Question Booklet No. ....................

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

**Roll No.**

**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, Please ensure that you have got the correct booklet and it contains all the pages in correct sequence and 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.*

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 Roll No. and OMR sheet No. on the Question Booklet.*

7. *Any changes in the aforesaid-entries is to be verified by the invigilator, otherwise it will be taken as unfair means.*

8. *This Booklet contains 40 multiple choice questions followed by 10 short answer questions. For each MCQ, 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 pen as mentioned in the guidelines given on the first page of the Answer Sheet. For answering any five short Answer Questions use five Blank pages attached at the end of this Question Booklet.*

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 marks).*

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 both OMR Answer Sheet and Question Booklet 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.

**Total No. of Printed Pages : 15**

**FOR ROUGH WORK**

# Research Entrance Test – 2014

## No. of Questions : 50

*Time : 2 Hours*                                        *Full Marks : 200*

*Note :* (i) This Question Booklet contains 40 Multiple Choice Questions followed by 10 Short Answer Questions.

(ii) Attempt as many MCQs as you can. Each MCQ carries **3 (Three)** marks. **1 (One)** mark will be deducted for each incorrect answer. Zero mark will be awarded for each unattempted question. If more than **one** alternative answers of MCQs seem to be approximate to the correct answer, choose the closest one.

(iii) Answer only 5 Short Answer Questions. Each question carries **16 (Sixteen)** marks and should be answered in **150-200** words. Blank **5 (Five)** pages attached with this booklet shall only be used for the purpose. Answer each question on separate page, after writing Question No.

1. Which of the following is *not* a greenhouse gas ?
   (1) Carbon dioxide
   (2) Methane
   (3) Sulphur dioxide
   (4) Nitrogen

2. The saliva of mammals contains starch splitting enzyme. The name of that enzyme is :
   (1) Amylase (Ptyalin)
   (2) Secretin
   (3) Lysozyme
   (4) Mucin

3. Cytosine in DNA combines with :
   (1) Adinosine
   (2) Uracil
   (3) Guanine
   (4) Thiamine

4. If Vectors $2i - j + k$, $i + 2j - 3k$, $3i + \lambda j + 5k$ are coplanar, then the value of $\lambda$ is :
   (1) –2
   (2) –3
   (3) –4
   (4) –5

5. The value of $\left(-1 + i\sqrt{3}\right)^{3/2}$ is :
   (1) $\sqrt{2}$
   (2) $2\sqrt{2}$
   (3) $2 + \sqrt{2}$
   (4) $2 - \sqrt{2}$

6. The number of electrons contained in 1 Coulomb of charge equals to :
   (1) $6.25 \times 10^{17}$
   (2) $6.25 \times 10^{18}$
   (3) $6.25 \times 10^{19}$
   (4) $1.6 \times 10^{19}$

7. A unit mass of solid is converted to liquid at its melting ; the heat required for this process is the :
   (1) Specific heat
   (2) Latent heat of vaporization
   (3) Latent heat of fusion
   (4) External latent heat

8. Granite is :
   (1) a sedimentary rock
   (2) a metamorphic rock
   (3) a volcanic rock
   (4) a plutonic igneous rock

9. Coal is a :
   (1) Sedimentary rock
   (2) Hydrothermal deposit
   (3) Low-grade metamorphic rock
   (4) High-grade metamorphic rock

10. Which one of the following gases is present in the stratosphere that filters out some of the sun's ultraviolet light and provides an effective shield against radiation damage to living things ?
    (1) Oxygen
    (2) Methane
    (3) Ozone
    (4) Helium

11. The reciprocal lattice of a body centered cubic lattice is :
    (1) Face centered cubic
    (2) Tetragonal
    (3) Hexagonal
    (4) Orthorhomic

12. The ratio of thermal conductivity to electrical conductivity of a metal is given by :

(1) $\left(\dfrac{\Pi k}{e}\right)^2 T$

(2) $\dfrac{\Pi^2}{3}\left(\dfrac{KT}{e}\right)^2$

(3) $\left(\dfrac{\Pi^2}{3}\right)\left(\dfrac{K}{e}\right)^2 T$

(4) $\left(\dfrac{\Pi KT}{2e}\right)^2$

13. Which of the following statements is true about the effective mass of electrons in crystals ?
   (1) It is constant throughout the band
   (2) It is negative near the top of energy band
   (3) It is negative near the bottom of energy band
   (4) It is positive near the top of energy band

14. The lattice of the CsCl type structure is :
   (1) Body Centered Cubic
   (2) Simple Cubic
   (3) Face Centered Cubic
   (4) Tetragonal

15. Which of the following one can *not* be accelerated in a cyclotron ?
   (1) Deutron      (2) Neutron      (3) Electron      (4) Alpha-particles

16. Which of the following ejects photoelectrons of the highest energy under optimum condition of irradiation ?
   (1) Ultraviolet radiation
   (2) Infrared radiation
   (3) Visible light
   (4) Gamma rays

17. If the binding energy of deuterium is 2.23 MeV, mass defect in amu (1amv = 931 MeV) is :
   (1) 0.0034
   (2) – 0.0012
   (3) 0.0024
   (4) 0.0012

18. Of the three basic forces : gravitational, electrostatic and nuclear; which two of these will be able to provide an attractive force between two neutrons ?
   (1) Gravitational and nuclear
   (2) Gravitational and electrostatic
   (3) Electrostatic and nuclear
   (4) None of these

19. The major factor for determining whether a medium is free space, loss less dielectric or good conductor is :
   (1) Attenuation constant
   (2) Reflection coefficient
   (3) Loss tangent
   (4) Constitutive parameters ( $\sigma$, $\mu$, $\in$ )

**20.** A $\Pi^\circ$ meson at rest decays into two gamma rays ($\Pi^\circ \to \gamma + \gamma$), then which of the following is correct ?
(1) The two $\gamma$-rays move in the direction opposite to each other
(2) The two $\gamma$-rays have unequal energies
(3) Both the $\gamma$-rays move in the same direction
(4) The $\gamma$-rays will be periodically approaching and receding each other

**21.** Amplitude modulation is basically a :
(1) Summing of two signals
(2) Multiplication of two signals
(3) Subtraction of two signals
(4) Non linear process

**22.** Changing dc voltage is known as :
(1) a crystal oscillator
(2) a VCO
(3) an Armstrong oscillator
(4) a piezoelectric oscillator

**23.** When a triangular waveform is applied to the input of a differentiator, the output is :
(1) a dc level
(2) an inverted triangular waveform
(3) a square wave form
(4) the first harmonic of the triangular waveform

**24.** The conservative nature of a given force $\vec{F}$ can be tested using :
(1) grad $\vec{F}$ = 0
(2) Curl $\vec{F}$ = 0
(3) div $\vec{F}$ = 0
(4) $|\vec{F}|$ = 0

**25.** If the Lagrangian is invariant under translation, then which one of the following is conserved ?
(1) Linear momentum
(2) Energy
(3) Angular momentum
(4) None of these

**26.** A CE amplifier is preferred over other configurations (CB and CC) because it has :
(1) Current gain but
(2) No current gain but voltage gain
(3) Current as well as voltage gains
(4) None of these

**27.** Which one is true for a p-n junction ?
(1) Junction field is from n to p side, holes move from p to n in forward bias, no mobile carriers in the depletion region.
(2) Junction field is from p to n side, holes flow from p to n side in forward bias, no mobile carrier in the depletion region.
(3) Junction field is from p to n side, holes flow from n to p-side in forward bias, mobile carriers in the depletion region.
(4) Junction field is from n to p side, holes flow from n to p-side in forward bias, immobile carriers in the depletion region.

**28.** Ground state of C (at. no. 6) and O (Z = 8) are :

(1) $^1S_0$ and $^3P_0$ respectively       (2) $^3P_0$ and $^3P_2$ respectively

(3) $^3P_2$ and $^3P_0$ respectively      (4) $^1D_2$ and $^3P_2$ respectively

**29.** The splitting due to spin-or bit interaction is minimum for which one of the following states, considering screening to be perfect for all states :

(1) 4d      (2) 4f      (3) 6p      (4) 5d

**30.** The first line of the pure rotational spectrum of $C^{12}-O^{16}$ appears at 3.8424 cm$^{-1}$. Avogadro number is $6.022 \times 10^{23}$/mole. The C-O bond length calculated from this data is :

(1) 1.138 Å

(2) 1.118 Å

(3) 1.081 Å

(4) Can not be calculated with the given data

**31.** The Zeeman pattern of a line consists of nine equidistant components. The upper state term is $3_{P_2}$ (in LS coupling). What is lower state-term ?

(1) $3_{S_1}$      (2) $2_{P_{1/2}}$      (3) $2_{P_{3/2}}$      (4) $3_{P_1}$

**32.** In a vibrational level, the rotational quantum number J having maximum population is given as :

(1) $J_{max} = \left(\dfrac{KT}{2Bhc}\right)^{1/2} - \dfrac{1}{2}$      (2) $J_{max} = \left(\dfrac{KT}{2Bhc} - \dfrac{1}{2}\right)^{\frac{1}{2}}$

(3) $J_{max} = \left(\dfrac{2KT}{Bhc}\right)^{\frac{1}{2}} - \dfrac{1}{2}$      (4) $J_{max} = \left(\dfrac{2KT}{Bhc} - \dfrac{1}{2}\right)^{\frac{1}{2}}$

**33.** Two particles approach each other, each with speed 0.9C with respect to laboratory frame. The relativistic speed of the two particles is :

(1) 0.994 C      (2) 1.8 C

(3) C      (4) 1.4 C

**34.** If the Laplace transform of cos (xt) is represented as $L\{\cos xt\}$, the expression $\dfrac{1}{\Pi} \lim_{s \to 0} L\{\cos xt\}$ is :

(1) $\delta(x)$      (2) 1      (3) $\theta(x)$      (4) 0

35. If a one-dimensional charged oscillator is subjected to a constant electric field E described by a Hamiltonian $H = \dfrac{p^{-2}}{2m} + \dfrac{1}{2}mw^2x^2 - qEx$, . . the ground state energy is :

(1) $\dfrac{1}{2}\hbar w - \dfrac{q^2E^2}{2mw^2}$

(2) $\dfrac{1}{2}\hbar w + \dfrac{q^2E^2}{2mw^2}$

(3) $\dfrac{1}{2}\hbar w$

(4) 0

36. If a system of three non-interacting spin $\dfrac{1}{2}$ fermions is confined to move in a one-dimensional infinite potential well of length a, then the energy of the first excited state is :

(1) $\dfrac{9\hbar^2\Pi^2}{2m\,a^2}$

(2) $\dfrac{7\hbar^2\Pi^2}{2m\,a^2}$

(3) $\dfrac{5\hbar^2\Pi^2}{2m\,a^2}$

(4) $\dfrac{3\hbar^2\Pi^2}{2m\,a^2}$

37. The ground state energy of a half-harmomic oscillator is :

(1) $\dfrac{3}{2}\hbar w$

(2) $\dfrac{1}{2}\hbar w$

(3) $2\,\hbar w$

(4) $\hbar w$

38. In a degenerate Bose-gas the Bose-Einstein condensation temperature ($T_C$) depends on the Boson density ($n$) as :

(1) $n^{2/3}$

(2) $n^{\frac{1}{3}}$

(3) $n^{5/2}$

(4) $n$

39. In a three-dimensional ideal Fermi-gas, the Fermi wave vector ($K_F$) depends on the electron density ($n$) as :

(1) $n^{2/3}$

(2) $n$

(3) $n^0$

(4) $n^{1/3}$

40. The relative root mean square fluctuation in energy in a canonical ensemble varies with the particle number N as :

(1) $\dfrac{1}{\sqrt{N}}$

(2) $\dfrac{1}{N^2}$

(3) $N$

(4) $\dfrac{1}{\sqrt{N}}$

*Attempt any five questions. Write answer in 150-200 words. Each question carries 16 marks. Answer each question on separate page, after writing Question Number.*

1. Establish the London equation and define the London perturbation depth. Explain Meissner effect.

2. Explain the concept of reciprocal lattice. Discuss Ewald construction for describing diffraction from crystals.

3. With the help of a neat diagram, describe the characteristics of the mode of operation of gas-filled detectors.

4. Mention the different criterion for existence of plasma. Write two characteristic properties of plasma and explain it with proper diagram.

5. An antenna has a radiation resistance of 0.5 $\Omega$ and a total loss resistance of 2.5 $\Omega$. If the current fed into the antenna is 100 A, calculate the radiated power, the power input and antenna efficiency. Find the value of directive gain also.

6. Giving circuit diagram for a unity gain operational amplifier (with IC-741), discuss its working. How, the impedance of the circuit is modified to be used as buffer amplifier ?

7. Discuss basic principles of NMR. How does the NMR frequency is related to the external magnetic field applied ?

8. A sample gives a Raman line at 5,000 Å with exciting laser line at 4,880 Å. What is the position of that Raman line when excited with 5,145 Å laser line ?

9. Using the rectangular as well as semi-circular contour, evaluate the integral

$$\int_{-\infty}^{\infty} \frac{e^{\alpha x}}{e^x + 1} \, dx, \ 0 < \alpha < 1$$

10. Consider a gas of N non-interacting fermions in a quantum mechanical grand canonical ensemble. Derive the grand partition function and obtain the mean occupation number.

Roll No. : ...................................

**Q. No. :**

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**FOR ROUGH WORK**

**FOR ROUGH WORK**