Computational Physics PHY 2003

Course Code: PHY 2003	**Course Title: Computational Physics** **Type of Course:1] Open Elective**	**L- P- C**	2	0	2
Version No.	1.0				
Course Pre-requisites	**Knowledge of Physics and Mathematics till class 12**				
Anti-requisites	**NIL**				
Course Description	This course introduces logarithmic concepts and familiarizes students with the basic computational tools which are essential for graduate students in computational physics and related areas. In this course, students work toward mastering computational skills and this course aims to give the students competence in the methods and techniques of calculations using computers. At the end of the course the student is expected to have a hands on experience in modeling, algorithm development, implementation and calculation of physical quantities. It is designed for the students who wishes to broaden their knowledge of applications and develop techniques.				
Course Objective	The objective of the course is to familiarize the learners with the concepts of "Computational Physics "and attain **Entrepreneurship Skill Development** through **Participative Learning** techniques.				
Course Out Comes	On successful completion of the course the students shall be able to: 1. Apply programming language to plot the graphical representation of a function 2. Apply interpolation techniques to estimate the result of a function 3. Solve partial differential equations using numerical computational techniques.				
Course Content:					
Module 1	Introduction to Python programming	Assignment	Programming/Simulation		**No. of Classes: 10**
Topics: Python: Variables and assignments, arrays, control structures, programming styles, plotting in Python, data input/output					

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Module 2	Interpolation and Numerical Integration	Assignment	Programming/Simulation	**No. of Classes: 10**
Topics: Interpolation: Lagrange interpolation, Interpolation in 2D, Numerical integration: Newton-Cotes and Gaussian Quadrature				
Module 3	Differentiation and Fourier Transform	Term Paper	Programming/Simulation	**No. of Classes: 10**
Topics: Concept of differentiation and Fourier Transform using Python programming, ODE solvers, vector and matrix operations. Implementing the methods in programing language, linear algebra				

Targeted Application & Tools that can be used:

1. Use of Statistical Mechanics models and solving different problems.
2. Python using Jupiter environment

Project work/Assignment: Mention the Type of Project /Assignment proposed for this course

Assessment Type

- Midterm exam
- Assignment (review of digital/ e-resource from PU link given in references section - mandatory to submit screen shot accessing digital resource.)
- Quiz
- End Term Exam

Self-Learning

Ising model using Monte- Carlo simulation

Text Book

Landau, Paez, Bordieanu, 'Computational Physics- Problem Solving with Computers', 3rd Ed., Wiley-VCH.

References

1.Jesse M. Kinder and Philip Nelson, 'A Student's Guide to Python for Physical Modeling', Princeton University Press, 2015.
2.University Physics Volumes 1 and 2 (OpenStax, 2016),
https://openstax.org/details/books/university-physics-volume-1
https://openstax.org/details/books/university-physics-volume-2.
3.J.P. Mueller, Beginning Programming with Python for Dummies, Wiley Publications, 2017

E-resources:

1. https://presiuniv.knimbus.com/user#/searchresult?searchId=computational%20physics&_t=1657687828581
2. https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=510994&site=ehost-live
3. https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=566180&site=ehost-live
4. https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=606257&site=ehost-live

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Topics relevant to "Entrepreneurship Skill Development": Python programing, Applying concepts of Physics in computer programs for Entrepreneurship Skill Development through Participative Learning Techniques. This is attained through the Assignment/Presentation as mentioned in the assessment component in course handout.	
Catalogue prepared by	Dr. Anindita Bhattacharya Dr. Pradeep Bhaskar Dr. Mohan Kumar Naidu P
Recommended by the Board of Studies on	6th BOS conducted on 26th JAN, 2022
Date of Approval by the Academic Council	18th Academic Council Meeting held on 3/08/2022

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PRESIDENCY UNIVERSITY

(Established under the Presidency University Act, 2013 of the Karnataka Act 41 of 2013)

A-8[2021] COURSE HAND OUT [Integrated Course]

SCHOOL: Engineering **DEPT.:** Physics **DATE OF ISSUE: 12.09.2022**

NAME OF THE PROGRAM: B.Tech

P.R.C. APPROVAL REF.: PU/AC18.11/PHY07/PHY2003

SEMESTER/YEAR: 1/2022-2023

COURSE TITLE & CODE: Computational Physics, PHY 2003

COURSE CREDIT STRUCTURE: 2-0-2

CONTACT HOURS: 2 classes of Theory/week

COURSE INSTRUCTOR: Dr. Anindita B, Dr. Pradeep Bhaskar, Dr. Mohan Kumar Naidu P

PROGRAM OUTCOMES:

Graduates of the B. Tech. Program in Computer Science and Engineering will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. (H)
PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. (M)
PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. (L)
PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. (H)
PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. (M)
PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. (M)
PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. (M)

COURSE PREREQUISITES:

NIL

COURSE DESCRIPTION:

This course introduces logarithmic concepts and familiarizes students with the basic computational tools which are essential for graduate students in computational physics and related areas. In this course, students work toward mastering computational skills and this course aims to give the students competence in the methods and techniques of calculations using computers. At the end of the course the student is expected to have a hands on experience in modeling, algorithm development, implementation and calculation of physical quantities. It is designed for the students who wishes to broaden their knowledge of applications and develop techniques.

COURSE OBJECTIVE:

The objective of the course is to familiarize the learners with the concepts of "Computational Physics"and attain **ENTREPRENEURSHIP SKILL** through **Participative Learning** techniques

COURSE OUTCOMES:

On successful completion of the course the students shall be able to:

1. Apply programming language to plot the graphical representation of a function. [Bloom's level: 3]
2. Apply interpolation techniques to estimate the result of a function [Bloom's level: 3]
3. Solve partial differential equations using numerical computational techniques. [Bloom's level: 3]

MAPPING OF C.O. WITH P.O.
[H-HIGH , M- MODERATE, L-LOW]

C.O. N0.	P.O.01	P.O.02	P.O.03	P.O.04	P.O.05	P.O.06	P.O.07	P.O.08	P.O.09	P.O.10	P.O.11	P.O.12
1	H											L
2	H	M								L		L
3			L		M					L		L

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COURSE CONTENT (SYLLABUS):

Module: 1 **[10 Hrs] [Bloom's level selected: 2]**

Python: Variables and assignments, arrays, control structures, programming styles, plotting in Python, data input/output

Module: 2 **[10 Hrs] [Bloom's level selected: 2]**

Interpolation: Lagrange interpolation, Interpolation in 2D, Numerical integration: Newton-Cotes and Gaussian Quadrature Random number generators, Monte Carlo Integration

Module: 3 **[10 Hrs] [Bloom's level selected: 3]**

Concept of differentiation and Fourier Transform using Python programming, ODE solvers, vector and matrix operations. Implementing the methods in programing language, linear algebra

SKILL SETS TO BE DEVELOPED:

1. **An attitude of enquiry.**
2. **Confidence and ability to tackle new problems.**
3. **Ability to interpret events and results.**
4. **Ability to work as a leader and as a member of a team.**
5. Assess errors in systems/processes/programs/computations and eliminate them.
6. **Observe and measure physical phenomena.**
7. **Write reports.**
8. **Select suitable equipment, instrument, materials & software**
9. Locate faults in system/Processes/software.
10. Manipulative skills for setting and handling systems/Process/ Issues
11. The ability to follow standard /Legal procedures.
12. An awareness of the Professional Ethics.
13. Need to observe safety/General precautions.
14. To judge magnitudes/Results/issues without actual measurement/actual contacts

DELIVERY PROCEDURE (PEDAGOGY):

The course is taught in an interactive manner with open book tests, presentations, group work and assignments to gauge learning during the classes.

Self-Learning Topics: Monte Carlo Integration

Experiential Learning Topics: Plotting in Python

Technology Enabled Learning Topics: Concept of differentiation and Fourier Transform using Python programming

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Problem Based Learning: Vector and matrix operations

Topics for Participative Learning through Group discussion: . Implementing the methods in programing language

REFERENCE MATERIALS:

Text Book:

1. Landau, Paez, Bordieanu, 'Computational Physics- Problem Solving with Computers', 3rd Ed., Wiley-VCH

Reference Materials:

1. Jesse M. Kinder and Philip Nelson, 'A Student's Guide to Python for Physical Modeling', Princeton University Press, 2015.
2. University Physics Volumes 1 and 2 (OpenStax, 2016), https://openstax.org/details/books/university-physics-volume-1 https://openstax.org/details/books/university-physics-volume-2.
3. J.P. Mueller, Beginning Programming with Python for Dummies, Wiley Publications, 2017

E-Resources:

1. **https://presiuniv.knimbus.com/user#/viewDetail?searchResultType=ECATALOGUE_BASED&unique_id=BOOKYARDS_1_15518**

2. **https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=2706837&site=ehost-live**

3. **https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=312238&site=ehost-live**

GUIDELINES TO STUDENTS:

1. This is assisted learning. You need to do the learning and the faculty will only guide you.
2. It is necessary to spend time practicing and putting in interested effort.
3. Attending all the classes helps in gathering information in all aspects of the course.
4. The course focuses on helping you learn by yourself. You need to use the internet to get solutions and to develop further.

COURSE SCHEDULE FOR THEORY COMPONENT: (This is a macro level planning. Mention the unit wise expected starting and ending dates along with the tests/assignments/quiz and any other activities) [allot about 75% for delivary,about10 to 12% for Evaluation Discussion, about 10 to 15% on integrating the learning Modules within the course and to the program]

Sl. No.	Activity	Starting Date	Concluding Date	Total Number of Periods
01	Over View of the course	12-Sep-2022	12-Sep-2022	1
02	Module: 01	13-Sep-2022	19-Oct-2022	10

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03	**Module: 02**	**20-Oct-2022**	**02-Nov-2022**	**9**
04	**Midterm**	**03-Nov-2022**	**07-Nov-2022**	**1**
05	**Module: 03**	**08- Nov-2022**	**29-Nov-2022**	**8**
06	**Module: 1,2,3 revision**	**30-Nov-2022**	**31-Dec-2022**	**3**
07	**Last Instruction Day**		**31-Dec-2022**	
08	**End Term Examination**	**05- Jan-2023**	**25-Jan-2023**	

SCHEDULE OF INSTRUCTION FOR THE THEORY COMPONENT: (This is a micro level planning and this is prepared unit wise. At the end of each Unit, mention unit is concluded.) [Here Mention the Self Learning component and the Innovative Methods if any.]

Sl. no	Session no [date if possible]	Lesson Title	Topics	Course Outcome Number	Delivery Mode &Tools used	Reference
1	**2**	Introduction to Python programming	Introduction	**CO1**	**Projection**	**Text book**
2	**3**	Introduction to Python programming	Python: Variables and assignments	**CO1**	**Projection**	**Text book**
3	**4**	Introduction to Python programming	Arrays	**CO1**	**Projection**	**Text book**
4	**5**	Introduction to Python programming	Control structures	**CO1**	**Projection**	**Text book**
5	**6**	Introduction to Python programming	Programming styles	**CO1**	**Projection**	**Text book**
6	**7**	Introduction to Python programming	Programming styles	**CO1**	**Projection**	**Text book**
7	**8**	Introduction to Python programming	Plotting in Python	**CO1**	**Projection**	**Text book**
8	**9**	Introduction to Python programming	Data input/output	**CO1**	**Projection**	**Text book**
9	**10**	Interpolation and Numerical Integration	Introduction	**CO2**	**Projection**	**Text book**
10	**11**	Interpolation and Numerical Integration	Interpolation: Lagrange interpolation	**CO2**	**Projection**	**Text book**
11	**12**	Interpolation and Numerical Integration	Interpolation: Lagrange interpolation	**CO2**	**Projection**	**Text book**
12	**13**	Interpolation and Numerical Integration	Interpolation in 2D	**CO2**	**Projection**	**Text book**
13	**14**	Interpolation and Numerical Integration	Revision	**CO2**	**Projection**	**Text book**
14	**15**	Interpolation and Numerical Integration	Class Test/ Group Discussion	**CO2**	**Projection**	**Text book**

15	**16**	Interpolation and Numerical Integration	Random number generators	**CO2**	**Projection**	**Text book**
16	**17**	Interpolation and Numerical Integration	Monte Carlo Integration	**CO2**	**Projection**	**Text book**
17	**18**	Interpolation and Numerical Integration	Monte Carlo Integration	**CO2**	**Projection**	**Text book**
18	**19**	Interpolation and Numerical Integration	Revision	**CO2**	**Projection**	**Text book**
19	**20**	Interpolation and Numerical Integration	Revision	**CO2**	**Projection**	**Text book**
20	**21**	Interpolation and Numerical Integration	Quiz	**CO2**	**Projection**	**Text book**
21	**22**	**Midterm**		**CO1 & CO2**		
22	**23**	Differentiation and Fourier Transform	Concept of differentiation and Fourier Transform using Python programming	**CO1 & CO2**	**Projection**	**Text book**
23	**24**	Differentiation and Fourier Transform	Concept of differentiation and Fourier Transform using Python programming	**CO3**	**Projection**	**Text book**
24	**25**	Differentiation and Fourier Transform	Concept of differentiation and Fourier Transform using Python programming	**CO3**	**Projection**	**Text book**
25	**26**	Differentiation and Fourier Transform	ODE solvers	**CO3**	**Projection**	**Text book**
26	**27**	Differentiation and Fourier Transform	Vector and matrix operations	**CO3**	**Projection**	**Text book**
27	**28**	Differentiation and Fourier Transform	Implementing the methods in programing language	**CO3**	**Projection**	**Text book**
28	**29**	Differentiation and Fourier Transform	Implementing the methods in programing language	**CO3**	**Projection**	**Text book**
29	**30**	Differentiation and Fourier Transform	linear algebra	**CO3**	**Projection**	**Text book**
30	**31**	Differentiation and Fourier Transform	Revision	**CO3**	**Projection**	**Text book**
31	**32**		Class Test			
32	**33**		**Revision module 1 and 2**			

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Topics relevant to development of "Entrepreneurship skill development": Python programming, applying concepts of Physics in computer programs for ENTREPRENEURSHIP Skill Development through Participative Learning Techniques. This is attained through the Assignment/Presentation as mentioned in the assessment component.

ASSESSMENT SCHEDULE FOR THEORY COMPONENT:

Sl. No.	Assessment type	Contents	Course outcome Number	Duration (In Hours)	Marks	Weightage	Venue, Date & Time
1	Mid-Term	Module 1,2	CO 1,2	1.5	50	25%	
2	Assignment Review of Digital e-resources from Pres. Univ. link given in the references Section- (Mandatory to submit screenshot of accessing digital resource . otherwise it will not be evaluated)	https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=2706837&site=ehost-live	CO 1,2,3	-	50	25%	
3	End Term Exam	Module 1,2,3	CO 1,2,3	3	100	50%	

E-resources

1. https://presiuniv.knimbus.com/user#/searchresult?searchId=science%20and%20technology%20of%20energy&_t=1657688527218
2. https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=207566&site=ehost-live
3. https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=433890&site=ehost-live

COURSE CLEARANCE &EVALUATION CRITERIA:

A student with shortage of attendance (i.e., less than 75% of the classes actually conducted in every Course in the concerned Academic shall not be permitted to appear in the End Term Final Examinations of the Course(s) in which the attendance shortfall exists, irrespective of the student's academic performance in the other components of CA. The student shall be given a placeholder grade "NP" (Not Permitted), to indicate that the student has not been permitted to appear for the End Term Final Examinations due to shortage of attendance during the Academic Term in the concerned Course(s).

Pass/ Fail Criteria:

- Both conditions should be met in the order given below :
  - A minimum 40% out of the total of MIDTERM+FINAL ASSESSMENT
  - A minimum 50% of Grand Total marks or F-grade limit under relative grading, whichever is lower

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Examination Make-up Policy: No make-up will be given for any evaluation component for the course.

The criteria in the Academic Regulations will over-ride the clearance criteria mentioned here if there are any differences.

CONTACT TIMINGS IN THE CHAMBER FOR ANY DISCUSSIONS: (Here mention the fixed slots on any of the week days for students to come and interact with you)

Will be announced later

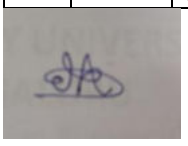
Sample Thought Provoking Questions [For Theory Component] :

(Here type sample typical questions for students 'reference)

Sl No.	Question	Marks	Course Outcome No.	Bloom's Level
1	Create a program for insertion sort visualization using python	5	CO1	2
2	Using Lagrange's interpolation formula find y(10) from the following table: x: 5, 6, 9, 11 y: 12, 13, 14, 16	5	CO2	3
3	Generate the graph for $f(x) = \{0, -L \le x \le 0\}$ $f(x) = \{1, 0 \le x \le L\}$ f(x) has period 2L for L=0.5, Period=1	5	CO3	2

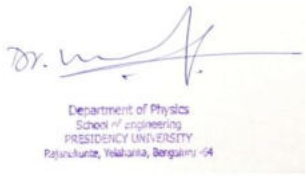
Target set for course Outcome attainment:

Sl. No	C.O. No.	Course Outcomes	Target set for attainment in percentage
01	CO1	Apply programming language to plot the graphical representation of a function.	60
02	CO2	Apply interpolation techniques to estimate the result of a function	50
03	CO3	Solve partial differential equations using numerical computational techniques.	60



Signature of the Course Instructor

This course has been duly verified Approved by the D.A.C.



Signature of the Chairperson D.A.C.

Course Completion Remarks &Self-Assessment. [*This has to be filled after the completion of the course*]

[Please mention about the course coverage details w.r.t. the schedule prepared and implemented. Any specific suggestions to incorporate in the course content. Any Innovative practices followed and its experience. Any specific suggestions from the students about the content, Delivery, Evaluation etc.]

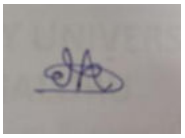
Sl. No.	Activity As listed in the course Schedule	Scheduled Completion Date	Actual Completion Date	Remarks

Any specific suggestion/Observations on content/coverage/pedagogical methods used etc.:

Course Outcome Attainment:

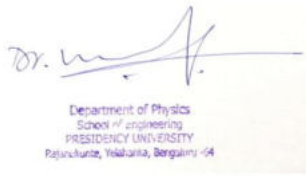
Sl. No.	C.O. No.	Course Outcomes	Target set for attainment in percentage	Actual C.O. Attainment In Percentage	Remarks on attainment & Measures to enhance the attainment
01	CO1	Apply programming language to plot the graphical representation of a function.	60	80	
02	CO2	Apply interpolation techniques to estimate the result of a function	50	70	

03	CO3	Solve partial differential equations using numerical computational techniques.	60	50	



Dr Anindita B

Name and signature of the Course Instructor:



D.A.C. observation and approval:

BLOOM'S TAXONOMY

Learning Outcomes Verbs at Each Bloom Taxonomy Level to be used for writing the course Outcomes.

Cognitive Level	Illustrative Verbs	Definitions
Knowledge	arrange, define, describe, duplicate, identify, label, list, match, memorize, name, order, outline, recognize, relate, recall, repeat, reproduce, select, state	remembering previously learned information
Comprehension	classify, convert, defend, discuss, distinguish, estimate, explain, express, extend, generalize, give example(s), identify, indicate, infer, locate, paraphrase, predict, recognize, rewrite, report, restate, review, select, summarize, translate	grasping the meaning of information
Application	apply, change, choose, compute, demonstrate, discover, dramatize,	applying knowledge to actual situations

	employ, illustrate, interpret, manipulate, modify, operate, practice, predict, prepare, produce, relate schedule, show, sketch, solve, use write	
Analysis	analyze, appraise, breakdown, calculate, categorize, classify, compare, contrast, criticize, derive, diagram, differentiate, discriminate, distinguish, examine, experiment, identify, illustrate, infer, interpret, model, outline, point out, question, relate, select, separate, subdivide, test	breaking down objects or ideas into simpler parts and seeing how the parts relate and are organized
Synthesis	arrange, assemble, categorize, collect, combine, comply, compose, construct, create, design, develop, devise, explain, formulate, generate, plan, prepare, propose, rearrange, reconstruct, relate, reorganize, revise, rewrite, set up, summarize, synthesize, tell, write	rearranging component ideas into a new whole
Evaluation	appraise, argue, assess, attach, choose, compare, conclude, contrast, defend, describe, discriminate, estimate, evaluate, explain, judge, justify, interpret, relate, predict, rate, select, summarize, support, value	making judgments based on internal evidence or external criteria