PH-8251

COMPUTATIONAL PHYSICS LAB

w.e.f. July, 202

L	T	P	C
0	0	8	4

Course outcomes

After successful completion of the course, the students should be able to

CO1: To have knowledge of programming techniques especially in C++

CO2: To have knowledge of Data types, Operators and expressions

CO3: To know how to handle data files

CO4: familiarity with special methods such as Simpson's 1/3rd , Euler's, Rugne-Kutta method

CO5: applying learned programming to typical physics problems.

CO/PO Mapping

S-strong, M-medium and W-weak indicate the strength of correlation

COs	Programme outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	W	W	W	W		M	S	S	S	S
CO2	S	M	S	M	S	W	M	S	M	W		M
CO3	M	W	M	W	W	S	S	S	S	M	S	S
CO4	W	S	S		S	M	M		M	S	W	W
CO5	M	W	S	W	W		S	S			S	W

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Programming with C++
List of general programs
Write a program to

1. Find the nature of the roots as well as value of the roots of quadratic equation.
2. Add two matrices.
3. Multiply two matrices.
4. Sort a list of n integer numbers in descending order.
5. Find the solution of non-linear equation using Bisection method.
6. Find the solution of non-linear equation using Newton's method.
7. Fit a straight line of type $y = ax + b$ through a given set of data points.
8. Find the numerical integration of a function using Trapezoidal rule.
9. Find the numerical integration of a function using Simpson's $1/3^{rd}$ rule.
10. Find the numerical solution of ordinary differential equations using Euler's method.
11. Find the numerical solution of ordinary differential equations using 4rth order Runge-Kutta method.
12. Find the solution of system of linear equations using Gauss-Seidel method.

List of Physics Problems

1. Write a program to study graphically the EM oscillations in a LCR circuit (use Runge-Kutta Method). Show the variation of (i) Charge vs Time and (ii) Current vs Time.
2. Study graphically the motion of falling spherical body under various effects of medium (viscous drag, buoyancy and air drag) using Euler method.
3. Study graphically the path of a projectile with and without air drag using FN method. Find the horizontal and maximum height in either case. Write your comments on the findings.
4. Study the motion of an artificial satellite.
5. Study the motion of
   (a) 1-D harmonic oscillator (without and with damping effects).
   (b) two coupled harmonic oscillators. Draw graphs showing the relations:
   I. Velocity vs Time II. Acceleration vs Time III. Position vs Time, also compare the numerical and analytical results.
6. To obtain the energy eigenvalues of a quantum oscillator using the Runge-Kutta method.
7. Study the motion of a charged particle in: (a) Uniform electric field, (b) Uniform Magnetic field, (c) in combined uniform electric and magnetic fields. Draw graphs in each case.
8. Use Monte Carlo techniques to simulate phenomenon of
   (i) Nuclear Radioactivity. Do the cases in which the daughter nuclei are also unstable with half life greater/lesser than the parent nucleus.
   (ii) to determine solid angle in a given geometry.
   (iii) simulate attenuation of gamma rays/neutron in an absorber and
   (iv) solve multiple integrals and compare results with Simpson's method.
9. To study phase trajectory of a Chaotic Pendulum.
10. To study convection in fluids using Lorenz system.

BOOKS

1. Numerical Recipes in C++ The Art of Scientific Computing, William H. Press, Saul A. Teukolsky, William T. Vetterling and Brian P. Flannery, (Cambridge), 2nd ed. 2002.
2. A First Course in Computational Physics: P.L. DeVries (John Wiley) 2000.
3. An introduction to Computational Physics: Tao Pang (Cambridge), 2nd ed. 2006.
4. Computer Applications in Physics: S. Chandra (Narosa), 2006.
5. Computational Physics: R.C. Verma, P.K.Ahluwalia and K.C. Sharma (New Age), 2005.
6. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill), 5th ed. 2011.

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