TEST SERIES CSIR-NET/JRF Dec. 2017

BOOKLET SERIES E

FULL LENGTH TEST - II

Paper Code 05 **Test Type: TEST SERIES**

PHYSICAL SCIENCES

Duration: 3:00 Hours **Date: 11-12-2017**

Maximum Marks: 200

Read the following instructions carefully:

* Single Paper Test is divided into **three** Parts.

Part - A: This part shall carry 20 questions. The candidate shall be required to answer any 15 questions. Each question shall be of **2 marks.**

Part - B: This part shall contain 2**5** questions covering the topics given in the Part 'B' of syllabus. The candidates are required to answer any 20 questions. Each question shall be of **3.5 Marks.**.

Part - C: This part shall contain **30** questions from Part - C of the syllabus. The candidates are required to answer any 20 questions. Each question shall be of **5 Marks**.

* Darken the appropriate bubbles with HB pencil/Ball Pen to write your answer.

* There will be negative marking @25% for each wrong answer.

* The candidates shall be allowed to carry the Question Paper Booklet after completion of the exam.

* For rough work, blank sheet is attached at the end of test booklet.

PART-A

1. Find the number of digits in 4^{50}?

(a) 30 (b) 31 (c) 100 (d) 200

2. The sum of the first 35 terms of the series $\frac{1}{2}+\frac{1}{3}-\frac{1}{4}-\frac{1}{2}-\frac{1}{3}+\frac{1}{4}+\frac{1}{2}+\frac{1}{3}-\frac{1}{4}$.......... is

(a) $-\frac{1}{2}$ (b) $-\frac{1}{4}$ (c) $\frac{1}{4}$ (d) $\frac{1}{2}$

3. If every 2 out of 3 readymade shirts need alterations in the collar, every 3 out 4 need alterations in the sleeves and every 4 out of 5 need it in the body. How many alterations will be required for 60 shirts?

(a) 24 (b) 123 (c) 133 (d) 143

4. When the numerator of a fraction increases by 4, the fraction increases by $\frac{2}{3}$. The denominator of the fraction is

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

5. 'Current' is related to 'Ampere' in the same way as 'weight' is related to

(a) scale (b) pound (c) commodity (d) Measurement

6. A printers numbers the pages of a book starting with 1 and uses 3189 digits in all. How many pages does the book have?

(a) 1000 (b) 1074 (c) 1075 (d) 1080

7. A student multiplied a number by $\frac{3}{5}$ instead of $\frac{5}{3}$. What is the percentage error in the calculation?

(a) 34% (b) 44% (c) 54% (d) 64%

8. One year ago, Promila was four times as old as her daughter Sakshi. Six years hence, Promila's age will exceed her daughter's age by 9 years. The ratio of the present ages of Promila and her daughter is

(a) 9 : 2 (b) 11 : 3 (c) 12 : 5 (d) 13 : 4

9. The price of tea being increased by 20%, a man reduces his consumption by 20%. By how much percent will his expenses for tea be decreased?

(a) 2% (b) 4% (c) 6% (d) 8%

10. A man buys an article for 10% less than its value and sells it for 10% more than its value. His gain or loss is

(a) No profit, no loss (b) 20% profit

(c) less than 20% profit (d) more than 20% profit

11. Find the missing number

15	6	5
13	3	9
8	2	?
20	7	13

(a) 1 (b) 4 (c) 6 (d) 7

12. 20 liters of a mixture contains milk and water in the ratio 5 : 3. If 4 liters of this mixture be replaced by 4 liters of milk. The ratio of milk to water in the new mixxture would be

(a) 2 : 1 (b) 7 : 3 (c) 8 : 3 (d) 4 : 3

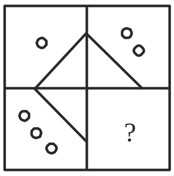
13. A can do a piece of work in 20 days. B is 25% more efficient than A. The number of days taken by B to do the same piece of work is

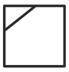
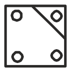
(a) 15 (b) 16 (c) 18 (d) 25

14. Two trains starting at the same time from two stations 200 km apart and going in opposite directions cross each other at a distance of 110 km from one of the stations. What is the ratio of their speeds?

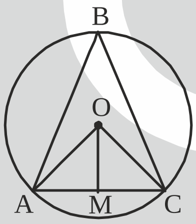
(a) 9 : 20 (b) 11 : 9 (c) 11 : 20 (d) none of these

15. Find the missing figure



(a)  (b)  (c)  (d) 

16. In the following figure, O is the centre of the circle, OA = 3cm, AC = 3 cm and OM is perpendicular to AC. Then find $\angle ABC = ?$



(a) 60º (b) 45º (c) 30º (d) 75º

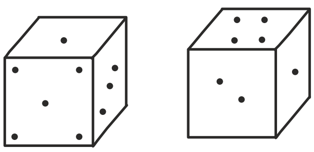
17. If the perimeters of a square and a rectangle are the same, then the Area A and B enclosed by them would satisfy the condition

(a) $A < B$ (b) $A \le B$ (c) $A > B$ (d) $A \ge B$

18. A cone, a hemisphere and a cylinder stand on equal bases and have the same height. Find the ratio of their volumes?

(a) 1 : 2 : 3 (b) 3 : 2 : 1 (c) 1 : 4 : 27 (d) 27 : 4 : 1

19. Two positions of a dice are shown below. When there are two dots at the bottom, the number of dots at the top will be



(a) 2 (b) 3 (c) 5 (d) 6

20. If $a+\frac{1}{a}=1$, then the value of a^3 is

(a) 2 (b) –1 (c) 4 (d) –2

PART-B

21. A point charge +q is placed at a distancec 'r' from the centre of a grounded conducting sphere of radius 'a'. Which of the following statements is not true?
(a) the induced surface charge density on the sphere is not the same everywhere
(b) the electric field inside the sphere is not zero
(c) the total induced charge on the sphere is $-\frac{qa}{r}$
(d) the electrostatic potential at a large distance *d* (compared to the distance between the charge and the sphere) falls off as 1/*d*.

22. In a region of space, a time dependent magnetic field $B(t) = 0.4t$ Tesla points vertically upwards. Consider a horizontal, circular loop of radius 2 cm in this region. The magnitude of the electric field (in mV/m) induced in the loop is
(a) 2.00 (b) 4.00 (c) 6.25 (d) 12.50

23. A dielectric sphere of radius R has constant polarization $\vec{P} = P_0\hat{z}$ so that the field inside the sphere is $\vec{E}_{in} = -\frac{P_0}{3\epsilon_0}\hat{z}$. Then, which of the following is not correct?
(a) The bound charge density on the surface of sphere is $P_0\cos\theta$
(b) The electric field at a distance *r* on the *z*-axis varies as $\frac{1}{r^3}$ for $r \gg R$
(c) Net charge on the sphere is $\frac{4\pi P_0 R^2}{3}$
(d) The electric field outside is equivalent to that of a dipole at the origin

24. A sphere of radius R carries a volume charge density $\rho(r) = \beta r^2$, where 'r' is distance from centre and β is a constant. The electrostatic potential (ϕ) at the centre of sphere is
(a) $\frac{\beta R^4}{4\varepsilon_0}$ (b) $\frac{21\beta R^5}{20\varepsilon_0}$ (c) $\frac{21\beta R^4}{20\varepsilon_0}$ (d) $\frac{\beta R^5}{4\varepsilon_0}$

25. The electric potential corresponding to a charge distribution is given by

$$V(r) = \frac{e^{-\lambda r}}{r}, \text{ where } \lambda \text{ is constant.}$$

The total charge enclosed over the entire space is
(a) $\frac{4\pi}{\lambda^2}$ (b) $-\frac{4\pi}{\lambda^2}$ (c) -4π (d) 0

26. Let $|l, m_l\rangle$ be the simultanous eigenfunction of the angular momentum operators $\hat{L}^2$ and $\hat{L}_z$, with eigen values $l(l+1)\hbar^2$ and $m_l\hbar$ respectively. Suppose $\hat{A}$ denote an operator corresponding to the component of the angular momentum along a direction making an angle 60^0 with z axis in the x-z plane. The uncertainty ΔA in the state $|2,1\rangle$, will be
(a) $\sqrt{\frac{15}{8}}\hbar$ (b) $\sqrt{\frac{5}{8}}\hbar$ (c) $\sqrt{\frac{15}{4}}\hbar$ (d) $\sqrt{\frac{5}{4}}\hbar$

27. Let φ_1 and φ_2 denote, the normalized eigenstates of a aprticle with energy eigenvalues E_1 and E_2 respectively. At time t = 0, the particle is prepared in a state

$$\psi(x,t=0)=\frac{1}{\sqrt{2}}\varphi_1(x)+\frac{1}{\sqrt{2}}\varphi_2(x)$$

It is observed that both $\psi(x,t=T_1)$ and are $\psi(x,t=T_2)$ orthogonal to $\psi(x,t=0)$. The minimum non-zero value of T_2-T_1, is

(a) $\frac{\pi\hbar}{|E_1-E_2|}$ (b) $\frac{2\pi\hbar}{|E_1-E_2|}$ (c) $\frac{\pi\hbar}{2|E_1-E_2|}$ (d) $\frac{4\pi\hbar}{|E_1-E_2|}$

28. A particle is moving in a two-dimensional potential well described as following:

$V(x,y)=0$ for $0<x<L, -L<y<L$

$=\infty$ otherwise

The ground state eigenfunction for the system, is

(a) $\frac{\sqrt{2}}{L}\sin\frac{\pi x}{L}\sin\frac{\pi y}{2L}$ (b) $\frac{\sqrt{2}}{L}\cos\frac{\pi x}{L}\sin\frac{\pi y}{2L}$

(c) $\frac{\sqrt{2}}{L}\sin\frac{\pi x}{L}\cos\frac{\pi y}{2L}$ (d) $\frac{\sqrt{2}}{L}\cos\frac{\pi x}{L}\cos\frac{\pi y}{2L}$

29. A positron is suddenly absorbed by the nucleus of a tritium $\left({}_1^3H\right)$ to turn the the latter into a He^+ ion. Suppose the electron in tritium atom was initially in the ground state and r_{mp} represents the most probable radial distance of the electron from the nucleus. If the resulting He^+ ion is also in the ground state, then r_{mp}

(a) will remain same (b) increases by a factor of 2

(c) increases by a factor of 4 (d) decreases by a factor of 2

30. Consider a beam of particles each of mass '*m*' and energy '*E*' is incident from the left on the following one-dimensional potential barrier:

$$V(x)=\begin{cases}V_0\left(1-\frac{|x|}{\lambda}\right) & \text{for } |x|<\lambda\\ 0 & \text{for } |x|>\lambda\end{cases}$$

Using WKB method, the transmission coefficient $\exp^{-T}$ for tunnelling through the barrier can be found out. The value of the ratio $T\left(E=\frac{V_0}{4}\right):T\left(E=\frac{V_0}{2}\right)$ will be

(a) $\left(\frac{3}{2}\right)^{1/2}$ (b) $\left(\frac{3}{2}\right)^{3/2}$ (c) $\left(\frac{1}{2}\right)^{3/2}$ (d) $\left(\frac{1}{2}\right)^{1/2}$

31. The value of the integral $\oint_C \sqrt{2}z\sin\left(\frac{1}{z}+\frac{\pi}{4}\right)dz$, where C is a closed contour defined by the equation $2|z|-5=0$, traversed in the clockwise direction, is

(a) $-\pi i$ (b) πi (c) $2\pi i$ (d) $-2\pi i$

32. The first few terms of the Laurent series expansion of the function $f(z) = \dfrac{1}{e^z - 1}$ about z = 0, will be

(a) $\dfrac{1}{z} - \dfrac{1}{2} + \dfrac{z}{12} + ...$ for all $0 < |z| < 2\pi$ (b) $\dfrac{1}{z} - \dfrac{1}{2} + \dfrac{z}{12} + ...$ for all $0 < |z| < \infty$

(c) $\dfrac{1}{z} + \dfrac{1}{2} - \dfrac{z}{6} + ...$ for all $0 < |z| < 2\pi$ (d) $\dfrac{1}{z} + \dfrac{1}{2} - \dfrac{z}{6} + ...$ for all $0 < |z| < \infty$

33. In a certain binary communication channel, the probability that transmitted "0" is received as "0" is 0.99 and probability that transmitted "1" is received as "1" is 0.95. If the probability that "0" is transmitted is 0.6, the probability that "0" is received, is

(a) 0.6 (b) 0.99 (c) 0.594 (d) 0.614

34. The joint probability distribution function of the random variables *x* and *y*, is given as following:

$$f(x, y) = K\left(xy + y^2\right) \quad [0 \le x \le 1,\ 0 \le y \le 2]$$

The probability that $x + y \le 1$, will be

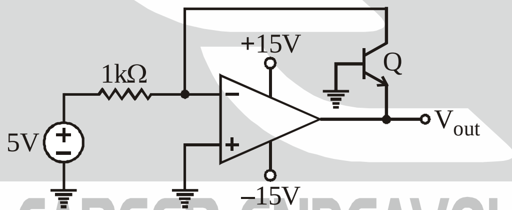
(a) 3/22 (b) 3/44 (c) 3/88 (d) 1/11

35. The interval $[0,1]$ is divided into 4 parts of equal length to evaluate the integral $\int_0^1 \dfrac{dx}{2x+3}$ using Trapezoidal rule.

The percentage error (in magnitude) in the calculation will be approximately, [You can use the result: $\ln(5/3) = 0.51082$]

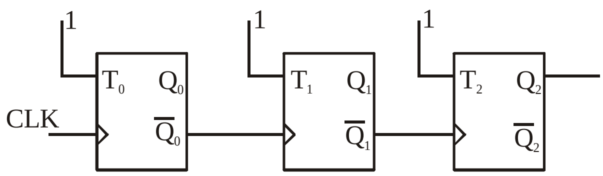
(a) 0.29 % (b) 0.78% (c) 1.14 % (d) 1.83%

36. In the circuit shown below what is the output voltage (V_{out}) if a silicon transistor Q and an ideal op-amp are used ?



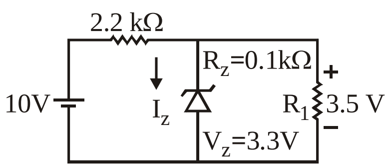
(a) –15 V (b) –0.7 V (c) +0.7 V (d) +15 V

37. Figure shows a ripple counter using positive edge triggered flip-flops. If the present state of counter is $Q_2Q_1Q_0 = 011$, then its next state $(Q_2Q_1Q_0)$ will be



(a) 010 (b) 100 (c) 111 (d) 101

38. The current through the Zener diode in figure is



(a) 33 mA (b) 3.3 mA (c) 2 mA (d) 0 mA

39. A particle of rest mass m_0 is subjected to a constant force F due to which particle accelerates from rest after what time kinetic energy of the particle will become equal to its rest mass energy

(a) $\frac{m_0 c}{F}$ (b) $\frac{m_0 c}{2F}$ (c) $\frac{\sqrt{3}\, m_0 c}{2F}$ (d) $\frac{\sqrt{3}\, m_0 c}{F}$

40. A particle of unit mass undergoes small oscillations about stable equilibrium point of one-dimensional potential $V(x) = x^2 + \frac{1}{x^2}$. Angular frequency is

(a) $\sqrt{2}$ (b) $2\sqrt{2}$ (c) 2 (d) $4\sqrt{2}$

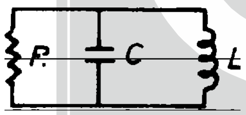
41. Lagrangian of a particle is $L = \frac{1}{2}m\dot{x}^2 - \frac{1}{2}m\omega^2 x^2$. If at $t = 0$, $x = A$, $\dot{x} = 0$, then at what time particle reaches $x = \frac{A}{2}$ for the first time.

(a) $\frac{\pi}{\omega}$ (b) $\frac{\pi}{2\omega}$ (c) $\frac{\pi}{3\omega}$ (d) $\frac{\pi}{4\omega}$

42. Hamiltonian of a particle is $H = \frac{p_x^2}{2m} + kx^4$. If energy of the particle is doubled then area of the phase space trajectory will become

(a) double (b) half (c) $2^{3/2}$ times (d) $2^{3/4}$ times

43. The circuit shown in the figure is in thermal equilibrium with its surroundings at a temperature T. What is the classical expression for the root mean square current through the inductor ?



(a) $\sqrt{\frac{2kT}{L}}$ (b) $\sqrt{\frac{3kT}{L}}$ (c) $\sqrt{\frac{kT}{L}}$ (d) $\sqrt{\frac{L}{2kT}}$

44. A system consists of N very weakly interacting particles at a temperature sufficiently high such that classical statistics are applicable. Each particle has mass m and oscillates in one direction about its equilibrium position. The heat capacity at temperature T ,if restoring force is proportional to x^3

(a) $\frac{3}{2}Nk$ (b) $\frac{5}{2}Nk$ (c) Nk (d) $\frac{3}{4}Nk$

45. If Ω is the number of accessible microstates and S is the corresponding entropy, then which of the following relation is true

(where k is the Boltzmann constant)

(a) $\Omega = S/k$ (b) $\Omega = e^{S/k}$ (c) $\Omega = e^{-S/k}$ (d) $\Omega = \ln(S/k)$

PART-C

46. A Si film is doped with 10^{19} P atoms/cm^3. Thickness of the film is 1 μm and the current passing through film is 1 mA. The Hall voltage developed in the film, if placed in a perpendicular magnetic field of 1T, is

(a) 1.25 mV (b) 2.5 mV (c) 5.00 mV (d) 0.625 mV

47. KCl has the NaCl type structure which is fcc with two-atom basis, one at (0, 0, 0) and the other at $\left(\frac{1}{2},\frac{1}{2},\frac{1}{2}\right)$. Assume that the atomic form factors of K^+ and Cl^- are identical. In an X-ray diffraction experiment on KCl, which of the following ($h\ k\ l$) peaks will not be observed :

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

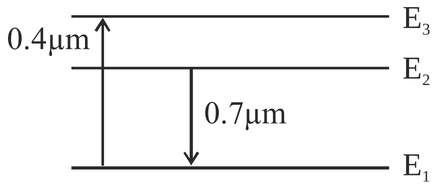
48. The dispersion relation for an unknown Boson particle is given by

$$\omega^2(k) = \omega_0^2\left(3 - \cos k_x a - \cos k_y a - \cos k_z a\right)$$

The specific heat of the particle at low temperature and long wavelength is

(a) AT (b) BT^3 (c) $CT^{3/2}$ (d) $AT + BT^3$

49. A typical three level laser has pumping rate of 1.5×10^{19} atoms/cm^3–sec. All the atoms excited by the 0.4μm radiation decay rapidly to level E_2 which has a life time t = 3ms.



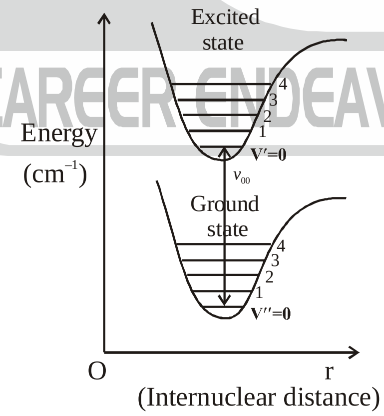
The density of atoms in level E_2 under steady state condition is:

(a) $1.5\times10^{19}/cm^3$ (b) $4.5\times10^{16}/cm^3$ (c) $5\times10^{21}/cm^3$ (d) $2\times10^{16}/cm^3$

50. Positronium is an atom formed by an electron and positron. The mass of a positron is the same as that of an electron and its charge is equal in magnitude but opposite in sign to that of an electron. The speed of electron in the lowest Bohr's orbit of positronium atom is (m/s)

(a) 2.2×10^6 (b) 1.1×10^6 (c) 4.4×10^6 (d) 3×10^8

51. A vibrational-electronic spectrum of homonuclear molecule is shown in the graph. The dissociation energy in ground state and excited state is 2000 cm^{-1} and 1500 cm^{-1} respectively. If the energy of the dissociated atoms in the excited state exceeds the total energy of dissociated atoms in the ground state by 2200 cm^{-1}. The energy (v_{00}) of $V'=0 \rightarrow V''=0$ transition is:



(a) 2700 cm^{-1} (b) 1700 cm^{-1} (c) 1300 cm^{-1} (d) 5700 cm^{-1}

52. A square loop of side 'a' lies in x-y plane. An electromagnetic wave $\vec{E} = E_o\hat{i}\cos\left(\frac{\sqrt{3}}{2}z + \frac{1}{2}y - \omega t\right)$ is propagating in free space. The power crossing through the square is,

(a) $\frac{E_o^2 a^2}{2\mu_o c}$ (b) $\frac{\sqrt{3}E_o^2 a^2}{4\mu_o c}$ (c) $\frac{\sqrt{3}E_o^2 a^2}{2\mu_o c}$ (d) $\frac{E_o^2 a^2}{4\mu_o c}$

53. A charge particle '*q*' is performing simple harmonic motion (SHM) along z-axis about origin (0, 0, 0). The amplitude of SHM is z_0 and the frequency is ω. The ratio of amplitude of intensity at (a, 0, 0) to (a, a, 0) is

(a) $\frac{1}{4}$ (b) $\frac{1}{2}$ (c) 2 (d) 4

54. A plane electromagnetic wave with

$$\vec{H} = 0.5\cos\left(4\times10^{8}t - 2z\right)\hat{y}\,;\quad \vec{E} = 80\,\pi\cos\left(4\times10^{8}t - 2z\right)\hat{x}$$

travelling in an isotropic magnetic dielectric medium. The relative permeability $\left(\mu_r\right)$ of medium is:

(a) 4 (b) 2.25 (c) 1.25 (d) 2

55. A solenoid of radius *R* with *n* turns per unit length carries a time dependent current $I = I_0 \sin\omega t$. The average value of poynting vector $\left(\langle \vec{S} \rangle\right)$ at a distance $r < R$ from axis of solenoid is

(a) $\frac{\mu_0 \omega n^2 I_0^2 r}{4}$ (b) $\frac{\mu_0 \omega n^2 I_0^2 R^2}{4r}$ (c) 0 (d) $\frac{\mu_0 \omega n^2 I_0^2 r}{2}$

56. A particle of mass *m* confined to move in a potential defined as following:

$$V(x) = \begin{cases} 0 & \text{for } 0 \le x \le a \\ \infty & \text{otherwise} \end{cases}$$

The wave function of the particle at time t = 0 is given by

$$\psi(x,0) = A\sin^5 \frac{\pi x}{a}$$

If a measurement of energy of the particle is made, the probability that it will yield $\frac{h^2}{8ma^2}$ will be

(a) $\frac{50}{63}$ (b) $\frac{25}{126}$ (c) $\frac{25}{63}$ (d) $\frac{1}{63}$

57. Two operators *A* and *B* are defined as following:

$$A = \left(p_x^2 - x^2\right), \quad B = \left(xp_x + p_x x\right)$$

The commutator bracket $[A, B]$ will be equal to

(a) $4i\hbar\left(x^2 - p_x^2\right)$ (b) $2i\hbar\left(x^2 - p_x^2\right)$ (c) $-4i\hbar\left(x^2 + p_x^2\right)$ (d) $-2i\hbar\left(x^2 + p_x^2\right)$

58. An electron of mass '*m*' and charge '-*e*' moves in a region where a uniform magnetic field $\vec{B} = B_0\hat{z}$ exists. The Hamiltonian of the system can be written as

(a) $H = \frac{1}{2m}\left[\left(p_x + \frac{eBx}{c}\right)^2 + p_y^2 + p_z^2\right]$ (b) $H = \frac{1}{2m}\left[p_x^{\,2} + p_y^2 + \left(p_z + \frac{eBz}{c}\right)^2\right]$

(c) $H = \frac{1}{2m}\left[p_x^{\,2} + p_y^2 + \left(p_z - \frac{eBz}{c}\right)^2\right]$ (d) $H = \frac{1}{2m}\left[p_x^2 + \left(p_y + \frac{eBx}{c}\right)^2 + p_z^2\right]$

59. Consider the following two-dimensional isotropic Harmonic oscillator system:

$$H = \frac{1}{2}\left(p_x^2 + p_y^2\right) + \frac{1}{2}\left(x^2 + y^2\right)$$

(Taking $m = \omega = \hbar = 1$ unit). Suppose the system is perturbed by the following Hamiltonian:

$$H_p = \frac{1}{2}\varepsilon xy\left(x^2 + y^2\right) \quad (\varepsilon << 1)$$

The energy of the first excited state corrected upto first order, will be

(a) $2 \pm \frac{3}{4}\varepsilon$ (b) $2 \pm \frac{1}{4}\varepsilon$ (c) $2 + \frac{1}{4}\varepsilon$ (d) $2 - \frac{1}{4}\varepsilon$

60. Let $H_n(x)$ be the Hermite polynomial satisfying the following generating function relation:

$$e^{2xt - t^2} = \sum_{n=0}^{\infty} \frac{H_n(x)}{n!} t^n$$

The value of $H_6(0)$ is

(a) 12 (b) -12 (c) 120 (d) –120

61. Condiser the following 3×3 matrix:

$$A = \begin{bmatrix} 3 & 1 & -1 \\ -2 & 1 & 2 \\ 0 & 1 & 2 \end{bmatrix}$$

The value of $\text{Trace}\left(A^2 + 5A + 3I\right)$, will be

(a) 50 (b) 53 (c) 43 (d) 6

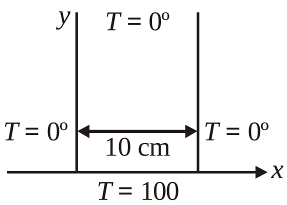
62. The Laplace transform of the following function:

$$f(t) = \begin{cases} 0 & \text{for } 0 < t < 1 \\ 1 & \text{for } 1 < t < 2 \end{cases}$$

such that $f(t+2) = f(t)$ for all $t \in [0, \infty)$, is

(a) $\frac{e^{-s}}{s\left(1 - e^{-s}\right)}$ (b) $\frac{1}{s\left(1 + e^{-s}\right)}$ (c) $\frac{e^{-s}}{s\left(1 + e^{-s}\right)}$ (d) $\frac{e^{-s}}{s\left(1 + e^{-2s}\right)}$

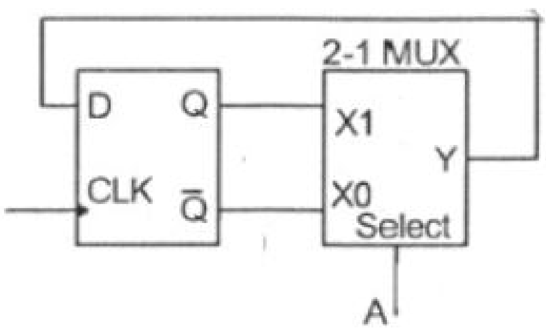
63. A long rectangular metal plate has its two long sides and the end at 0°C and the base at 100°, the width of the plate is 10 cm. The steady state temperature T that satisfies Laplace's equation inside the plate (there are no sources of heat), will be

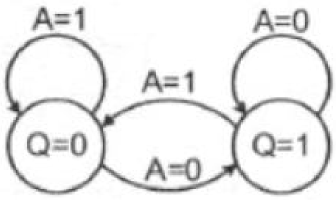


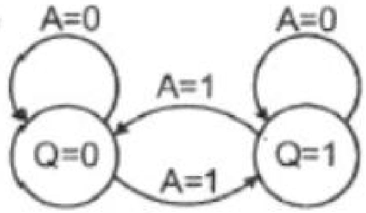
(a) $T = \sum_{n=1,3,5,\ldots}^{\infty} C_n e^{-n\pi y/10} \sin\frac{n\pi x}{10}$ (b) $T = \sum_{n=1,2,3,\ldots}^{\infty} C_n e^{-n\pi y/10} \sin\frac{n\pi x}{10}$

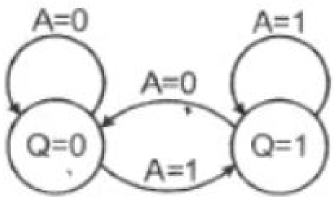
(c) $T = \sum_{n=1,2,3,\ldots}^{\infty} C_n e^{-n\pi y/10} \sin\frac{n\pi x}{10}$ (d) $T = \sum_{n=1,3,5,\ldots}^{\infty} C_n e^{-n\pi y/10} \cos\frac{n\pi x}{10}$

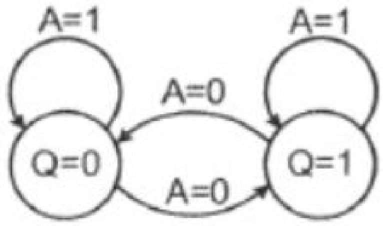
64. The state transition diagram for the logic circuit shown is



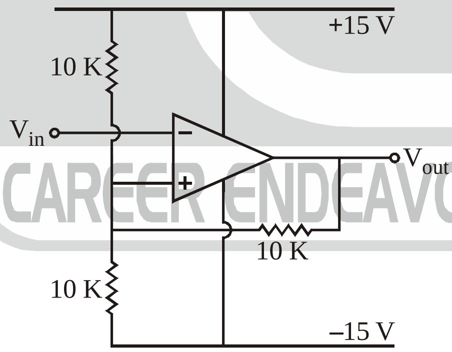
(a)


(b)


(c)


(d)


65. Consider the Schmitt trigger circuit shown below :



A triangular wave which goes from –12V to 12V is applied to the inverting input of the op-amp. Assume that the output of the op-amp swings from +15V to –15V. The voltage at the non-inverting input switches between

(a) –12V and +12V (b) –7.5V and +7.5V (c) –5V and +5V (d) 0 V and 5 V

66. A source emits electromagnetic radiation of a frequency v_0 in its rest frame. The source is moving with uniform velocity $\frac{4c}{5}$ along positive x-direction. A stationary detector is placed at $(0, d, 0)$. What is frequency detected by the detector at the moment source is at $(0, 0, 0)$.

(a) v_0 (b) $\frac{3v_0}{5}$ (c) $\frac{5v_0}{3}$ (d) $\frac{4v_0}{3}$

67. For a dynamical system, time evolution of dynamical variable is given by

$$\frac{dx}{dt} = x - x^3$$

Which one of the following statement is correct
(a) There are two fixed points
(b) There is one stable and two unstable fixed points
(c) There is one unstable and two stable fixed points
(d) There are three stable fixed points

68. Lagrangian of a particle is $L = \frac{1}{2}m\left(\dot{x}^2 + \dot{y}^2\right) - \frac{1}{2}m\omega^2\left(x^2 + y^2\right)$. At $t = 0, x = 0, y = y_0, \dot{x} = \dot{y} = v_0$, angular momentum of the particle at time 't' is

(a) $mv_0 y_0$ (b) $mv_0 y_0 \cos\omega t$ (c) $mv_0 y_0 \cos^2 \omega t$ (d) $mv_0 y_0 e^{\omega t}$

69. A thin rod of length 'l' and mass 'm' is suspended from one end. The rod is deflected by 60º from vertical position and released. If the rod rotates freely about one end and motion remains confined to vertical plane, then which of the following statements is NOT correct.
(a) Energy is conserved but angular momentum is not conserved

(b) Lagrangian of the rod in terms of angle θ with downward vertical is $L = \frac{1}{6}m\ell^2\dot{\theta}^2 + \frac{mg\ell}{2}\cos\theta$

(c) Angular velocity of the rod at the lowest point is $\sqrt{\frac{3g}{\ell}}$

(d) Angular acceleration of the rod at the initial moment is $-\frac{3\sqrt{3}g}{4\ell}$

70. Consider a system of N particles, each of mass 'm', enclosed in an infinitely long cyclinder container placed in a uniform gravitational field. The system is in thermal equilibrium. The canonical partitition function is (A = cross-sectional area of cylinder)

(a) $\frac{1}{N!}\left(\frac{AkT}{mg}\right)^N\left(\frac{2\pi mkT}{h^2}\right)^{3N/2}$ (b) $\frac{1}{N!}\left(\frac{mg}{AkT}\right)^N\left(\frac{h^2}{2\pi mkT}\right)^{3N/2}$

(c) $N\left(\frac{AKT}{mg}\right)^N\left(\frac{mkT}{h^2}\right)^{N/2}$ (d) $N!\left(\frac{AKT}{mg}\right)^{1/2}\left(\frac{2\pi mkT}{h^2}\right)^{N/2}$

71. Consider a Boson gas consisting of N molecules each of mass m, confined to a volume V. If the mass of the particle is doubled and the number density increased by a factors of 8, then the temperature at which the Bose-Einstein condensation takes place
(a) Increases by a factor of 2 (b) Increases by a factor of 4
(c) Decreases by a factor of 8 (d) Decreases by a factor of 4

72. The value of isothermal compressibility for a non-relativestic Ideal Fermi gas of N spin-$\frac{1}{2}$ non-interacting fermions and occupying a volume V at T=0, is

(a) 0 (b) $\frac{5}{3p}$ (c) $\frac{2}{3p}$ (d) $\frac{3}{5p}$

73. Read the following statements

(I) The electromagnetic radiation emitted in a transition from spin-parity $J^P = 1^+$ to $J^P = 3^+$ in a γ - decay are E_2, M_3 and E_4.

(II) The reaction, ${}_{38}Sr^{89} \rightarrow {}_{39}Y^{89} + \beta^- + \overline{\nu}_e$ undergoes a first forbidden β-decay only by Gamow-Teller but not by Fermi selection rule

(III) In an alpha decay at rest ${}_Z X^A \rightarrow {}_{Z-2}Y^{A-4} + {}_2He^4$ (masses m_X, m_Y and m_α respectively), if energy released in Q, then the velocity of nucleus Y is given by $\sqrt{\dfrac{2Qm_\alpha}{m_Y\left(m_\alpha + m_Y\right)}}$

Choose the correct option

(a) only I and II are correct
(b) only I and III are correct
(c) only II and III are correct
(d) all I, II and III are correct

74. Read the following statements

(I) If a particle X has isospin $I = \dfrac{3}{2}$, Baryon number B = 1 and strangeness number S = 0, then possible values of the electric charges for X are +2, +1, 0 and –1

(II) If reaction, $\pi^+ + X \rightarrow \Sigma^+ + k^+$ is governed by strong interaction then the third component of Isospin, Isospin, Baryon number and strangeness number of X are respectively, $+\dfrac{1}{2}, +\dfrac{1}{2}, +1$ & 0

(III) The quark content of k^-, Σ^+ and Ξ^- are $s\overline{u}, uus$ and uss respectively

Choose the correct option

(a) Only I and II are correct
(b) Only I and III are correct
(c) Only II and III are correct
(d) All, I, II and III are correct

75. For the given nuclear reactions, choose the correct option

(I) $\Xi^- \rightarrow \Lambda^0 + \pi^-$ (II) $\mu^- \rightarrow e^- + \overline{\nu}_e + \nu_\mu$ (III) $\Lambda^0 \rightarrow n + \pi^0$

(IV) $P + P \rightarrow P + P + \pi^0$ (V) $\pi^+ + n \rightarrow \Xi^- + k^+ + k^+$

(a) Reactions I, II and III are governed by weak interaction, reaction IV by strong interaction and V is forbidden reaction.

(b) Reactions IV and V are governed by strong interaction and reaction IV has $I_3 = 1$ and $I = 1$ and reaction V has $I_3 = \dfrac{1}{2}$ and $I = \dfrac{1}{2}$ and $\dfrac{3}{2}$ both

(c) Reactions I and III are governed by weak interaction , reaction IV by electromagnetic and reactions II and V are forbidden

(d) Reactions I, II and III are governed by weak interaction reaction IV by electromagnetic and V by strong interaction.

Space for rough work

PHYSICAL SCIENCES
TEST SERIES-E

Date : 11-12-2017

FULL LENGTH TEST-2

PART-A

1. (b)	2. (b)	3. (c)	4. (d)	5. (b)	6. (b)	7. (b)
8. (d)	9. (b)	10. (d)	11. (a)	12. (b)	13. (b)	14. (b)
15. (c)	16. (c)	17. (c)	18. (a)	19. (b)	20. (b)	

PART-B

21. (b)	22. (b)	23. (c)	24. (a)	25. (d)	26. (a)	27. (b)
28. (c)	29. (d)	30. (b)	31. (b)	32. (a)	33. (d)	34. (c)
35. (a)	36. (b)	37. (b)	38. (c)	39. (d)	40. (b)	41. (c)
42. (d)	43. (c)	44. (d)	45. (b)			

PART-C

46. (d)	47. (c)	48. (b)	49. (b)	50. (a)	51. (a)	52. (b)
53. (c)	54. (d)	55. (c)	56. (a)	57. (c)	58. (d)	59. (a)
60. (d)	61. (b)	62. (c)	63. (b)	64. (d)	65. (c)	66. (c)
67. (c)	68. (a)	69. (c)	70. (a)	71. (a)	72. (d)	73. (d)
74. (a)	75. (b)					