

13P/204/5

Question Booklet No.....

(To be filled up by the candidate by blue/black ball-point pen)

Roll No.

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108 (3)

120 (deleted)

123 (3)

131 (3)

135 (1)

138 (1)

Roll No.

(Write the digits in words)

Serial No. of OMR Answer Sheet

Day and Date

(Signature of Invigilator)

INSTRUCTIONS TO CANDIDATES(Use only **blue/black ball-point pen** in the space above and on both sides of the Answer Sheet)

1. Within 10 minutes of the issue of the Question Booklet, check the Question Booklet to ensure that it contains all the pages in correct sequence and that no page/question is missing. In case of faulty Question Booklet bring it to the notice of the Superintendent/Invigilators immediately to obtain a fresh Question Booklet.
2. Do not bring any loose paper, written or blank, inside the Examination Hall *except the Admit Card without its envelope*.
3. A separate Answer Sheet is given. *It should not be folded or mutilated. A second Answer Sheet shall not be provided. Only the Answer Sheet will be evaluated.*
4. Write your *Roll Number and Serial Number of the Answer Sheet* by pen in the space provided above.
5. **On the front page of the Answer Sheet, write by pen your Roll Number in the space provided at the top, and by darkening the circles at the bottom. Also, wherever applicable, write the Question Booklet Number and the Set Number in appropriate places.**
6. No overwriting is allowed in the entries of Roll No., Question Booklet No. and Set No. (if any) on OMR sheet and also Roll No. and OMR Sheet No. on the Question Booklet.
7. Any change in the aforesaid entries is to be verified by the invigilator, otherwise it will be taken as unfair means.
8. Each question in this Booklet is followed by four alternative answers. *For each question, you are to record the correct option on the Answer Sheet by darkening the appropriate circle in the corresponding row of the Answer Sheet, by ball-point pen as mentioned in the guidelines given on the first page of the Answer Sheet.*
9. For each question, darken only one circle on the Answer Sheet. If you darken more than one circle or darken a circle partially, the answer will be treated as incorrect.
10. *Note that the answer once filled in ink cannot be changed. If you do not wish to attempt a question, leave all the circles in the corresponding row blank (such question will be awarded zero mark).*
11. For rough work, use the inner back page of the title cover and the blank page at the end of this Booklet.
12. Deposit *only the OMR Answer Sheet* at the end of the Test.
13. You are not permitted to leave the Examination Hall until the end of the Test.
14. If a candidate attempts to use any form of unfair means, he/she shall be liable to such punishment as the University may determine and impose on him/her.



13P/204/5

No. of Questions/प्रश्नों की संख्या : 150

Time/समय : 2½ Hours/घण्टे

Full Marks/पूर्णांक : 450

Note/नोट : (1) Attempt as many questions as you can. Each question carries 3 marks. One mark will be deducted for each incorrect answer. Zero mark will be awarded for each unattempted question.

अधिकाधिक प्रश्नों को हल करने का प्रयत्न करें। प्रत्येक प्रश्न 3 अंक का है। प्रत्येक गलत उत्तर के लिए एक अंक काटा जाएगा। प्रत्येक अनुत्तरित प्रश्न का प्राप्तांक शून्य होगा।

(2) If more than one alternative answers seem to be approximate to the correct answer, choose the closest one.

यदि एकाधिक वैकल्पिक उत्तर सही उत्तर के निकट प्रतीत हों, तो निकटतम सही उत्तर दें।

1. Let N coplanar forces each of magnitude F , where each force is making an angle of $\frac{2\pi}{N}$ with the preceding one, act from a point . Then the vector sum is

(1) $N\vec{F}$

(2) \vec{F}

(3) $\frac{N\vec{F}}{2}$

(4) Zero (vector)

(314)

1

(P.T.O.)

2. A balloon of mass 100 kg is stationary at a height of 100m above the ground. A man of 50 kg is standing stationary on a rope ladder hanging from the bottom of the balloon. When the man starts climbing up of the ladder, with a speed of 0.3 m/s relative to the rope, the balloon will

- (1) remain stationary
- (2) move downward with a speed of 0.3 m/s
- (3) move upwards with a speed of 0.3 m/s
- (4) move downward with a speed of 0.1 m/s.

3. Consider three observers A, B and C , each of whom is at rest in different inertial frames of references. A flash of light is emitted by observer A , who observes the light to travel at speed c . The frame of the observer B is moving away from A at a speed of $c/4$ and that of C is moving toward A with a speed of $c/4$. Then according to Galilean kinematics

- (1) B will measure the speed of light emitted by A as $5c/4$, while C will measure it as $3c/4$
- (2) B will measure the speed of light emitted by A $3c/4$, while C will measure $5c/4$
- (3) Both will measure it as $3c/4$
- (4) Both will measure it as c

4. If the earth is treated as a sphere of radius R and mass M , its angular momentum about the axis of its diurnal motion with period T is

- | | |
|----------------------------|---------------------------|
| (1) $\frac{4\pi MR^2}{5T}$ | (2) $\frac{2\pi MR^2}{T}$ |
| (3) $\frac{MR^2T}{2\pi}$ | (4) $\frac{\pi MR^3}{T}$ |

5. Let the displacement of an oscillator be given by the expression

$$y = 4 \cos^2\left(\frac{t}{2}\right) \sin(1000t)$$

Then the number of independent simple harmonic motions contained in this expression is

- (1) 4 (2) 3 (3) 2 (4) 1
6. The graph of restoring force vs time for a linear harmonic oscillator is
- (1) sinusoidal (2) parabolic (3) circular (4) a straight line
7. Conservation of four-vector momentum implies conservation of
- (i) momentum only (2) energy only (3) both momentum and energy (4) mass and energy
8. A pion at rest decays in a time interval of 24 ns . An observer in the laboratory relative to whom the pion is in motion at a speed of $u = 0.8c$ will measure the time interval as
- (1) 24 ns (2) 40 ns (3) 19.2 ns (4) 30 ns
9. A constant torque acting on a uniform circular wheel changes its angular momentum from a_0 to $4a_0$ in 4 seconds. The magnitude of this torque is
- (1) a_0 (2) $2a_0$ (3) $\frac{3a_0}{4}$ (4) $3a_0$

10. A body is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to

(1) $t^{1/2}$ (2) $t^{3/4}$ (3) $t^{3/2}$ (4) t^2

11. It is possible that the Newtonian theory of gravitation may need to be modified at short ranges. Suppose that the potential energy between two masses m and m' is given by $V(r) = \frac{Gmm'}{r}(1 - ae^{r/\lambda})$. For short distances $r \ll \lambda$, the force between m and m' is given by

(1) $F = -\frac{Gmm'}{r^2}$ (2) $F = -\frac{Gmm'a}{\lambda r}$ (3) $F = -\frac{Gmm'(1-a)}{r^2}$ (4) $F = -\frac{Gmm'(1+a^2)}{r^2}$

12. A 2 kg body and a 3 kg body are moving along the x -axis. At a particular instant the 2 kg body is 2m from the origin and the 3 kg body is 3m from the origin. The position of the centre of mass from the origin is

(1) 2.0m (2) 2.5m (3) 2.8m (4) 3.0m

13. A particle of mass m is moving in a horizontal circle of radius r under a centripetal force which is equal to $\frac{-k}{r^2}$, where k is a constant. Then the total energy of the particle is

(1) 0 (2) $\frac{-k}{r}$ (3) $\frac{-k}{2r}$ (4) $\frac{k}{2r}$

14. The rotation of a Foucault's pendulum denotes

- (1) the spinning motion of the earth
- (2) that earth is stationary
- (3) the rotational motion of the earth
- (4) linear motion of the earth

15. The centripetal force required to keep a 4 kg mass moving in a circle of radius 0.8m at a speed of 6m/s is

- (1) 280 N (2) 180 N (3) 360 N (4) 1000 N

16. The co-ordinates of a particle moving in the xy plane is given as a function of time by $x = 1+2t^2$ and $y = 2t+t^3$, given in metres. What is the magnitude of the velocity of the particle at time $t = 2$ s?

- (1) 15.1 m/s (2) 16.1 m/s (3) 8.2 m/s (4) 14.2 m/s

17. The moment of inertia of a uniform sphere of radius R and mass M , with its axis through the center is

- (1) MR^2 (2) $\frac{1}{2}MR^2$ (3) $\frac{2}{5}MR^2$ (4) $\frac{3}{5}MR^2$

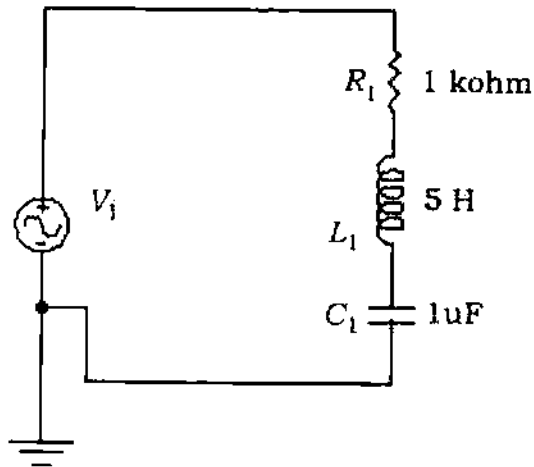
18. Let a force of 4N causes a displacement of 0.02m. Then the force constant is

- (1) 0.08 N-m (2) 200 N-m (3) 200 N-m⁻¹ (4) 0.08 N-m⁻¹

19. A simple harmonic oscillator has a period $T = \frac{2\pi}{3}$. If the amplitude of the oscillator's motion is 2 metres, what is its maximum acceleration during its motion ?

- (1) 6 m/s² (2) 18 m/s² (3) 8 m/s² (4) 20 m/s²

20. What is the quality factor of the given circuit ?



- (1) 999 (2) 223 (3) 2.2 (4) 0.99

21. A 100 Hz A.C. is flowing in a coil of inductance 7 millihenry. The reluctance of the coil is

- (1) 4.44Ω (2) 4.4Ω (3) 7Ω (4) 14Ω

22. Let a plane electromagnetic wave be associated with a value of the electric field $E=100 \text{ V/m}$ and magnetic field $H=0.25 \text{ A/m}$. Then maximum energy flow is

- (1) 50 W/m^2 (2) 25 W/m^2 (3) 12.5 W/m^2 (4) 6.25 W/m^2

23. The average of the function $f(x) = \sin(x)$ in the interval $(0, \pi)$ is

- (1) zero (2) $\frac{2}{\pi}$ (3) $\frac{\pi}{2}$ (4) 2π

24. A plane electromagnetic wave of frequency 25 MHz travels in free space along the x -direction. At a particular point in space and time the magnitude of the electric field is $E = 6.3$ V/m. What is the magnitude of the magnetic induction B at this point?
- (1) 6.3×10^{-10} T (2) 2.1×10^{-8} T (3) 2.1×10^{-10} T (4) 6.3×10^{-8} T
25. A transistor has a current gain factor $\alpha = 0.95$. The transistor is connected with emitter grounded. What is the change in the collector current when the base current is changed by 0.1 mA?
- (1) 9.5 mA (2) 19 mA (3) 1.9 mA (4) 0.95 mA
26. An intrinsic Ge crystal has an intrinsic concentration $N_i = 10^{13}/\text{cm}^3$ (at room temperature). When doped with antimony, the hole density N_h is decreased to $10^{11}/\text{cm}^3$ at room temperature. Then the majority carrier density is
- (1) $10^{15}/\text{cm}^3$ (2) $10^2/\text{cm}^3$ (3) $10^{24}/\text{cm}^3$ (4) $10^{12}/\text{cm}^3$
27. A change of 200 mV in base emitter voltage causes a change of 100 μA in the base current. Then the input resistance of the transistor becomes
- (1) 20 Ω (2) 200 Ω (3) 1 k Ω (4) 2 k Ω
28. A plane electromagnetic wave $E_x = 100 \cos(6 \times 10^8 t + 4x)$ V/m propagates in a medium. Then the dielectric constant of the medium is
- (1) 1 (2) 2 (3) 4 (4) 6

29. For a silicon diode the value of the forward bias voltage typically
- (1) must be greater than 0.3 V
 - (2) must be greater than 0.7 V
 - (3) depends on the width of the depletion region
 - (4) depends on the concentration of the majority carriers
30. An amplifier that operates in the linear region at all times is
- (1) Class A
 - (2) Class AB
 - (3) Class C
 - (4) Class C
31. A band-pass filter has resonant frequency of 950 Hz with the upper cutoff frequency as 3000 Hz. Then the lower cutoff frequency is
- (i) 2050 Hz
 - (2) 1500 Hz
 - (3) 300 Hz
 - (4) 100 Hz
32. Reluctance offered by a coil having no resistance in an a.c. circuit is equal to
- (1) ωL
 - (2) $\frac{1}{\omega L}$
 - (3) $\omega^2 L^2$
 - (4) ωLR
33. In an L - C - R series resonant circuit the current through the resistance and the current through inductance have a phase difference of value
- (1) $\frac{\pi}{2}$
 - (2) $\frac{\pi}{4}$
 - (3) $\frac{\pi}{4}$
 - (4) 0

34. In cylindrical co-ordinates the vector magnetic potential is $\vec{A} = 50 r^2 \vec{a}_z$ Wb/m in a certain region of free space. The value of magnetic induction is

- (1) $-100 r \vec{a}_r$ Wb /m² (2) $-100 r \vec{a}_\phi$ Wb /m²
 (3) $-50 r \vec{a}_r$ Wb /m² (4) $-50 r \vec{a}_\phi$ Wb /m²

35. An 800 MHz travelling plane wave has an average Poynting vector of 8mW/m² and the velocity of the wave is 1×10^8 m/s. Then the wavelength of the plane wave is

- (1) 1 m (2) 0.5 m (3) 0.25 m (4) 0.125 m

36. The electric field of a plane EM wave travelling along the z-axis is

$$E_z = (E_x x + E_{0y} y) \sin(\omega t - kz + \phi)$$

Then the magnetic field B_z is

- (1) $(-E_{0x} x + E_{0y} y) \cos(\omega t - kz + \phi)/c$ (2) $(E_{0x} x + E_{0y} y) \sin(\omega t - kz + \phi)/c$
 (3) $(-E_{0y} x + E_{0x} y) \sin(\omega t - kz + \phi)/c$ (4) $(E_{0x} x + E_{0y} y) \cos(\omega t - kz + \phi)/c$

37. Which of the following Maxwell equations implies that there is no magnetic monopoles?

- (1) $\Delta \cdot E = \rho/\epsilon_0$ (2) $\Delta \cdot B = 0$ (3) $\Delta \times E = -\partial B/\partial t$ (4) $\Delta \times B = \mu_0 J + \mu_0 \epsilon_0 \partial E/\partial t$

38. What is the electric flux density (or electric displacement) through each face of a cube, of side length 2 metres, that contains a central point charge of 2 coulombs?

- (1) 0.50 coulomb/m² (2) 0.33 coulomb/m² (3) 0.23 tesla (4) 0.13 coulomb/m²

39. In an L - C - R circuit with an external forcing signal $f \sin \omega t$, after a sufficiently long time the current will oscillate with a frequency

(1) $\frac{1}{2\pi\sqrt{LC}}$

(2) $\frac{\omega}{2\pi\sqrt{LC}}$

(3) $\frac{\omega}{2\pi}$

(4) $\frac{\omega}{\pi}$

40. If the temperature of a transistor rises by 10°C , which of the following current doubles?

(1) I_C (2) I_B (3) I_{CBO} (4) I_E

41. Which of the following statements is wrong ?

- (1) Voltmeter should have high resistance
- (2) Ammeter should have low resistance
- (3) Ammeter should be placed in parallel across the electric circuit
- (4) Voltmeter should be placed in parallel across the electric circuit

42. When a current passing through a straight conductor is 1mA, what is the magnetic induction at a point 20cm from the current carrying conductor ?

(1) 1×10^{-7} tesla (2) 2×10^{-7} tesla (3) 1.5×10^{-10} tesla (4) 2×10^{-10} tesla

43. A radially pulsating charged sphere

- (1) emits electromagnetic radiation
- (2) creates a static magnetic field
- (3) can set a nearby charged particle into circular motion
- (4) creates a vacuum

44. The avalanche effect is observed in a diode, when

- (1) the forward voltage exceeds the break-down voltage
- (2) the heavily doped diode is forward biased
- (3) the reverse voltage exceeds the break-down voltage
- (4) the majority carriers have enough energy compared to valence electrons

45. An electromagnetic wave incident from a rarer to a denser medium undergoes a phase change of

- (1) 0
- (2) $\frac{\pi}{2}$
- (3) π
- (4) 2π

46. In a Fraunhofer diffraction experiment with slit width of 12×10^{-5} cm and with 6000 \AA monochromatic light, the half angular width of the bright central maximum will be found at

- (1) $\frac{\pi}{4}$
- (2) $\frac{\pi}{6}$
- (3) $\frac{\pi}{3}$
- (4) $\frac{\pi}{2}$

47. The Brewster angle of a material with refractive index 1.732 is

- (1) $\frac{\pi}{4}$
- (2) $\frac{\pi}{6}$
- (3) $\frac{\pi}{3}$
- (4) $\frac{\pi}{2}$

48. A sound wave travels from air to water . The angle of incidence is α_1 and the angle of refraction is α_2 . Assuming Snell's law to be valid

- (1) $\alpha_2 < \alpha_1$
- (2) $\alpha_2 > \alpha_1$
- (3) $\alpha_2 = \alpha_1$
- (4) $\alpha_2 = 90^\circ$

49. In a Newton's rings experiment, the diameter of a certain order of the dark ring is measured to be double that of the second dark ring. The order of the dark ring becomes

- (1) 2 (2) 6 (3) 4 (4) 8

50. In a Michelson interferometer 200 fringes cross the field of view when the movable mirror is moved through 0.0589 mm. Then the value of wavelength of light used is

- (1) 5890 Å (2) 4800 Å (3) 5896 Å (4) 6100 Å

51. Consider the interference between two sources of intensities I and $4I$. What is the intensity at a point where the phase difference is $\frac{\pi}{2}$?

- (1) $2I$ (2) $5I$ (3) $4I$ (4) 0

52. Laser beam is considered to be coherent because it consists of

- (1) many wavelength
 (2) un-correlated wavelength
 (3) co-ordinated waves of exactly the same wavelength
 (4) divergent beam

53. A beam of light of wavelength λ having an illumination I falls on a clean surface of sodium. If n photoelectrons with kinetic energy E are emitted, then

- (1) $n \propto I^2, E \propto \frac{1}{\lambda}$ (2) $n \propto I, E \propto \frac{1}{\lambda}$ (3) $n \propto I, E \propto \lambda$ (4) $n \propto \lambda, E \propto I$

54. A star emits light with a peak wavelength at 200nm. The surface temperature is
- (1) 20490 K (2) 18490 K (3) 16490 K (4) 14490 K
55. The energy of a photon with a wavelength 3 cm is
- (1) 3.143×10^{-5} (2) 4.143×10^{-5} (3) 2.143×10^{-5} (4) 5.143×10^{-5}
56. An electron accelerated through a potential difference of 10 kV hits a target to produce X-rays. The minimum wavelength of the X-rays produced is
- (1) 1.3026×10^{-10} m (2) 1.2306×10^{-10} m (3) 1.2326×10^{-12} m (4) 1.3326×10^{-12} m
57. The diameters of the 5th and 15th Newton's rings are 0.4 cm and 0.6 cm, respectively. The radius of the plano-convex lens is 100cm and the wavelength of the light used is
- (1) 5000 Å (2) 5880 Å (3) 5790 Å (4) 6000 Å
58. The velocity of extraordinary ray in a positive uniaxial crystal is
- (1) least in a direction at right angles to optic axis
(2) equal to the velocity of ordinary ray
(3) maximum in a direction at the right angles to optic axis
(4) lesser than the velocity of ordinary ray

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59. The areal spread of laser beam of wavelength $8 \times 10^{-7} \text{m}$ and aperture 10^{-3}m travelling 10^6km is

- (1) $4 \times 10^{10} \text{m}^2$ (2) $8 \times 10^8 \text{m}^2$
(3) $8 \times 10^{10} \text{m}^2$ (4) $4 \times 10^{10} \text{m}^2$

60. The readings of a Fahrenheit thermometer and a Centigrade thermometer will be identical at the value of

- (1) 20° (2) -20° (3) -40° (4) 40°

61. A turbine in a steam power plant takes steam from a boiler at 450°C and exhausts it into a condenser at 100°C . The maximum possible efficiency is ,

- (1) 48 % (2) 60 % (3) 80 % (4) 100 %

62. A lump of ice whose mass m is 200 gm melts into water. The temperature remains at 0°C throughout the process. What is the entropy change for the ice? (The latent heat of fusion of ice 300kJ/kg)

- (1) 220 J/K (2) 0.23J/K (3) 0.023 J/K (4) 22 J/K

63. Isothermal curves correspond to

- (1) constant pressure (2) constant volume
(3) constant entropy (4) constant temperature

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64. The amount of mechanical work which has to be done to completely melt 1gm of ice is
($L = 80 \text{ cal/gm}$)

- (1) 4.2 J (2) 42 J (3) 80 J (4) 336 J

65. Under the steady state, the temperature of a body

- (1) increases with time
(2) decreases with time
(3) does not change with time and it has to remain the same at all points of the body
(4) does not change with time, but may be different at different points of the body

66. The temperatures inside and outside of a refrigerator are 273°K and 303°K respectively. Assuming that the refrigerator cycle is reversible, the energy delivered to the surroundings for every joule of work done is

- (1) 9.9 J (2) 8.1 J (3) 10.1 J (4) 9.1 J

67. A gas is compressed at a constant pressure of 50 N/m^2 with a change of volume as 6 m^3 . Then 100 J energy is added to the gas. What is the change in the internal energy of the gas?

- (1) 300 J (2) 200 J (3) 400J (4) 100 J

68. Two Carnot engines A and B have their sources at 327°C and 227°C , and sinks at 127°C and 27°C , respectively. Then the ratio of their efficiency is

- (1) 1:2 (2) 6:5 (3) 5:6 (4) 2:3

69. Heat sinks are used in power amplifiers
- (1) to increase output power
 - (2) to reduce heat losses in the transistor
 - (3) to increase voltage gain
 - (4) to increase collector dissipation rating of the transistor
70. The photoelectric threshold for a metal is 3000\AA . The kinetic energy of an electron ejected from it by radiation of wavelength 1200\AA is
- (1) 9.93 eV
 - (2) 6.2 eV
 - (3) 4.5 eV
 - (4) 7.5 eV
71. The specific heat of a substance is a function of its
- (1) mass
 - (2) weight
 - (3) volume
 - (4) molecular structure
72. Two tuning forks A and B which are vibrating simultaneously produce 5 beats. Frequency of B is 512 Hz . It is seen that if one arm of A is fixed, then the number of beats increases. Frequency of A will be
- (1) 502 Hz
 - (2) 507 Hz
 - (3) 517 Hz
 - (4) 522 Hz
73. Which of the following set of equations is invariant under Lorentz transformation?
- (1) Maxwell's equation
 - (2) Schrodinger's equation
 - (3) Newton's equation of motion
 - (4) Laplace equation

74. Which of the following does not support purely wave nature of light ?

- (1) Interference
- (2) Diffraction
- (3) Polarization
- (4) Photoelectric effect

75. Light of wavelength 4500 \AA is incident on a Na surface for which the threshold wavelength of the photoelectrons is 5420 \AA . Then the work function is

- (1) 2.76 eV
- (2) 2.29 eV
- (3) 1.00 eV
- (4) 4.76 eV

76. If A and B are non-empty sets with m and n elements respectively, then the number of mapping from A into B is

- (1) mn
- (2) $m + n$
- (3) m^n
- (4) n^m

77. If A has m elements and B has n elements, then the number of elements of $A \times B$ is

- (1) m
- (2) n
- (3) mn
- (4) $m + n$

78. A factor of $(x - y)^3 + (y - z)^3 + (z - x)^3$ is

- (1) $x + y + z$
- (2) $(x - y)(y - x)(z - x)$
- (3) $(x + y)(y + z)(z + x)$
- (4) xyz

85. The range of the strictly increasing function $f : [a, b] \rightarrow \mathbb{R}$ is
- (1) $(f(a), f(b))$ (2) $(f(b), f(a))$
 (3) $[f(b), f(a)]$ (4) $[f(a), f(b)]$
86. If z is a complex number with $\arg\left(\frac{z-1}{z+1}\right) = \frac{\pi}{2}$, then z lies
- (1) on the unit circle (2) inside the unit circle
 (3) at all points ± 1 (4) outside the unit circle
87. The number of triangles in the plane whose vertices are order pairs of rational numbers is
- (1) 0 (2) 2 (3) 3 (4) 1
88. The value of ${}^n C_k / {}^{n-1} C_{k-1}$ is
- (1) nk (2) n/k
 (3) $n+k$ (4) $n-k$
89. The probability that exactly one of the events A, B to occur is
- (1) $p(A) + p(B)$ (2) $p(A)p(B)$
 (3) $p(A \cup B) - p(A \cap B)$ (4) $p(A \cup B) + p(A \cap B)$
90. If z is a complex number, then the modulus of e^{iz} is
- (1) 1 (2) $e^{\operatorname{Re} z}$
 (3) $e^{-\operatorname{Im} z}$ (4) $e^{|z|}$

91. If A is a bounded subset of the positive real numbers and if $\frac{1}{A} = \{\frac{1}{x}/x \in A\}$ then $\sup \frac{1}{A}$ is equal to
- (1) $\frac{1}{\sup A}$ (2) $\sup A$
 (3) $\inf A$ (4) $\frac{1}{\inf A}$
92. The number of real solutions of $x^3 + 3x - 4 = 0$ is
- (1) 0 (2) 1
 (3) 2 (4) 3
93. The pair of planes represented by $ax^2 + by^2 + cz^2 + 2fyz + 2gzx + 2hxy = 0$ is perpendicular if
- (1) $a - b + c = 0$ (2) $a + b - c = 0$
 (3) $a - b - c = 0$ (4) $a + b + c = 0$
94. The conjugate of the complex number represented by i^n (where $i^2 = -1$) are represented by
- (1) i^n (2) $\pm i$
 (3) ± 1 (4) $1 + i$ and $1 - i$
95. The magnitude of the resultant of two perpendicular forces whose magnitudes are equal and equal to R is
- (1) $2R$ (2) $\sqrt{2}R$
 (3) $2\sqrt{R}$ (4) $\sqrt{2R}$
96. The product of n (≥ 4) consecutive positive integers divided by $n!$ is
- (1) 1 (2) a fraction between 0 and 1
 (3) 2 (4) an integer greater than 1

97. The order of the group of permutations of n symbols is

- (1) n (2) $(n-1)!$
 (3) $n!$ (4) $(n+1)!$

98. The mapping $x \rightarrow e^{ix}$ between the group of real numbers under additive and the multiplicative group of complex numbers of modulus 1 is

- (1) a homomorphism which is not one-to-one (2) an isomorphism
 (3) a homomorphism which is not onto (4) not a homomorphism

99. The least upper bound of $(1 + \frac{1}{x})^x$ ($x > 1$) is

- (1) e (2) $\frac{1}{e}$
 (3) 2 (4) ∞

100. If $\sin\theta$, $\cos\theta$ and $\tan\theta$ are in GP, then $\frac{1-\tan^4\theta}{\tan^6\theta}$ is

- (1) 0 (2) 1
 (3) $\tan\theta$ (4) $\sec^2\theta$

101. A variable chord is drawn through the origin to the circle $x^2 + y^2 - 2ax = 0$. The locus of the centre of the circle whose diameter is the variable chord is

- (1) $x^2 + y^2 + ax = 0$ (2) $x^2 + y^2 + ay = 0$
 (3) $x^2 + y^2 - ax = 0$ (4) $x^2 + y^2 - ay = 0$

102. Defining a simple group as a group having no proper normal subgroups, we can say that a homomorphism $f : G \rightarrow G'$ where G is a simple group and G' is any group is

- (1) trivial (2) injective
 (3) surjective (4) either trivial or injective

103. The series $\sum_{n=2}^{\infty} \frac{1}{n(\log n)^p}$

- (1) converges for $p > 1$ and diverges for $p \leq 1$ (2) converges for all p
 (3) converges for $p \leq 1$ and diverges for $p > 1$ (4) diverges for all p

104. The curve $z = z(t) = e^{i2\pi t}$ ($0 \leq t \leq 2$) describes

- (1) the lower semi-circle excluding ± 1 (2) the unit circle twice
 (3) the upper semi-circle including ± 1 (4) the unit circle

105. The eigenvalues of the matrix $\begin{pmatrix} a & a & a \\ a & a & a \\ a & a & a \end{pmatrix}$ (a -real) are

- (1) a, a, a (2) $a, 1 - a, 2 - a$
 (3) $0, 0, 3a$ (4) $a, 2a, 3a$

106. The functions whose Laplace transform is $\frac{1}{(s-a)^n}$ ($n = 1, 2, 3, \dots$) is

- (1) $\frac{e^{at}}{n!}$ (2) $\frac{t^n e^{at}}{n!}$
 (3) $\frac{t^{n-1} e^{at}}{(n-1)!}$ (4) $\frac{t^{n+1} e^{at}}{(n+1)!}$

107. If z is a complex number with $|z| = 1$, then one of the values of $\arg \frac{z-1}{z+1}$ is

- (1) $\pi/3$ (2) $\pi/6$
 (3) $\pi/2$ (4) π

108. The locus of the complex number z such that $|z - 1| + |z + 1| = 3$ is

- (1) a circle (2) a straight line
 ✓ (3) an ellipse (4) a hyperbola

109. If A and B are mutually exclusive events, then

- (1) $p(A) \leq P(B')$ and $p(B) \leq P(A')$ (2) $p(A) > P(B')$ and $p(B) < P(A')$
 (3) $p(A) < P(B')$ and $p(B) < P(A')$ (4) $p(A) = P(B')$ and $p(B) = P(A')$

110. The function $f(x) = x|x|$ (x -real) is

- (1) differentiable everywhere (2) differentiable except at $x = 0$
 (3) differentiable except at $x = \pm 1$ (4) nowhere differentiable

111. The function $f(x) = 1$ for $x \geq 1$ and -1 for $x < 1$ is such that

- (1) f and $|f|$ are continuous (2) f is continuous but $|f|$ is not
 (3) $|f|$ is continuous but f is not (4) neither f nor $|f|$ is continuous

112. The function $f(z) = z^2$ is conformal of both kinds

- (1) for all z (2) for all $z \neq 0$
 (3) for $|z| < 1$ (4) for $z = \pm 1$

113. The complex number z satisfying $e^z = 0$

- (1) is $z = 0$ (2) does not exist
 (3) is $z = 1$ (4) is $z = i$

114. The shortest distance between the lines $x - 2 = \frac{y-1}{2} = z + 2$ and $x - 1 = y + 4 = \frac{z-2}{2}$ is

- (1) $\frac{1}{\sqrt{11}}$ (2) $\frac{2}{\sqrt{11}}$
 (3) $\frac{3}{\sqrt{11}}$ (4) $\frac{4}{\sqrt{11}}$

115. The equation of the sphere whose center is $(1, -2, 2)$ and radius 4 is

- (1) $x^2 + y^2 + z^2 - 2x + 4y - 4z = 7$ (2) $x^2 - y^2 - z^2 - 2x - 4y - 4z = 7$
 (3) $x^2 + y^2 + z^2 - 2x + 4y - 4z = -5$ (4) $x^2 + y^2 + z^2 + 2x + 4y + 4z = -5$

116. The directional derivative of $\phi(x, y, z) = xy^2 + yz^3$ at the point $(1, -2, 1)$ in the direction of the vector $\vec{i} - 2\vec{j} + 3\vec{k}$ is

- (1) $\frac{8}{\sqrt{13}}$ (2) $\frac{4}{\sqrt{3}}$
 (3) $-\frac{8}{\sqrt{11}}$ (4) $-\frac{8}{\sqrt{14}}$

117. The magnitude and the direction of the greatest rate of change of $u = x^2yz^2$ at $(4, 0, 1)$ are

- (1) 4 and x -axis (2) 4 and z -axis
 (3) 16 and y -axis (4) 16 and x -axis

118. The vector $x\vec{i} + y\vec{j} + z\vec{k}$ is

- (1) irrotational (2) always \perp to its divergence
 (3) solenoidal (4) always \perp to its curl

119. Let \mathbf{w} be any constant vector and \mathbf{r} be the position vector $x\vec{i} + y\vec{j} + z\vec{k}$. If $\mathbf{v} = \mathbf{w} \times \mathbf{r}$, then \mathbf{w} is

- (1) $\text{curl } \mathbf{v}$ (2) $(\text{curl } \mathbf{v})^2$
 (3) $2 \text{ curl } \mathbf{v}$ (4) $\frac{1}{2} \text{ curl } \mathbf{v}$

120. The value of n , if the vector $\mathbf{v} = (x\vec{i} + y\vec{j} + z\vec{k})^{n+1}$ is solenoidal is

- (1) -1 (2) -3
 (3) 1 (4) 3

121. The curve whose torsion and the curvature are both constant is

- (1) hyperbola (2) parabola
 (3) rectangular hyperbola (4) circular helix

122. The area between the curves $y^2 = 4x$ and $x^2 = 4y$ is

- (1) $\frac{16}{3}$ (2) $\frac{8}{3}$ (3) $\frac{4}{3}$ (4) $\frac{2}{3}$

123. Let V be the volume enclosed by the closed surface S , \mathbf{n} , the normal to S and \mathbf{r} , the position vector. Then $\int_S \mathbf{r} \cdot \mathbf{n} \, dS$ is equal to

- (1) V (2) $2V$ (3) $3V$ (4) $4V$

124. The torque about the point $(1, -2, 2)$ of the force represented by $\vec{i} + 5\vec{k}$ acting through the point $(2, -1, -1)$ is

- (1) $5\vec{i} - 8\vec{j} - \vec{k}$ (2) $5\vec{i} - \vec{j} - 8\vec{k}$
 (3) $5\vec{i} + 8\vec{j} + \vec{k}$ (4) $5\vec{i} + \vec{j} + 8\vec{k}$

125. A real function $f : \mathbb{R} \rightarrow \mathbb{R}$ satisfying $|f(x) - f(y)| \leq k(x - y)^2$ for all $x, y \in \mathbb{R}$, k -a constant must be

- (1) identically zero (2) identically a constant
 (3) the identity function i.e., $f(x) = x \forall x \in \mathbb{R}$ (4) e^x

126. A particle acted on by the forces $2\vec{i} + \vec{j} + 4\vec{k}$ and $\vec{i} + 3\vec{j} - 7\vec{k}$ is displaced from the point $(1, 1, 4)$ to $(2, 4, 7)$. Then the total work done by the forces is

- (1) 4 units (2) 6 units
 (3) 8 units (4) 10 units

127. The solution of the equation $x^2 \frac{d^2y}{dx^2} + 3x \frac{dy}{dx} + y = x$ is

- (1) $\frac{1}{x}(A + B \log x) + \frac{x}{4} + C$ (2) $e^x(A + B \log x) + \frac{x}{4} + C$
 (3) $x(A + B \log x) + \frac{x}{4} + C$ (4) $\frac{1}{x}(A + B) + \frac{x}{4} + C$

128. The acceleration of a particle moving along a straight line after t seconds is $12t^2 + 6t + 2 \text{ m/sec}^2$. If the particle starts with the initial velocity of 2 m/sec and covers a distance 12 m in 2 sec , then the distance covered in 3 seconds is

- (1) 103 m (2) 123 m (3) 83 m (4) 113 m

129. If $x + y + z = 1$ where x, y, z are all positive real numbers, then

- (1) $(1-x)(1-y)(1-z) < 8xyz$ (2) $(1-x)(1-y)(1-z) > 8xyz$
 (3) $(1+x)(1-y)(1-z) > 8xyz$ (4) $(1-x)(1+y)(1-z) < 8xyz$

130. The solution of the equation $y = 2x \frac{dy}{dx} + y^2 \left(\frac{dy}{dx}\right)^3$ is

- (1) $y = cx + c^3$ (2) $y^2 = 2cx + c^3$
 (3) $y = cx^2 + c^3$ (4) $y^2 = cx^2 + c^3$

131. The value of $\lim_{n \rightarrow \infty} \frac{\sin n}{n}$ is

- (1) 1 (2) ∞ (3) 0 (4) 2

132. The series $\frac{1}{3}x + \frac{1}{3} \times \frac{2}{5}x^2 + \frac{1}{3} \times \frac{2}{5} \times \frac{3}{7}x^3 + \dots$

- (1) converges for all x (2) converges for $x > 2$ and diverges for $x < 2$
 (3) diverges for all x (4) converges for $x < 2$ and diverges for $x > 2$

133. A ball is released from a balloon 20 sec after it starts ascending with a uniform acceleration of 1.96 m/sec^2 . If the acceleration due to gravity is 9.8 m/sec^2 , then the greatest height above the ground reached by the ball is

- (1) 392 m (2) 78.4 m (3) 470.4 m (4) 313.6 m

134. The series $\sum_{n=1}^{\infty} \frac{x^{n-1}}{(n-1)!}$

- (1) converges absolutely for all x (2) converges absolutely for $x < 0$ only
 (3) does not converges absolutely (4) converges absolutely for $x > 0$ only

135. The solution of the equation $x^2 \frac{d^2y}{dx^2} + \frac{dy}{dx} = 0$ is

- (1) $y = c' + c \int e^{\frac{1}{x}} dx$ (2) $y = c' + c \int e^{-\frac{1}{x}} dx$
 (3) $y = c' + c \int e^x dx$ (4) $y = c' + c \int e^{-x} dx$

136. The solutions of the equation $xyp^2 + (3x^2 - 2y^2)p - 6xy = 0$ where $p = \frac{dy}{dx}$ are

- (1) $y = cx$ and $y = 3x^2 + c$ (2) $y^2 = cx$ and $y = 3x^2 + c$
 (3) $y = cx^2$ and $y = -3x^2 + c$ (4) $y = cx^2$ and $y = 3x^2 + c$

137. The vector equation of the line $6x - 2 = 3y + 1 = 2z - 2$ is

- (1) $\vec{r} = \vec{i} - \vec{j} + 3\vec{k} + \lambda(\vec{i} + 2\vec{j} + 3\vec{k})$ (2) $\vec{r} = \vec{i} + 2\vec{j} + 3\vec{k} + \frac{\lambda}{3}(\vec{i} - \vec{j} + 3\vec{k})$
 (3) $\vec{r} = \frac{1}{3}\vec{i} - \frac{1}{3}\vec{j} + \vec{k} + \lambda(\vec{i} + 2\vec{j} + 3\vec{k})$ (4) $\vec{r} = -2\vec{i} + \vec{j} - 2\vec{k} + \lambda(6\vec{i} + 3\vec{j} + 2\vec{k})$

138. The equation of a sphere which passes through $(1, 0, 0)$, $(0, 1, 0)$ and $(0, 0, 1)$ and whose centre lies on the curve $4xy = 1$ is

- (1) $x^2 + y^2 + z^2 - x - y - z = 0$ (2) $x^2 + y^2 + z^2 + x - y - z = 0$
 (3) $x^2 + y^2 + z^2 + x + y - z = 0$ (4) $x^2 + y^2 + z^2 + x - y + z = 0$

139. Let $f, g : \mathbb{R} \rightarrow \mathbb{R}$ be functions. If $g \circ f$ is bijective, then

- (1) both f and g are bijective (2) f is bijective but not g
 (3) g is bijective but not f (4) f is injective and g is surjective

140. The angle between the lines whose direction cosines are proportional to 1, 2, 3 and $-2, 2, 5$ is

- (1) $\cos^{-1} \frac{7}{\sqrt{462}}$ (2) $\cos^{-1} \frac{17}{\sqrt{462}}$
 (3) $\cos^{-1} \frac{17}{\sqrt{461}}$ (4) $\cos^{-1} \frac{7}{\sqrt{461}}$

141. The co-ordinates of the point equidistant from the points $(a, 0, 0)$, $(0, b, 0)$, $(0, 0, c)$ and $(0, 0, 0)$ are

- (1) (a, b, c) (2) $(a, 0, c)$
 (3) $(a/2, b/2, c/2)$ (4) $(a/2, b, c/2)$

142. If $\frac{1+3p}{4}$, $\frac{1-p}{3}$, $\frac{1-2p}{3}$ are probabilities of three mutually exclusive events, then the value of p is

- (1) $1/3$ (2) $1/4$ (3) $1/5$ (4) $1/2$

143. A bag contains 12 pairs of socks. 4 socks are picked up at random. The probability that there is at least one pair is

- (1) $41/161$ (2) $40/160$ (3) $8/25$ (4) $20/161$

144. If $f(x) = \int_0^x \frac{1-\sqrt{t}}{1+\sqrt{t}} dt$ ($0 \leq x \leq 1$), then $f'(1)$ is

- (1) 1 (2) $1/\sqrt{2}$ (3) $\sqrt{2}$ (4) 0

145. The value of $\int \frac{\sin x - \cos x}{\sqrt{\sin 2x - 1}} dx$ is

(1) $-\log[(\sin x + \cos x) + \sqrt{\sin 2x - 1}] + c$

(2) $-\log[(\sin x + \cos x) + \sqrt{\sin 2x}] + c$

(3) $-\log[(\sin x - \cos x) + \sqrt{\sin 2x - 1}] + c$

(4) $-\log[(\sin x - \cos x) + \sqrt{\sin 2x}] + c$

146. If $\Delta = \begin{vmatrix} a^2 & bc & ac + c^2 \\ a^2 + ab & b^2 & ac \\ ab & b^2 + bc & c^2 \end{vmatrix}$ then $\sqrt{\frac{\Delta}{3}}$ is

(1) $(a + b)abc$

(2) $(b + c)abc$

(3) $(c + a)abc$

(4) abc

147. In a group G if $a^2 * b^2 = (a * b)^2$ for all $a, b \in G$, then which of the following is true?

(1) G is Abelian

(2) G is cyclic

(3) G is infinite

(4) Every element of G is its own inverse

148. $\int \frac{\log x + \log^2 x + \dots + \log^n x}{x} dx$ is

(1) a polynomial in x

(2) a polynomial in $\log x$

(3) a constant

(4) a polynomial in x and $\log x$

अभ्यर्थियों के लिए निर्देश

(इस पुस्तिका के प्रथम आवरण-पृष्ठ पर तथा उत्तर-पत्र के दोनों पृष्ठों पर केवल नीली या काली बाल-प्वाइंट पेन से ही लिखें।)

1. प्रश्न पुस्तिका मिलने के 10 मिनट के अन्दर ही देख लें कि प्रश्नपत्र में सभी पृष्ठ मौजूद हैं और कोई प्रश्न छूटा नहीं है। पुस्तिका दोषयुक्त पाये जाने पर इसकी सूचना तत्काल कक्ष-निरीक्षक को देकर सम्पूर्ण प्रश्नपत्र की दूसरी पुस्तिका प्राप्त कर लें।
2. परीक्षा भवन में लिफाफा रहित प्रवेश-पत्र के अतिरिक्त, लिखा या सादा कोई भी खुला कागज साथ में न लायें।
3. उत्तर-पत्र अलग से दिया गया है। इसे न तो मोड़ें और न ही विकृत करें। दूसरा उत्तर-पत्र नहीं दिया जायेगा, केवल उत्तर-पत्र का ही मूल्यांकन किया जायेगा।
4. अपना अनुक्रमांक तथा उत्तर-पत्र का क्रमांक प्रथम आवरण-पृष्ठ पर पेन से निर्धारित स्थान पर लिखें।
5. उत्तर-पत्र के प्रथम पृष्ठ पर पेन से अपना अनुक्रमांक निर्धारित स्थान पर लिखें तथा नीचे दिये वृत्तों को गाढ़ा कर दें। जहाँ-जहाँ आवश्यक हो वहाँ प्रश्न-पुस्तिका का क्रमांक तथा सेट का नम्बर उचित स्थानों पर लिखें।
6. ओ० एम० आर० पत्र पर अनुक्रमांक संख्या, प्रश्न-पुस्तिका संख्या व सेट संख्या (यदि कोई हो) तथा प्रश्न पुस्तिका पर अनुक्रमांक सं० और ओ० एम० आर० पत्र सं० की प्रविष्टियों में उपरिलेखन की अनुमति नहीं है।
7. उपर्युक्त प्रविष्टियों में कोई भी परिवर्तन कक्ष निरीक्षक द्वारा प्रमाणित होना चाहिये अन्यथा यह एक अनुचित साधन का प्रयोग माना जायेगा।
8. प्रश्न-पुस्तिका में प्रत्येक प्रश्न के चार वैकल्पिक उत्तर दिये गये हैं। प्रत्येक प्रश्न के वैकल्पिक उत्तर के लिये आपको उत्तर-पत्र की सम्बन्धित पंक्ति के सामने दिये गये वृत्त को उत्तर-पत्र के प्रथम पृष्ठ पर दिये गये निर्देशों के अनुसार पेन से गाढ़ा करना है।
9. प्रत्येक प्रश्न के उत्तर के लिये केवल एक ही वृत्त को गाढ़ा करें। एक से अधिक वृत्तों को गाढ़ा करने पर अथवा एक वृत्त को अपूर्ण भरने पर वह उत्तर गलत माना जायेगा।
10. ध्यान दें कि एक बार स्याही द्वारा अंकित उत्तर बदला नहीं जा सकता है। यदि आप किसी प्रश्न का उत्तर नहीं देना चाहते हैं, तो सम्बन्धित पंक्ति के सामने दिये गये सभी वृत्तों को खाली छोड़ दें। ऐसे प्रश्नों पर शून्य अंक दिये जायेंगे।
11. रफ़ कार्य के लिये प्रश्न-पुस्तिका के मुखपृष्ठ के अन्दर वाले पृष्ठ तथा अंतिम पृष्ठ का प्रयोग करें।
12. परीक्षा के उपरान्त केवल ओ०एम०आर० उत्तर-पत्र परीक्षा भवन में जमा कर दें।
13. परीक्षा समाप्त होने से पहले परीक्षा भवन से बाहर जाने की अनुमति नहीं होगी।
14. यदि कोई अभ्यर्थी परीक्षा में अनुचित साधनों का प्रयोग करता है, तो वह विश्वविद्यालय द्वारा निर्धारित दंड का/की, भागी होगा/होगी।