RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FOURTH SEMESTER EXAMINATION, MAY 2018

SECOND YEAR (BATCH 2016-19)

Date : 25/05/2018 **PHYSICS (General)**

Time : 11.00 am – 1.00 pm Paper : IV Full Marks : 50

[Use a separate Answer Book for each group]

Group - A

(*Answer **any four** questions*) [4×5]

1. a) Draw the circuit diagram of a full-wave rectifier using bridge connection. [1]
   b) Explain its working very clearly. What is the Peak-Inverse Voltage (PIV) of the rectifier. [3+1]

2. a) Describe the characteristics of a transistor in the CE mode of operation with a suitable circuit. [2+1]
   b) Prove the relation : $\beta = \frac{\alpha}{1-\alpha}$ where α is the current gain in the CB mode and β in the CE mode of operation respectively. [2]

3. a) What is zener diode? Explain its characteristics. [1+2]
   b) Breakdown voltage of a Zener diode is 4·7V and its resistance is 100Ω. It is connected to a 10V supply. Determine the current in the breakdown condition through the Zener. [2]

4. a) For the logic expression $Y = A\bar{B} + \bar{A}B$, realize this operation using NAND gate only. [3]
   b) Prove the following using De Morgan's theorem.
      1. $\bar{A}\,\bar{B}\,\bar{C} + \bar{A}\,BC + ABC + A\,\bar{B}\,\bar{C} = \bar{B}\,\bar{C} + BC$
      2. $(A + BC)(B + \bar{C}\,A) = AB + A\bar{C} + BC$ [1+1]

5. a) Perform the following operations with binary number system using 2's complement method.
      (i) 45 – 25 (ii) 25 – 45 (iii) –45 – 25 [3]
   b) Given the logical equation, $Y = AB + A\bar{C} + BC$. Design a circuit using gates to realize Y. [2]

6. What is Full-Adder? Realize the Full-Adder circuit with the help of truth table. [5]

Group - B

(*Answer **any six** questions*) [6×5]

7. a) Consider the nuclear reaction : $x + X = y + Y$. The symbols bear their usual meanings. Calculate Q-value of the reaction. [2]
   b) What is mean life of a radioactive atom. Derive an expression of it. [1+2]

8. a) What do you mean by binding energy per nucleon and packing fraction. [1·5+1·5]
   b) Plot a graph between packing fraction and mass number and discuss the graph. [2]

9. a) How transient equilibrium and secular equilibrium occurs in successive disintegration. [2+2]
   b) Write a name of radio isotope and its use. [1]

10. a) Write down time dependent Schrodinger equation. Prove that time evolution of the state $\psi(t)$ is determined by the Hamiltonian. [1+2]
    b) Normalise the wave function as defined : [2]
    $\psi(x) = Ae^{-\alpha x}$ for $x > 0$ and
    $= Ae^{\alpha x}$ for $A < 0$

11. From relativistic momentum conservation show that $m = \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}$ where m is the mass of the moving body and m_0 is its rest mass, c is the velocity of light and v is the relative velocity of two frame. [5]

12. a) Show that in the space time interval $x^2 + y^2 + z^2 - c^2t^2$ is invariant. [3]

    b) A radioactive nucleus of half-life $1\mu s$ moves through the laboratory at $2 \cdot 7 \times 10^{10}\ cm/s$. What will be its half life as measured by an observer in the laboratory? $c = 3 \times 10^{10} cm/s$. [2]

13. a) What are the basic lattice parameters? Define a mono-clinic crystal in terms of the lattice parameters. [1+1]

    b) Write down Bragg's law for crystal diffraction. For an X-ray diffraction of wavelength $0 \cdot 842\,Å$ the glancing angle is $8°35'$ for the first order. What will be the glancing angle for the third order? (Given $\sin(8°35') = 0 \cdot 15$) [1+2]

14. An electron is trapped in an infinite square well of length $2 \times 10^{-10} m$. In the ground state, calculate the probability of finding the particle between x = 0 to $x = 0 \cdot 25 \times 10^{-10} m$. [5]

15. What is Compton effect? Obtain an expression for the Compton shift. [1+4]

16. State de Broglie hypothesis. Establish Bohr's quantization condition on the basis of de Broglie's concept of matter waves. From the expression of phase velocity u of de Broglie waves i.e. $u = c\sqrt{1+\frac{m_0^2c^2\lambda^2}{h^2}}$. Show that the de Broglie waves show dispersion in vacuum. [1+2+2]

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