258

QUESTION PAPER SERIES CODE
A

Registration No. : | | | | | |

Centre of Exam. : _____

Name of Candidate : _____

Signature of Invigilator

ENTRANCE EXAMINATION, 2018

Ph.D. in COMPUTATIONAL BIOLOGY AND BIOINFORMATICS
P.G. Diploma in BIG DATA ANALYTICS

[Field of Study Code : CBBH (903) / PGDE (184)]

Time Allowed : 3 hours *Maximum Marks* : 80

INSTRUCTIONS FOR CANDIDATES

Candidates must read carefully the following instructions before attempting the Question Paper :

(i) 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.

(ii) **Please darken the appropriate Circle of Question Paper Series Code on the Answer Sheet.**

(iii) The Question Paper consists of three Tracks : (1) Physical Sciences; (2) Life Sciences/Bioinformatics and (3) Engineering Sciences. Each Track has **two** Parts : **Part—A** and **Part—B**. Please choose any ONE Track, and answer **Part—A** and any **one** Section of **Part—B** within this Track.

(iv) Each **Part—A** consists of thirty (**30**) questions. **All** questions are to be answered. Each correct answer will be awarded **1** mark.

(v) **Part—B** consists of different subjects within a Track with 40 subject-specific questions in each of the Sections, out of which candidates are to answer any 25 questions. Each correct answer will be awarded **2** marks subject to a maximum marks of 50.

(vi) There is **NO** negative marking in any Part/Section.

(vii) 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.

(viii) In case you think none of the possible answers are correct, mark the correct answer which you think is closest to the correct one.

(ix) Answer written by the candidates inside the Question Paper will not be evaluated.

(x) Simple Calculators and Log Tables may be used.

(xi) Pages at the end have been provided for Rough Work.

(xii) 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

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

Wrong	Wrong	Wrong	Wrong	Correct
● ⓑ ⓒ ●	Ⓐ ⓑ ⓒ ⓓ	Ⓐ ⓑ ⓒ Ⓓ	⊙ ⓑ ⓒ ●	ⓐ ⓑ ⓒ ●

4. Once marked, no change in the answer is allowed.
5. Please do not make any stray marks on the Answer Sheet.
6. Please do not do any rough work on the Answer Sheet.
7. Mark your answer only in the appropriate space against the number corresponding to the question.
8. **Ensure that you have darkened the appropriate Circle of Question Paper Series Code on the Answer Sheet.**

TRACK—I

PHYSICAL SCIENCES

PART—A

(Common for Track—I)

1. Two resistance wires on joining in parallel have a resultant $\frac{6}{5}\ \Omega$. One of the wires breaks. The effective resistance is 2 Ω. The resistance of the broken wire is

   (a) $\frac{6}{5}\ \Omega$

   (b) $2\ \Omega$

   (c) $\frac{3}{5}\ \Omega$

   (d) $4\ \Omega$

2. The property of fluid that describes its internal resistance is known as

   (a) viscosity

   (b) friction

   (c) resistance

   (d) internal energy

3. The ratio of the intensity at the centre of a bright fringe to the intensity at a point one-quarter of the distance between two fringes from the centre is

   (a) 2

   (b) $\frac{1}{2}$

   (c) 4

   (d) 16

4. A simple pendulum has a time period T_1 when observed on the surface of the earth and T_2 when taken to a height R above the earth's surface. The ratio T_2 / T_1 is

   (a) 1

   (b) $\sqrt{2}$

   (c) 4

   (d) 2

5. An ideal choke takes a current 8 A when connected to an a.c. source of 100 volts and 50 Hz. A pure resistor under the same conditions takes a current of 10 A. If the two are connected in series to an a.c. supply 100 volts and 40 Hz, then the current in the series combination of above resistor and inductor is

(a) 10 A

(b) 8 A

(c) $5\sqrt{2}$ A

(d) $10\sqrt{2}$ A

6. When a charge $+q$ is brought near an isolated metal cube having no charge initially, then

(a) the cube becomes positively charged

(b) the cube becomes negatively charged

(c) the external surface becomes negatively charged and the interior becomes positively charged

(d) the interior remains charge free and the surface gets non-uniform charge distribution

7. A block is suspended by an ideal spring of the force constant K. If the block is pulled down by applying a constant force F and if maximum displacement of the block from its initial position of rest is δ, then

(a) $\frac{F}{K} < \delta < \frac{2F}{K}$

(b) $\delta = \frac{2F}{K}$

(c) $\delta = \frac{F}{K}$

(d) increase in potential energy of the spring is $\frac{1}{2}K\delta^2$

8. A particle of mass m collides with another stationary particle of mass M. If the particle stops just after the collision, the coefficient of restitution of collision is equal to

(a) 1

(b) $\frac{m}{M}$

(c) $\frac{M-m}{M+m}$

(d) $\frac{m}{M+m}$

9. What is the dimensional formula of kinematic viscosity?

(a) $M^1L^{-1}T^{-1}$

(b) $M^1L^{-3}T^0$

(c) $M^1L^1T^{-2}$

(d) $M^0L^2T^{-1}$

10. The molecules of a gas A travel four times faster than the molecules of gas B at the same temperature. The ratio of molecular weights $\frac{M_A}{M_B}$ will be

(a) $\frac{1}{16}$

(b) 4

(c) $\frac{1}{4}$

(d) 16

11. Peptide bonding results in the formation of an

(a) ester

(b) amide

(c) ether

(d) aldehyde

12. What does a pH meter measure?

(a) Voltage

(b) Current

(c) Resistance

(d) Power

13. The density of a gas is directly proportional to its

(a) pressure

(b) volume

(c) temperature

(d) molecular velocity

14. The chemical reactions always involve

(a) release of energy

(b) absorption of energy

(c) release or absorption of energy

(d) release and absorption of energy

15. Oxidation is characterized by

(a) loss of electrons

(b) gain of electrons

(c) loss of protons

(d) gain of protons

16. Which one of the following has the largest atomic radii?

(a) Ne

(b) Be

(c) N

(d) O

17. Which of the following changes involves reduction?

(a) The conversion of ferrous sulphate to ferric sulphate

(b) The conversion of H_2S to S

(c) The conversion of Cl_2 to NaCl

(d) The conversion of Zn to $ZnSO_4$

18. The molality of 40% NaOH (w/w) with density 1·2 g/mL is

(a) 22·3

(b) 12

(c) 16·7

(d) 18

19. The electromagnetic radiation used to find out the spacing between planes in a lattice is

(a) X-ray

(b) ultraviolet

(c) infrared

(d) microwave

20. 1 nm is equal to

(a) 10^{-7} cm

(b) 10^{-8} cm

(c) 10^{-9} cm

(d) 10^{-10} cm

21. The differential equation of all conics having centre at the origin is of order

(a) 2

(b) 3

(c) 4

(d) 5

22. Order and degree of differential equation of all tangent lines to the parabola $y^2 = 4ax$ are

(a) 2, 2

(b) 3, 1

(c) 1, 2

(d) 4, 1

23. The differential equation whose solution is $Ax^2 + By^2 = 1$, where A and B are arbitrary constants is of

(a) second order and second degree

(b) first order and first degree

(c) first order and second degree

(d) second order and first degree

24. The solution of $xdy - ydx = 0$ represents

(a) parabola having vertex at (0, 0)

(b) circle having centre at (0, 0)

(c) a straight line passing through (0, 0)

(d) a rectangular hyperbola

25. The solution of the initial value problem $x\frac{dy}{dx} = x + y;\ y(1) = 1$ is

(a) $x\log x - 1$

(b) $x\log x + 1$

(c) $x(\log x + 1)$

(d) $x(\log x - 1)$

26. The directional derivative of the scalar function $f(x, y, z) = x^2 + 2y^2 + z$ at the point $P = (1, 1, 2)$ in the direction of the vector $a = 3_i\, 4_j$ is

(a) 4

(b) -2

(c) -1

(d) 1

27. The function $Y = |2 - 3x|$ is

(a) continuous $\forall\, x \in R$ and differentiable $\forall\, x \in R$

(b) continuous $\forall\, x \in R$ and differentiable $\forall\, x \in R$ except at $x = \frac{3}{2}$

(c) continuous $\forall\, x \in R$ and differentiable $\forall\, x \in R$ except at $x = \frac{2}{3}$

(d) continuous $\forall\, x \in R$ except at $x = 3$ and differentiable $\forall\, x \in R$

28. A cubic polynomial with real coefficients

(a) can possibly have no extrema and no zero crossings

(b) may have up to three extrema and up to two zero crossings

(c) cannot have more than two extrema and more than three zero crossings

(d) will always have an equal number of extrema and zero crossings

29. The area enclosed between the parabola $y = x^2$ and the straight line $y = x$ is

(a) $\frac{1}{8}$

(b) $\frac{1}{6}$

(c) $\frac{1}{3}$

(d) $\frac{1}{2}$

30. The system of linear equations, $4x + 2y = 7$, $2x + y = 6$ has

(a) a unique solution

(b) no solution

(c) an infinite number of solutions

(d) exactly two distinct solutions

PART—B

Section—I

(Physics)

31. The electromagnetic wave equation with velocity v for electric and magnetic fields **E** and **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) $\nabla f = v$

32. Consider an electromagnetic wave is propagating through a homogeneous linear medium of permittivity ε, permeability μ and dielectric constant ε_r. The refractive index of the material is given by

(a) $n = \mu$

(b) $n = \varepsilon$

(c) $n = \frac{\mu}{\varepsilon}$

(d) $n = \sqrt{\varepsilon_r}$

33. Consider a parallel-plate capacitor filled with an insulating material of dielectric constant ε_r. If C_0 is the capacitance in vacuum, what is the capacitance driven by the material?

(a) $C \sim C_0$

(b) $C = \frac{C_0}{\varepsilon_r}$

(c) $C = \frac{\sqrt{C_0}}{\varepsilon}$

(d) $C = \varepsilon_r C_0$

34. If the current density in a wire of cross-sectional area r is proportional to the distance from the axis d given by $J = kd$, where k is a constant, then total current in the wire is given by

(a) $I = \frac{2\pi k d^3}{3}$

(b) $I = \frac{kd^2}{\pi}$

(c) $I = \frac{2\pi k}{3d^3}$

(d) $I = 2\pi k d^3$

35. The magnetic field of a uniformly magnetized sphere of radius R (inside the sphere) is given by

(a) $\mathbf{B} = \frac{2}{3}\mu_0 \mathbf{M}$

(b) $\mathbf{B} = \frac{1}{R}\mu_0 \mathbf{M}$

(c) $\mathbf{B} = \mu_0 R \mathbf{M}$

(d) $\mathbf{B} = \mathbf{M}$

36. Let R and T be reflection and transmission coefficients of an electromagnetic wave traversing from one medium to another. If the permeabilities of the two media are taken to be the same, which of the following is true?

(a) $R + T > 1$

(b) $R + T < 1$

(c) $R + T = 1$

(d) $R + T = 0$

37. If V and $\mathbf{A}$ are scalar and vector potentials, then they can be transformed with a scalar λ by gauge transformation given by

(a) $\mathbf{A}' = \mathbf{A} + \nabla\lambda, \quad V' = V - \frac{\partial\lambda}{\partial t}$

(b) $\mathbf{A}' = \mathbf{A} + \nabla\lambda, \quad V' = V + \frac{\partial\lambda}{\partial t}$

(c) $\mathbf{A}' = \mathbf{A} - \nabla\lambda, \quad V' = V + \frac{\partial\lambda}{\partial t}$

(d) $\mathbf{A}' = \mathbf{A} - \nabla\lambda, \quad V' = V - \frac{\partial\lambda}{\partial t}$

38. Is it possible for a $2^2 P_{5/2}$ state to exist?

(a) Yes

(b) No

(c) Cannot say

(d) None of the above

39. An electron collides with a hydrogen atom in its ground state and excites to a state of $n = 3$. How much energy was given to the hydrogen atom in this elastic collision?

(a) 1·21 eV

(b) 12·1 eV

(c) 121 eV

(d) 1000 eV

40. What is the quantum number of the Bohr orbit in a hydrogen atom whose radius is 0·01 mm?

(a) 235

(b) 335

(c) 435

(d) 535

41. Experiments indicate that 13·6 eV is required to separate a hydrogen atom into a proton and an electron. The velocity of the electron in a hydrogen atom is

(a) $2{\cdot}2\times10^{6}$ m/s

(b) 1×10^{5} m/s

(c) $2{\cdot}2\times10^{4}$ m/s

(d) $2{\cdot}2\times10^{3}$ m/s

42. The average period that elapses between the excitation of an atom and the time it radiates is 10^{-8} s. The inherent uncertainty in the frequency of the photon is given by ($h = 1{\cdot}054\times10^{-34}$ J-s)

(a) $\Delta\nu \geq 8\times10^{6}$ Hz

(b) $\Delta\nu \geq 7\times10^{5}$ Hz

(c) $\Delta\nu \geq 6\times10^{4}$ Hz

(d) $\Delta\nu \geq 5\times10^{3}$ Hz

43. The spectral series whose lines have wavelength given by $\frac{1}{\lambda} = R\left(\frac{1}{5^2} - \frac{1}{n^2}\right)$ is

(a) Lyman series

(b) Paschen series

(c) Brackett series

(d) Pfund series

44. The entropy of an ideal gas of N population at temperature T occupying volume V is given by

(a) $\frac{S}{Nk} = \ln(V) + \frac{3}{2}\ln T$

(b) $\frac{S}{Nk} = \ln(V) - \frac{3}{2}\ln T$

(c) $\frac{S}{Nk} = \frac{3}{2}\ln T$

(d) $\frac{S}{Nk} = \frac{3}{2}V\ln T$

45. For gas-liquid system, the chemical potential (μ) can be expressed in terms of Helmholtz's (A) and Gibbs' (G) free energies as

(a) $\mu = \left(\frac{\partial A}{\partial N}\right)_{V,T} = \left(\frac{\partial G}{\partial N}\right)_{V,T}$

(b) $\mu = \left(\frac{\partial A}{\partial N}\right)_{V,T} = \left(\frac{\partial G}{\partial N}\right)_{P,T}$

(c) $\mu = \left(\frac{\partial A}{\partial N}\right)_{P,T} = \left(\frac{\partial G}{\partial N}\right)_{V,T}$

(d) $\mu = \left(\frac{\partial A}{\partial N}\right)_{P,T} = \left(\frac{\partial G}{\partial N}\right)_{P,T}$

46. For van der Waals' equation of state given by $\left(V - bP + \frac{a}{V^2} = RT\right)$, the critical values of the thermodynamical parameters are given by

(a) $T_c = \frac{27bR}{8a}, P_c = \frac{a}{27b^2}, V_c = 3b$

(b) $T_c = \frac{8a}{27bR}, P_c = \frac{a}{27b^2}, V_c = 3b$

(c) $T_c = \frac{8a}{27bR}, P_c = \frac{27b^2}{a}, V_c = 3b$

(d) $T_c = \frac{27bR}{8a}, P_c = \frac{27b^2}{a}, V_c = 3b$

47. Consider Fermi-Dirac distribution of particles in a system. The internal energy per particle at absolute zero (U_0 / N) of such distribution system with Fermi energy ε_F is given by

(a) $\frac{U_0}{N} = \frac{3}{2}\varepsilon_F$

(b) $\frac{U_0}{N} = \frac{1}{2}\varepsilon_F$

(c) $\frac{U_0}{N} = \frac{3}{5}\varepsilon_F$

(d) $\frac{U_0}{N} = \frac{3}{7}\varepsilon_F$

48. Consider a distribution of boson particles in a system. The specific heat per unit volume in such distribution system is given by

(a) $C_V = 3\sigma T^2$

(b) $C_V = 4\sigma T^3$

(c) $C_V = 5\sigma T^4$

(d) $C_V = 6\sigma T^5$

(σ is Stefan's constant)

49. A particle of mass m moves in a potential $V(r) = V_0 e^{-\lambda^2 r^2}$. What is the largest value of angular momentum L for which a circular orbit does in fact exist?

(a) $L_{max} = \frac{8mV_0}{\lambda^2 e^2}$

(b) $L_{max} = \frac{V_0}{\lambda^2}$

(c) $L_{max} = \frac{V_0}{\lambda^2 e^2}$

(d) $L_{max} = \frac{8mV_0}{\lambda e}$

50. The location of the centre of mass of a hollow hemispherical shell with uniform mass density and radius R is given by

(a) $x_{cm} = R$

(b) $x_{cm} = \frac{2}{R}$

(c) $x_{cm} = \frac{R}{2}$

(d) $x_{cm} = \frac{R^2}{4}$

51. A mass m travels perpendicular to a stick of mass m and length l, which is initially at rest. At what location should the mass collide elastically with the stick, so that the mass and the center of the stick move with equal speeds after the collision?

(a) $h = \frac{l}{\sqrt{2}}$

(b) $h = \frac{l}{2}$

(c) $h = \frac{l}{\sqrt{6}}$

(d) $h = \frac{l}{2\sqrt{2}}$

52. Hamiltonian of a system of particles expressed in generalized coordinates q and p, and Lagrangian L is given by, $H = \dot{q}p - L$. Then Hamilton's canonical equations are

(a) $\dot{q} = \frac{\partial H}{\partial p}, -\dot{p} = \frac{\partial H}{\partial q}, -\frac{\partial L}{\partial t} = \frac{\partial H}{\partial t}$

(b) $\dot{q} = \frac{\partial H}{\partial q}, -\dot{p} = \frac{\partial H}{\partial p}, -\frac{\partial L}{\partial t} = \frac{\partial H}{\partial t}$

(c) $\dot{q} = \frac{\partial H}{\partial p}, \dot{p} = \frac{\partial H}{\partial q}, \frac{\partial L}{\partial t} = \frac{\partial H}{\partial t}$

(d) $-\dot{q} = \frac{\partial H}{\partial p}, \dot{p} = \frac{\partial H}{\partial q}, \frac{\partial L}{\partial t} = \frac{\partial H}{\partial t}$

53. The solution of the differential equation $\frac{dy}{dx} = \frac{y^2}{1-3xy}$ is

(a) $3y = x + c$

(b) $y = c$

(c) $2xy^3 - y^2 = 2c$

(d) $xy^2 = y + 2c$

54. The solution of the differential equation $\frac{dy}{dx} + \frac{y \ln y}{x - \ln y} = 0$ is

(a) $y = x + c$

(b) $y = x$

(c) $2x \ln y = (\ln y)^2 + 2c$

(d) $x(\ln y)^2 = \ln y + 2c$

55. The Fourier sine series expansion of $f(x) = x$ in $(0, \pi)$ is

(a) $f(x) = \sum_1^{\infty} \frac{1}{\pi}(-1)^{n-1} \sin(nx)$

(b) $f(x) = \sum_1^{\infty} \frac{2}{n}(-1)^{n+1} \sin(nx)$

(c) $f(x) = \sum_0^{n} \frac{1}{n}(-1)^{n} \sin(nx)$

(d) $f(x) = -\sin(nx)$

56. The inverse Fourier sine transform of $\frac{1}{s}e^{-as}$ is

(a) $f(x) = \frac{2}{\pi}\tan^{-1}\left(\frac{x}{a}\right)$

(b) $f(x) = a\tan^{-1}\left(\frac{x}{a}\right)$

(c) $f(x) = \frac{1}{\pi}\tan^{-1}(ax)$

(d) $f(x) = -\pi\sin(ax)$

57. The principal value of $\sqrt{2i}$ is

(a) $1+i$

(b) i

(c) $i-1$

(d) 1

58. The residues at the poles of $\frac{2z+1}{z^2-z-2}$ are

(a) $\frac{1}{3}, \frac{5}{3}$

(b) $\frac{1}{2}, \frac{3}{2}$

(c) 1, 3

(d) $\frac{3}{2}, \frac{5}{2}$

59. The value of $\int_C \frac{dz}{\sinh(2z)}$ with $C: |z| = 2$ is

(a) π

(b) 2π

(c) πi

(d) $-\pi i$

60. The Laplace transform of $\int_0^t \frac{\sin(u)}{u} du$ is

(a) $s.\tan^{-1} s$

(b) $s.\tan(s)$

(c) 0

(d) $\frac{1}{s}\tan^{-1}\left(\frac{1}{s}\right)$

61. In Laplace transform if $L\{f(t)\} = F(s)$, then $L\{f(at)\}$, where a is a constant, is equal to

(a) $(1/a)F(s/a)$

(b) $aF(s)$

(c) $sF(a)$

(d) $(1/s)F(a/s)$

62. Electrostatic force on a unit charged particle due to another identical one at a distance r is inversely proportional to r^2 as per Coulomb's law. If this force were inversely proportional to r instead of r^2, which of the following would be correct?

(a) Electric potential near a charged particle would be independent of distance from it

(b) Electric field near the charged particle would be inversely proportional to r^2

(c) Gauss' law of electric flux conservation would be violated

(d) Principle of conservation of charge would be violated

63. As per the Newtonian principles of relativity

(a) velocity of light is independent of the refractive index of the medium

(b) there is no upper limit on the velocity of light in an inertial frame of reference

(c) mass of a particle increases with velocity

(d) distance between two point objects will increase at high velocity

64. Two spheres of equal mass undergo head-on elastic collision. What is the consequence to their motion immediately after the collision?

(a) The direction of motion will be interchanged

(b) Magnitudes of velocity will be interchanged

(c) Both of the above

(d) None of the two will change if it is an elastic collision

65. In a radioactive decay at its half-life period, which one is correct?

(a) Half of the time since a particle was created

(b) Half of the time to the radioactive decay of the particle is over

(c) The probability of the decay of the particle has decreased

(d) The probability of the decay remains unchanged

66. Which of the following is/are ***not*** valid type(s) of optical spectra from a single atom?

(a) Vibrational and rotational

(b) Electronic

(c) Mechanical

(d) Gravitational

67. A monochromatic radiation of wavelength λ_1 is incident on a stationary atom as a result of which the wavelength of the photon after collision becomes λ_2. The atom has De Broglie's wavelength λ_3 and velocity in the direction on incident photon after collision. Then

(a) $\lambda_3 = \sqrt{\lambda_1 \lambda_2}$

(b) $\lambda_1 = \dfrac{\lambda_2 \lambda_3}{\lambda_2 + \lambda_3}$

(c) $\lambda_2 = \sqrt{\lambda_1^2 + \lambda_3^2}$

(d) $\lambda_3 = \sqrt{\lambda_1^2 + \lambda_2^2}$

68. A small charged particle of mass m and charge q is suspended by an insulated thread in front of a very large sheet of charge density σ. The angle made by the thread with the vertical in equilibrium is

(a) $\tan^{-1}\left(\frac{\sigma q}{2\varepsilon_0 mg}\right)$

(b) $\tan^{-1}\left(\frac{\sigma q}{\varepsilon_0 mg}\right)$

(c) $\tan^{-1}\left(\frac{2\sigma q}{\varepsilon_0 mg}\right)$

(d) zero

69. The ratio of minimum to maximum wavelengths in the Lyman series of radiation that an electron causes in a Bohr's hydrogen atom is

(a) $\frac{1}{2}$

(b) $\frac{7}{9}$

(c) $\frac{3}{4}$

(d) $\frac{27}{32}$

70. The behaviour of a real gas is usually depicted by plotting compressibility factor Z versus pressure P at a constant temperature. At high temperature and high pressure, Z is usually more than one. This fact can be explained by van der Waals' equation with van der Waals' constants related to pressure and volume corrections a and b when

(a) the constant a is negligible and not b

(b) the constant b is negligible and not a

(c) both the constants a and b are negligible

(d) both the constants a and b are not negligible

Section—II

(Chemistry)

71. A buffer is formed by adding 500 mL of 0·20 *M* $HC_2H_3O_2$ to 500 mL of 0·10 *M* $NaC_2H_3O_2$. What would be the maximum amount of HCl that could be added to this solution without exceeding the capacity of the buffer?

(a) 0·01 mol

(b) 0·05 mol

(c) 0·10 mol

(d) 0·15 mol

72. A molecule exhibits sp^3d^2 hybridization in its bonding structure. The most probable geometric shape of this molecule is

(a) triangular bipyramidal

(b) T-shaped

(c) octahedral

(d) linear

73. What is the molality of a 10 % (by weight) C_6H_2O (MW=90) solution?

(a) 0·012 *m*

(b) 0·12 *m*

(c) 1·2 *m*

(d) 12 *m*

74. When a solid melts, which of the following is true?

(a) $\Delta H > 0,\ \Delta S > 0$

(b) $\Delta H < 0,\ \Delta S < 0$

(c) $\Delta H > 0,\ \Delta S < 0$

(d) $\Delta H < 0,\ \Delta S > 0$

75. Which of the following elements most readily shows the photoelectric effect?

(a) Noble gases

(b) Alkali metals

(c) Halogen elements

(d) Transition metals

76. An energy value of $3 \cdot 313 \times 10^{-19}$ joule is needed to break a chemical bond. What is the wavelength of energy needed to break the bond?

(The speed of light = $3 \cdot 00 \times 10^{10}$ cm/sec; Planck's constant = $6 \cdot 626 \times 10^{-34}$ J-s)

(a) $5 \cdot 00 \times 10^{18}$ cm

(b) $1 \cdot 00 \times 10^{15}$ cm

(c) $2 \cdot 00 \times 10^{5}$ cm

(d) $6 \cdot 00 \times 10^{-5}$ cm

77. Which one of the following ***does not*** exhibit resonance?

(a) SO_2

(b) SO_3

(c) HI

(d) CO_3^{2-}

78. Which of the following best explains why sulfur can make more bonds than oxygen?

(a) Sulfur is more electronegative than oxygen

(b) Oxygen is more electronegative than sulfur

(c) Sulfur has 3*d* orbitals not available to oxygen

(d) Sulfur has fewer valence electrons

79. No two electrons of an atom can have the same sets of four quantum numbers. This is known as

(a) Heisenberg's uncertainty principle

(b) Hund's rule

(c) Pauli's exclusion principle

(d) Aufbau's principle

80. Among the following molecules, the shortest bond length is to be found in

(a) C_2

(b) N_2

(c) O_2

(d) F_2

81. In comparison with HCl, the frequency for the transition of DCl from the ground vibrational state to the first excited vibrational state is

(a) higher for DCl

(b) lower for DCl

(c) same for the both

(d) It depends on the temperature

82. When subjected to the flame test, a solution that contains K^+ ions produces the color

(a) yellow

(b) violet

(c) crimson

(d) green

83. The bond energy of Br—Br is 192 kJ/mole, and that of Cl—Cl is 243 kJ/mole. What is the approximate Cl—Br bond energy?

(a) 54·5 kJ/mole

(b) 109 kJ/mole

(c) 218 kJ/mole

(d) 435 kJ/mole

84. The half-life of C is 5770 years. What percent of the original radioactivity would be present after 28850 years?

(a) 1·56%

(b) 3·12%

(c) 6·26%

(d) 12·5%

85. Which one of the following is ***not*** an assumption of the kinetic theory of gases?

(a) Gas particles are negligibly small

(b) Gas particles undergo a decrease in kinetic energy when passed from a region of high pressure to a region of low pressure

(c) Gas particles are in constant motion

(d) Gas particles do not attract each other

86. In expanding from 5·00 to 6·00 liters at a constant pressure of 2·00 atmospheres, a gas absorbs 505·64 joules of energy (101·32 joules = 1 liter atm). The change in energy ΔE, for the gas is

(a) 50·66 J

(b) 101·32 J

(c) 303·00 J

(d) 505·64 J

87. For the spontaneous freezing of supercooled water at −20 °C and 1 atm pressure, which of the following is true?

(a) Del $G_{system} < 0$

(b) Del $S_{system} > 0$

(c) Del $H_{system} > 0$

(d) Del $U_{surrounding} > 0$

88. Which of the following partial derivatives is zero for an ideal gas?

(a) $\left(\frac{du}{dT}\right)_v$

(b) $\left(\frac{dH}{dT}\right)_p$

(c) $\left(\frac{du}{dv}\right)_T$

(d) $\left(\frac{ds}{dv}\right)_T$

89. Which of the following is ***not*** an allotrope of carbon?

(a) Diamond

(b) C60

(c) C70

(d) C_2^{-2}

90. How much 2·0 M H_2SO_4 would be required to make 500 mL of 0·50 M H_2SO_4?

(a) 100 mL

(b) 125 mL

(c) 250 mL

(d) 500 mL

91. What happens to the velocities of different molecules as the temperature of the gas increases?

(a) The velocities of all component molecules increase equally.

(b) The velocity range among different molecules at higher temperatures is smaller than that at lower temperatures.

(c) The effect on the velocities of the molecules depends on whether the pressure remains constant.

(d) The velocity range among different molecules at higher temperatures is wider than the range at lower temperatures.

92. The boiling points increase as $F_2 < Cl_2 < Br_2 < I_2$. The reason is

(a) van der Waals interaction

(b) ionic bonding

(c) electrostatics

(d) covalent bonding

93. Of the following experimental observations, which one shows the wave nature of electron?

(a) Photoelectric effect

(b) Ionization of an atom

(c) Diffraction of electrons by X-ray

(d) Flow of electrons in a metal wire

94. If ΔH° and ΔS° are both negative, then ΔG° is

(a) always negative

(b) always positive

(c) positive at low temperatures and negative at high temperatures

(d) negative at low temperatures and positive at high temperatures

95. What is the name of the following branched alkene?

$$CH_3(CH_2)_2C(CH_3) = CHCH_3$$

(a) 3-methyl-2-hexene

(b) 2-methyl-3-hexene

(c) 1-methyl-2,3-diethyl-3-hexene

(d) 1-methyl-2,2-diethyl-3-hexene

96. The equilibrium constant for the formation of NO_2 from NO and O_2 at 298 K

$$NO(g) + \left(\frac{1}{2}\right)O_2 \longrightarrow NO_2(g)$$

where $\Delta G^\circ(NO_2) = +52{\cdot}0\ kJ\ mol^{-1}$, $\Delta G^\circ(NO) = 87{\cdot}0\ kJ\ mol^{-1}$, $\Delta G^\circ(O_2) = 0\ kJ\ mol^{-1}$, is

(a) $1{\cdot}562 \times 10^8$

(b) $1{\cdot}365 \times 10^6$

(c) $5{\cdot}655 \times 10^3$

(d) $8{\cdot}56 \times 10^2$

97. In a mixture of He and Xe, at equilibrium the average speed follows (V_{He} and V_{Xe} are the velocities and M_{He} and M_{Xe} are the masses of He and Xe)

(a) $V_{He} / V_{Xe} = M_{He} / M_{Xe}$

(b) $V_{He} / V_{Xe} = M_{Xe} / M_{He}$

(c) $V_{He} / V_{Xe} = \text{sqrt}(M_{Xe} / M_{He})$

(d) $V_{He} / V_{Xe} = \text{sqrt}(M_{He} / M_{Xe})$

98. The rate of first-order reactions depends on

(a) concentration of substrate

(b) concentration of reactants

(c) concentration of both substrate and reactant

(d) concentration of neither substrate nor reactant

99. A large activation energy implies that the reaction

(a) is at equilibrium

(b) is endothermic

(c) has highly temperature dependent rate constant

(d) is spontaneous

100. The measurement of rate under conditions of insignificant substrate concentration change gives

(a) reaction velocity

(b) initial velocity

(c) reaction rate

(d) specific activity

101. According to Maxwell's law of distribution of velocities of molecules, the most probable velocity is

(a) greater than mean velocity

(b) equal to mean velocity

(c) equal to root-mean-square velocity

(d) less than the root-mean-square velocity

102. The relation between the number of microstates $\Omega(E)$ for an ideal gas of N monatomic molecules in a volume V is related to energy E as

(a) $\Omega(E) \propto E$

(b) $\Omega(E) \propto E^N$

(c) $\Omega(E) \propto E^{N/2}$

(d) $\Omega(E) \propto E^{3N/2}$

103. In a chromatographic separation, which of the following indices is the most appropriate for the qualitative identification of a substance?

(a) Relative retention factor

(b) Retention factor

(c) Retention time

(d) Resolution

104. A series of three coloured glass plates of equal thickness is placed in a light beam. Each plate absorbs one quarter of the light incident upon it. What is the intensity of the light transmitted by the third glass plate?

(a) 1·56%

(b) 42·19%

(c) 56·25%

(d) 75·0%

105. The wavelength of an absorption is 495 nm. In what part of the electromagnetic spectrum does this lie?

(a) Ultraviolet-visible

(b) Microwave

(c) Radio wave

(d) Infrared

106. Hexane and 3-methylpentane are the examples of

(a) enantiomers

(b) stereoisomers

(c) diastereomers

(d) constitutional isomers

107. The effect of temperature on the rate of reaction is given by

(a) Gibbs equation

(b) van der Waals equation

(c) Freundlich equation

(d) Arrhenius equation

108. The enzyme-catalysed reaction is faster than a metal-catalysed reaction because as compared to the latter, the activation energy of the former is

(a) same

(b) lesser

(c) greater

(d) None of the above

109. The difference in experimentally measured heat capacity at low temperatures and the predicted value from theory using equipartition principle is mainly due to decreased contribution from

(a) translational modes

(b) rotational modes

(c) vibrational modes

(d) All of the above

110. In NMR spectroscopy, which of the following can be used to measure the distance between atoms?

(a) Nuclear Overhauser Effect (NOE)

(b) Coupling constant

(c) Magic angle spectroscopy

(d) COSY

Section—III

(Mathematics)

111. The Fourier series of a real periodic function has only

P. cosine terms if it is even

Q. sine terms if it is even

R. cosine terms if it is odd

S. sine terms if it is odd

Which of the above statements are correct?

(a) P and S

(b) P and R

(c) Q and S

(d) Q and R

112. Bernoulli's equation ***cannot*** be applied when the flow is

(a) rotational

(b) turbulent

(c) unsteady

(d) All of the above

113. Relative density of mercury is

(a) 1

(b) 9·8

(c) 13·6

(d) 1000

114. If the Reynolds number is less than 2000, then the flow in a pipe is

(a) turbulent

(b) laminar

(c) transitional

(d) None of the above

115. A flow is called supersonic if the

(a) velocity of flow is very high

(b) discharge is difficult to measure

(c) Mach number is between 1 and 5

(d) Mach number is less than 1

116. The continuity equation is the result of application of which of the following laws to the flow field?

(a) First law of thermodynamics

(b) Conservation of energy

(c) Newton's second law of motion

(d) Conservation of mass

117. Reynolds number signifies the ratio of

(a) gravity forces to viscous forces

(b) inertial forces to viscous forces

(c) inertial forces to gravity forces

(d) buoyant forces to inertial forces

118. Which fluid ***does not*** experience shearing stress during flow?

(a) Pseudoplastic

(b) Dilatant

(c) Newtonian

(d) Inviscid

119. Stress-strain relationship for Newtonian fluid is

(a) parabolic

(b) hyperbolic

(c) linear

(d) inverse type

120. The Pitot tube is used to measure

(a) velocity at stagnation point

(b) stagnation pressure

(c) static pressure

(d) dynamic pressure

121. Centre of buoyancy always

(a) coincides with the centre of gravity

(b) coincides with the centroid of the volume of fluid displaced

(c) remains above the centre of gravity

(d) remains below the centre of gravity

122. The eddy viscosity for turbulent flow is

(a) a function of temperature only

(b) a physical property of the fluid

(c) dependent on the flow

(d) independent of the flow

123. Flow at constant rate through a tapering pipe is

(i) steady flow

(ii) uniform flow

(iii) unsteady flow

(iv) non-uniform flow

The correct answer is

(a) *(i)* and *(ii)*

(b) *(i)* and *(iv)*

(c) *(ii)* and *(iii)*

(d) *(ii)* and *(iv)*

124. Streamlines and path lines always coincide in case of

(a) steady flow

(b) laminar flow

(c) uniform flow

(d) turbulent flow

125. Consider the initial value problem :

$$y'(t) = f(t)\, y(t),\ y(0) = 1$$

where $f : R \to R$ is continuous. Then this initial value problem has

(a) infinitely many solutions for some f

(b) a unique solution R

(c) no solution in R for some f

(d) a solution in an interval containing 0, but not on R for some f

126. The differential equation $xu_x + yu_y = 2u$ satisfying the initial condition $y = x\,g(x)$ and $u = f(x)$ with

P. $f(x) = 2x,\ g(x) = 1$, has no solution

Q. $f(x) = 2x^2,\ g(x) = 1$, has infinite number of solutions

R. $f(x) = x^3,\ g(x) = x$, has a unique solution

S. $f(x) = x^4,\ g(x) = x$, has a unique solution

Which of the above are necessarily true?

(a) P and Q

(b) Q and R

(c) P, Q and R

(d) P, R and S

127. The partial differential equation $yu_{xx} + xu_{yy} = 0$ is hyperbolic in

(a) the second and fourth quadrants

(b) the second and third quadrants

(c) the first and second quadrants

(d) the first and third quadrants

128. Let V be the set of $n \times n$ upper triangular matrices over C. The dimension of V as a vector space over C is

(a) n^2

(b) $\frac{n(n+1)}{2}$

(c) n

(d) $n(n-1)$

129. Let A and B be $n \times n$ matrices over field F. Let rank $A = n$. Then

(a) rank AB = rank B = rank BA

(b) rank AB = rank A

(c) rank AB must be n

(d) rank AB must be less than n

130. Let A be an $n \times n$ real symmetric non-singular matrix. Suppose there exists $x \in R^n$ such that $x'Ax < 0$. Then we can conclude that

(a) $\det(A) < 0$

(b) $B = -A$ is positive definite

(c) $\exists\ y \in R^n : yA^{-1}y < 0$

(d) $\forall\ y \in R^n : yA^{-1}y < 0$

131. Dijkstra's algorithm is used

(a) for minimum spanning tree

(b) for shortest distance

(c) to find eigenvalue

(d) to find eigenvector

132. A graph is Eulerian if and only if the degree of each vertex of the graph is

(a) prime

(b) odd

(c) even

(d) fraction

133. A Petri net is always

(a) spanning graph

(b) directed bipartite graph

(c) complete graph

(d) tripartite graph

134. How many non-isomorphic trees are possible using six vertices?

(a) 12

(b) 10

(c) 5

(d) 6

135. If a connected planner graph G with n vertices and e edges has f regions, then

(a) $n+e+f=2$

(b) $n-e-f=2$

(c) $n-e+f=2$

(d) $n+e-f=2$

136. Let $X = \{1, 2, 3, 4\}$ and binary relation R is defined as

$$R = \{(1, 1), (2, 1), (2, 2), (3, 3), (4, 4), (4, 3)\}$$

then

(a) R is reflexive, symmetric and transitive relation

(b) R is not reflexive, not symmetric and transitive relation

(c) R is reflexive, not symmetric and transitive relation

(d) R is reflexive, not symmetric and not transitive relation

137. If f is any feasible flow and if $(X, \overline{X})$ is any cut, then the

(a) value of $f \geq$ capacity

(b) value of $f \leq$ capacity

(c) value of f is always zero

(d) value of f is negative

138. For what relations the vectors $x_1 = (1, 2, -1)$, $x_2 = (2, 1, -1)$ and $x_3 = (7, -4, 1)$ are linearly dependent?

(a) $\lambda_1 - \lambda_2 + \lambda_3 = 0,\ 3\lambda_2 - 6\lambda_3 = 1$

(b) $\lambda_1 + \lambda_2 - \lambda_3 = 0,\ 3\lambda_2 + 6\lambda_3 = 0$

(c) $\lambda_1 - \lambda_2 + \lambda_3 = 0,\ 3\lambda_2 + 6\lambda_3 = 0$

(d) $2\lambda_1 - 7\lambda_2 + \lambda_3 = 0,\ 3\lambda_2 - 6\lambda_3 = 0$

139. If the graph has no self-loop, then the sum of all entries in any row or column is

(a) half of the degree of vertex corresponding to that row or column

(b) less than to the degree of vertex corresponding to that row or column

(c) greater than to the degree of vertex corresponding to that row or column

(d) equal to the degree of vertex corresponding to that row or column

140. Every tree with two or more vertices is

(a) 5-chromatic

(b) 4-chromatic

(c) 2-chromatic

(d) 3-chromatic

141. 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 skew symmetric

142. Let u and v be distinct vertices of a tree, then

(a) there is no path from u to v

(b) there are exactly three paths from u to v

(c) there are exactly two paths from u to v

(d) there is a unique path from u to v

143. Ten students got the following marks in mathematics and economics in end-sem examination :

Students	:	1	2	3	4	5	6	7	8	9	10
Marks in Economics	:	78	36	98	25	75	82	90	62	65	39
Marks in Mathematics	:	81	51	91	60	68	62	86	58	53	47

Then the rank correlation coincident is

(a) -1

(b) 0

(c) 0·8182

(d) 1

144. Degeneracy at any iteration can be removed by placing ε (where $\varepsilon \to 0$) in an unoccupied cell which

(a) has the least cost

(b) is an independent cell, beginning with which a closed path cannot be drawn

(c) is an independent cell, beginning with which a closed path can be drawn

(d) has the largest cost

145. Mean and variance of geometric distribution are

(a) q/p and q/p^3

(b) q^2/p and q/p^2

(c) q^2/p and q^2/p^2

(d) q/p and q/p^2

146. What is the expectation of the number of failures preceding the first success in an infinite series of independent trials with constant probability p of success in each trial?

(a) q^2/p

(b) p/q

(c) q/p

(d) q/p^2

147. A disease is present in 10% of population and a diagnostic test designed to detect this disease does not always detect correctly. The table below shows the proportion of times that the test produces various results :

Disease	*Positive*	*Negative*
Present (D)	0·08	0·02
Absent ($\bar{D}$)	0·05	0·85

Find the proportion of times the disease is present when the test is negative.

(a) 0·067

(b) 0·023

(c) 0·50

(d) 0·25

148. The value of β_2 gives a measure of kurtosis of a curve, then we have

(a) for normal curve $\beta_2 < 3$, for leptokurtic curve $\beta_2 > 3$ and for platykurtic curve $\beta_2 = 3$

(b) for normal curve $\beta_2 = 3$, for leptokurtic curve $\beta_2 > 3$ and for platykurtic curve $\beta_2 < -3$

(c) for normal curve $\beta_2 = 3$, for leptokurtic curve $\beta_2 > 3$ and for platykurtic curve $\beta_2 < 3$

(d) for normal curve $\beta_2 < 3$, for leptokurtic curve $\beta_2 = 3$ and for platykurtic curve $\beta_2 > 3$

149. Let $X_1, X_2, X_3, \cdots$ be a sequence of independent and identically distributed (i.i.d.) random variables each having expected value μ and standard deviation σ. Then for any $\varepsilon > 0$

(a) $\lim_{n\to\infty} P\left\{\left|\frac{X_1 + X_2 + X_3 + \cdots}{n} - \mu\right| < \varepsilon\right\} = 0$

(b) $\lim_{n\to\infty} P\left\{\left|\frac{X_1 + X_2 + X_3 + \cdots + X_n}{n} - \mu\right| > \varepsilon\right\} = 0$

(c) $\lim_{n\to\infty} P\left\{\left|\frac{X_1 - X_2 - X_3 - \cdots - X_n}{n} - \mu\right| > \varepsilon\right\} = 0$

(d) $\lim_{n\to\infty} P\left\{\left|\frac{X_1 + X_2 + X_3 + \cdots + X_n}{n} + \mu\right| > \varepsilon\right\} > 0$

150. Let X be a continuous random variable with the parameters μ and σ. Then probability density function for normal variate is given by

(a) $f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-1}{2}\left(\frac{x-\mu}{\sigma}\right)}, -\infty < x < \infty$

(b) $f(x) = \frac{1}{\sigma\sqrt{\pi}} e^{\frac{-1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}, -\infty < x < \infty$

(c) $f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}, -\infty < x < \infty$

(d) $f(x) = \frac{1}{\sigma\sqrt{2}} e^{\frac{-1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}, -\infty < x < \infty$

TRACK—II

LIFE SCIENCES/BIOINFORMATICS

PART—A

(Common for Track—II)

151. What do you understand by heterochromatin?

(a) Highly condensed state of DNA present at centromeres and telomeres

(b) Highly transcriptionally active form of DNA

(c) Highly supercoiled form of DNA that does not contain any genes

(d) DNA segment that helps in the attachment of genetic material with cell membrane

152. Post-translational modifications of proteins are ***not*** required for

(a) localization of proteins

(b) natural functioning of proteins

(c) correct folding of a protein

(d) sequencing of a protein

153. During DNA replication in bacteria, which of the following enzymes is responsible for removing RNA primers?

(a) DNA polymerase I

(b) DNA polymerase II

(c) DNA polymerase III

(d) Ligase

154. What will be the sequence of polypeptide coded by an RNA sequence?

"AUGAAAGACGGGUGA"

(a) MKDG

(b) MKDGC

(c) IKDG

(d) IKDGC

155. During which of the following phases of cell cycle, DNA replication occurs?

(a) G1 phase

(b) G2 phase

(c) S phase

(d) M phase

156. What is a bibliography?

(a) List of all the authors along with their affiliations

(b) A detailed description of a person's life

(c) A detailed description of methods used in developing a scientific tool

(d) List of all the sources used in writing a research article

157. Which of the following is used to work with BSL-4 pathogenic agents?

(a) Class I biosafety cabinet

(b) Class II biosafety cabinet

(c) Class III biosafety cabinet

(d) Class IV biosafety cabinet

158. Why plants look green?

(a) Because chlorophyll absorbs green color

(b) Because chlorophyll has a chemical which is green in color

(c) Because chlorophyll absorbs red and blue light

(d) Because chloroplasts have their own DNA

159. Vinegar is produced by the fermentation of sugars by yeast and

(a) lactobacillus

(b) bacillus

(c) streptococcus

(d) acetobacter

160. The cell elongation in stem internodes takes place due to

(a) gibberellin

(b) silicon

(c) auxin

(d) brassinosteroid

161. In the secondary structure of a protein, which of the following is the main force required for alpha helix formation?

(a) Disulphide bond

(b) Ionic interaction

(c) Hydrogen bond

(d) Hydrophobic interaction

162. The only genetically modified crop/food plant approved in India is

(a) golden rice

(b) Bt brinjal

(c) Bt tomato

(d) Bt cotton

163. Post-transcriptional gene silencing is mediated by

(a) mRNA

(b) siRNA

(c) sense RNA

(d) rRNA

164. The sedimentation coefficient of large subunit of ribosome isolated from chloroplast is

(a) 40S

(b) 30S

(c) 50S

(d) 20S

165. A degenerate primer is generally designed from a/an

(a) DNA sequence

(b) amino acid sequence

(c) RNA sequence

(d) cDNA sequence

166. During transcription, the strand which has the same nucleotide sequence as the mRNA produced, is

(a) anti-sense strand

(b) coding strand

(c) non-sense strand

(d) sense strand

167. Which of the following is ***not*** a sequence alignment program/algorithm?

(a) FASTA

(b) BLAST

(c) Needle

(d) Modeller

168. Which of the following is ***not*** a secondary structure of proteins as defined by DSSP?

(a) Alpha helix

(b) Beta strand

(c) Kink

(d) Pi helix

169. In a regular DNA helix, which of the following statements is ***not*** correct?

(a) Number of a Gua and Cyt is equal.

(b) Number of Ade and Thy is equal.

(c) Number of Gua and Thy is equal.

(d) G—C bond is stronger than A—T bond.

170. Which of the following can model non-additive properties of a predictive mode?

(a) Linear regression

(b) Support vector machine with linear kernel

(c) Neural networks with one hidden layer

(d) All of the above

171. The prediction models trained on a small number of data points show a high performance but fail to make useful predictions for new data sets. Such a situation is called

(a) overfitting

(b) under-learning

(c) training failure

(d) feature redundancy

172. Which of the following is the most crucial step of comparative modeling of protein structures?

(a) Template identification

(b) Energy minimization

(c) Side-chain orientation

(d) Visualization of the modeled structure

173. Which of the following serves as a substitution matrix for sequence alignment?

(a) Adjacency matrix

(b) BLOSUM62

(c) Contact matrix

(d) Confusion matrix

174. Which of the following can form maximum number of structures without changing the sequence or composition?

(a) Proteins

(b) DNAs

(c) Carbohydrates

(d) Esters

175. Galaxy in bioinformatics most likely means

(a) a web server for genome data analysis

(b) a collection of desktop software applications

(c) a web repository of bioinformatics tools

(d) a seminar in which both biologists and information scientists take part

176. Submission to GenBank is done using

(a) Bankit and Sequin

(b) Bankit and Bankin

(c) Sequin and Bankin

(d) Entrez

177. FlyBase is a

(a) biodiversity database

(b) model organism database

(c) literature database

(d) biomolecular database

178. Ribosomes are composed of

(a) DNA and RNA

(b) RNA and proteins

(c) DNA and proteins

(d) RNA only

179. Which of the following nucleotide sequences contains four pyrimidine bases?

(a) GATCAATGC

(b) UAGCGGUAA

(c) GCUAGACAA

(d) Both (b) and (c)

180. Independently folded functional unit of a protein is called

(a) motif

(b) fold

(c) domain

(d) module

PART—B

Section—I

(Life Sciences/Biotechnology)

181. Which of the following is ***not*** true about alternative splicing?

(a) One gene can code for multiple proteins

(b) A particular exon may be included or excluded from processed mRNA

(c) A particular intron may be included or excluded from processed mRNA

(d) A stop codon is introduced after exons join together

182. Which of the following is ***not*** patentable in India?

(a) Genetically modified animal

(b) Process used for genetic modification

(c) Gene used for genetic modification

(d) Therapeutic drug

183. Which of the following is ***not*** an example of plagiarism?

(a) Rewriting somebody else's lines without citing the source

(b) Copying your own lines from a previously published manuscript with proper citation

(c) Copying the lines as such from multiple papers to write one paragraph and then citing all of them

(d) Using quotations to write a line copied from another paper and citing the source

184. What is the natural function of CRISPR-Cas system in bacteria?

(a) Repair mutations introduced during DNA replication

(b) Confer resistance to phages

(c) Help in recombination during crossing-over

(d) Introduce beneficial mutations

185. Which of the following is normally ***not*** present in plant cell walls?

(a) Lignin

(b) Cellulose

(c) Hemicellulose

(d) Chitin

186. Which of the following is ***not*** a grass of family Poaceae?

(a) Rice

(b) Maize

(c) Quinoa

(d) Sorghum

187. Apomictically produced offspring is

(a) genetically identical to the parent plant

(b) genetically different from the parent plant

(c) genetically better than the parent plant

(d) genetically worse than the parent plant

188. DNA polymorphism can be present

(a) anywhere in genome

(b) only in coding regions

(c) in active part of genome

(d) only in non-coding part of genome

189. Methylation of a DNA segment typically

(a) activates gene expression

(b) suppresses gene expression

(c) alters DNA sequence

(d) alters protein coded by that segment

190. Which of the following is ***not*** true about microarrays?

(a) Microarrays can determine expression of thousands of genes simultaneously.

(b) Microarrays can be used to study gene expression in an organism for which no sequence information is known.

(c) Microarrays can be used to determine expression patterns of splicing variants.

(d) Microarrays cannot be used for identifying promoter elements.

191. After RNA extraction from flowers, Reema performed gel electrophoresis and could see two clear bands. What do they correspond to?

(a) 50S and 30S RNA

(b) 18S and 5S RNA

(c) 60S and 40S RNA

(d) 28S and 18S RNA

192. Natural antisense transcripts are

(a) altered transcripts created due to natural mutations

(b) transcripts that can code for more than one protein

(c) complementary to other RNA transcripts

(d) complementary to only the transcripts of housekeeping genes

193. You had developed a novel method and published it in an open access journal. After five years, you realized that your method can have huge industrial application. Can you now patent it?

(a) Yes, but only for half than normal period for which patent is granted.

(b) No, because the applications of the method were not revealed at the time of discovery.

(c) No, because information is already in public domain.

(d) Yes, but you will have to retract the publication.

194. Dr. Neil sequenced the genome of a rare form of fish and annotated 50000 transcripts from it. Reviewers asked him to experimentally validate the transcripts. Which approach should Dr. Neil use?

(a) Southern blotting

(b) RNA sequencing

(c) Increase sequencing coverage

(d) Chromatin immunoprecipitation

195. How can one sterilize antibiotics?

(a) By autoclaving

(b) By filter sterilization

(c) By dissolving them in ethanol

(d) By incubating them at 100 °C for 5 minutes

196. Nucleosomes are ***not*** found in

(a) *Escherichia coli*

(b) *Saccharomyces cerevisiae*

(c) *Entamoeba histolytica*

(d) *Trypanosoma brucei*

197. Quantitative RT-PCR is used to

(a) determine gene sequence

(b) amplify RNA sequence

(c) amplify DNA sequence

(d) determine gene expression

198. Particular RNAs that are important for the development are located in distinct region of a plant embryo. This can be most directly demonstrated by

(a) Northern blotting

(b) *in situ* hybridization

(c) *in vitro* transcription

(d) Western blotting

199. Which one of the following ***does not*** represent next-generation sequencing technology?

(a) Affymetrix GeneChip

(b) Roche 454

(c) Illumina

(d) SOLiD

200. *Agrobacterium tumefaciens* produces crown gall disease in

(a) monocotyledonous plants

(b) dicotyledonous plants

(c) gymnosperms

(d) angiosperms

201. Which of the following chemicals is used for inducing polyploidy?

(a) Colchicine

(b) Ethyl methanesulfonate

(c) Methyl methanesulfonate

(d) Nitrous acid

202. cDNA libraries are constructed using which of the following vectors?

(a) Phagemid

(b) Plasmid

(c) YAC

(d) BAC

203. The square root of variance of sample mean represents

(a) mean deviation

(b) standard error

(c) median

(d) standard deviation

204. Seed dormancy is due to which of the following plant hormones?

(a) Abscisic acid

(b) Auxin

(c) Ethylene

(d) Cytokinin

205. A gene with more than one allele is termed as

(a) heterologous

(b) hybrid

(c) pleiotropic

(d) polymorphic

206. Homologous genes in different species having similar functions are known as

(a) orthologues

(b) paralogues

(c) isozymes

(d) biochemical variants

207. LOD scores are used to predict which of the following?

(a) Crossover frequency

(b) Gene sequence

(c) Gene linkage

(d) Number of genes involved in the determination of a given phenotype

208. Which of the following is odd one?

(a) Enhancer

(b) Copia elements

(c) Retrotransposons

(d) FB elements

209. Which of the following can be used as sequence similarity search tool?

(a) RASMOL

(b) PHYLIP

(c) BLASTX

(d) PYMOL

210. TBLASTN refers to which of the following sequence similarity searches?

(a) Nucleotide against nucleotide

(b) Nucleotide against protein

(c) Protein against nucleotide

(d) Protein against protein

211. Which of the following ***does not*** represent a molecular marker?

(a) SNP

(b) SSR

(c) PEG

(d) RAPD

212. Which of the following ***does not*** represent a sequence format?

(a) FASTA

(b) FASTQ

(c) GFF

(d) SFF

213. Which of the following represents an epigenetic modification?

(a) Ubiquitination

(b) Glycosylation

(c) Histone acetylation

(d) Sumoylation

214. Genes that are inactive for long periods of time tend to be bound to

(a) each other

(b) methyl groups

(c) actin and myosin

(d) nucleolus

215. Grafting is not possible in monocots, because they

(a) have scattered vascular bundles

(b) have parallel venation

(c) are herbaceous

(d) lack vascular cambium

216. For protein detection, most commonly used probe is

(a) antibody

(b) lectins

(c) antigens

(d) interferons

217. The separation technique of charged molecules under the influence of electric current is called

(a) colony hybridization

(b) electrophoresis

(c) dot blot technique

(d) Western blotting

218. Growth hormone producing apical dominance is

(a) gibberellin

(b) auxin

(c) ethylene

(d) cytokinin

219. Literature databases include

(a) Medline and PubMed

(b) Medline and PDB

(c) PubMed and PDB

(d) Medline and PDS

220. The enzyme used in SOLiD sequencing technology is

(a) sequenase

(b) DNA polymerase

(c) DNA ligase

(d) Taq polymerase

Section—II

(Bioinformatics)

221. Burrows-Wheeler transform is associated with

(a) protein secondary structure prediction

(b) Next-generation Sequencing (NGS) data analysis

(c) sequence logos

(d) phylogenetic tree visualisation

222. Which of the following databases is a repository for transcription measurement expression data derived from micro-arrays or RNA-seq experiments?

(a) GEO

(b) PDB

(c) GenBank

(d) TrEMBL

223. Which of the following statements is ***not*** correct?

(a) BLOSUM (Blocks Substitution Matrix) is a scoring matrix for sequence alignment derived from closely related global alignments in the BLOCKS database. The BLOSUM62 matrix is derived from alignments containing 62% identity, and is most commonly used.

(b) PET91 (Pair Exchange table for the year 1991) was developed by Jones, Taylor and Thornton and derived from sequences clustered at 85% similarity from 2621 protein families. It corrects for mutations that were poorly represented in the original Dayhoff matrix.

(c) PAM (Percentage Accepted Mutation) matrix is derived from PAM1 which estimates the rate at which 1% of amino acids are mutated. PAM250 is derived by multiplying this matrix by itself 250 times. The PAM alignments are based on stretches of local alignments forbidden to contain gaps.

(d) The BLOSUM and PAM matrices can be used interchangeably, with the higher number in both used for scoring sequences which are less divergent. Typically, BLOSUM90 and PAM250 are used for detecting nearly identical sequences, while BLOSUM45 and PAM100 are used for weak similarities.

224. The following dynamic programming recurrence equation is used in which algorithm?

$$H_{ij} = \max \begin{cases} H_{i-1,\, j-1} + S(a_i,\, b_j) \\ H_{i-1,\, j} - W \\ H_{i,\, j-1} - W \\ 0 \end{cases}$$

where $S(a_i, b_j)$ is the score of aligning a_i and b_j; W is the gap penalty.

(a) Needleman-Wunsch global alignment

(b) Basic Local Alignment Search Tool (BLAST)

(c) Smith-Waterman local alignment

(d) Profile hidden Markov models as implemented by HMMER

225. Match the following multiple alignment methods with the statements that best describe them :

1. Muscle
2. MAFFT
3. ClustalW
4. T-Cofee

(i) is a progressive alignment method which requires two stages : a first stage in which the relationships between the sequences are represented as a tree, called a *guide tree*, and a second stage in which the MSA is built by adding the sequences sequentially to the growing MSA according to the guide tree

(ii) is an iterative method that uses a distance measure to assess the relatedness of two sequences. The distance measure is updated between iterations

(iii) based on the fast Fourier transform, can align large numbers of sequences. Recent versions also have a range of methods with more accuracy for small numbers of sequences'

(iv) is a progressive method, which in addition to a *guide tree* can optimise local alignments using secondary structure and library extension

(a) 1–*(i)*, 2–*(iii)*, 3–*(iv)*, 4–*(ii)*

(b) 1–*(ii)*, 2–*(iii)*, 3–*(iv)*, 4–*(i)*

(c) 1–*(ii)*, 2–*(iii)*, 3–*(i)*, 4–*(iv)*

(d) 1–*(i)*, 2–*(ii)*, 3–*(iii)*, 4–*(iv)*

226. Given that S is the bit score, m is the length of the query, n is the length of the database sequence, k and (λ) are parameters for the extreme-value distribution for the search space and scoring space respectively. The correct expression for the E-value is

(a) $E = S.m.n.e^{k\lambda}$

(b) $E = k.m.n.e^{-2S\lambda}$

(c) $E = k.\lambda.S.e^{m.n}$

(d) $E = S.k.\lambda.e^{m.n}$

227. Which of the following methods is used to align protein structures?

(a) DALI (Distance Alignment Matrix Method)

(b) BLAST (Basic Local Alignment Search Tool)

(c) Smith-Waterman Local Alignment

(d) AutoDock Vina

228. The following sequence of steps is typically used in homology modelling : find template—align subject with template—model core (backbone)—model loops—model side-chains—check the whole model.

Which program contains functions/routines that can perform all the above steps?

(a) Visual Molecular Dynamics

(b) SWISSPRÓT

(c) Modeller

(d) CE (Combinatorial Extension)

229. Protein structures are managed and distributed by which of the following consortiums?

(a) European Molecular Biology Laboratory

(b) National Institutes of Health, USA

(c) Brookhaven National Laboratory's research collaboratory for structural bioinformatics

(d) wwPDB—World Wide Protein Data Bank Foundation

230. Pymol is a commonly used open-source program used in bioinformatics for

(a) the use in python libraries for sequence analysis

(b) parsing BLAST results

(c) molecular visualisation

(d) deep learning

231. Which of the following equations is commonly used to calculate the van der Waals energy in a force field (where r is the distance between the two atom centers, $c1$ and $c2$ are the charges on each respectively, and θ is the bond angle)?

(a) $\Sigma k(\theta_i - \theta_0)$

(b) $\frac{c1c2}{r}$

(c) $\left(\frac{1}{r}\right)^{12} - \left(\frac{1}{r}\right)^{6}$

(d) $\frac{1}{r} + \frac{1}{\theta} + \frac{1}{c1c2}$

232. Which of the following Perl commands would replace the substring ATG with AUG in a DNA sequence stored in the string $seq?

(a) $seq=~s/AUG/ATG/gi

(b) @count=$seq=~/ATG/gi; scalar(@count)

(c) $count=$seq=~/ATG/gi

(d) $seq=~s/ATG/AUG/gi

233. The SDF file formats used for representing chemicals is best described by which of the following descriptions?

(a) Single line notation for molecules. These strings include connectivity but do not include 2D or 3D coordinates. Hydrogen atoms are not represented. Other atoms are represented by their element symbols B, C, N, O, F, P, S, Cl, Br and I

(b) Contains layers and sub-layers separated by a delimeter. The main layer contains the chemical formula, atom connections and hydrogen atoms. Other layers include the charge, stereochemical and isotopic layers

(c) Contains some header information, the Connection Table (CT) containing atom info, then bond connections and types, followed by sections for more complex information

(d) Contains only heavy atoms with their coordinate information specified by an ATOM header, followed by connectivity information in rows labelled CONNECT

234. The scoring function for the docking program AutoDock Vina is

(a) a force field based function to predict binding energy, based on the summation of the van der Waals and electrostatic functions

(b) an empirical function based on counting the number of various types of interactions between the two binding partners

(c) a knowledge-based function derived from statistical observations of intermolecular close contacts in large 3D databases

(d) a combination of knowledge-based potentials and empirical scoring functions : it extracts empirical information from both the conformational preferences of the receptor-ligand complexes and the experimental affinity measurements

235. ADME-Tox is an abbreviation of

(a) Adsorbtion, Desorbtion, Metabolism, Excretion and Toxicity

(b) Absorption, Distribution, Metabolism, Excretion and Toxicity

(c) Adsorbtion, Delivery, Metabolism, Excretion and Toxicity

(d) Absorbtion, Delivery, Metabolism, Exclusion and Toxicity

236. The algorithm used in the gene prediction programs GenScan, GeneMark and Glimmer are

(a) based on support vector machines trained using standard genes and non-coding sequences

(b) based on hidden or interpolated Markov models of gene structure

(c) modifications of the fast Fourier transform

(d) based on signals such as the start and stop codons and splice site signals

237. In RNA-Seq analysis, the abundance of RNA is estimated using the normalised measure FPKM. This is

(a) fragments of transcript per kilobase per million reads

(b) fragments per kilobase reads per million base pairs

(c) fragments per kilobase of exon per million reads mapped

(d) fragments per kilobase nucleotides per million reads

238. The model that uses different values for transversions and transitions in phylogenetic analysis is

(a) Kimura model

(b) Jukes-Cantor model

(c) Jones-Taylor-Thornton model

(d) Felsenstein model

239. Match the following methods commonly used in phylogenetic analysis with their descriptions :

1. UPGMA
2. Maximum Parsimony
3. Neighbour-Joining
4. Maximum likelihood

(i) distance-based and uses sequential clustering to build a rooted phylogenetic tree

(ii) distance matrix based taking and examining all possible pairs to find the combination of pairs that minimizes the total length of the phylogenetic tree

(iii) character-based method that infers a phylogenetic tree by minimizing the total number of evolutionary steps required to explain a given set of data

(iv) character-based method and uses a stochastic model that gives the probability of a particular character changing at any given point on a tree

(a) 1–*(ii)*, 2–*(iii)*, 3–*(iv)*, 4–*(i)*

(b) 1–*(i)*, 2–*(iii)*, 3–*(ii)*, 4–*(iv)*

(c) 1–*(ii)*, 2–*(iv)*, 3–*(i)*, 4–*(iii)*

(d) 1–*(i)*, 2–*(ii)*, 3–*(iii)*, 4–*(iv)*

240. A protein-protein interaction network is defined as scale-free. Which of the following statements is correct about such a network?

(a) The degree distribution follows a power law

(b) The degree distribution is linear

(c) The degree distribution is dependent on the number of nodes in the network

(d) The degree distribution approximates a normal distribution

241. Profile hidden Markov models are models of protein families derived from multiple alignments. A hidden Markov model is made up of states—for the profile hidden Markov model, these correspond to the match, delete and insert states for each column in the multiple alignment. In addition, the model has transition probabilities between the states, and state emission probabilities which are

(a) the probabilities of a state occurring in a particular column

(b) the probabilities of amino acids in each state

(c) the probabilities of a state being modelled as an error

(d) the probabilities of a state being converted into another state

242. For the pairwise alignment using local dynamic programming strategy, which one of the following is true?

(a) The traceback starts from the first cell of the score matrix to the last cell

(b) The traceback starts from the last cell of the score matrix to the first cell

(c) The traceback starts from the cell having the highest score to the cell having a score of zero

(d) The traceback starts from anywhere to anywhere

243. It is known that 'uncertainty' measured by Shannon's information theoretic method is maximum when conditions are equally likely or highly variable. In the context of a DNA multiple sequence alignment, uncertainty at the fully conserved position is

(a) less than zero

(b) zero

(c) unity

(d) between zero and one

244. One of the benchmark performance measures called specificity is given by

(a) TN/(TP+FN)

(b) TP/(TP+FN)

(c) TN/(TN+FP)

(d) TP/(TN+TP)

245. The term 'kernel function' is associated with

(a) multilayer perceptron

(b) Baysian network

(c) support vector machine

(d) hidden Markov model

246. Relative entropy is also referred to as

(a) Shannon entropy

(b) Renyi entropy

(c) Kullback-Leibler entropy

(d) Tsallis entropy

247. A researcher has sequenced the genome of a rare fish using illumina sequencing platform technology. Which of the following steps is essential for initial processing of the sequencing data?

(a) Adaptor trimming

(b) Removing reads longer than 200 bp

(c) Aligning reads to entries in miRBase

(d) Filter reads containing radioactive labels

248. Which of the following ***cannot*** be inferred from RNA sequencing data?

(a) Expression of isoforms

(b) Single nucleotide polymorphism in coding regions

(c) Expression of very low expressed genes

(d) Regulatory elements in promoter region

249. In an RNA sequencing data obtained from kidney tissue, a researcher observed read count of 10 for a 10 kb gene A and read count of 5 for a 5 kb gene B. Which of the following should be most plausible interpretation?

(a) Gene A has higher expression than Gene B in kidney tissue

(b) Gene B has higher expression than gene A in kidney tissue

(c) None of the genes A or B is kidney-specific

(d) Both the genes likely express at similar level in kidney tissue

250. What would be the amount of possible k-mers for a string of length L?

(a) $L+k-2$

(b) L/k

(c) $L-k+1$

(d) $4L$

251. A genome was sequenced to 30X sequencing depth to achieve a coverage of 95%. Which of the following statements will be true?

(a) Only 30% of the genome is represented in total sequence obtained.

(b) 95% of total genes is represented in the total sequence obtained.

(c) Only 30% of the total genes is represented in the sequence obtained.

(d) 95% of the genome is represented in total sequence obtained.

252. Which of the following projects would be best suited for next-generation sequencing?

(a) To determine if a tumour sample contains a common missense mutation

(b) To find the transcriptome of a tumour sample

(c) To genotype ten genomic DNA samples for a known single nucleotide polymorphism

(d) All of the above

253. Once the sequences are obtained from your next-generation sequencing experiment, what is the first thing you should do?

(a) Perform a bioinformatics analysis of your data.

(b) Check your data using a quality control method/tool.

(c) Publish your results.

(d) Further investigate the sequences of interest.

254. Protein-coding genes can be identified by

(a) transposon tagging

(b) ORF scanning

(c) blotting

(d) nuclease S1 mapping

255. Which file format is used for storing the sequence data of assembled genomes (draft and finished)?

(a) Sanger format

(b) FASTQ format

(c) FASTA format

(d) ASCII format

256. Which of the following program suites is used to build and query the popular PFAM database?

(a) SAM Tools

(b) HHSearch

(c) HMMER

(d) BLAST

257. The odds score or odds ratio is

(a) ratio between the lengths of two genomes in comparative genomics

(b) ratio of the state and emission probabilities in a hidden Markov model

(c) ratio between the observed probability and the null probability of an event

(d) None of the above

258. Which of the following programs commonly used in studying bimolecular structures ***cannot*** perform molecular dynamics simulations?

(a) GROMACS

(b) CHARMM

(c) AMBER

(d) DALI

259. Which of the following methods/algorithms is ***not*** used for energy minimisation?

(a) Newton-Raphson

(b) Conjugate Gradient

(c) Ewald Summation

(d) Steepest Descent

260. Most drug receptors are

(a) small molecules with a molecular weight between 100 and 1000

(b) lipids arranged in a bilayer configuration

(c) proteins located on cell membranes or in the cytosol

(d) DNA molecules

TRACK—III

ENGINEERING SCIENCES

PART—A

(Common for Track—III)

261. Convert the decimal number 379_{10} to BCD.

(a) 001001100110

(b) 001101111001

(c) 001000000001

(d) 111110010011

262. Simplify the following Boolean expression :

$$Y = \overline{A}\overline{B}\overline{C} + \overline{A}B\overline{C} + A\overline{B}\overline{C} + AB\overline{C}$$

(a) $\overline{C}$

(b) B

(c) 0

(d) 1

263. Address range of memory, which can be connected with 8085 microprocessor, is

(a) 0000 H–1111 H

(b) 0000 H–FFFF H

(c) 00 H–FF H

(d) 000 H–FFF H

264. Calculate the capacity of a standard 4-kHz telephone channel with a 32-dB signal-to-noise ratio.

(a) 37216 bits per second

(b) 66448 bits per second

(c) 32953 bits per second

(d) 32359 bits per second

265. Define the terms 'apogee' and 'perigee' respectively.

(a) The path traced out on the earth's surface directly below and above the satellite respectively

(b) The point where the orbit crosses the equatorial plane going from south to north and north to south respectively

(c) The point farthest from the earth and closest to the earth respectively

(d) The line joining ascending to descending nodes and descending to ascending nodes through the centre of the earth respectively

266. In a certain medium, $E = 10\cos(10^8 t - 3y)a_x$ V/m. What type of medium is it?

(a) Free space

(b) Lossy dielectric

(c) Lossless dielectric

(d) Perfect conductor

267. A lossless transmission line with $Z_0 = 50$ ohm is 30 m long and operates at 2 MHz. The line is terminated with a load $Z_L = 60 + j40$ ohm. If $u = 0{\cdot}6c$ on the line, find the s.

(a) 2·088

(b) 1·25

(c) 1·6

(d) 4·865

268. Rise-time bandwidth characteristics for a photodiode with a rise time of 2 ns and a capacitance of 3 pF would be

(a) 195 MHz

(b) 275 MHz

(c) 150 MHz

(d) 175 MHz

269. An antenna located in a city is a source of radio waves. How much time does it take the waves to reach a town 12000 km away?

(a) 20 μs

(b) 40 ms

(c) 36 s

(d) 20 ms

270. The radiation intensity of a certain antenna is

$$U(\theta, \phi) = \begin{cases} 2\sin\theta \sin^3 \phi, & 0 \le \theta \le \pi,\ 0 \le \phi \le \pi \\ 0 \quad , & \text{elsewhere} \end{cases}$$

Determine the directivity of the antenna.

(a) 6

(b) 20·94

(c) 16·53

(d) 2·546

271. A quarter-wave monopole antenna operating in air at frequency 1 MHz must have an overall length of

(a) 150 m

(b) $L \ll \lambda$

(c) 75 m

(d) $L \gg \lambda$

272. Which of the following belongs to the first generation of computers?

(a) ENIAC

(b) UNIVAC

(c) IBM 8090

(d) IBM 1401

273. Device that includes the ALU, register arrays and control circuits on a single chip using LSI techniques along with input device, output device and memory is called

(a) microcontroller

(b) microcomputer

(c) microprocessor

(d) central processing unit

274. The time required to complete one clock to execute an instruction in opcode fetch operation is called

(a) instruction cycle

(b) machine cycle

(c) opcode fetch machine cycle

(d) T-state

275. The operation $a = a * b + a$ can also be written as

(a) $a = (b + 1) * a;$

(b) $(a * b)! = (b + a);$

(c) $a * = b + a;$

(d) $a = (b + a) * 1;$

276. What will be the time complexity of the following expression?

$$\frac{n^3}{3} + \frac{n^2}{2} + \frac{n}{4}$$

(a) $O(n^2)$

(b) $O(n^1)$

(c) $O(n^3)$

(d) $O(n^4)$

277. A process utilizes a resource in the sequence

(a) request, use, release

(b) use, request, release

(c) use, release, request

(d) request, release, use

278. Four necessary conditions for deadlock to exist are mutual exclusion, no pre-emption, circular wait and

(a) multiprogramming

(b) hold and wait

(c) race-around condition

(d) buffer flow

279. The family of WLANs like Ethernet meets the IEEE standard

(a) 802.10

(b) 802.11

(c) 802.15

(d) 802.12

280. Which of the following networks meets the IEEE standard 802.15.6?

(a) WPAN

(b) WLAN

(c) WMAN

(d) WBAN

281. A conducting line on an IC chip is 2·8 mm long and has a rectangular cross-section of 1 μm × 4 μm. A current of 5 mA produces a voltage drop of 100 mV across the line. If the electron mobility is 500 $cm^2/V.s$, the electron concentration is

(a) $3 \cdot 5 \times 10^{17}\ cm^{-3}$

(b) $5 \cdot 48 \times 10^{21}\ cm^{-3}$

(c) $4 \cdot 38 \times 10^{21}\ cm^{-3}$

(d) $4 \cdot 6 \times 10^{20}\ cm^{-3}$

282. In a MOSFET, the drain saturation current is

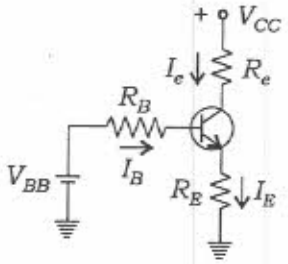
(a) $\frac{\mu_n C_{ox} W}{L}(V_{gs} - V_{th})$

(b) $\frac{\mu_n C_{ox} W}{2L}(V_{gs} - V_{th})^2$

(c) $\frac{\mu_n C_{ox} W}{2L}(V_{gs} - V_{th}) V_{ds}$

(d) $\frac{\mu_n C_{ox} L}{W}(V_{gs} - V_{th})^2$

283. In the circuit given below, the base current I_B is



(a) $\frac{V_{BB}}{R_B}$

(b) $\frac{(V_{BB} - V_{BE})}{(R_B + R_E)}$

(c) $\frac{(V_{BB} - V_{BE})}{(R_B + (\beta + 1)R_E)}$

(d) $\frac{V_{BB}}{(R_B + (\beta + 1)R_E)}$

284. The Hilbert transform of $\cos \omega_1 t + \sin \omega_2 t$ is

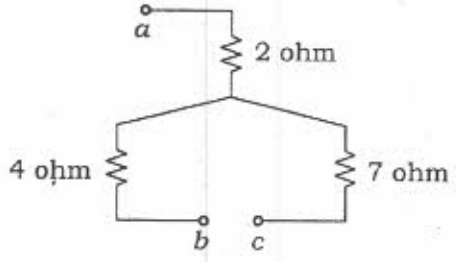
(a) $\sin \omega_1 t + \sin \omega_2 t$

(b) $\cos \omega_1 t + \sin \omega_2 t$

(c) $\sin \omega_1 t + \cos \omega_2 t$

(d) $\cos \omega_1 t + \cos \omega_2 t$

285. Consider a star network as shown in the following figure :



If the resistance between terminals b and c with a open is represented by R_A, the resistance between c and a with b open is represented by R_B and the resistance between a and b with c open is represented by R_C, then arrange R_A, R_B, R_C in descending order.

(a) R_C, R_B, R_A

(b) R_B, R_C, R_A

(c) R_A, R_B, R_C

(d) R_B, R_A, R_C

286. Which of the following relates to Chomsky hierarchy?

(a) Regular < CFL < CSL < Unrestricted

(b) CFL < CSL < Unrestricted < Regular

(c) CSL < Unrestricted < CFL < Regular

(d) None of the above

287. Which of the following functions a Turing machine ***cannot*** perform?

(a) Copying a string

(b) Deleting a symbol

(c) Accepting a pal

(d) Inserting a symbol

288. The action of parsing the source code into proper syntactic classes is known as

(a) parsing

(b) interpretation analysis

(c) lexicography

(d) lexical analysis

289. Booth's algorithm is used in floating point

(a) addition

(b) subtraction

(c) multiplication

(d) division

290. How many binary search trees are possible with four distinct keys?

(a) 12

(b) 14

(c) 16

(d) 20

PART—B

Section—I

(Engineering)

291. Which of these is ***not*** a photoelectric device?

(a) Photoconductive cells

(b) Photoemissive cells

(c) Photoresistive cells

(d) Photovoltaic cells

292. Which of these represents short in a series circuit?

(a) Increase in resistance

(b) Increase in current

(c) Increase in voltage

(d) Increase in conductance

293. Superposition theorem stays valid for a/an

(a) LTI system

(b) discrete system

(c) LT system

(d) None of the above

294. Condition for critical damping of an *R-L-C* circuit is

(a) $R = \sqrt{L / C}$

(b) $R = L / C$

(c) $R = 1 \cdot 5\sqrt{L / C}$

(d) $R = 2\sqrt{L / C}$

295. Active high-pass filters are

(a) *R-C* circuits

(b) differential amplifiers

(c) operational amplifiers

(d) *R-L-C* circuits

296. Which amongst the following has a negative coefficient of temperature for resistance?

(a) Copper

(b) Lead

(c) Carbon

(d) Aluminium

297. To prevent ground fault currents in 3-phase autotransformer, which type of construction is used?

(a) Shell

(b) Wound

(c) Centre tapped

(d) Zig-zag

298. Which of these is not a *P-N* junction capacitance in BJT ?

(a) Junction capacitance

(b) Drift capacitance

(c) Diffusion capacitance

(d) Internal capacitance

299. The Kirchhoff's voltage law for a.c. is applicable upon consideration of

(a) phasor sum

(b) algebraic sum

(c) progression sum

(d) linear sum

300. In a Kirchhoff's voltage law, mesh is a

(a) graph

(b) tree

(c) cotree

(d) loop

301. Which of these is ***not*** a semiconductor?

(a) Si

(b) Germanium

(c) Tungsten

(d) None of the above

302. Which of these represents the half-time constant?

(a) 0·693T

(b) 0·504T

(c) 0·876T

(d) 0·450T

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

(a) purely imaginary

(b) zero

(c) complex quantity

(d) real value

304. Asymmetrical two-port networks have

(a) $Z_{scl} = Z_{oc2}$

(b) $Z_{scl} = Z_{sc2}$

(c) $Z_{ocl} \neq Z_{oc2}$

(d) $Z_{ocl} \neq Z_{oc2}$ and $Z_{scl} \neq Z_{sc2}$

305. An all-pass filter passes

(a) whole of the audio band

(b) whole of the radio band

(c) all frequencies with very low attenuation

(d) all frequencies without attenuation but phase is changed

306. A delta connection contains three impedances of 60 Ω each. The impedances of equivalent star connection will be

(a) 15 Ω each

(b) 20 Ω each

(c) 30 Ω each

(d) 40 Ω each

307. Millman theorem yields

(a) equivalent resistance

(b) equivalent voltage

(c) equivalent voltage or current

(d) value of current in milliamperes input to a circuit from a voltage source

308. A PIN diode is microwave

(a) oscillator

(b) mixer

(c) detector

(d) switch

309. A transmission line of VSWR 7 has a reflection coefficient

(a) 0·25

(b) 0·5

(c) 0·75

(d) 0

310. Microwave repeaters are typically

(a) 25 km apart

(b) 50 km apart

(c) 75 km apart

(d) 100 km apart

311. Strapping is used in a magnetron to

(a) prevent mode jumping

(b) reduce frequency drift

(c) ensure proper bunching

(d) dissipate heat

312. The resonant frequency of a cavity resonator depends upon

(a) the mode of operation

(b) its electrical dimensions

(c) its physical dimensions

(d) the capacitor which tunes it

313. The intrinsic impedance of free space is

(a) 75 ohm

(b) 73 ohm

(c) 120π ohm

(d) 377 ohm

314. Consider a transmission line of characteristic impedance 50 ohm and the line is terminated at one end by $+j50$ ohm. The VSWR produced in the transmission line will be

(a) +1

(b) zero

(c) infinity

(d) –1

315. Which one of the following conditions will ***not*** guarantee a distortionless transmission line?

(a) $R = 0 = G$

(b) $RC = LG$

(c) Very low frequency range ($R \gg \omega L,\ G \gg \omega C$)

(d) Very high frequency range ($R \ll \omega L,\ G \ll \omega C$)

316. The dominant mode of rectangular waveguide is

(a) TE11

(b) TM11

(c) TE01

(d) TE10

317. Which of the following has the longest wavelength?

(a) HF

(b) VHF

(c) UHF

(d) SHF

318. The gain of the half-wave dipole is

(a) 1

(b) 1·641

(c) 6

(d) 16

319. Radar antenna is usually

(a) dipoles

(b) Yagi antennas

(c) parabolic dishes

(d) None of the above

320. For a good conductor, the skin depth varies

(a) directly as frequency f

(b) directly as $\sqrt{f}$

(c) inversely as f

(d) inversely as $\sqrt{f}$

321. When the electromagnetic waves are reflected at an angle from the wall, their wavelength along the wall is

(a) same as in free space

(b) same as wavelength perpendicular to the wall

(c) shortened due to Doppler Effect

(d) greater than that in actual direction

322. In a hollow rectangular waveguide, phase velocity

(a) increases with increase in frequency

(b) decreases with increase in frequency

(c) is independent of frequency

(d) will vary with frequency in a given range

323. An oscillator circuit is mainly

(a) d.c. to a.c. converter

(b) d.c. to d.c. converter

(c) a.c. to d.c. converter

(d) a.c. to a.c. converter

324. The consumption of LEDs may be of the order

(a) 5 to 10 nanoamperes

(b) 5 to 10 microamperes

(c) 5 to 10 milliamperes

(d) 5 to 10 amperes

325. The properties of JFET resemble of

(a) thermionic values

(b) NPN transistors

(c) PNP transistors

(d) unijunction transistors

326. How many maximum number of functions can be defined with two symbols which are Boolean in nature?

(a) 4

(b) 8

(c) 2

(d) 16

327. Which one of the following is used as the interface chip for data transmission between 8086 and a 16-bit ADC?

(a) 8259

(b) 8255

(c) 8253

(d) 8251

328. The gate delay of an NMOS inverter is dominated by charge time rather than discharge time because

(a) the driver transistor has larger threshold voltage than the load transistor

(b) the driver transistor has larger leakage current compared to the load transistor

(c) the load transistor has smaller W/L ratio compared to the driver transistor

(d) None of the above

329. MOSFET can be used as

(a) current-controlled capacitor

(b) voltage-controlled capacitor

(c) current-controlled inductor

(d) voltage-controlled inductor

330. The effective channel length of a MOSFET in saturation decreases with increase in

(a) gate voltage

(b) drain voltage

(c) source voltage

(d) body voltage

Section—II

(IT/Computer Sciences)

331. The minimum time delay between the initiation of two independent memory operations is called

(a) access time

(b) cycle time

(c) transfer time

(d) latency time

332. Which of the following logic families is well-suited for high-speed operations?

(a) TTL

(b) ECL

(c) MOS

(d) CMOS

333. The value of an automatic variable that is declared but not initialized, will be

(a) 0

(b) –1

(c) unpredictable

(d) None of the above

334. In a compiler, grouping of characters into tokens is done by

(a) scanner

(b) parser

(c) code generator

(d) code optimizer

335. CFG can be recognized by

(a) push-down automata

(b) 2-way linear bounded automata

(c) infinite state automata

(d) None of the above

336. The logic of pumping lemma is a good example of

(a) pigeon-hole principle

(b) divide and conquer technique

(c) recursion

(d) iteration

337. Virtual memory is

(a) an extremely large main memory

(b) an extremely large secondary memory

(c) an illusion of an extremely large memory

(d) a type of memory used in supercomputers

338. In which of the scheduling policies, context switch never takes place?

(a) Round-robin

(b) Shortest job first

(c) Pre-emptive

(d) First-come-first-served

339. How many pointers are necessarily changed for the insertion in a linked list?

(a) One

(b) Three

(c) Two

(d) Five

340. Which algorithm specifies the addition of edges to the spanning tree in an increasing order of cost?

(a) Prim's algorithm

(b) Kruskal's algorithm

(c) Both (a) and (b)

(d) None of the above

341. E-R modeling technique is a

(a) top-down approach

(b) bottom-up approach

(c) left-right approach

(d) None of the above

342. If a relation scheme is in BCNF, then it is also in

(a) 1NF

(b) 2NF

(c) 3NF

(d) All of the above

343. Transmission media are usually categorized as

(a) fixed or unfixed

(b) guided or unguided

(c) deterministic or undeterministic

(d) metallic or non-metallic

344. The number of bits in an IPv6 address is

(a) 32

(b) 64

(c) 128

(d) 256

345. Wi-Fi stands for

(a) Wired-Philosophy

(b) Wireless-Philosophy

(c) Wireless-Fidelity

(d) Wired-Fiber

346. Which of the following ISO levels is more closely related to the physical communication facilities?

(a) Application

(b) Session

(c) Network

(d) Data Link

347. Secret key cryptography makes use of

(a) one key

(b) two keys

(c) three keys

(d) any number of keys

348. Which of the following services is ***not*** provided by digital signatures directly?

(a) Message authenticity

(b) Message confidentiality

(c) Message integrity

(d) Non-repudiation

349. The number of possible ordered trees with three nodes *A*, *B*, *C* is

(a) 16

(b) 12

(c) 6

(d) 10

350. The following sequence of operation is performed on stack :

push(1),push(2),pop,push(1),push(2),pop,pop,pop,push(2),pop

The sequence of popped out values are?

(a) 2,2,1,1,2

(b) 2,2,1,2,2

(c) 2,1,2,2,1

(d) 2,1,2,2,2

351. The complexity of merge sort algorithm is

(a) $O(n)$

(b) $O(\log n)$

(c) $O(n^2)$

(d) $O(n \log n)$

352. The depth of a complete binary tree is given by

(a) $D_n = n \log 2n$

(b) $D_n = n \log 2n + 1$

(c) $D_n = \log 2n$

(d) $D_n = \log 2n + 1$

353. How many strings of length less than 4 contain the language described by the regular expression $(x + y)^* \, y(a + ab)^*$?

(a) 7

(b) 10

(c) 12

(d) 11

354. A language is regular if and only if

(a) accepted by DFA

(b) accepted by PDA

(c) accepted by LBA

(d) accepted by Turing machine

355. 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) $(1 + 2 + 0)^* (1 + 2)^*$

356. If L and $\sim L$ are recursively enumerable, then L is

(a) regular

(b) context free

(c) context sensitive

(d) recursive

357. Which of the following denotes Chomskian hierarchy?

(a) $REG \subset CFL \subset CSL \subset$ type0

(b) $CFL \subset REG \subset$ type0 $\subset CSL$

(c) $CSL \subset$ type0 $\subset REG \subset CFL$

(d) $CSL \subset CFL \subset REG \subset$ type0

358. Consider the following right-linear grammar :

$G = (N, T, P, S)\ N = \{S\}$

$P : S \rightarrow aS \mid aA\ T = \{a, b\}$

$A \rightarrow bA \mid b$

Which of the following regular expressions denotes $L(G)$?

(a) $(a + b)^*$

(b) $a(ab)^* b$

(c) $aa^* bb^*$

(d) $a^* b^*$

359. Set of all strings over the alphabet $\Sigma = \{a, b\}$ (including ε) is denoted by

(a) $(a + b)^*$

(b) $(a + b) +$

(c) $a + b +$

(d) $a^* b^*$

360. Which of the following regular expressions denotes a language comprising of all possible strings over $\Sigma = \{a, b\}$ of length n, where n is a multiple of 3?

(a) $(a + b + aa + bb + aba + bba)^*$

(b) $(aaa + bbb)^*$

(c) $((a + b)(a + b)(a + b))^*$

(d) $(aaa + ab + a) + (bbb + bb + a)$

361. Which of the following conversions is ***not*** possible (algorithmically)?

(a) Regular grammar to context-free grammar

(b) Nondeterministic FSA to deterministic FSA

(c) Nondeterministic PDA to deterministic PDA

(d) Nondeterministic TM to deterministic TM

362. A computer has six tape drivers with n process competing for them. Each process may need two drivers. What is the maximum value of n for the system to be deadlock free?

(a) 6

(b) 4

(c) 5

(d) 3

363. E-R model uses which of the following symbols to represent weak entity set?

(a) Dotted rectangle

(b) Diamond

(c) Doubly outlined rectangle

(d) Square

364. Which of the following is ***not*** a guided transmission line?

(a) Twisted pair

(b) Coaxial cable

(c) Optical fiber

(d) Laser beam

365. ICMP is primarily used for

(a) error and diagnostic functions

(b) addressing

(c) forwarding

(d) load shedding

366. In the architecture of a database system, external level is the

(a) physical level

(b) logical level

(c) conceptual level

(d) view level

367. Cartesian product in relational algebra is

(a) a unary operator

(b) a binary operator

(c) a ternary operator

(d) Not defined

368. Secret-key encryption is also known as

(a) asymmetric encryption

(b) symmetric encryption

(c) secret encryption

(d) private encryption

369. A RAM chip has a capacity of 1024 words of 8 bits each (1 K × 8). The number of 2 × 4 decoders with enable line needed to construct a 16 K × 16 RAM from 1 K × 8 RAM is

(a) 4

(b) 5

(c) 6

(d) 7

370. In an E-R diagram, attributes are represented by

(a) rectangle

(b) square

(c) ellipse

(d) triangle