

Marks Scored:

KATHMANDU UNIVERSITY  
End Semester Examination  
February/March, 2019

Level : B.Sc.  
Year : IV

Course : PHYS 405  
Semester : I

Exam Roll No. :

Time : 30 mins.

F. M. : 15

Registration No.:

Date

FEB 25 2019

SECTION "A"  
[15Q × 1 = 15 marks]

- I. Choose and tick the most appropriate answer. The symbols, unless mentioned otherwise, have their usual meanings.
- If  $n$  is a vector containing  $N > 1$  number of elements. The syntax  $B = \text{sum}((1 - n^2) ./ n)$ 
    - [a] gives the sum of  $\frac{1 - n^2}{n}$
    - [b] gives the sum of  $\frac{1 - n^2}{n}$  assign the result to B
    - [c] gives an error message
    - [d] does give the result and error message.
  - If  $E_x$  and  $E_y$  are the components of electric field at any point  $(x, y, z)$ , then the appropriate syntax for plotting the field vector is
    - [a] `quiver3(x, y, z, Ex, Ey, Ez)`
    - [b] `quiver(x, y, z, Ex, Ey, Ez)`
    - [c] `quiver(x, Ex, y, Ey, z, Ez)`
    - [d] `quiver3(Ex, Ey, Ez, x, y, z)`
  - The random walk in which the walker dies as it encounters to already visited site is called
    - [a] self-avoiding walk
    - [b] diffusive random walk
    - [c] simple random walk.
    - [d] growing self-avoiding walk
  - The optimal value for the relaxation parameter in the second order difference approximation with  $N_x$  and  $N_y$  as the number of interval along x- and y- axes is
    - [a]  $\frac{4}{2 + \sqrt{4 - \left[ \cos \frac{\pi}{N_x} + \cos \frac{\pi}{N_y} \right]^2}} + 1$
    - [b]  $\frac{4}{2 + \sqrt{4 - \left[ \cos \frac{\pi}{N_x} + \cos \frac{\pi}{N_y} \right]^2}} - 1$
    - [c]  $\frac{4}{2 - \sqrt{4 - \left[ \cos \frac{\pi}{N_x} + \cos \frac{\pi}{N_y} \right]^2}} - 1$
    - [d]  $\frac{4}{2 + \sqrt{4 + \left[ \cos \frac{\pi}{N_x} + \cos \frac{\pi}{N_y} \right]^2}} - 1$
  - If  $A$  be a matrix of random numbers between 0 and 1. In order to count the random number greater than 0.25 in  $A$  the required expression is
    - [a] `sum(A > 0.25)`
    - [b] `count(A > 0.25)`
    - [c] `sum(sum(A > 0.25))`
    - [d] `sum(A < 0.25)`

6. The force law predicted by general relativity which is used to study the precession of perihelion of Mercury is ( $\alpha$  as the precession constant)

[a]  $\vec{F}_G = -\frac{GM_S M_M}{r^2} \left(1 - \frac{\alpha}{r^2}\right) \hat{r}$

[b]  $\vec{F}_G = \frac{GM_S M_M}{r^2} \left(1 + \frac{\alpha}{r^2}\right) \hat{r}$

[c]  $\vec{F}_G = -\frac{GM_S M_M}{r^2} \left(1 + \frac{\alpha}{r}\right) \hat{r}$

[d]  $\vec{F}_G = -\frac{GM_S M_M}{r^2} \left(1 + \frac{\alpha}{r^2}\right) \hat{r}$

7. The operation  $B=A$  ( $A > r_1$  &  $A < r_2$ ) generates vector B with

[a] the elements of A less than  $r_2$ .

[b] the elements of A between  $r_1$  and  $r_2$ .

[c] the indices of the elements of A between  $r_1$  and  $r_2$ .

[d] the indices of the elements of A do not lie in between  $r_1$  and  $r_2$ .

8. If  $D^0 u = \frac{u_{i+1} - u_{i-1}}{2h}$ , then  $D^0 D^0 u$  gives

[a]  $\frac{u_{i+1} - 2u_i + u_{i-1}}{h^2}$

[b]  $\frac{u_{i+2} - 2u_i + u_{i-2}}{4h^2}$

[c]  $\frac{u_{i+2} + u_{i+1} - u_{i-1} - u_{i+2}}{4h^2}$

[d]  $\frac{u_{i+2} - 2u_{i-1} + u_{i-2}}{4h^2}$

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. An anonymous function is declared as

$F = @ (x, y) [x(1) * y(2), y(3)^2 * x(2) + y(1) * x(3)]$ . Then

$F([2, 1, 3], [1, 0, -1])$  produces a vector .....

11. An electric field  $E = E_0 \sin \omega t$  incident on a birefringence crystal of thickness  $D$ . The x- and y-components of electric fields after emerging from crystal (with refractive index for s and y direction as  $\mu_x$  and  $\mu_y$ ) are .....

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

13. The x-component of electric field used for writing the code and drawing the field vector around uniformly charged ring on xy- plane is .....

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

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

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SECTION "B"

[5Q × 3 = 15 marks]

1. Explain RK method for solving ordinary differential equation of any order.
2. Write a single program to study the motion of a projectile in a field of linear as well as quadratic velocity drag.

OR

Write a program to visualize the square wave using the Fourier series.

3. Write a program to study the intensity distribution in Young's double slits experiment. Your program should compute the fringe width too.
4. Explain the method for solving the time-dependent Schrodinger's equation and obtain the discretized formula.

OR

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

5. What is the Monte Carlo technique for finding the area of irregular bodies? Write a program to compute the value of  $\pi$  using Monte Carlo technique.

SECTION "C"

[5Q × 5 = 25 marks]

6. Consider an electron is revolving round a nucleus of hydrogen atom with force of attraction given by  $\vec{F} = -\frac{e^2}{4\pi\epsilon_0 r^3} \vec{r}$ . Write a program to simulate the motion of electron around the nucleus.
7. Write a program to animate the motion of charge particle on the presence of electric and magnetic fields.

OR

Write a program to study the driven harmonic oscillation. Your program should produce the plot for amplitude versus frequency of periodic force.

8. Deriving the necessary difference formula, write a program to study the motion of wave set up on the vibrating string.
9. Derive an expression for resultant electric field due to a ring charge of radius  $R$  and a line charge of length  $L$  passing through the center and perpendicular to the plane of the ring. Write a program to visualize the distribution of the field lines in this system of charge distribution.

OR

- Deriving the necessary theory, write a program to find the radius of the Newton's rings and another program to visualize the ring.
10. Show that the probability in random walk obeys the diffusion equation. Write a program to animate the diffusion of cane-sugar block in water.