

BACHELOR OF ENGINEERING EXAMINATION, 2017

(Electrical Engg, 1<sup>st</sup> Year, 2<sup>nd</sup> Sem)

Time – Three hours

PHYSICS-IIB

Full Marks : 100

Answer any five questions (all carry equal marks)

1. a) How the motion of a particle is described in Quantum Mechanics?  
b) What are phase velocity and group velocity of a wave?  
c) Show that group velocity is equal to the particle velocity. Show that phase velocity can be greater than the velocity of light.  
d) A proton is confined to a nucleus of radius  $5 \times 10^{-15}$  m. Calculate the minimum uncertainty in its momentum. Also calculate the minimum kinetic energy the proton should have. The proton mass is  $1.67 \times 10^{-27}$  kg.  
e) Can an electron reside within the nucleus? Explain.

[3+3+6+5+3]

2. a) What is wave function? Write down the properties of a wave function.  
b) Can  $\psi = e^{x^2}$  be a wave function?  
c) Write down the postulates of quantum mechanics.  
d) Write down the time dependent Schrodinger equation in three dimensions.  
e) Using separation of variable method, find the time independent Schrodinger equation. Write down the condition of the potential when this separation is not possible.

(2+3)+2+6+2+(4+1)

3. a) Solve Schrodinger equation for a particle confined in one dimensional infinite potential well to find its wave function.  
b) Show that energy eigenvalues are discrete and equally spaced in this case.  
c) Draw the wave function versus distance and probability density versus distance for different energy eigen states of the above system.  
e) Find the position expectation value of the particle in the ground state of the above system.  
f) Assuming the energy eigen value of a particle confined in 3-dimensional infinite potential well, determine the degeneracy of the wave function for first excited state.

[5+3+4+5+3]

4. a) What do you mean by probability current density ( $j$ ) in quantum mechanics? Derive the expression for  $j$  for free particle in one dimension.

[ Turn over

- b) Consider a particle of mass  $m$  moving along  $x$ -axis being acted upon by a constant potential  $V_0$  at all points  $x > 0$ , while the potential is zero for all points  $x < 0$ .
- Write down the Schrödinger equations
  - Determine the reflection ( $R$ ) and transmission ( $T$ ) coefficients of the particle wave.
  - Show that  $R + T = 1$ . [(2+4)+(2+8+4)]
5. a) What do you mean by phase space in Statistical Mechanics. Write down the infinitesimal volume element of a phase space.
- b) What do you mean by partition function? Calculate the probability of being a micro-canonical system at energy state  $E_r$  using partition function.
- c) What do you mean by ensemble? Distinguish among micro-canonical, canonical and grand-canonical systems. [6+7+7]
6. a) State Faraday's law of electromagnetic induction and express it in differential form.
- b) Find the expressions for the growth and the decay of charge on a capacitor connected in series with a resistor. What do you mean by the time constant of the circuit? When can the transient be said to practically die out?
- c) A DC voltage of 80 volt is switched on to a circuit containing a resistor of 5 ohm in series with an inductance of 20 Henry. Calculate the rate of growth of current at the instant when the current is 6 amp. [5+12+3]
7. a) A sinusoidal emf is applied to a circuit with inductance, capacitance and resistance in series. Derive an expression for the instantaneous current and power factor.
- b) Find an expression for the voltage drop  $V_R$  across R. How do the magnitude and the phase of  $V_R$  vary with  $\omega$ ? At what value of  $\omega$  the maximum power is consumed by the circuit?
- c) A resistance of 5 ohm and an inductance of 0.8 Henry are put in series with a variable capacitance and the combination is placed across 100 volt, 50 Hz main. Find the capacitance for which the current is a maximum. [10+7+3]
8. a) Write down and explain four Maxwell's equations in electromagnetism.
- b) Derive the wave equations from Maxwell's equations in free space.
- c) State and prove Poynting theorem? [6+8+6]