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End Semester Examination of Semester–III, 2015
Subject : ELECTRONICS (HONS.) (UG)
Paper : VI
Full Marks : 40
Time : 2 Hrs

The figures in the margin indicate the marks corresponding to the question.

Candidates are requested to give their answers in their own word as far as practicable.

Illustrate the answers wherever necessary.

Group A

Answer **any two** out of four questions : 10X2=20

1. a) Derive a relation between group velocity and phase velocity for a wave representing a free particle. Show that the particle velocity is equal to the group velocity of the wave packet.

   b) Compare the de Broglie Wavelength of a cricket ball of mass 200 gram, with a speed of 180 Km/Hr to that of an electron in the ground state of the hydrogen atom with a total energy of –13.6 eV. (3+3)+4

2. a) Though both Compton effect and photoelectric effect are the interaction between photon and electrons, but the two effects are not same — explain it clearly.

b) Write down time independent Schroodinger equations for the case of an one-dimensional step potential of height V_0.

Calculate transmission and reflection probability in this case when total energy of the particle $E < V_0$. What will be the value of transmission probability when $E = 0$?

2+(2+5+1)

3. a) What is Hermitian operator? Prove that the eigen function of a Hermitian operator is real.

b) Prove that if $\hat{A}$ and $\hat{B}$ are two linear operators, then $\left(\hat{A}+\hat{B}\right)$ and $\hat{A}\hat{B}$ are also linear.

c) Are the followings pairs of quantum mechanical operators commuting or non-commuting.

i) $\hat{x}$ and $\widehat{P_x}$

ii) $\widehat{L_z}$ and $\widehat{L^2}$

[The symbols have their own meaning]

(1+2)+3+(2+2)

4. a) Express the function $Y = A + \overline{B}C$ in

i) Canonical SOP and ii) Canonical POS form.

b) Minimize the following expressions using KMap and realize with NAND gates.

$f(A, B, C, D) = \Sigma m(1, 3, 5, 8, 9, 11, 15) + d(2, 13)$

5+5

Group B

Answer **any two** out of four questions : 5X2=10

5. Write the time independent Schrödinger equation for a linear harmonic oscillator.

   Show that the energy eigen value of the linear harmonic oscillator in the n^{th} state is

   $$E_n = \left(n + \frac{1}{2}\right)\hbar\omega, \quad \text{where } n = 0, 1, 2, \ldots$$

   and ω is the characteristic angular frequency. 1+4

6. a) An electron of energy 200 eV is passed through a circular hole of radius 10^{-6} m. Determine the uncertainty introduced in the angle of emergence.

   b) What would be the corresponding uncertainty for a 10^{-3} Kg lead ball thrown with a velocity 10 m/s through a hole of radius 10^{-2} m? 3+2

7. Draw and explain 3 input TTL NAND gate circuit. 2+3

8. A circuit has three input and one output terminals. The output is 1 if any two of the three inputs are 1 and 0 for any other combination of the inputs. Draw a block diagram of this logic circuit and explain. 2+3

Group C

Answer **any five** out of ten questions : 2X5=10

9. A reverse voltage of $V_0 = 2{\cdot}5$ volt is required to reduce the photo current to zero value when photon of 4000 Å wavelength strikes the metal. Calculate the work function of this metal.

10. What do you mean by Normalized and orthogonal wave functions?

11. In what respect the Schrödinger equation differ from classical wave equation?

12. Draw the square well potential, where the potential is define as :

    Region I : $V(x) = V_0$ for $-\infty < x < 0$

    Region II : $V(x) = 0$ for $0 \leq x \leq a$

    Region III : $V(x) = V_0$ for $a < x < \infty$

    Write the Schrödinger time-independent equations for this case.

13. Show that the eigen value of an Hermitian operators is real.

14. If $H=\frac{p^2}{2\mu}+\frac{1}{2}\mu\omega^2x^2$ then show that $[x,H]=\frac{i\hbar}{\mu}p$, where the symbols have their own meaning.

15. Prove that $(B+BC)(B+\bar{B}C)(B+D)=B$.

16. What do you mean by 'Don't care terms'? Explain with example.

17. Design a logic circuit to realize a function

$$F = W\overline{X}Y\overline{Z} + W\overline{X}\overline{Y}Z$$

Using only AND and OR gates. The number of inputs to any gate should not exceed two.

18. What is propagation delay?