PROVISIONAL ANSWER KEY

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Note - Candidate must ensure the compliance to send all suggestion in the given format with reference to this paper with provisional answer key only

101. A force is expressed as $F = \alpha t - \beta t^2$, where t is the time. The dimensions of α and β are respectively

(A) $[LMT^{-4}]$ and $[LMT^{-3}]$

(B) $[LMT^{-3}]$ and $[LMT^{-4}]$

(C) $[LMT^{-2}]$ and $[LMT^{-3}]$

(D) $[LMT^{-4}]$ and $[LMT^{-2}]$

102. The necessary and sufficient condition for the following equality to hold good $\vec{A} \times (\vec{B} \times \vec{C}) = (\vec{A} \times \vec{B}) \times \vec{C}$ is

(A) $\vec{A} \times (\vec{B} \times \vec{C}) = \vec{0}$

(B) $\vec{A} \times \vec{B} = \vec{0}$

(C) $\vec{B} \times \vec{C} = \vec{0}$

(D) $(\vec{A} \times \vec{C}) \times \vec{B} = \vec{0}$

103. The following set of homogenous equations to have a non-trivial solution

$$2x + y + 2z = 0$$
$$x + y + 3z = 0$$
$$4x + 3y + bz = 0$$

the value of b must be

(A) –9

(B) 9

(C) –8

(D) 8

104. If the matrix $A = \begin{pmatrix} \cos\theta & 0 & \sin\theta \\ 0 & 1 & 0 \\ -\sin\theta & 0 & \cos\theta \end{pmatrix}$, A is

(A) Hermition

(B) Orthogonal

(C) Skew Hermition

(D) Unitary

105. If A represents a square matrix of order n and I represents an identity matrix of same order, according to Cayley- Hamilton theorem, there exists n roots 'λ' such that

(A) $|\lambda^2 I - A| = 0$

(B) $|A - \lambda^2 I| = 0$

(C) $|A - \lambda I| = 0$

(D) $|I - \lambda A| = 0$

106. The eigenvectors of the matrix $\begin{pmatrix} 1 & -1 \\ -1 & 1 \end{pmatrix}$ are;

(A) (1, 1) and (1, -1)

(B) (2, 1) and (2, -1)

(C) (1, 2) and (1, -2)

(D) (1, 1) and (-1, 1)

107. The solution of $x\ln x\, dy + (y - 2\ln x)dx = 0$ for an arbitrary constant k, is

(A) $y = 2\ln x + \frac{k}{\ln x}$ (B) $y = \ln x + \frac{k}{2\ln x}$

(C) $y = \ln(x^2) + \frac{k}{\ln x}$ (D) $y = \ln x + \frac{k}{\ln x}$

108. The general solution of differential equation $\frac{d^2y}{dx^2} + xy = 0$, for the arbitrary constants c_1 and c_2 , is

(A) $c_1 \cos\sqrt{m}\,x + c_2 \exp(\sqrt{m}\,x)$ (B) $c_1 \cos\sqrt{mx} + c_2 \sin\sqrt{mx}$

(C) $c_1 \cos\sqrt{m}\,x + c_2 \sin\sqrt{m}\,x$ (D) $c_1 \sec\sqrt{m}\,x + c_2 \sin\sqrt{m}\,x$

109. Which of the following identities regarding the Hermite Function $H_n(x)$ is/are correct?

(I) Hermite differential equation is $\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + 2my = 0$

(II) $H'_n(x) = nH'_{n-1}(x)$

(III) $H'_n(x) = 2xH_n(x) - H_{n+1}(x)$

(A) (I) only (B) (I) and (II) only

(C) (I) and (III) only (D) all (I), (II) and (III)

110. The orthogonality condition for Laguerre polynomial s can be expressed as

(A) $\int_0^\infty e^{-x} L_m(x) L_n(x)\, dx = \delta_{mn}$ (B) $\int_0^\infty e^{-2x} L_m(x) L_n(x)\, dx = \delta_{mn}$

(C) $\int_0^\infty e^{-3x} L_m(x) L_n(x)\, dx = \delta_{mn}$ (D) $\int_0^\infty xe^{-x} L_m(x) L_n(x)\, dx = \delta_{mn}$

111. Which of the following condition of a function is incorrect, in order to be expanded in Fourier series?

(A) The function must be periodic

(B) The function must be single valued

(C) The function must be discontinuous everywhere

(D) The function must have a finite number of maxima and minima within one period

112. The Fourier transform $F(\omega)$ of a given function $f(x)$ is given by

(A) $F(\omega) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} f(x)\, e^{-i\omega x} dx$ (B) $F(\omega) = \frac{1}{\sqrt{\pi}}\int_{-\infty}^{\infty} f(x)\, e^{-i\omega x} dx$

(C) $F(\omega) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} f(x)\, e^{i\omega x} dx$ (D) $F(\omega) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} f(x)\, e^{-2i\omega x} dx$

113. Laplace transform of $\left\{\frac{1}{\sqrt{\pi t}}\right\}$ is

(A) $\frac{1}{s}$

(B) $\frac{1}{\sqrt{s}}$

(C) $\frac{s}{2}$

(D) $\sqrt{s}$

114. If $f(z) = u + iv$ is analytic in a region R, then the correct pair of Cauchy-Reimann equations are

(A) $\frac{\partial u}{\partial x} = -\frac{\partial v}{\partial y}$ and $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$

(B) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$ and $\frac{\partial u}{\partial y} = -\frac{\partial v}{\partial x}$

(C) $\frac{\partial u}{\partial x} = -\frac{\partial v}{\partial y}$ and $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial x}$

(D) $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$ and $\frac{\partial u}{\partial y} = \frac{\partial v}{\partial x}$

115. Taylor series expansion of tan z about $z = 0$ is

(A) $1 + \frac{z}{3} - \frac{z^2}{18} + ...$

(B) $1 + \frac{z}{3} + \frac{z^2}{18} + ...$

(C) $1 - \frac{z}{3} - \frac{z^2}{18} + ...$

(D) $1 - \frac{z}{3} + \frac{z^2}{18} + ...$

116. Rigid body moving freely in space has .... degree of freedom.

(A) 3

(B) 6

(C) 9

(D) 4

117. The theory that provides canonical transformation, in which all the coordinates- position as well as momenta are cyclic is

(A) Hamilton-Jacobi theory

(B) Hamilton Theory

(C) Lagrange Theory

(D) Euler Theory

118. Which of the following represents generalized momentum P_k

(A) $\frac{\partial L}{\partial qk}$

(B) $\frac{\partial L}{\partial \dot{q}k}$

(C) $\frac{\partial L}{\partial pk}$

(D) $\frac{\partial L}{\partial \dot{p}k}$

119. Equation of motion of a simple pendulum of length l is

(A) $\theta + \frac{g}{l}\sin\theta = 0$

(B) $\frac{g}{l} + \dot{\theta}\sin\theta = 0$

(C) $\dot{\theta} + \frac{g}{l}\sin\theta = 0$

(D) $\ddot{\theta} + \frac{g}{l}\sin\theta = 0$

120. Which of the following equation is Lagranges equation of motion for a conservative system

(A) $\frac{d}{dt}\left(\frac{dL}{\partial \dot{q}k}\right)-\frac{\partial L}{\partial qk}=0$

(B) $\frac{d}{dt}\left(\frac{dL}{\partial qk}\right)-\frac{\partial L}{\partial \dot{q}k}=0$

(C) $\frac{d}{dt}\left(\frac{dL}{\partial qk}\right)-\frac{\partial L}{\partial qk}=0$

(D) $\frac{d}{dt}\left(\frac{dL}{\partial \dot{q}k}\right)+\frac{\partial L}{\partial qk}=0$

121. If L is the Lagrangian then the Hamiltonian H is

(A) $\Sigma q_K \dot{p}_K - L$

(B) $\Sigma p_K \dot{q}_K - L$

(C) $\Sigma q_K p_K - L$

(D) $\Sigma \dot{p}_K \dot{q}_K - L$

122. If the Lagrangian L does not depend on time explicitly then

(A) H is constant

(B) H is not constant

(C) Kinetic energy is constant

(D) Potential energy is constant

123. If the Lagrangian $L=\frac{1}{2}m\dot{x}^2-\frac{1}{2}kx^2$, then the Hamiltonian is

(A) $Px+\frac{1}{2}kx^2$

(B) $P_x^2+\frac{1}{2}kx^2$

(C) $\frac{P_x^2}{2m}+\frac{1}{2}kx^2$

(D) $P_x^2+\frac{1}{2m}kx^2$

124. Number of elements in inertia tensor

(A) 3

(B) 6

(C) 9

(D) 1

125. The value of moment of inertia depends on

(A) Direction of rotation

(B) Speed of rotation

(C) Mass of body

(D) all the above

126. Under canonical transformations Poisson's bracket is

(A) Zero

(B) Variable

(C) Covariant

(D) Invariant

127. For one-dimensional oscillator the representative point in 2D phase space traces

(A) an ellipse

(B) a parabola

(C) a hyperbola

(D) a straight line

128. If two objects with equal angular velocity have their moment of inertia as $I_1 > I_2$, their Kinetic Energies

(A) $E_1 = E_2$
(B) $E_1 < E_2$
(C) $E_1 > E_2$
(D) $E_1 \geq E_2$

129. For charged particle in electromagnetic field, the canonical momentum is

(A) $m\vec{v} + \frac{q}{c}\vec{A}$
(B) $\frac{1}{2}mv^2 + \frac{q}{c}\vec{A}$
(C) $m\vec{v} - \frac{q}{c}\vec{A}$
(D) $\frac{1}{2}mv^2 - \frac{q}{c}\vec{A}$

130. The force which is always directed away or towards a fix center and magnitude of which is a function of only of the distance from the fixed center is known as

(A) Coriolis force
(B) Centripetal force
(C) Centrifugal force
(D) Central force

131. The generalized coordinate has the dimensions of momentum; the generalized velocity will have the dimensions of

(A) Velocity
(B) Acceleration
(C) Force
(D) Torque

132. Einstein's relation between momentum and energy is

(A) $E^2 = p^2c^2 - m_0^2c^4$
(B) $E^2 = p^2c^2 + m_0^4c^4$
(C) $E^2 = p^2c^2 + m_0^2c^4$
(D) $E^2 = c\sqrt{p^2 + m_0^2c^2}$

133. According to special theory of relativity, the speed v of a free particle of mass m and total energy E is

(A) $v = c\sqrt{1 - \frac{m_0c^2}{E}}$
(B) $v = \sqrt{\frac{2E}{m_0}}\left(1 + \frac{m_0c^2}{E}\right)$
(C) $v = c\sqrt{1 - \left(\frac{m_0c^2}{E}\right)^2}$
(D) $v = c\left(1 - \frac{m_0c^2}{E}\right)$

134. If the generating function has the form $F = F(q_k, P_k, t)$, then

(A) $P_k = \frac{\partial F}{\partial q_k}, Q_k = \frac{\partial F}{\partial P_k}$
(B) $P_k = -\frac{\partial F}{\partial q_k}, Q_k = \frac{\partial F}{\partial P_k}$
(C) $P_k = \frac{\partial F}{\partial q_k}, Q_k = -\frac{\partial F}{\partial P_k}$
(D) $P_k = -\frac{\partial F}{\partial q_k}, Q_k = -\frac{\partial F}{\partial P_k}$

135. Which of the following is not true in case of Poisson's brackets for angular momentum components (Jx, Jy, Jz)

(A) $[J_x, P_x] = 0$

(B) $[J_x, P_z] = -P_y$

(C) $[J_y, J_z] = J_x$

(D) $[J_z, J_x] = -J_y$

136. The Hamiltonian of relativistic particle or rest mass m and momentum p is given by $H = \sqrt{p^2 + m^2} + V(x)$ in units in which speed of light $c = 1$. The corresponding Lagrangian is

(A) $L = m\sqrt{1 + \dot{x}^2} - V(x)$

(B) $L = -m\sqrt{1 + \dot{x}^2} - V(x)$

(C) $L = \sqrt{1 + m\dot{x}^2} - V(x)$

(D) $L = \frac{1}{2}m\dot{x}^2 - V(x)$

137. The Euler's equation of motion for a freely rotating rigid body is (symbols have usual meaning)

(A) $\frac{d\vec{L}}{dt} + \vec{\omega} \times \vec{L} = \vec{\tau}$

(B) $\frac{d\vec{L}}{dt} + \vec{\omega} \times \vec{L} = 0$

(C) $\vec{\omega} \times \vec{L} = \vec{0}$

(D) $\vec{\omega} \times \vec{L} = \vec{\tau}$

138. The electric field intensity on the surface of a charged conductor is

(A) Zero

(B) Directed along a line making 30° with the surface

(C) Directed along tangent to the surface

(D) Directed along normal to the surface

139. The electric field due to an infinite plane carrying a uniform surface charge density σ is ($\hat{n}$ is a unit vector away from the surface)

(A) $\frac{2\sigma}{\varepsilon_0}\hat{n}$

(B) $\frac{\sigma}{2\varepsilon_0}\hat{n}$

(C) $\frac{\sigma}{\varepsilon_0}\hat{n}$

(D) $\frac{\sigma}{3\varepsilon_0}\hat{n}$

140. The Laplace and Poisson equations for electric potential V of a electric charge density ρ are expressed respectively by

(A) $\nabla^2 V = 0$ and $\nabla^2 V = -\frac{\rho}{\varepsilon_0}$

(B) $\nabla^2 V = -\frac{\rho}{\varepsilon_0}$ and $\nabla^2 V = 0$

(C) $\nabla^2 V = 0$ and $\nabla^2 V = -\frac{\rho}{2\varepsilon_0}$

(D) $\nabla^2 V = 0$ and $\nabla^2 V = -\frac{3\rho}{\varepsilon_0}$

141. The potential at a distance r outside a uniformly charged spherical shell of radius R and surface charge density σ is given by

(A) $\frac{R^2\sigma}{3\varepsilon_0 r}$ (B) $\frac{R^2\sigma}{\varepsilon_0 r^2}$

(C) $\frac{R\sigma}{\varepsilon_0 r}$ (D) $\frac{R^2\sigma}{\varepsilon_0 r}$

142. The work done due to magnetic force is

(A) Zero

(B) Infinite

(C) Proportional to the magnitude of the electric charge

(D) Inversely proportional to velocity of electrically charged particle

143. The differential and integral form of Ampere's law for magnetostatics respectively are

(A) $\vec{\nabla} \times \vec{B} = -\mu_0 \vec{J}$ and $\oint \vec{B} \cdot d\vec{l} = -\mu_0 I_{enclosed}$

(B) $\vec{\nabla} \cdot \vec{B} = \mu_0 \vec{J}$ and $\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enclosed}$

(C) $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$ and $\oint \vec{B} \times d\vec{l} = -\mu_0 I_{enclosed}$

(D) $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J}$ and $\oint \vec{B} \cdot d\vec{l} = -\mu_0 I_{enclosed}$

144. The magnetic field at distance r from an infinite long straight wire carrying a steady current I

(A) $\frac{\mu_0 I}{\pi r}$ (B) $\frac{\mu_0 I}{2\pi r}$

(C) $\frac{2\mu_0 I}{\pi r}$ (D) $\frac{\mu_0 I}{2r}$

145. A changing magnetic field induces

(A) An electric field (B) A changing electric field

(C) A magnetic field (D) A changing magnetic field

146. The total energy stored in an electrostatic field, all symbols being with usual notation, is

(A) $\frac{1}{2}\int [\varepsilon_0 E^2] dV$ (B) $\frac{1}{2}\int \left[\varepsilon_0 E^2 + \frac{B^2}{\mu_0}\right] dV$

(C) $\frac{1}{2}\int \left[\frac{B^2}{\mu_0}\right] dV$ (D) $\frac{1}{2}\int [\varepsilon_0 \mu_0 E^2 B^2] dV$

147. The direction of propagation of electromagnetic wave is given by the direction of

(A) $\vec{E}$
(B) $\vec{B}$
(C) $\vec{E} \cdot \vec{B}$
(D) $\vec{E} \times \vec{B}$

148. If all the following particles are moving with same velocity, then maximum de-Broglie wavelength is for

(A) α-particle
(B) β-particle
(C) proton
(D) neutron

149. An electron and a proton have the same de-Broglie wavelength of $3.1\,\text{Å}$ Which one of the following statements is correct with regard them?

(A) Both have same linear velocity
(B) Both have same linear momentum
(C) Both have same kinetic energy
(D) The kinetic energy of electron is less than that of proton

150. If the solution $\psi(r)$, of Schrodinger equation is constant for constant potential $V(r)$, the probability current density will be

(A) 1
(B) –1
(C) 0
(D) ∞

151. The time independent wave function of a particle of mass m in a potential $V(x) = \alpha^2 x^2$ is $\psi(r) = \exp\left(-\sqrt{\frac{m\alpha^2}{2\hbar}}x^2\right)$, α being constant, the energy E of the system is

(A) $\frac{2\hbar\alpha}{\sqrt{2m}}$
(B) $\frac{\hbar\alpha}{\sqrt{2m}}$
(C) $\frac{\hbar\alpha}{\sqrt{m}}$
(D) $\frac{\hbar\alpha}{\sqrt{3m}}$

152. For an electron in one-dimensional infinite potential well of width $1\,\text{Å}$, the energy difference between two lowest energy levels is

(A) 13.27 eV
(B) 12.27 eV
(C) 113.27 eV
(D) 212.27 eV