KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2018

Marks Scored:

Level : B.Sc.
Year : IV

Course : PHYS 405
Semester : I

Exam Roll No. :

Time : 30 mins.

F. M. : 15

Registration No. :

Date : MAR 0 7 2018

SECTION "A"
[15Q × 1 = 15 marks]

I. *Choose and tick the most appropriate answer. The symbols, unless mentioned otherwise, have their usual meanings.*

1. The differential equation for studying the effect of linear air drag is $m\frac{d^2\vec{r}}{dt^2}+b\frac{d\vec{r}}{dt}+mg\hat{j}=0$. This equation can be converted in the form of $\frac{dS}{dt}=F(t,\mathrm{S})$. If $S=\left(x,v_x,y,v_y\right)$, then $F(t,\mathrm{S})$ is

[a] $\left(S(2),-\frac{b}{m}S(2),\mathrm{S}(4),-\frac{b}{m}S(4)-g\right)$

[b] $\left(S(1),-\frac{b}{m}S(2),\mathrm{S}(3),-\frac{b}{m}S(4)-g\right)$

[c] $\left(S(2),-\frac{b}{m}S(2)-\mathrm{g},\mathrm{S}(4),-\frac{b}{m}S(4)-g\right)$

[d] $\left(S(2),-\frac{b}{m}S(2)-\mathrm{g},\mathrm{S}(4),-\frac{b}{m}S(4)\right)$

2. If E_x, E_y and E_z are the components of electric field at any point (x,y,z), then the appropriate syntax for plotting the field vector is

[a] `quiver2(x,y,z,Ex,Ey,Ez)` [b] `quiver(x,y,z,Ex,Ey,Ez)`
[c] `quiver3(x,y,z,Ex,Ey,Ez)` [d] `quiver3(Ex,Ey,Ez,x,y,z)`

3. The conditional statement in if-statement for $y=f(x)$ curve to locate the valley position is

[a] `x(i)>x(i-1)&&x(i)>x(i+1)` [b] `x(i)<x(i-1)&&x(i)<x(i+1)`
[c] `y(i)<y(i-1)&&y(i)<y(i+1)` [d] `y(i)>y(i-1)&&y(i)>y(i+1)`

4. The initial conditions for solving time independent Schrodinger's equation for odd parity using shooting and matching method are

[a] $\psi(0)=0$ and $\left.\frac{d\psi}{dx}\right|_{x=0}=1$ [b] $\psi(0)=1$ and $\left.\frac{d\psi}{dx}\right|_{x=0}=0$

[c] $\psi(0)=0$ and $\left.\frac{d\psi}{dx}\right|_{x=0}=0$ [d] $\psi(0)=1$ and $\left.\frac{d\psi}{dx}\right|_{x=0}=1$

5. Let c be the speed of a wave, h_x and δt are the step size for the position and time respectively for solving the one-dimensional wave equation using finite difference method. For the stability of the solution

[a] $\frac{c\delta t}{h_x}>1$ [b] $\frac{h_x}{c\delta t}>1$ [c] $\frac{ch_x}{\delta t}>1$ [d] $\frac{h_x\delta t}{c}>1$

6. A and B are two arrays of same length of random numbers between 0 and 1. In order to create another array C, which contains the random number of B with respective indices of A whose random numbers lie between 0.3 and 0.6, the appropriate syntax is

[a] `C=A(0.3<B<0.6)` [b] `C=A(B>0.3 &B<0.6)`

[c] `C=B(0.2<A<0.6)` [d] `C=B(A>0.2 & A<0.6)`

7. The syntax `A=triu(B,-1)` extracts

[a] the upper triangular part of the matrix B from the first upper diagonal and assign to A.
[b] the upper triangular part of the matrix B from the first lower diagonal and assign to A
[c] the lower triangular part of the matrix B from the first upper diagonal and assign to A
[d] the lower triangular part of the matrix B from the first lower diagonal and assign to A

8. In finite difference method, $\frac{d\psi}{dx} \approx \frac{\psi(x+h)-\psi(x-h)}{2h}$. This difference approximation is called

[a] forward difference approximation. [b] backward difference approximation
[c] central difference approximation. [d] second difference approximation.

II. *Fill in the following blanks with appropriate answer. The symbols, unless mentioned otherwise, have their usual meanings.*

9. The terms of matrix a of parameter array for classic RK method are .....

10. The appropriate syntax to eliminate all the zero elements from a vector V is .....;

11. The expression of average intensity of light of electric field E after superposition which can be used for writing the code is ....

12. The y-component of electric field used for writing the code and drawing the field vector around the straight wire carrying current along x-direction is .....

13. The one line syntax to find the sum $S = \sin^2 x + \frac{1}{3^2}\sin^2 3x + \frac{1}{5^2}\sin^2 5x + ...$ to N terms for a given value of x is .....

14. The random walk in which the walker sees the site of death and chooses the appropriate site to proceed the random walk is called .....

15. The program which display the animation of standing wave for given wavelength and speed is ....

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SECTION "B"
[5Q × 3 = 15 marks]

1. Explain the RK method for solving system of ordinary differential equations.

2. Write a program to study the motion of a projectile of mass m projected with an angle of projection and initial velocity as the input. The force of gravity is given by $\vec{F} = mg\frac{R^2}{R^2+y^2}\hat{j}$.

   OR

   Write a program to find the Fourier coefficient and hence to compute the Fourier sum.

3. Write a program to study the intensity distribution in a Young's double-slits experiment.

4. Explain the matrix method for solving the 2-D time-independent Schrodinger's equation.

   OR

   Explain the shooting and matching method for solving the 1-D time-independent Schrodinger's equation.

5. What do you mean by Monte Carlo integration? Using Monte Carlo integration, write a program to estimate the value of π .

SECTION "C"
[5Q × 5 = 25 marks]

6. Write a program to study the forced harmonic oscillation. Your program should produce the plot of frequency versus amplitude for different damping constants.

7. Write a program to study the motion of the spacecraft after shooting towards the moon.

   OR

   What is three body problem? Deriving the necessary foundation, write a program to study the effect of Jupiter on the Earth.

8. Deriving the necessary theory, write a program to find the radius of the Newton's rings and to visualize the ring.

9. Write a program for plotting the magnetic vector fields due to a ring of radius R carrying a steady current I.

   OR

   Show that the probability in random walk obeys the diffusion equation. Write a program to animate the diffusion of cane-sugar block in water.

10. Obtain the finite difference formula for the standing wave $\frac{\partial^2 u}{\partial x^2} = \frac{1}{c^2}\frac{\partial^2 u}{\partial t^2}$ set up on the stretched string of unit length with both ends fixed to a rigid support. Using the iteration technique, write a program to animate the motion of the wave in the string.