UPES

End Semester Examination, December 2024

Course: Computational Physics   Semester: III
Program: BSc Physics by Research   Time   : 03 hrs.
Course Code: PHYS 2014K   Max. Marks: 100

Instructions:
All questions are compulsory
(Q8 in section B has an internal choice & Q10 in section C has an internal choice)
Use of scientific calculator is allowed
No. of pages: 3

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Explain the meaning of "post-test" structure with the help of a flowchart.	4	CO1
Q 2	Using the precedence of operators, list the steps in which the following expression will be evaluated and write the outcome: $$a * b/(c + d ** k/m + k) + a$$	4	CO1
Q 3	Write a Gnuplot command to plot data from two data files with each file containing two columns. Entries of the first columns in the two data files are the same and these should be placed on the x axis.	4	CO3
Q 4	Explain the meaning of "equations with no label" method in LaTeX.	4	CO3
Q 5	Find a real root of $f(x) = x^3 + x^2 + x + 7 = 0$ correct to the three decimal places using the Bisection method.	4	CO2

SECTION B
(4Qx10M= 40 Marks)

Q 6	(a) With just the basic LaTeX package one could theoretically typeset any document. However, LaTeX provides packages which extend functionality in ways such as improved design elements, graphic generation, etc. Elaborate on the use of "amsmath", "geometry", "graphicx", and "enumerate" packages. (b) Write a LaTeX code to generate the following expression of the work-energy (Poynting) theorem:	10 (4+6)	CO3

	$$\int_V \vec{E} \cdot \vec{J} dV = -\frac{\partial}{\partial t} \int_V \left[\frac{1}{2} \mu_0 H^2 + \frac{1}{2} \epsilon_0 E^2 \right] dV - \oint_S \left(\vec{E} \times \vec{H} \right) \cdot \vec{ds}$$ where the symbols have their usual meaning.		
Q 7	Provide Gnuplot commands to create a surface plot of the function $(x^3+y)^{1/4}$ with the x and y axes set from -8 to 8. Then increase the sampling rate to improve plot accuracy, and then enable contour lines for the surface.	10	CO1
Q 8	Write a FORTRAN 90 program that generates the following 5 data entries: $x(i) = i \times 5.0$ and $y(i) = \left(\cos(x(i)) - 1 \right)$ where $i = 1 - 5$. Finally write this data to an output file "out.dat" with $x(i)$ entries in first column and $y(i)$ entries in the second column. **OR** Write a FORTRAN 90 program to check if a given number is a palindrome. A palindrome is a number that reads the same forwards and backwards (for example, 34543, with symmetry around the middle digit).	10	CO2
Q 9	(a) Explain the Simpson's $1/3^{rd}$ rule of carrying out numerical integration. (b) Use Simpson's $1/3^{rd}$ rule to find $\int_0^{0.6} e^{-x^2} \, dx$ by dividing the interval (0, 0.6) into six parts each of width 0.1.	10 (4+6)	CO1
SECTION-C **(2Qx20M=40 Marks)**			
Q 10	Explain the interpolation technique and derive the Newton's forward interpolation formula: $$y_p = y_0 + p \Delta y_0 + \frac{p(p-1)}{2!} \Delta^2 y_0 + \cdots + \frac{p(p-1)..(p-n-1)}{n!} \Delta^n y_0$$ where the symbols have their usual meanings. **OR** The following table gives the distance in nautical miles of the visible horizon for the given heights in feet above the earth's surface: x = height: 100 150 200 250 300 350 400 y = distance: 10.63 13.03 15.04 16.81 18.42 19.90 21.27 Find the value of "y" when x=160 ft. and x = 410 ft.	20	CO2

Q 11	(a) Explain the usage of "\displaystyle" in LaTeX with an example. (b) You have to create a document using LaTeX that has a table with three columns. The first two columns should be center justified while for the second column you must force LaTeX to word wrap in individual cells by giving them a fixed width of 2 inch. Also put a line between the columns and a horizontal line under the first row. The following should be the table entries: 1. Entries of the first row should be "Scientist", "Year", and "Details". 2. Entries of the second row should be "J.J. Thomson", "1897", and "Discovered the electron, identifying it as a fundamental particle and proving the existence of particles smaller than atoms.". 3. Entries of the third row should be "Ernest Rutherford", "1911", and "Discovered the atomic nucleus through his gold foil experiment, establishing that atoms have a dense, positively charged core.". 4. Entries of the last row should be "Murray Gell-Mann", "1964", and "Proposed the existence of quarks as the fundamental building blocks of protons and neutrons, leading to the quark model of particle physics.".	**20** **(4+16)**	**CO3**