PHY F242 QUANTUM MECH I

ASSIGNMENT-01

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**Q** :

Given a 1D electron in a box of length a = 0.1m, the wavefunction is made up of three stationary states defined by n1, n2 and n3. Find the wavefunction of the electron and plot the following :

• Ψ(x, 0) vs x

• Ψ(x, t) vs x for a given time t

• |Ψ(x, 0)|2 vs x

• |Ψ(x, t)|2 vs x

**SOL:**

The wavefunction for electron in nth stationery state is :

;

Where, En = energy associated with nth state

a = length of the box = 0.1m

m = mass of electron = 9.109 x 10-31kg

ħ = (modified) Planck’s constant = 1.054 x 10-34 J.s

General expression for wavefunction of *k* (here, k =3) number of stationery states is :

Where, *ck ϵ c (constant).*

Now, we know that for the set of coefficients {c1, c2, c3},

Assuming that coefficients are equal, i.e. c1 = c2 = c3 = c (say), we get

|c|2+|c|2+|c|2 = 1

3|c|2 = 1

Assuming that *c ϵ r (real)* , we get .

Given: n1 = 14, n2 = 12, n3 = 17 the 14th,12th and 17th stationery states are:

;

;

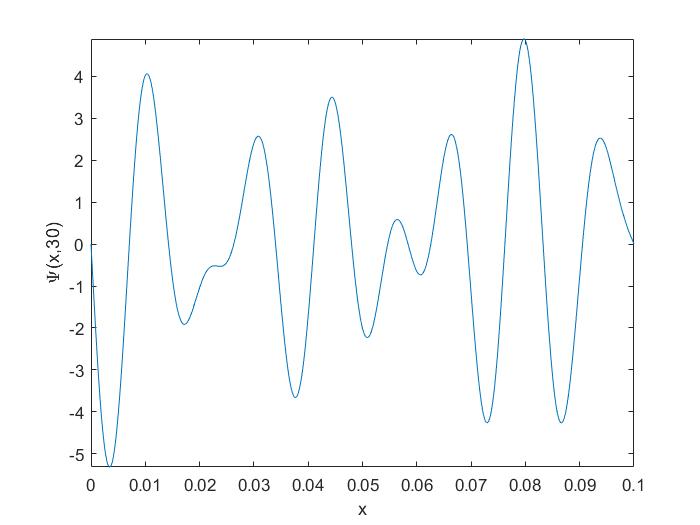
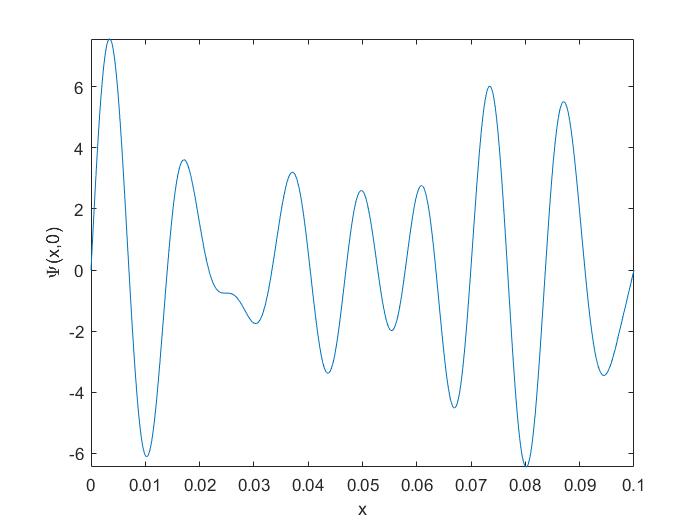
;

Thus,

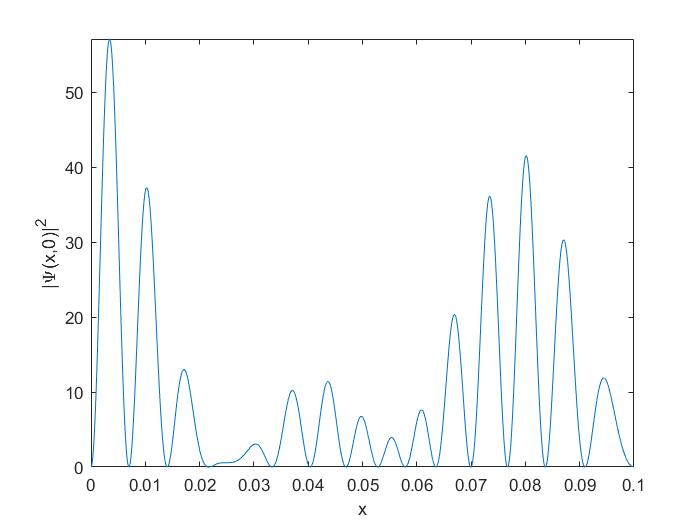
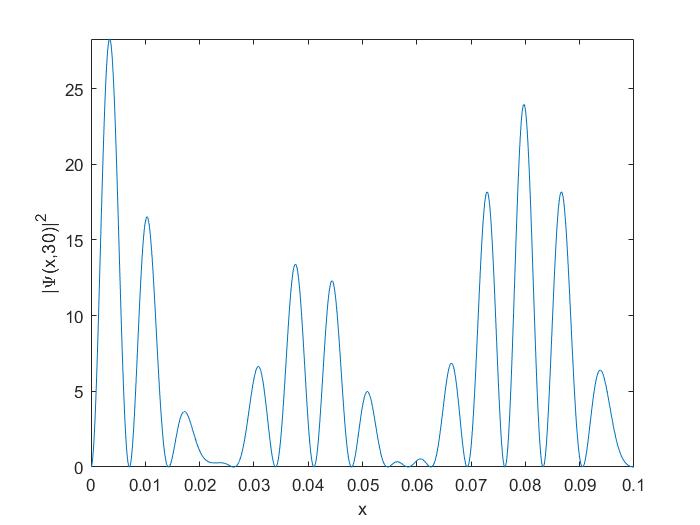


(For , only the real part of the wavefunction has been considered for plotting.)

The wavefunctions were plotted using MATLAB, and the following were obtained.



**Ψ(x, 0) vs x Ψ(x, t) vs x, for t = 30s**

**|Ψ(x, 0)|2 vs x |Ψ(x, t)|2 vs x, for t = 30s**

APPENDIX

MATLAB code :

1. x = 0:0.001:0.1;
2. a=0.1; %length of the box
3. m=9.102\*10^-31; %mass of electron
4. hbar = (6.602\*10^-34)/(2\*pi); %Planck's constant
5. syms psi(x,t) %create a function psi(x,t)
6. psi(x,t) = sqrt(1/3)\*sqrt(2/a)\*sin(14\*pi\*x/a)\*exp((-i\*(14^2)\*(pi^2)\*hbar\*t) /(2\*m\*a^2))) + sqrt(1/3)\*sqrt(2/a)\*sin(12\*pi\*x/a)\*exp((-i\*(122^2)\*(pi^2) \*hbar\*t)/(2\*m\*(a^2))) + sqrt(1/3)\*sqrt(2/a)\*sin(17\*pi\*x/a)\*exp((-i\*(17^2) \*(pi^2)\*hbar\*t)/(2\*m\*(a^2))); %define psi
7. fplot (psi(x,0), [0 0.1]), xlabel('x'), ylabel('\Psi(x,0)')

%plot psi(x,t) vs x for diff values of t; add axis labels

1. fplot (real(psi(x,30)), [0 0.1]), xlabel('x'), ylabel('\Psi(x,30)')
2. fplot (abs(psi(x,0))^2, [0 0.1]), xlabel('x'), ylabel('|\Psi(x,0)|^{2}')
3. fplot (abs(real(psi(x,30)))^2, [0 0.1]), xlabel('x'), ylabel('|\Psi(x,30)|^{2}')