and **0.5 marks will be deducted for every wrong answer.**
  - Answer all the questions in the Answer Sheet provided for the purpose by darkening the correct choice, i.e., (a) or (b) or (c) or (d) with **BLUE/BLACK BALLPOINT PEN** only against each question in the corresponding circle.
  - In case you think none of the possible answers are correct, mark the correct answer which you think is closest to the correct one.
  - Answer written by the candidates inside the Question Paper will not be evaluated.
  - Simple Calculators and Log Tables may be used.
  - Pages at the end have been provided for Rough Work.
  - Return the Question Paper and Answer Sheet to the Invigilator at the end of the Entrance Examination. **DO NOT FOLD THE ANSWER SHEET.**

**INSTRUCTIONS FOR MARKING ANSWERS**

- Use only Blue/Black Ballpoint Pen (do not use pencil) to darken the appropriate Circle.
- Please darken the whole Circle.
- Darken **ONLY ONE CIRCLE** for each question as shown in example below :

Wrong ● (b) (c) ●	Wrong ⊗ (b) (c) (d)	Wrong ⊗ (b) (c) ⊗	Wrong ● (b) (c) ●	Correct (a) (b) (c) ●
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- Once marked, no change in the answer is allowed.
- Please do not make any stray marks on the Answer Sheet.
- Please do not do any rough work on the Answer Sheet.
- Mark your answer only in the appropriate space against the number corresponding to the question.
- Ensure that you have darkened the appropriate Circle of Question Paper Series Code on the Answer Sheet.**

/104-A

**PART—A**

( Common to all Tracks and all Sections )

1. If the set  $A$  contains 5 elements and the set  $B$  contains 6 elements, then the number of one-one onto mappings from  $A$  to  $B$  is
  - (a) 720
  - (b) 120
  - (c) 0
  - (d) 30
  
2. If a relation on the set  $\{1, 2, 3\}$  be defined by  $R = \{(1, 2)\}$ , then  $R$  is
  - (a) reflexive
  - (b) transitive
  - (c) symmetric
  - (d) refractive
  
3. The value of the expression  $\sin [\cot^{-1} (\cos (\tan^{-1}))]$  is
  - (a) 0
  - (b) 1
  - (c)  $1/\sqrt{3}$
  - (d)  $\sqrt{2/3}$
  
4. If  $A$  is a matrix of order  $m \times n$  and  $B$  is a matrix such that  $AB'$  and  $B'A$  are both defined, then the order of matrix  $B$  is
  - (a)  $m \times m$
  - (b)  $n \times n$
  - (c)  $n \times m$
  - (d)  $m \times n$
  
5. If  $A$  and  $B$  are the two matrices of the order  $3 \times m$  and  $3 \times n$  respectively and  $m = n$ , then the order of matrix  $(5A - 2B)$  is
  - (a)  $m \times 3$
  - (b)  $3 \times 3$
  - (c)  $m \times n$
  - (d)  $3 \times n$

6. A die is thrown and a card is selected at random from a deck of 52 playing cards. The probability of getting an even number on the die and a spade card is
- (a)  $1/2$
  - (b)  $1/4$
  - (c)  $1/8$
  - (d)  $3/4$
7. The magnitude of the vector  $6\hat{i} + 2\hat{j} + 3\hat{k}$  is
- (a) 5
  - (b) 7
  - (c) 12
  - (d) 1
8. The order of the differential equation of all circles of given radius  $a$  is
- (a) 1
  - (b) 2
  - (c) 3
  - (d) 4
9. If  $y = \sqrt{\sin x + y}$ , then  $dy/dx$  is equal to
- (a)  $\cos x / 2y - 1$
  - (b)  $\cos x / 1 - 2y$
  - (c)  $\sin x / 1 - 2y$
  - (d)  $\sin x / 2y - 1$
10. If  $x = t^2$ ,  $y = t^3$ , then  $d^2y/dx^2$  is
- (a)  $3/2$
  - (b)  $3/4t$
  - (c)  $3/2t$
  - (d)  $2/3t$

11. If  $\begin{vmatrix} 2x & 5 \\ 8 & x \end{vmatrix} = \begin{vmatrix} 6 & -2 \\ 7 & 3 \end{vmatrix}$ , then the value of  $x$  is

- (a) 3
- (b)  $\pm 3$
- (c)  $\pm 6$
- (d) 6

12. Let  $X$  be a discrete random variable. The probability distribution of  $X$  is given below :

$X$	:	30	10	- 10
$P(X)$	:	1/5	3/10	1/2

Then  $E(X)$  is equal to

- (a) 6
- (b) 4
- (c) 3
- (d) - 5

13. Which of the following functions represents the equation of a straight line?

- (a)  $y = ax + b$
- (b)  $y = ax + bz$
- (c)  $y = x$
- (d) All of the above

14. If the slope of a curve is zero, then the curve displayed is a

- (a) horizontal line
- (b) wave-like line
- (c) vertical line
- (d) slant line

15. The shortest distance between two points

- (a) is a straight line
- (b) is a curvilinear geometry
- (c) is dependent on the starting point
- (d) depends on the end point

16. What is the harmonic mean of two numbers whose geometric mean and arithmetic mean are 8 and 5 respectively?
- (a) 12.8
  - (b) 12
  - (c) 13.5
  - (d) 14.6
17. If  $x + y + z = 9$  and  $xy + yz + zx = 11$ , then  $x^3 + y^3 + z^3 - 3xyz$  is equal to
- (a) 384
  - (b) 192
  - (c) 432
  - (d) 90
18. A student can take one of the four Mathematics sections and one of the five English sections. The number  $n$  of ways he can register for the two courses is
- (a) 4
  - (b) 5
  - (c) 20
  - (d) 30
19. The function  $f(x) = x^3 - 6x^2 + 9x + 25$  has
- (a) a maxima at  $x = 1$  and a minima at  $x = 3$
  - (b) a maxima at  $x = 3$  and a minima at  $x = 1$
  - (c) no maxima, but a minima at  $x = 1$
  - (d) a maxima at  $x = 1$ , but no minima
20.  $\int \log x dx$  has the value
- (a)  $x \log x - 1$
  - (b)  $\log x - x$
  - (c)  $x(\log x - 1)$
  - (d)  $(\log x - 1)/x$

PART—B

Answer all questions from any ONE Section

TRACK—1

[ PHYSICS, CHEMISTRY, MATHEMATICS, ENGINEERING/COMPUTER SCIENCES ]

Section—A

( Physics )

21. The magnetic field  $B$  at a distance  $d$  from a long straight wire carrying a steady current  $I$  is given by

(a)  $B = \frac{\mu_0}{2\pi d}$

(b)  $B = \frac{\mu_0 I}{2\pi d}$

(c)  $B = \frac{1}{\pi d}$

(d)  $B = 2\pi Id$

22. Vector potential  $\mathbf{A}$  of an infinite solenoid with  $m$  turns per unit length, radius  $R$  and current  $I$  at a distance  $s$  with  $s > R$  is given by

(a)  $\mathbf{A} = \frac{\mu_0 m I R^2}{2s} \hat{n}$

(b)  $\mathbf{A} = 0$

(c)  $\mathbf{A} = \frac{\mu_0 R^2}{sI} \hat{n}$

(d)  $\mathbf{A} = \mu_0 m I R^2 s \hat{n}$

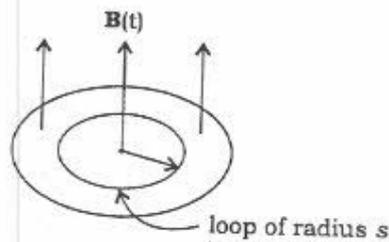
23. A uniform magnetic field  $\mathbf{B}(t)$ , pointing straight up, fills the shaded circular region as in the figure given below. If  $\mathbf{B}$  is changing with time, then which of the following is the induced electric field?

(a)  $\mathbf{E} = -\frac{s}{2} \frac{d\mathbf{B}}{dt} \hat{n}$

(b)  $\mathbf{E} = \frac{s}{2} \frac{d\mathbf{B}}{dt} \hat{n}$

(c)  $\mathbf{E} = \frac{d\mathbf{B}}{dt} \hat{n}$

(d)  $\mathbf{E} = -\frac{d\mathbf{B}}{dt} \hat{n}$



24. When a current flows down in a wire length  $L$  and radius  $r$ , the wire is heated up due to Joule's heating effect. Consider the energy per unit time delivered is uniform with electric field  $E$  and electric potential  $V$ . Then the magnitude of the Poynting vector  $S$  is given by

(a)  $S = \frac{VI}{L}$

(b)  $S = \frac{V}{L}$

(c)  $S = \frac{VI}{2\pi rL}$

(d)  $S = \frac{2\pi rVI}{L}$

25. The electromagnetic wave equation with velocity  $v$  for electric and magnetic fields  $\mathbf{E}$  and  $\mathbf{B}$  expressed in Cartesian coordinates  $f$  is given by

(a)  $\nabla f = \frac{1}{v^2} \frac{\partial f}{\partial t}$

(b)  $\nabla^2 f = \frac{1}{v^2} \frac{\partial^2 f}{\partial t^2}$

(c)  $\nabla^2 f = -\frac{1}{v^2} \frac{\partial^2 f}{\partial t^2}$

(d)  $\nabla f = v$

26. A particle limited to the  $x$ -axis has the wave function  $\psi = ax$  between  $x = 0$  and  $x = 1$ ;  $\psi = 0$  elsewhere. Then the probability that the particle can be found between  $x = 0.45$  and  $x = 0.55$  is given by

(a) 1

(b)  $a^2$

(c)  $0.0251a^2$

(d)  $0.25a^2$

27. The probability that a particle is trapped in a box  $L$  wide can be found between  $0.45L$  and  $0.55L$  for the first excited state is given by

(a) 0.198

(b) 0.35

(c) 0.65

(d) 0.95

28. The expectation value  $\langle x \rangle$  of the position of a particle trapped in a box  $L$  wide is given by
- $L$
  - $L^2$
  - $\frac{L}{2}$
  - $2L$
29. The ground state electron energy  $E_1$  of hydrogen atom ( $n = 1, l = 0$ ) is given by
- $E_1 = -\frac{me^4}{32\pi^2\epsilon_0^2\hbar^2}$
  - $E_1 = -\frac{m}{\pi^2\epsilon_0^2\hbar^2}$
  - $E_1 = \frac{\hbar^2}{\pi^2\epsilon_0^2}$
  - $E_1 = -\frac{me}{3\pi^2}$
30. The possible orientations of total angular momentum  $J$  for the  $j = \frac{3}{2}$  state corresponding to  $l = 1$  is given by
- $m_j = -3/2, -1/2, 1/2, 3/2$
  - $m_j = -1/2, 1/2$
  - $m_j = -3/2, 3/2$
  - $m_j = -5/2, -3/2, -1/2, 1/2, 3/2, 5/2$
31. The carbon monoxide (CO) molecule has a bond length  $R$  of  $0.113$  nm and masses of the  $^{12}\text{C}$  and  $^{16}\text{O}$  atoms are respectively  $1.99 \times 10^{-26}$  kg and  $2.66 \times 10^{-26}$  kg. The energy of CO molecule when it is in its lowest rotational state is
- $4.76 \times 10^{-4}$  eV
  - $4.76 \times 10^{-5}$  eV
  - $4.76 \times 10^{-6}$  eV
  - $4.76 \times 10^{-7}$  eV

32. In CO, the  $J = 0 \rightarrow J = 1$  absorption line occurs at a frequency of  $1.15 \times 10^{11}$  Hz. The bond length of the CO molecule is
- 0.113 nm
  - 0.335 nm
  - 0.446 nm
  - 0.557 nm
33. When CO is dissolved in liquid carbon tetrachloride, infrared radiation of frequency  $6.42 \times 10^{13}$  Hz is absorbed. The spacing between its vibrational energy levels is given by
- $\Delta E = 0.266$  eV
  - $\Delta E = 0.566$  eV
  - $\Delta E = 0.966$  eV
  - $\Delta E = 1.16$  eV
34. A sample of a certain element is placed in a 0.300 T magnetic field and suitably excited. How far apart are Zeeman components of 450 nm spectral line of this element?
- $\Delta\lambda = 0.00283$  nm
  - $\Delta\lambda = 0.0283$  nm
  - $\Delta\lambda = 0.283$  nm
  - $\Delta\lambda = 2.83$  nm
35. Using Maxwell-Boltzmann distribution, the populations of the rotational states of a rigid diatomic molecule is given by
- $n_J = n_0(2J + 1)e^{-J(J+1)\hbar^2/2IkT}$
  - $n_J = n_0(2J + 1)e^{\hbar^2/kT}$
  - $n_J = n_0e^{-J(J+1)\hbar^2/2IkT}$
  - $n_J = n_0e^{-\hbar^2/kT}$

36. The ratio of root-mean-square speed of ideal gas molecule to its average speed is given by

(a)  $\frac{v_{r.m.s}}{v_a} = \sqrt{\frac{3}{8}}$

(b)  $\frac{v_{r.m.s}}{v_a} = \sqrt{\frac{3\pi}{8}}$

(c)  $\frac{v_{r.m.s}}{v_a} = \sqrt{\frac{8}{3}}$

(d)  $\frac{v_{r.m.s}}{v_a} = \sqrt{\frac{8}{3\pi}}$

37. The root-mean-square speed of oxygen molecules at 0 °C is given by

(a) 161 m/s

(b) 261 m/s

(c) 361 m/s

(d) 461 m/s

38. How many photons are present in 1.00 cm<sup>3</sup> of radiation thermal equilibrium at 1000 K?

(a)  $2.03 \times 10^{10}$

(b)  $2.03 \times 10^9$

(c)  $2.03 \times 10^8$

(d)  $2.03 \times 10^7$

39. The thermodynamical parameters  $C_p$  and  $C_v$  (specific heats at constant pressure and volume) which can express in measurable parameters  $\alpha$  (coefficient of thermal expansion),  $\kappa_T$  (isothermal compressibility) satisfy which of the following relations?

(a)  $C_p - C_v = \alpha^2 TV$

(b)  $C_p - C_v = \frac{\alpha^2 TV}{\kappa_T}$

(c)  $C_p - C_v = \alpha^2 TV \kappa_T$

(d)  $C_p - C_v = \frac{\alpha^2}{\kappa_T}$

40. The entropy ( $S$ ) in microcanonical ensemble can be expressed in terms of phase space volume ( $\Gamma$ ) in  $\Gamma$  space given by
- (a)  $S = -k \ln \Gamma$
  - (b)  $S = k \ln \Gamma$
  - (c)  $S = -k \Gamma \ln \Gamma$
  - (d)  $S = k \Gamma \ln \Gamma$
41. If Lagrangian  $L$  has no explicit time dependence and the motion obeys Euler-Lagrangian equation of motion, then
- (a) total energy is conserved
  - (b) generalized force is conserved
  - (c) momentum is conserved
  - (d) both total energy and momentum are conserved
42. If a particle is subject to a central force only, then its motion takes place in a
- (a) straight line
  - (b) plane
  - (c) cylinder
  - (d) None of the above
43. Two trains,  $A$  and  $B$ , each have proper length  $L$  and move in the same direction with velocities  $4c/5$  and  $3c/5$  respectively ( $c$  is the velocity of light). How long, as viewed by a person on the ground, does it take for  $A$  to overtake  $B$ ?
- (a)  $L/c$
  - (b)  $3L/c$
  - (c)  $5L/c$
  - (d)  $7L/c$

44. A train with proper length  $L$  moves at speed  $5c/13$  with respect to the ground. A ball is thrown from the back of the train to the front. The speed of the ball with respect to the train is  $c/3$ . As viewed by someone on the ground, how far does it travel?

(a)  $L/3$

(b)  $4L/3$

(c)  $5L/3$

(d)  $7L/3$

45. A particle with mass  $m$  and energy  $E$  approaches an identical particle at rest. They collide elastically in such a way that they both scatter at an angle  $\theta$  relative to the incident direction. What is  $\theta$  in terms of  $E$  and  $m$ ?

(a)  $\theta = \cos^{-1} \left[ \frac{E+m}{E+3m} \right]$

(b)  $\theta = \cos^{-1} \left[ \sqrt{\frac{E+m}{E+3m}} \right]$

(c)  $\theta = \cos^{-1} \left[ \frac{E+m}{E+3m} \right]^2$

(d)  $\theta = \cos^{-1} \left[ \frac{E+m}{E+3m} \right]^3$

46. The rank of the matrix

$$\begin{bmatrix} 4 & 2 & 3 \\ 8 & 4 & 6 \\ -2 & -1 & -1.5 \end{bmatrix}$$

is

(a) 3

(b) 2

(c) 1

(d) 0

47. The eigenvectors of the matrix  $\begin{bmatrix} 8 & -4 \\ 2 & 2 \end{bmatrix}$  are

(a)  $c_1 \begin{bmatrix} 1 \\ 1 \end{bmatrix}, c_2 \begin{bmatrix} 1 \\ 2 \end{bmatrix}$

(b)  $c_1 \begin{bmatrix} 1 \\ 0 \end{bmatrix}, c_2 \begin{bmatrix} 0 \\ 2 \end{bmatrix}$

(c)  $c_1 \begin{bmatrix} 3 \\ 0 \end{bmatrix}, c_2 \begin{bmatrix} 2 \\ 2 \end{bmatrix}$

(d)  $c_1 \begin{bmatrix} 4 \\ 1 \end{bmatrix}, c_2 \begin{bmatrix} 4 \\ 2 \end{bmatrix}$

48. The solution of  $\nabla \cdot (r^3 \vec{r})$  is

(a)  $3r^3$

(b)  $6r^3$

(c)  $6r$

(d)  $r$

49. The solution of  $\nabla \times \nabla F(x, y, z)$  is

(a)  $f$

(b)  $0$

(c)  $xyz$

(d)  $1$

50. The solution of  $\nabla(\nabla \cdot \vec{A})$  with  $\vec{A} = \vec{r}/r$  is

(a)  $r$

(b)  $0$

(c)  $-2\vec{r}/r^3$

(d)  $1$

**Section—B**

**( Chemistry )**

51. The dielectric constant of water at 25 °C is
- (a) 80
  - (b) 60
  - (c) 40
  - (d) 20
52. The spatial arrangement of groups in a molecule denotes its
- (a) configuration
  - (b) molecular mass
  - (c) molecular weight
  - (d) conformation
53. The second-order rate constant is represented by
- (a)  $k = v$
  - (b)  $v = k$
  - (c)  $v = k[A]$
  - (d)  $v = k[A][B]$
54. What is the molality of a 10% (by weight)  $C_6H_2O$  (MW = 90) solution?
- (a) 0.012M
  - (b) 0.12M
  - (c) 1.2M
  - (d) 12M
55. Which of the following *does not* exist?
- (a)  $SF_6$
  - (b)  $OF_6$
  - (c)  $H_3PO_3$
  - (d)  $NH_4NO_2$

56. The addition of aqueous ammonia to a solution containing a metallic ion may result in all of these, *except*
- (a) an increase in the pH
  - (b) a decrease in the pH
  - (c) the formation of a precipitate containing  $\text{OH}^-$
  - (d) the formation of a complex ion containing  $\text{NH}_3$
57. The silver ion in the complex  $[\text{Ag}(\text{CN})_2]^-$  has a coordination number of
- (a) 2
  - (b) 3
  - (c) 4
  - (d) 5
58. The hybridization of the central atom in  $\text{NH}_2^-$  would be
- (a)  $sp$
  - (b)  $sp^2$
  - (c)  $sp^3$
  - (d)  $sp^3d$
59. What is the partial pressure of helium, when 8.0 grams of helium and 16 grams of oxygen are in a container with a total pressure of 5.00 atm?
- (a) 1.00 atm
  - (b) 1.50 atm
  - (c) 2.00 atm
  - (d) 4.00 atm
60. Calculate the approximate standard free-energy change for the ionization of hydrofluoric acid, HF ( $K_a = 1 \times 10^{-3}$ ) at 25 °C.
- (a) -9 kJ
  - (b) -4 kJ
  - (c) 4 kJ
  - (d) 20 kJ

61. Joule-Thomson effect describes gas's
- (a) contraction
  - (b) sudden expansion
  - (c) expansion
  - (d) volume increase
62. What is the total pressure, in atmosphere, of a 10 L container that contains 10 moles of nitrogen gas and 10 moles of oxygen gas at 300 K?
- (a) 24.6 L
  - (b) 49.3 L
  - (c) 33.2 L
  - (d) 2460 L
63. According to kinetic theory of gases, the absolute zero temperature is attained when
- (a) volume of the gas is zero
  - (b) pressure of the gas is zero
  - (c) kinetic energy of the molecule is zero
  - (d) specific heat of the gas is zero
64. Change in enthalpy of a system is the heat supplied at
- (a) constant pressure
  - (b) constant temperature
  - (c) constant volume
  - (d) constant entropy
65. Carnot cycle efficiency is maximum when
- (a) initial temperature is 0 K
  - (b) final temperature is 0 K
  - (c) difference between initial and final temperature is 0 K
  - (d) difference between initial and final temperature is 100 K

66. Consider the binding of oxygen to haemoglobin :



If we decrease the pressure of the system, what is the effect on this equilibrium reaction?

- (a) The equilibrium shifts to the left
  - (b) The equilibrium shifts to the right
  - (c) There is no change in the system
  - (d) None of the above
67. For a reaction  $A + B \leftrightarrow 2C$ , 2 moles of  $A$  and 3 moles of  $B$  are allowed to react. If equilibrium constant is 4 at  $400^\circ\text{C}$ , then the mole of  $C$  at equilibrium is
- (a) 1
  - (b) 2.4
  - (c) 4
  - (d) 3.6
68. Ionization constant of acetic acid is  $1.8 \times 10^{-5}$ . The concentration of  $\text{H}^+$  ions in  $0.1\text{M}$  solution is
- (a)  $1.78 \times 10^{-3}$
  - (b)  $1.87 \times 10^{-5}$
  - (c)  $1.43 \times 10^{-3}$
  - (d)  $1.34 \times 10^{-3}$
69. In a reaction  $A_2 + 4B_2 \leftrightarrow 2AB_4$ ;  $\Delta H < 0$ , the formation of  $AB_4$  will be favoured by
- (a) low temperature and high pressure
  - (b) high temperature and low pressure
  - (c) low temperature and low pressure
  - (d) high temperature and high pressure
70. Which of the following aqueous solutions will have highest pH?
- (a) Sodium acetate
  - (b) Sodium chloride
  - (c) Ammonium phosphate
  - (d) Calcium chloride

71. Variable valency is shown by
- (a) N
  - (b) Na
  - (c) F
  - (d) O
72. Ionic solids are characterized by
- (a) good conductivity in solid state
  - (b) solubility in polar solvent
  - (c) high vapour pressure
  - (d) low melting point
73. Higher is the bond order, greater is
- (a) bond energy
  - (b) bond angle
  - (c) bond length
  - (d) paramagnetism
74. If the door of a refrigerator is kept open, then which of the following is true?
- (a) Room is cooled
  - (b) Room is heated
  - (c) Room is either cooled or heated
  - (d) Room is neither cooled nor heated
75. The specific heat of a gas in an isothermal process
- (a) is zero
  - (b) is infinite
  - (c) is negative
  - (d) remains constant

76. The magnitude of  $(C_p / C_v)$  for an ideal monatomic gas is
- (a) 1.66
  - (b) 1.40
  - (c) 2.01
  - (d) 1.10
77. The expression for the most probable speed of an ideal gas is
- (a)  $(3RT / M)^{1/2}$
  - (b)  $(8RT / pM)^{1/2}$
  - (c)  $(RT / pM)^{1/2}$
  - (d)  $(2RT / M)^{1/2}$
78. At constant temperature and pressure the change in Gibbs' free energy is the measure of available
- (a) mechanical work
  - (b) non-mechanical work
  - (c) mechanical + non-mechanical work
  - (d) mechanical - non-mechanical work
79. Among the systems, F—H...F, O—H...O, N—H...O, S—H...S, the strongest hydrogen bond observed is
- (a) O—H...O
  - (b) N—H...N
  - (c) S—H...S
  - (d) F—H...F
80. If at standard temperature and pressure two ideal gases are mixed, then the correct condition is
- (a)  $\Delta S_{\text{mix}} = 0$
  - (b)  $\Delta H_{\text{mix}} = 0$
  - (c)  $\Delta G_{\text{mix}} = 0$
  - (d)  $\Delta U_{\text{mix}} = 0$

**Section—C**  
**( Mathematics )**

81. In general, the ratio of truncation error to that of round-off error is

- (a) 2 : 1
- (b) 1 : 1
- (c) 1 : 2
- (d) 1 : 3

82. Match the following :

- |                   |   |
|-------------------|---|
| A. Newton-Raphson | 1. Integration                            |
| B. Runge-Kutta    | 2. Root finding                           |
| C. Gauss-Seidel   | 3. Ordinary differential equations        |
| D. Simpson's rule | 4. Solution of system of linear equations |

The correct sequence is

- (a) A-2, B-3, C-4, D-1
- (b) A-3, B-2, C-1, D-4
- (c) A-1, B-4, C-2, D-3
- (d) A-4, B-1, C-2, D-3

83. If  $\Delta f(x) = f(x+h) - f(x)$ , then for a constant  $k$ ,  $\Delta k$  equals

- (a) 1
- (b) 0
- (c)  $f(k) - f(0)$
- (d)  $f(x+k) - f(x)$

84. Newton-Raphson method is applicable to the solution of

- (a) both algebraic and transcendental equations
- (b) both algebraic and transcendental and also used when the roots are complex
- (c) algebraic equations only
- (d) transcendental equations only

85. In which of the following methods proper choice of initial value is very important?
- (a) Bisection method
  - (b) False position method
  - (c) Newton-Raphson method
  - (d) Bairstow method
86. The order of error in the Simpson's rule for numerical integration with a step size  $h$  is
- (a)  $h$
  - (b)  $h^2$
  - (c)  $h^3$
  - (d)  $h^4$
87. Errors may occur in performing numerical computation on the computer due to
- (a) rounding errors
  - (b) power fluctuation
  - (c) operator fatigue
  - (d) All of the above
88. A graph is totally disconnected if and only if
- (a) its adjacency matrix is a unit matrix
  - (b) its adjacency matrix is a zero matrix
  - (c) its adjacency matrix is a diagonal matrix
  - (d) its adjacency matrix is a skew symmetric matrix
89. The following set of equations
- $$\begin{aligned}3x + 2y + z &= 4 \\x - y + z &= 2 \\-2x + 2z &= 5\end{aligned}$$
- has
- (a) no solution
  - (b) a unique solution
  - (c) multiple solutions
  - (d) an inconsistency

90. The following system of equations

$$x + y + z = 3$$

$$x + 2y + 3z = 4$$

$$x + 4y + kz = 6$$

will **not** have a unique solution for  $k$  equal to

- (a) 0
- (b) 5
- (c) 6
- (d) 7

91. As  $x$  is increased from  $-\infty$  to  $\infty$ , the function

$$f(x) = \frac{e^x}{1+e^x}$$

- (a) monotonically increases
- (b) monotonically decreases
- (c) increases to a maximum value and then decreases
- (d) decreases to a minimum value and then increases

92. The value of  $\lim_{\theta \rightarrow 0} \frac{\sin \frac{\theta}{2}}{\theta}$  is

- (a) 0.5
- (b) 1
- (c) 2
- (d) not defined

93. Stokes' theorem connects

- (a) a line integral and a surface integral
- (b) a surface integral and a volume integral
- (c) a line integral and a volume integral
- (d) gradient of a function and its surface integral

94. What is the derivative of  $f(x) = |x|$  at  $x = 0$ ?

- (a) 1
- (b) -1
- (c) 0
- (d) Does not exist

95. Consider the function  $f(x) = |x|^3$ , where  $x$  is real. Then the function  $f(x)$  at  $x = 0$  is
- (a) continuous but not differentiable
  - (b) once differentiable but not twice
  - (c) twice differentiable but not thrice
  - (d) thrice differentiable
96. Which one of the following functions is strictly bounded?
- (a)  $\frac{1}{x^2}$
  - (b)  $e^x$
  - (c)  $x^2$
  - (d)  $e^{-x^2}$
97. The function  $f(x) = 2x^3 - 3x^2 - 36x + 2$  has its maxima at
- (a)  $x = -2$  only
  - (b)  $x = 0$  only
  - (c)  $x = 3$  only
  - (d) both  $x = -2$  and  $x = 3$
98.  $\iint (\nabla \times P) \cdot ds$ , where  $P$  is a vector, is equal to
- (a)  $\int P \cdot dl$
  - (b)  $\int \nabla \times \nabla \times P \cdot dl$
  - (c)  $\int \nabla \times P \cdot dl$
  - (d)  $\iiint \nabla \cdot P \, dv$
99. The maximum value of the directional derivative of the function  $\phi = 2x^2 + 3y^2 + 5z^2$  at a point  $(1, 1, -1)$  is
- (a) 10
  - (b) -4
  - (c)  $\sqrt{152}$
  - (d) 152

100. A necessary and sufficient condition for a basic feasible solution to an LPP to be an optimal (minimum) is
- (a)  $z_j - c_j \leq 0$
  - (b)  $z_j - c_j \geq 0$
  - (c)  $z_j - c_j = 0$
  - (d)  $z_j - c_j < 0$  or  $z_j - c_j > 0$
101. The gradient of the curve  $y = x^2 - 5x + 6$  is zero at which of the following values of  $x$ ?
- (a) 2.5
  - (b) -2.5
  - (c) 0
  - (d) 3.5
102. In a convex combination of  $n$  vectors, the sum of scalars is
- (a) less than one
  - (b) not equal to one
  - (c) always one
  - (d) greater than one
103. Let  $V$  be the vector space of the field  $F$ , then
- (a) rank + nullity is less than the dimension of  $V$
  - (b) rank + nullity is equal to the dimension of  $V$
  - (c) rank + nullity is more than the dimension of  $V$
  - (d) rank + nullity is infinite
104. Let  $S$  be the set of linearly independent vectors of  $V(F)$ , then
- (a) superset is always independent
  - (b) superset is always dependent
  - (c) subset is always linearly dependent
  - (d) subset is always linearly independent
105. Given two vectors  $\vec{x} = (21, 7, -49)$  and  $\vec{y} = (21, -28, k)$ . Find  $k$ , if vector  $x$  and vector  $y$  are orthogonal.
- (a) -6
  - (b) -5
  - (c) 5
  - (d) 6

106. Let  $A$  be a  $3 \times 3$  matrix with rank 2. Then  $AX = 0$  has
- (a) only the trivial solution  $X = 0$
  - (b) one independent solution
  - (c) two independent solutions
  - (d) three independent solutions
107. The eigenvalues of a skew-symmetric matrix are
- (a) always zero
  - (b) always pure imaginary
  - (c) either zero or pure imaginary
  - (d) always real
108. Let  $V$  be the vector space of polynomials of degree  $\leq n$ . Then the derivative operator on  $V$  is nilpotent of index
- (a)  $n + 1$
  - (b)  $n - 1$
  - (c)  $n + 2$
  - (d)  $n - 2$
109. A set of linear equations is represented by the matrix equation  $Ax = b$ . The necessary condition for the existence of a solution for this system is
- (a)  $A$  must be invertible
  - (b)  $b$  must be linearly dependent on the columns of  $A$
  - (c)  $b$  must be linearly independent of the columns of  $A$
  - (d)  $A$  must be singular
110. If  $A$  and  $B$  are square matrices of size  $n \times n$ , then which of the following statements is **not** true?
- (a)  $\det(AB) = \det(A) \det(B)$
  - (b)  $\det(kA) = k^n \det(A)$
  - (c)  $\det(A + B) = \det(A) + \det(B)$
  - (d)  $\det(A^T) = 1 / \det(A^{-1})$

Section—D

( Engineering/Computer Sciences )

111. Secret-key encryption is also known as
- (a) asymmetric encryption
  - (b) symmetric encryption
  - (c) secret encryption
  - (d) private encryption
112. The packet of information at the application layer is called
- (a) packet
  - (b) message
  - (c) segment
  - (d) frame
113. Which of the following is *not* a guided transmission line?
- (a) Twisted pair
  - (b) Coaxial cable
  - (c) Optical fiber
  - (d) Laser beam
114. Which of the following is *not* a regular expression?
- (a)  $[(a + b)^* - (aa + bb)]^*$
  - (b)  $[(0 + 1) - (0b + a1)^* (a + b)]^*$
  - (c)  $(01 + 11 + 10)^*$
  - (d)  $(1 + 2 + 0)^* (1 + 2)^*$
115. Which of the following flip-flops is used as latch?
- (a) *J-K* flip-flop
  - (b) *D* flip-flop
  - (c) *R-S* flip-flop
  - (d) *T* flip-flop

116. The Gray code of 6 is
- (a) 1100
  - (b) 1001
  - (c) 0101
  - (d) 0110
117. EAROM memory is
- (a) magnetically alterable
  - (b) electrically alterable
  - (c) Either (a) or (b)
  - (d) None of the above
118. The standard IF value for AM receivers is
- (a) 455 kHz
  - (b) 455 MHz
  - (c) 107 kHz
  - (d) 10.7 MHz
119. If a station is tuned to station frequency 1600 kHz, the image frequency is
- (a) 16000 kHz
  - (b) 1145 kHz
  - (c) 2055 kHz
  - (d) 2510 kHz
120. FM discriminator changes the FM signal into
- (a) AM signal
  - (b) FM signal
  - (c) PM signal
  - (d) None of the above

121. The commonly employed filter in SSB generation is
- (a) HPF
  - (b) mechanical filter
  - (c) RC filter
  - (d) LC filter
122. Sampling theorem finds application in
- (a) amplitude modulation
  - (b) frequency modulation
  - (c) PCM
  - (d) None of the above
123. For global communication, the number of satellites needed is
- (a) 1
  - (b) 2
  - (c) 3
  - (d) 10
124. A logic circuit is having logical inputs  $A$ ,  $B$  and  $C$  and output  $Y$ . The output is high only when a majority of inputs is high. Which one of the following is the correct logical relation between inputs and outputs?
- (a)  $Y = BC + AC + AB$
  - (b)  $Y = A + BC$
  - (c)  $Y = ABC$
  - (d)  $Y = AB + C$
125. A modem is a device used for
- (a) digitizing voice data
  - (b) transmission of data on lines
  - (c) modulating and demodulating signals sent on a line
  - (d) suppressing noise interference

126. Digital computers are more widely used as compared to analog computers, because they are
- (a) less expensive
  - (b) always more accurate and faster
  - (c) useful over wider ranges of problem types
  - (d) easier to maintain
127. Most of the digital computers do not have floating point hardware, because
- (a) floating point hardware is costly
  - (b) it is slower than software
  - (c) it is not possible to perform floating point addition by hardware
  - (d) of no specific reason
128. A process utilizes a resource in the sequence
- (a) request, use, release
  - (b) use, request, release
  - (c) use, release, request
  - (d) request, release, use
129. Four necessary conditions for deadlock to exist are mutual exclusion, no preemption, circular wait and
- (a) multiprogramming
  - (b) hold and wait
  - (c) race around condition
  - (d) buffer flow
130. For a coil with inductance  $L$  and resistance  $R$  in series with a capacitor  $C$  has
- (a) resonance impedance as zero
  - (b) resonance impedance  $R$
  - (c) resonance impedance  $L/CR$
  - (d) resonance impedance as infinity

131. Laplace transform of a unit impulse function is

- (a)  $S$
- (b) 0
- (c)  $e^{-s}$
- (d) 1

132. The characteristic impedance of a low-pass filter in attenuation band is

- (a) purely imaginary
- (b) zero
- (c) complex quantity
- (d) real value

133. Asymmetrical two-port networks have

- (a)  $Z_{sc1} = Z_{oc2}$
- (b)  $Z_{sc1} = Z_{sc2}$
- (c)  $Z_{oc1} \neq Z_{oc2}$
- (d)  $Z_{oc1} \neq Z_{oc2}$  and  $Z_{sc1} \neq Z_{sc2}$

134. All-pass filter

- (a) passes whole of the audio band
- (b) passes whole of the radio band
- (c) passes all frequencies with very low attenuation
- (d) passes all frequencies without attenuation but phase is changed

135. In a purely capacitive circuit

- (a) current leads voltage by  $90^\circ$
- (b) voltage leads current by  $90^\circ$
- (c) current lags voltage by  $90^\circ$
- (d) current and voltage have a phase relationship of 0

136. Power stored from the source and then returned to the source is called
- (a) apparent power
  - (b) impedance power
  - (c) reactive power
  - (d) true power
137. Which of the following is an indirect way of generating FM?
- (a) Armstrong modulator
  - (b) Varactor diode modulator
  - (c) Reactance FET modulator
  - (d) Reactance bipolar transistor
138. The action of parsing the source code into proper syntactic classes is known as
- (a) parsing
  - (b) interpretation analysis
  - (c) lexicography
  - (d) lexical analysis
139. Circular polarization
- (a) is useful in reducing depolarization effect on received wave
  - (b) involves critical alignment of transmitting and receiving antenna
  - (c) is useful in discrimination between reception of adjacent beams
  - (d) None of the above
140. Which of the following functions can a Turing machine **not** perform?
- (a) Copying a string
  - (b) Deleting a symbol
  - (c) Accepting a pal
  - (d) Inserting a symbol

**TRACK—2**

**[ LIFE SCIENCES ]**

**Section—E**

**( Biology )**

- 141.** Catabolite activator protein (CAP) activates transcription of lac operon, when
- (a) glucose levels are high
  - (b) glucose levels are low
  - (c) cAMP forms a homodimer
  - (d) cAMP interacts with cyclin
- 142.** Cancer is characterized by uncontrolled growth of cells. Which of the following are responsible for cancer?
- (a) Oncogenes
  - (b) Carcinomorphous genes
  - (c) Proto-oncogenes
  - (d) Telomeric genes
- 143.** Which of the following combinations are required for PCR?
- (a) Primers, DNA template, RNA polymerase and dNTPs
  - (b) Primers, RNA template, Taq polymerase and dNTPs
  - (c) Primers, DNA template, Taq polymerase and dNTPs
  - (d) Primers, RNA template, exonuclease, Taq polymerase and ATP
- 144.** Topoisomerases play role in unwinding of DNA during
- (a) only replication
  - (b) only transcription
  - (c) both replication and transcription
  - (d) replication and translation
- 145.** In the absence of oxygen, the muscle pyruvate is converted to
- (a) lactate
  - (b) ethanol
  - (c) glucose
  - (d) acetyl coenzyme A

146. If a trait is controlled by multiple alleles in human beings, how many alleles an individual can have for the trait?
- (a) One
  - (b) Two
  - (c) Multiple
  - (d) Two each on every chromosome
147. If you increase the sample size in an experiment, what will happen to standard error?
- (a) Standard error will decrease
  - (b) Standard error will increase
  - (c) Standard error will become zero
  - (d) Standard error will become infinity
148. Which of the following is **not** an example of a bivariate data?
- (a) Sale of ice cream and day temperature
  - (b) Number of sleeping hours and stress levels
  - (c) Number of crackers burst and amount of air pollution
  - (d) Height of students and marks scored in an examination
149. In an autoclave, equipment and reagents are sterilized by subjecting them to
- (a) saturated steam under at least 15 psi pressure, 121 °C temperature for 15–20 minutes
  - (b) saturated steam under at least 35 psi pressure, 121 °C temperature for 1.5 hours
  - (c) saturated steam under at least 15 psi pressure, 100 °C temperature for 15–20 minutes
  - (d) saturated steam under at least 10 psi pressure, 100 °C temperature for 1.5 hours
150. Which of the following is an example of ribozyme?
- (a) Rho factor
  - (b) Helicase
  - (c) Peptidyl transferase
  - (d) Aminoacyl tRNA synthetase

151. Which of the following is *not* an aliphatic amino acid?
- (a) Methionine
  - (b) Tryptophan
  - (c) Alanine
  - (d) Valine
152. If the genetic code consisted of four bases per codon rather than three, the maximum number of unique amino acids that could be encoded would be
- (a) 64
  - (b) 128
  - (c) 256
  - (d) 512
153. Which of the following organelles contain DNA in addition to the nucleus?
- (a) Chloroplast and glyoxysome
  - (b) Mitochondria and chloroplast
  - (c) Mitochondria and peroxisome
  - (d) Chloroplast and lysosome
154. Why is the red color used for danger signals?
- (a) It is very bright
  - (b) It is scattered most
  - (c) It is scattered least
  - (d) Our eyes are most sensitive to red color
155. Protoplasts can be made from the plant cells using which one of the following enzyme combinations?
- (a) Cellulase and pectinase
  - (b) Replicase and ligase
  - (c) Cellulase and protease
  - (d) Pectinase and chitinase

156. A sequence of 306 nucleotides containing a stop codon at the 3' end can encode for how many maximum amino acids?
- (a) 100
  - (b) 102
  - (c) 101
  - (d) 103
157. What is the sequence of Pribnow box?
- (a) TTGACA
  - (b) TTATAT
  - (c) TATAAT
  - (d) TATATT
158. In which phase of cell cycle DNA is duplicated?
- (a) G<sub>1</sub> phase
  - (b) G<sub>0</sub> phase
  - (c) S phase
  - (d) G<sub>2</sub> phase
159. Which of the following plant parts is triploid?
- (a) Endosperm
  - (b) Pollen
  - (c) Embryo
  - (d) Ovule
160. A unit to measure a distance between genes is called
- (a) kilobase
  - (b) dalton
  - (c) megabase
  - (d) centimorgan

161. Which of the following RNAs serves as adaptor molecule during protein synthesis?
- (a) mRNA
  - (b) tRNA
  - (c) rRNA
  - (d) hnRNA
162. Which of the following viruses has double-stranded RNA as genetic material?
- (a) Tobacco mosaic virus
  - (b) Rous sarcoma virus
  - (c) Retrovirus
  - (d) Influenza virus
163. The mobility of DNA in agarose gel electrophoresis is solely based on its
- (a) charge
  - (b) conformation
  - (c) size
  - (d) None of the above
164. Ribozymes are
- (a) enzymes with catalytic activity
  - (b) RNAs with catalytic activity
  - (c) proteins with catalytic activity
  - (d) nucleic acids with catalytic activity
165. A medium which is composed of chemically defined compound(s) is called
- (a) natural media
  - (b) synthetic media
  - (c) artificial media
  - (d) None of the above

166. GenBank and Swissprot are examples of
- (a) primary database
  - (b) secondary database
  - (c) composite database
  - (d) None of the above
167. Which of the following detergents is commonly used to release integral proteins from its membranes?
- (a) Urea
  - (b) Dimethyl sulphoxide
  - (c) Triton X 100
  - (d) Cyanogen bromide
168. Which of the following ions is required for the activity of Type II restriction enzymes?
- (a)  $\text{Ca}^{2+}$
  - (b)  $\text{Mg}^{2+}$
  - (c)  $\text{Cl}^{2+}$
  - (d)  $\text{Mn}^{2+}$
169. Ti plasmid that is used as a plant vector is obtained from
- (a) *Agrobacterium tumefaciens*
  - (b) *Agrobacterium rhizogenes*
  - (c) *Agrobacterium radiobactor*
  - (d) *Thermus aquaticus*
170. Holiday junction is observed during
- (a) mitosis
  - (b) interphase
  - (c) recombination
  - (d) DNA repair