UNIVERSITY OF CALCUTTA

NotificationNo.CSR/18/2023

It is notified for information of all concerned that in terms of the provisions of Section 54 of the Calcutta University Act, 1979, (as amended), and, in exercise of her powers under 9(6) of the said Act, the Vice-Chancellor has, by an order dated 17.07.2023 approved the syllabus of the under mentioned subjects semester wise Four-year (Honours & Honours with Research) /Three-year (Multidisciplinary) programme of U.G. courses of studies, as applicable under CCF,2022, under this University, as laid down in the accompanying pamphlet.

SL.NO.	NAME OF SUBJECTS
1.	ENVIRONMENTAL Science
2.	Physics
3.	French
4.	Sanskrit (Honours)
5.	Arabic
6.	Library & Information Studies
7.	Statistics
8.	Electronics
9.	Household Art (Minor/MDC)
10.	Microbiology (Revised syllabus After incorporating some amendments, in the syllabus Published in CSR/13/23, Dt.12/07/2023)
11.	Psychology (Revised syllabus After incorporating some amendments, in the syllabus Published in CSR/13/23, Dt.12/07/2023)
12.	Hindi (Revised syllabus After incorporating some amendments, in the syllabus Published in CSR/13/23, Dt.12/07/2023)
13.	B.B.A. (Honours syllabus After incorporating some amendments, in the syllabus Published in CSR/13/23, Dt.12/07/2023)

The above shall be effective from the academic session 2023-2024.

24.7.2023

SENATE HOUSE

KOLKATA-700 073

The 24th July, 2023

Prof.(Dr.) Debasis Das

Registrar

The syllabus of Physics major and minor under CCF, 2022 is mentioned below. The details of the CCF, 2022 are described in the CSR/05/2023 dated 23.06.2023. The essentials of the regulations are mentioned here briefly for better understanding.

CURRICULUM AND CREDIT FRAMEWORK (CCF, 2022)

A four-year degree program in science discipline is constructed with one major and two minor subjects. All the subjects must be taken from Science discipline

Subjects in Science Discipline: Physics, Zoology, Chemistry, Botany, Molecular Biology, Microbiology, Geology, Geography, Physiology, Defence Studies, Computer Science, Electronics, Bio-Chemistry, Physical Education, Environmental Science, Economics, Statistics, Mathematics, Anthropology, Psychology, Film Studies.

Core Courses in Major subject are mentioned as discipline specific core or DSC and minor subjects are mentioned as Minor. i.e., **m1 Minor and m2 Minor**.

Apart from one major and two minor subjects student need to take some other courses. These are listed below.

IDC (Interdisciplinary Course): In first three semesters student should study **three IDC courses** from three different subjects other than the concerned major and minor subjects. Each subject provides an IDC in their curriculum. Student of physics major should find the details of the course from respective subjects.

SEC (Skill Enhancement Course): In first three semesters student should study **three SEC courses**. The structure is given below.

Semester	SEC
SEM-1	SEC from Major Subject (Physics) mentioned in first semester
SEM-2	Artificial Intelligence or SEC from Major Subject (Physics) mentioned in second semester
SEM-3	SEC from Major Subject (Physics) mentioned in third semester

CVAC (Common Value Added Course): CVAC has nothing to do with the major or minor subjects. They are based on knowledge of human & social values. Student should study **four CVAC courses** in first two semesters. Details of the CVAC courses are given below.

Semester	CVAC	
SEM-1	Environment Science I	Constitution Values
SEM-2	Environment Science II	Optional CVAC from a pool

AEC (Ability Enhancement Course): In first four semesters student should study one AEC in each semester. i.e., **total four AEC courses** required to be studied. The details of the AEC are mentioned below.

Semester	AEC
SEM-1	Compulsory English paper 1
SEM-2	Compulsory English paper II
SEM-3	MIL/Alternative English paper I
SEM-4	MIL/Alternative English paper II

MIL stands for Modern Indian Language. Here, three subjects are available: Bengali, Hindi and Urdu. Student can take any one of them for the third and fourth semester. However, if the students are not at all familiar with these then they can choose Alternative English for these two semesters.

YEARWISE PROGAM WITH EXIT OPTION WITH CREDIT

First Year

	DSC	m1& m2 minor	IDC	AEC	SEC	CVAC			
SEM 1	1 Course 1X4=4C	1 Course (m1) 1X4=4C	1 Course 1X3=3C	1 Course 1X2=2C	1 Course 1X4=4C	2 Courses 2X2=4C	Total 21 C		
SEM 2	1 Course 1X4=4C	1 Course (m1) 1X4=4C	1 Course 1X3=3C	1 Course 1X2=2C	1 Course 1X4=4C	2 Courses 2X2=4C	Total 21 C	Summer Internship 1X3=3C and Exit	**Certificate**
								21+21+3=	45 C

Second Year

	DSC	m1& m2 minor	IDC	AEC	SEC			
SEM 3	2 Courses 2X4=8C	1 Course (m2) 1X4=4C	1 Course 1X3=3C	1 Course 1X2=2C	1 Course 1X4=4C	Total 21 C		**Diploma**
SEM 4	4 Courses 4X4=16C	1 Course (m2) 1X4=4C		1 Course 1X2=2C		Total 22 C	Summer Internship 1X3=3C and Exit	
						21+21+21+22+3=		88 C

Third Year

	DSC	m1 minor	m2 minor			
SEM5	4 Courses 4X4=16C	1 Course 1X4=4C	1 Course 1X4=4C	Total 24 C		**Three-year single major degree**
SEM 6	3 Courses 3X4=12C	1 Course 1X4=4C	1 Course 1X4=4C	Total 20 C	Summer Internship 1X3=3C and Exit	
			21+21+21+22+24+20+3=			132 C

Fourth Year

Total credit in 7th and 8th semester is 20 each. There are two possibilities in the fourth year. Only students who have **CGPA equivalent to 75% marks** up to the sixth semester can opt for **four year Honours with research degree course**. Students who do not have such qualification even can opt for fourth year but in that situation, he/she have to study one additional DSC in the 7th semester and two additional DSC in the 8th semester. Total credit for these courses in the 7th and 8th semester is 4+8 =12. Such students receive **four year Honours without research degree course.**

For Students performing research work under faculty members:

	DSC			**Four year Honours with research degree course in single major**
SEM 7	4 Courses 4X4=16C	Research work equivalent to 4 credits	Total 20 C	
SEM 8	3 Courses 3X4=12C	Research work equivalent to 8 credits	Total 20 C	
		21+21+21+22+24+20+3+20+20=		172 C

For Students not performing research work under faculty members:

	DSC	Additional DSC			**Four year Honours without research degree course in single major**
SEM 7	4 Courses 4X4=16C	1 Course 1X4=4C	Total 20 C		
SEM 8	3 Courses 3X4=12C	2 Course 2X4=8C	Total 20 C		
	21+21+21+22+24+20+3+20+20=				172 C

COURSES FOR THE STUDENTS TAKING PHYSICS AS MAJOR SUBJECT

	DSC	Minor	SEC	AEC	CVAC	IDC		
SEM-1	DSC-1 3T+1L (@4C=4C)	m1-Minor-1 3T+1L (@4C=4C)	SEC-1 @4L=4C	Eng-1 @2TH=2C	ENVS-1 Constitution @2TH=4C	Sub1 2TH+1Tu @3=3C	Summer Internship @3=3C in any of either 2 or 4 or 6 for exit otherwise at	
SEM-2	DSC-2 3T+1L (@4C=4C)	m1-Minor-2 3T+1L (@4C=4C)	SEC-2 @4L=4C	Eng-2 @2TH=2C	ENVS-2 Optional @2TH=4C	Sub 2 2TH+1Tu @3=3C		
SEM-3	DSC-3,4 3T+1L (@4C=8C)	m2-Minor-1 3T+1L (@4C=4C)	SEC-3 @4L=4C	MIL/ Alt Eng-1 @2TH=2C		Sub3 2TH+1Tu @3=3C		

SEM-4	DSC-5,6,7,8 3T+1L (@4C=16C)	m2-Minor-2 3T+1L (@4C=4C)		MIL/ Alt Eng-1 @2TH=2C				
SEM-5	DSC-9, 10, 11, 12 3T+1L (@4C=16C)	m1-Minor-3 m2-Minor-3 3T+1L (@4C=8C)						
SEM-6	DSC-13, 14, 15 3T+1L (@4C=12C)	m1-Minor-4 m2-Minor-4 3T+1L (@4C=48)						
SEM-7	DSC-16 ,17, 18, 19 3T+1L (@4C=16C)							Research Work @4C=4C Or DSC -23 @4C=4C
SEM-8	DSC-20, 21, 22 3T+1L (@4C=12C)							Research Work @8C=8C Or DSC - 24,25 @4C=8C

Here, two subjects can be taken as minor. e.g., a student with Physics major may chose Chemistry and Mathematics as two minor subjects. Here, Chemistry can be taken as m1 and Mathematics as m2. Then, in the first two semester CEM-minor 1 and minor 2 paper can be opted where in the third and fourth semester MTM minor 1 and minor 2 will be opted. The minor papers in fifth semester will be CEM minor 3 and MTM minor 3 and that for fourth semester will be CEM minor 4 and MTM minor 4. However, student can take CEM as m2 and MTM as m1. Then subject in semester 1 and 2 will be MTM and that for semester 3 and 4 be CEM.

Optional CVAC can be taken from the pull opted from the university. Three subjects for IDC required to be chosen from science discipline.

COURSES FOR THE STUDENTS TAKING PHYSICS AS MINOR SUBJECT

	Minor	
SEM-1	m1-Minor-1 3T+1L (@4C=4C) Basic Physics-I *If the student opt m1 as Physics	Same as DSC-1 of Physics Major
SEM-2	m1-Minor-2 3T+1L (@4C=4C) Basic Physics-II *If the student opt m1 as Physics	Same as DSC-2 of Physics Major

SEM-3	m2-Minor-1 3T+1L (@4C=4C) Basic Physics-I *If the student opt m2 as Physics	Same as DSC-1 of Physics Major
SEM-4	m2-Minor-2 3T+1L (@4C=4C) Basic Physics-II *If the student opt m2 as Physics	Same as DSC-2 of Physics Major
SEM-5	m1-Minor-3 3T+1L (@4C=8C) Waves and Optics	Same as DSC-3 of Physics Major
SEM-6	m1-Minor-4 3T+1L (@4C=48) Modern Physics	Same as DSC-5 of Physics Major

FOUR YEARS U.G PHYSICS PROGRAMME UNDER THE UNIVERSITY OF CALCUTTA

STRUCTURE OF THE COURSE

1st Semester: **A) DSC-1 (Level-100) for students of PHYSICS MAJOR** **B) SEC – 1**: for Physics Majors only **C) MINOR-1 (Level-100), same content as DSC-1, for students of other departments of science discipline. This course will be offered to students who choose Physics as m1.** **D) Interdisciplinary Course (IDC)** will be offered for students of other disciplines who do not have Physics as a major or minor subject, in any one of the first three semesters.	***2nd Semester:*** **A) DSC-2 (Level-100) for students of PHYSICS MAJOR** **B) SEC – 2**: Artificial intelligence (offered centrally by the University) or specified for Physics Majors only **C) MINOR-2 (Level-100), same content as DSC-2, for students of other departments of science discipline. This course will be offered to students who choose Physics as m1.** **D) Interdisciplinary Course(IDC)**will be offered for students of other disciplines who do not have Physics as a major or minor subject, in any one of the first three semesters.
3rd Semester: **A) DSC-3 & 4 (Level-200) for students of PHYSICS MAJOR** **B) SEC – 3**: for Physics Major only **C) MINOR-1 (Level-100), same content as DSC-1, for students of other departments of science discipline. This course will be offered to students who choose Physics as m2.** **D) Interdisciplinary Course (IDC)** will be offered for students of other disciplines who do not have Physics as a major or minor subject, in any one of the first three semesters.	***4th Semester:*** **A) DSC-5, 6, 7, 8 (Level-200) for students of PHYSICS MAJOR** **B) MINOR-2 (Level-100), same content as DSC-1, for students of other departments of science discipline. This course will be offered to students who choose Physics as m2.**
5th Semester: **A) DSC-9, 10, 11, 12 (Level-300) for students of PHYSICS MAJOR** **B)Minor-3 (Level-200): For students who choose physics as m1 or m2.**	6***th Semester:*** **A) DSC-13, 14, 15 (Level-300) for students of PHYSICS MAJOR** **B) Minor-4 (Level-200) For students who choose physics as m1 or m2.**
7th Semester: **A) DSC-16, 17, 18, 19 (Level-400)** to be studied by all students of Honours **B)DSC/DSE-20 (Level-400)** would be studied only by those without a research component. C) Students with research component would carry out a dissertation and would be evaluated on the same.	***8th Semester:*** **A) DSC-21, 22 & 23 (Level-400)** to be studied by all students of Honours **B) DSC/DSE-24, 25 (Level-400)** would be studied only by those without a research component. C) Students with research component would carry out a Research Project and would be evaluated on the same.

- **IDC will be offered to any one of the first three semesters.**
- **At least one summer internship should be taken up by a student in his/her exit semester up to the 4th Semester. Internship is compulsory in the 6th Semester.**

CURRICULUM STRUCTURE

ODD SEMESTERS (JULY TO DECEMBER)			
SEMESTER-I		***CREDIT***	***MARKS***
DSC-1	Basic Physics-I (Level-100)	3T+1L = 4	100
SEC-1	Introduction to Graph plotting & Programming	0T+4L = 4	100
Minor 1	Basic Physics-I (Level-100)	3T+1L = 4	100
IDC	Frontiers of Physics	2T+1Tu	75
SEMESTER-III		***CREDIT***	***MARKS***
DSC-3	Waves & Optics (Level-200)	3T+1L=4	100
DSC-4	Mathematical Physics – I (Level-200)	3T+1L=4	100
SEC-3	Arduino / Data analysis	1T+3P=4	100
Minor 1	Basic Physics-I (Level-100)	3T+1L=4	100
IDC	Frontiers of Physics	2T+1Tu	75
SEMESTER-V		***CREDIT***	***MARKS***
DSC-9	Analog Electronics (Level-300)	3T+1L=4	100
DSC-10	Nuclear & Particle Physics (Level-300)	3T+1Tu=4	100
DSC-11	Quantum Mechanics (Level-300)	3T+1L=4	100
DSC-12	Thermal Physics and Statistical Mechanics (Level-300)	3T+1 L=4	100
Minor 3	Waves & Optics (Level-200)	3T+1L=4	100
The exact structure for Semester VII is yet to be decided. This is a tentative structure.			
SEMESTER-VII (M.Sc. Sem-I)		***CREDIT***	***MARKS***
DSC-16	Advanced Mathematical Physics	3T+1L=4	100
DSC-17	Advanced Classical Mechanics	3T+1L=4	100
DSC-18	Advanced Quantum Mechanics-I	3T+1L=4	100
DSC-19	Electronics & Instrumentation	3T+1L=4	100
DSC/DSE-20	Atomic & Molecular Physics / Laser and Fiber Optics	3+1=4	100

EVEN SEMESTERS (JANUARY TO JUNE)			
SEMESTER-II		***CREDIT***	***MARKS***
DSC-2	Basic Physics-II (Level-100)	3T+1L = 4	100
SEC-2	Artificial Intelligence/ Scientific writing	0+ 4L = 4	100
Minor 2	Basic Physics-II (Level-100)	3T+1L = 4	100
IDC	Frontiers of Physics	2T+1Tu	75
SEMESTER-IV		***CREDIT***	***MARKS***
DSC-5	Modern Physics (Level-200)	3T+1L=4	100
DSC-6	Electromagnetism (Level-200)	3T+1L=4	100
DSC-7	Mathematical Physics – II (Level-200)	3T+1L=4	100
DSC-8	Classical Mechanics and Special Theory of Relativity (Level-200)	3T+1L=4	100
Minor 2	Basic Physics-I (Level-100)	3T+1L=4	100
SEMESTER-VI		***CREDIT***	***MARKS***
DSC-13	Digital Electronics (Level-300)	3T+1L=4	100
DSC-14	Solid State Physics (Level-300)	3T+1L=4	100
DSC-15	Atomic, Molecular, and Laser Physics (Level-300)	3T+1 Tu=4	100
Minor 4	Modern Physics (Level-200)	3T+1L=4	100
The exact structure for Semester VIII is yet to be decided. This is a tentative structure.			
SEMESTER-VIII (M.Sc. Sem-II)		***CREDIT***	***MARKS***
DSC-21	Advanced Electrodynamics	3T+1L=4	100
DSC-22	Advanced Statistical Mechanics	3T+1L=4	100
DSC-23	Advanced Quantum Mechanics-II	3T+1L=4	100
DSC/DSE-24	Nuclear & Particle Physics / Nanomaterials & Applications	3+1=4	100
DSC/DSE-25	Condensed Matter Physics / Introductory Astrophysics & Cosmology	3+1=4	100

Abbreviations: {T – Theory, L – Laboratory, Tu – Tutorial, P – Project}

DETAILED SYLLABUS FOR FOUR YEAR UNDERGRADUATE PROGRAMME

SUBJECT: PHYSICS MAJOR

SEMESTER- I

PAPER: DSC-1/Minor-1: BASIC PHYSICS-I

THEORY [3 Credits, 50 Lecture Periods]

(A) Mathematical Physics: [20 Lecture Periods (LP)]

1. Preliminaries: SI system of units, dimensional analysis. Plotting of functions (both cartesian and polar), Limits, Intuitive ideas about continuity and differentiability of a function. Taylor series of one variable and binomial series (statements only); Maxima and minima for functions of one variable. Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. [5 LP]

2. Ordinary Differential Equations: First order linear differential equations and integrating factor. Linear second order homogeneous equations with constant coefficients. Simple harmonic motion as an example. [2 LP]

3. Vectors: Dot, cross, scalar triple and vector triple products of cartesian vectors (using Levi-Civita symbol and summation convention). Vector differentiation. Scalar and vector fields --- gradient, divergence, curl and Laplacian (for Cartesian coordinates), solenoidal and irrotational vector field. Statement and proof of Divergence theorem and Stokes' theorem; application to simple cases. [7 LP]

4. Curvilinear coordinates: Plane polar, spherical polar and cylindrical polar coordinates: their unit vectors, role of unit vectors as basis vectors. Surface and volume element (from geometry). Line, surface and volume integrals. Form of the gradient operator in curvilinear coordinates. Velocity and acceleration of point particle in Cartesian, plane polar, spherical polar, cylindrical polar coordinates. [6 LP]

(B) Classical Mechanics: [30 Lecture Periods]

1. Review of Newton's Laws: Concepts of Inertial frames; force and mass. Galilean transformations and Galilean invariance; Newton's laws of motion, principle of conservation of linear momentum, Simple problems involving motion under resistive forces. Rotational motion: Angular velocity, angular acceleration, angular momentum, torque, principle of conservation of angular momentum. [6 LP]

2. Work Kinetic Energy Theorem. Conservative Forces: Force as the gradient of a scalar field. Concept of potential and potential energy. Other equivalent definitions of a conservative force. Conservation of energy. Qualitative study of one-dimensional motion from potential energy curves. Stable and unstable equilibrium. Simple harmonic oscillation for small displacement from a stable equilibrium. [4 LP]

3. Dynamics of a system of particles: The problem of solving equation of motion; Action-reaction kind of forces and the two body problem; Reduced mass & centre of mass; Properties of

the centre of mass; Effect of torque; Linear momentum, angular momentum & total energy of a system of particles. [4 LP]

4. Central force: Newton's Law of Gravitation; Kepler's Laws; Conservation of angular momentum, Gauss's law for Gravitation (integral form); Gravitational potential and intensity due to uniform spherical shell, solid sphere of uniform density and infinite flat sheet. Differential equation for the path in a central force field. Motion under an inverse square force, calculation of orbits. [8 LP]

6. Scattering: Two body collision and scattering [2 LP]

7. Mechanics of Continuum: Kinematics of Moving Fluids: Idea of compressible and incompressible fluids, Equation of continuity; streamline and turbulent flow, Reynold's number. Stokes' law from dimensional analysis; Euler's Equation and the special case of fluid statics. Simple applications (e.g.: Pascal's law and Archimedes principle). Bernoulli's Theorem. [6 LP]

Recommended Texts for Theory:

(For Mathematical Preliminaries portion)

1. Mathematical Methods in the Physical Sciences, M. L. Boas, 2005, Wiley
2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier
3. Essential Mathematical Methods, K.F.Riley and M.P.Hobson, 2011, Cambridge Univ. Press
4. Vector Analysis and an introduction to Tensor Analysis, S. Lipschutz, D. Spellman, M. R. Spiegel, Schaum's Outline Series, Tata Mc Graw Hill Education Private Limited, edition 2009
5. Play with Graphs, Amit M. Agarwal, Arihant Publisher

(For Mechanics portion)

1. An Introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw- Hill
2. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
3. Classical Mechanics and General Properties of Matter. S.N. Maiti and D.P. Raychaudhuri, New Age
4. Introduction to Classical Mechanics, R. G. Takwale and P.S.Puranik, Tata McGraw-Hill Publishing Company Ltd.
5. Theory and Problems of Theoretical Mechanics, M. R. Spiegel, Mc Grow Hill Education
6. Classical Mechanics , R.D. Gregory, 2006, Cambridge University Press
7. Introduction to Classical Mechanics With Problems and Solutions , D. Morin, Cambridge University Press
8. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill. Physics
9. Mechanics, Resnick, Halliday and Walker 8/e. 2008, Wiley
10. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning
11. Mechanics , K. Symon, 2016, Pearson Education India
12. Classical Mechanics , Kibble and Berkshire, Imperial College Press
13. Classical Mechanics , J.M. Finn, 2010, Laxmi Publications
14. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
15. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
16. Classical Mechanics, J C Upadhyay, Himalaya Publishing.

PRACTICAL [1 Credit, 30 Laboratory Periods]

Pre-requisites: Measurements using slide calipers, screw gauge & travelling microscope; Ideas about rounding off experimental data in conformity with the least count of the measuring instrument; Idea of systematic & random errors introduced in different instruments. It is expected that the necessary theory for each of the experiments, for this and the subsequent semesters, will be discussed in brief in the laboratory itself.

1. Measurement of the diameter of a wire using screw gauge a number of times and to determine the mean, median, mode & standard deviation for study of random error in observation.

2. Measurement of a suitable vertical height using Sextant.

3. Determination of the Moment of Inertia of a metallic cylinder / rectangular rod about an axis passing through its centre of gravity

4. Determination of modulus of rigidity of the material of a suspension wire by dynamical method.

5. To determine the coefficient of viscosity of water by Poiseuille's method.

Recommended Texts for Practical:

1. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press
2. B.Sc. Practical Physics, C.L. Arora, S Chand and Company Limited
3. Physics in Laboratory, Mandal, Chowdhury, Das, Das, Santra Publication
4. Advanced Practical Physics Vol 1, B. Ghosh, K. G. Majumder, Sreedhar Publisher
5. Practical Physics, P.R. Sasi Kumar, PHI Learning Private Limited
6. B.Sc. Practical Physics, Harnem Singh, P.S. Hemne, S Chand and Company Limited
7. Engineering Practical Physics, S.Panigrahi&B.Mallick, 2015, Cengage Learning India Pvt. Ltd

PAPER: SEC-1: INTRODUCTION TO COMPUTER PROGRAMMING AND GRAPH PLOTTING

PRACTICAL [4 Credits, 60 Laboratory Periods]

1. Introduction to Graph Plotting (2D only, using GNUPLOT)

(a) Plotting 2D graphs: both functions and data files. Changing plot range and plot styles: the options- with points (w p), with dots (w d), with lines (w l), with linespoints (w lp), linetype (lt), linewidth (lw). Using the set command for samples, xrange, yrange, xlabel ,ylabel, title etc. The using option.
(b) User defined functions [Including the use of ternary operator (? :) for piece-wise defined functions.]
(c) Fitting data files using gnuplot.
(d) Polar and parametric plots
(e) Conditional Plotting of data from file using $, &&, || operators. (Graphs to be saved without using GUI)

2. Introduction to programming in python (Version 3):
(a) Introduction

• Using the python interpreter as a calculator
• Variable and data types (int, float, complex, list, tuple, set, string, the type () function)
• Basic mathematical operations
• Compound statements in python
– Conditionals (if, elif, else)
– Loops (for, while)
– User defined functions def: (return statement, default values for arguments, keyword arguments), lambda function.
• Importing modules with math and cmath as examples
• Using help and dir command to use the inbuilt manual
• Basic idea of namespaces-local and global
• Python scripts, I/O operations (including opening and writing to files)

(b) The python data types
• List: defining lists, reading and changing elements from lists, slicing (with discussion on the difference between ll=mm and ll=mm[:], concatenation, list comprehension.
– built in functions involving lists: range(), len(), sum(), min(), max() – list methods: append(), extend(), count(), index(), sort(), insert(), pop(), remove(), reverse()
• Tuples: Contrast and compare with lists, packing/unpacking using tuples (including a,b=b,a to swap variables) • Sets : set methods: update(), pop(), remove(), Set Theoretic operations: union, intersection, difference and symmetric difference of two sets.
• Strings: defining strings, the use of single, double or triple quotes as string delimiters, len(),indexing, slicing, string concatenation, some string methods: strip(), split(), join(), find(), count(), replace(), string formatting in python (using the % operator)

3. Problems and Applications
• Finding factors of an integer
• Determining whether an integer is prime or not.
• Finding out prime number greater than or lesser than a given value.
• Finding out all prime numbers within a given range
• Root finding for a single variable (basic theory and algorithm) using Newton-Raphson and Bisection method
• Sorting of lists (algorithm, flowchart and code) using Bubble or Selection sort
• Sum of series correct up to given decimal places (Sine, Cosine, Exponential etc.)
• Simulation of motion of a particle in 1D under a given force F(x, t, v) with given initial condition and plotting (x, t), (x, v), (t, v). (Output to be saved in data files and Gnuplot to be used to plot graphs), using Euler's method only.
• Matrix Addition, Multiplication and Transpose using List Comprehension.

Recommended Texts:
1. Gnuplot in Action understanding data and Graphs, Phillipp K. Janert
2. Scientific Computing in Python. Abhijit Kar Gupta, Techno World
3. Computational Physics, Mark Newman, Amazon Digital.
3. Physics in Laboratory including Python Programming (Semester I), Mandal, Chowdhury, Das, Das, Santra Publication

4. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd
5. Numerical Methods, Arun Kr Jalan, Utpal Sarkar, Univerisity Press
6. Numerical Mathematical Analysis, J. B. Scarborough, OXFORD and IBH Co. Pvt. Ltd.
7. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition
8. Gnuplot 5, Lee Phillips, Alogus Publishing, edition 2012.
9. Python Programming, Satyanarayana, Radhika Mani, Jagdesh, Univerisity Press
10. Python 2.1 Bible Dave Brueck, Stephen Tanner, Hungry Minds Inc, New York

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SEMESTER- 2

PAPER: DSC-2/Minor-2: BASIC PHYSICS - II

THEORY [3 Credits, 50 Lecture Periods]

(A) Basic Electricity and Magnetism [22 LP]

1. Electrostatics: Coulomb's law, Electric field, Electric field lines. Superposition Principle. Electric flux. Idea of charge density (linear, surface, volume) and continuous charge distributions. Gauss' Law (in integral form) with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Introduction to electrostatic potential, Equipotential surfaces. Calculation of potential for linear, surface and volume charge distributions: simple cases (e.g.: uniform line charge, disc, spherical shell, sphere etc.). Potential and field due to a physical dipole; Torque, force and Potential Energy of an electric dipole in a uniform electric field.

Electrostatic energy of system of charges, a charged sphere. Conductors in an electrostatic Field. Mechanical force on the surface of a charged conductor. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Capacitance for parallel-plate, cylindrical, spherical capacitors (without dielectrics). Energy stored in Electrostatic field. [11 LP]

2. Lorentz force*:* Force on a moving charge in simultaneous electric and magnetic fields, force on a current carrying conductor in a magnetic field. Trajectory of charged particles in uniform electric field, crossed uniform electric and magnetic fields. Basic principle of cyclotron. [3 LP]

3. Magnetostatics*:* Concept of current density (linear, surface, volume). Equation of continuity. Biot and Savart's law, magnetic field due to a straight conductor, circular coil, Helmholtz coil, solenoid. Ampere's circuital law with applications (Infinite long wire, infinite solenoid, infinite current sheet). Magnetic field due to a small current loop - concept of magnetic dipole. Torque and force on magnetic dipole in a uniform magnetic field. [8 LP]

(B) Introduction to Thermodynamics [28 LP]

1. *Kinetic theory*: Macroscopic and microscopic description of matter, Postulates of molecular kinetic theory of an ideal gas, Relation between microscopic and macroscopic state variables, Maxwell's velocity distribution, Concept of pressure and temperature. [3 LP]

2. *Zeroth and First Law of Thermodynamics*: Extensive and intensive thermodynamic variables. Thermodynamic equilibrium, zeroth law of Thermodynamics & concept of temperature. Concept

of work & heat, State Functions, internal energy and first law of Thermodynamics, its differential form, first law & various processes. Applications of first law: General relation between C_P and C_V, work done during isothermal and adiabatic processes, compressibility and expansion coefficient. [9 LP]

3. *Second Law of Thermodynamics*: Reversible and irreversible process with examples. Interconversion of work and heat. Heat engines. Carnot's cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, Kelvin-Planck and Clausius statements for the second law and their equivalence. Carnot's Theorem. Applications of second law of Thermodynamics: Thermodynamic scale of temperature and its equivalence to perfect gas scale. [10 LP]

3. *Entropy*: Concept of Entropy, Clausius theorem. Clausius inequality, Second law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of increase of Entropy. Entropy changes in reversible and irreversible processes with examples. Entropy of the universe. Principle of increase of Entropy. Temperature- Entropy diagrams for different cycles. Third law of Thermodynamics. Unattainability of absolute zero. [6 LP]

Recommended Texts for Theory:

(For Electromagnetism portion)

1. Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
2. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings
3. Electricity and Magnetism, D.Chattopadhyay and P.C.Rakshit, New Central Book Agency, 2011
4. Fundamentals of Electricity and Magnetism, B. Ghosh, Books and Allied (P) Ltd., 4th edition, 2015.
5. Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw Hill
6. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
7. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press
8. Classical Electromagnetism, Jerrold Franklin, Pearson Education
9. Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press
10. Electricity and Magnetism, D. C. Tayal, Himalayan Publisher

(For Thermal portion)

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill
2. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa
3. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
4. Thermodynamics, E. Fermi, 2007, Sarat Book House
5. Basic Thermodynamics, E. Guha, 2010, Narosa
6. Kinetic theory of gases, Loeb, Radha Publishing House
7. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press
8. Thermodynamics and an introduction to thermostatistics, H. B. Callen, 1985, Wiley
9. Elements of Classical Thermodynamics A.B. Pippard , 1957, Cambridge University Press
10. গ্যাসের আণবিক তত্ত্ব, প্রতীপ চৌধুরী, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ।
11. তাপগতিতত্ত্ব, অশোক ঘোষ, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ।

PRACTICAL [1 Credit, 30 Laboratory Periods]

Pre-requisites: Ideas about handling electrical apparatus & components; Safety against electrical hazards; Use of digital multimeter; Reading colour codes for carbon resistors etc.

1. Conversion of an ammeter to voltmeter and vice versa.

2. Determination of an unknown low resistance using Carey-Foster's Bridge.

3. Measurement of current by potentiometer.

4. Measurement of pressure coefficient of expansion of air by Jolly's apparatus.

5. Measurement of coefficient of thermal expansion of a metallic rod by optical lever arrangement.

Recommended Texts for Practical:

1. Advance Practical Physics (Vol 2), B. Ghosh, Sreedhar Publication
2. An Advanced Course in Practical Physics, D. Chattopadhyay, P. C. Rakshit, New Central Book Agency

PAPER: SEC-2

SCIENTIFIC WRITING SKILLS (LATEX)
PRACTICAL [4 Credits, 60 Laboratory Periods]

1. *Introduction to LATEX:* The difference between WYSIWYG and WYSIWYM. Preparing a basic LATEX file. Compiling LATEX file.
2. *Document classes*: Different type of document classes, e.g., article, report, book and beamer.
3. *Page Layout:* Titles, Abstract, Chapters, Sections, subsections, paragraph, verbatim, References, Equation references, citation.
4. *List structures:* Itemize, enumerate, description etc.
5. *Representation of mathematical equations:* Inline math, Equations, Fractions, Matrices, trigonometric, logarithmic, exponential functions, line-surface-volume integrals with and without limits, closed line integral, surface integrals, Scaling of Parentheses, brackets etc.
6. *Customization of fonts:* Bold fonts, emphasize, mathbf, mathcal etc. Changing sizes Large, Larger, Huge, tiny, etc.
7. *Writing tables:* Creating tables with different alignments, placement of horizontal, vertical lines.
8. *Figures:* Changing and placing the figures, alignments Packages: amsmath, amssymb, graphics, graphicx, Geometry, algorithms, color, Hyperref etc. Use of Different LATEX commands and environments, Changing the type style, symbols from other languages. Special characters.

Note: Software required: LATEX in Linux and Mik-TEX in Windows. Preferred editor Kile/ Emacs/ TEX Studio in Linux and TEX Studio in Windows.

Recommended Texts & sites:

1. LATEX- A Document Preparation System , Leslie Lamport , 1994, Addison-Wesley
2. Walking with LATEX, Suman Bandopadhyaya, Techno World
3. LATEX Tutorials A PRIMER, Indian TEXuser group, E. Krishnan
4. Practical LATEX, George Gratzer, Springer
5. Official LATEX site: https://www.latex-project.org
6. The Not So Short Introduction to LATEX: http://mirror.iopb.res.in/tex-archive/info/lshort/english/lshort.pdf
7. LATEX Wikibookhttps://en.wikibooks.org/wiki/LaTeX
8. TEX Live http://www.tug.org/texlive/

PAPER: IDC (INTERDISCIPLINARY): FRONTIERS IN PHYSICS

1. Nature of Science: Role of proper reasoning and experiments, with examples. Inductive and deductive logic. The character of physical laws, including universality. Difference between science and pseudoscience.

2. Universe: The Copernican revolution, Kepler's laws and the Solar system, Galileo and birth of Telescopic Astronomy, Modern observations: Stars and galaxies, Life cycle of stars. Birth of the Universe, Big Bang and Hubble expansion, Dark matter and dark energy. Origin of life & exoplanets.

3. Matter:
Atoms and molecules: The physical basis of the Periodic table.
Heat and Thermodynamics: Basic idea about the kinetic theory of gases; Distinction between ideal and real gases; The three laws of thermodynamics. Concept of Entropy.
Radioactivity: Alpha, beta & gamma decay; X-Rays – Properties.
Structure of the atom: Electron, Nucleus: proton and neutron. Mention of the Standard Model of particles & interactions.

4. Forces: Laws of falling bodies, Inertia, Gravitation, Electricity and Magnetism, Light and its dual property.
The microscopic world of Quantum Mechanics.
Special and General Theory of Relativity (brief and qualitative ideas only)

[No Mathematical derivation beyond simple algebra should be used]

Suggested Texts:

1. Six Easy Pieces – Richard P. Feynman
2. The first three minutes – Steven Weinberg
3. The character of physical laws – Richard P. Feynman
4. Introduction to Astronomy: From Darkness to Blazing Glory – J. W Scott, JAS Educational Publications
5. আধুনিক বিজ্ঞানের ক্রমবিকাশ, সম্পাদনা সুশান্ত মজুমদার, ভূপতি চক্রবর্তী, অনুষ্টুপ প্রকাশনী।

DETAILED SYLLABI OF THE COURSES OF SEMESTERS III-VIII WOULD BE PROVIDED AFTERWARDS.

The syllabus of Multidisciplinary Courses (MDC) with Physics as one of the subject major or minor subject under CCF, 2022 is mentioned below. The details of the CCF, 2022 are described in the CSR/04/2023 dated 23.06.2023. The essentials of the regulations are mentioned here briefly for better understanding.

CURRICULUM AND CREDIT FRAMEWORK (CCF, 2022)

A three year MDC degree program in science discipline is constructed with two major and one minor subject. To get B.Sc. degree **any two** of the major or minor subjects must be chosen from **science discipline / Home Science discipline**. Other one major/minor may be taken from science discipline or from Humanities discipline.

Disciplines of Multidisciplinary courses for B.A./B.Sc.:

(i) Humanities Discipline: History, English, Bengali, Ancient Indian & World History, Islamic History and Culture, Hindi, Urdu, Russian, Political Science, Sanskrit, Pali , Philosophy, Sociology, Education, Arabic, Persian, Journalism & Mass Communication, French, Music, Linguistics, Physical Education, Human Rights, Women Studies.

(ii) Science Discipline: Physics, Zoology, Chemistry, Botany, Molecular Biology, Microbiology, Geology, Geography, Physiology, Defence Studies, Computer Science, Electronics, Bio-Chemistry, Physical Education, Environmental Science, Economics, Statistics, Mathematics, Anthropology, Psychology, Film Studies.

(iii) Home Science Discipline: Food & Nutrition, Household Art, Human Development, Social Science, Home Science Extension Education, Library and Information Studies.

However, there are eight subject groups and no two subjects can be taken from same subject group.

The distribution of subjects in science and humanities disciplines within the groups are mentioned here

Groups	Subjects
Group I	Physics, Zoology, Education, Home Science Extension Education, Social Science, Film Studies, Physical Education, Human Rights, Russian, Women Studies.
Group-II	Human Development, History, Ancient Indian and World History, Islamic History & Culture, Mathematics, Environmental Science
Group-III	Chemistry, Sociology, Defense Studies, Music, Household Art, Pali, Arabic, Persian, Sanskrit, Biochemistry
Group-IV	Botany, Economics, Food & Nutrition
Group-V	Geology, Political Science, Electronics, Library and Information Studies
Group-VI	Geography, Molecular Biology, Psychology, Philosophy, Microbiology, Journalism & Mass Communication
Group-VII	Statistics, Physiology, English
Group-VIII	Anthropology, Computer Science, Bengali, Hindi, Urdu, French, Linguistics.

The choice of subjects will further be restricted by respective college where student get admitted. **Core Courses in Major subject are mentioned as discipline specific core (DSC) and minor subjects are mentioned as MDC Minor**

Students need to pass some subjects as a prerequisite condition for choosing some such subjects. That table is found in the page number 9 in the table 11 of CSR/04/2023 dated 23.06.2023.

Apart from two major and one of minor subjects student need to take some other courses. These are listed below.

IDC (Interdisciplinary Course): In first three semesters student should study **three IDC courses** from three different subjects other than the concerned major and minor subjects. Each subject provides an IDC in their curriculum. Student of physics major should find the details of the course from respective subjects.

SEC (Skill Enhancement Course): In first three semesters student should study **three SEC courses**. The structure is given below.

Semester	SEC
SEM-1	SEC from Major Subject (Physics) mentioned in first semester
SEM-2	Artificial Intelligence or SEC from Major Subject (Physics) mentioned in second semester
SEM-3	SEC from Major Subject (Physics) mentioned in third semester

CVAC (Common Value Added Course): CVAC has nothing to do with the major or minor subjects. They are based on knowledge of human & social values. Student should study **four CVAC courses** in first two semesters. Details of the CVAC courses are given below.

Semester	CVAC	
SEM-1	Environment Science I	Constitution
SEM-2	Environment Science II	Optional CVAC from a pull

AEC (Ability Enhancement Course): In first four semesters student should study one AEC in each semester. i.e., **total four AEC courses** required to be studied. The details of the AEC are mentioned below.

Semester	AEC
SEM-1	Compulsory English paper 1
SEM-2	Compulsory English paper II
SEM-3	MIL/Alternative English paper I
SEM-4	MIL/Alternative English paper II

MIL stands for Modern Indian Language. Here, three subjects are available: Bengali, Hindi and Urdu. Student can take any one of them for the third and fourth semester. However, if the students are not at all familiar with these then they can chose Alternative English for these two semesters.

YEARWISE PROGAM WITH EXIT OPTION WITH CREDIT

First Year

	DSC Major1	DSC Major 2	IDC	AEC	SEC	CVAC			
SEM 1	1 Course 1x4=4C	1 Course 1x4=4C	1 Course 1x3=3C	1 Course 1x2=2C	1 Course 1x4=4C	2 Courses 2x2=4C	Total 21 C		
SEM 2	1 Course 1x4=4C	1 Course 1x4=4C	1 Course 1x3=3C	1 Course 1x2=2C	1 Course 1x4=4C	2 Courses 2x2=4C	Total 21 C	Summer Internship 1x3=3C and Exit	**Certificate**
								21+21+3=	45 C

Second Year

	DSC Major1	DSC Major 2	Minor	IDC	AEC	SEC			
SEM 3	1 Course 1x4=4C	1 Course 1x4=4C	1 Course 1x4=4C	1 Course 1x3=3C	1 Course 1X2=2C	1 Course 1x4=4C	Total 21 C		**Diploma**
SEM 4	2 Courses 2x4=8C	2 Courses 2x4=8C	1 Course 1x4=4C		1 Course 1x2=2C		Total 22 C	Summer Internship 1X3=3C and Exit	
							21+21+21+22+3=		88 C

Third Year

	DSC Major1	DSC Major 2	Minor			
SEM 5	2 Course 2x4=8C	1 Courses 1x4=4C	2 Courses 2x4=8C	Total 20 C		**B.Sc. degree**
SEM 6	1 Course 1x4=4C	2 Courses 2x4=8C	2 Courses 2x4=8C	Total 20 C	Summer Internship 1X3=3C and Exit	
			21+21+21+22+3+2020=			128 C

COURSES FOR THE STUDENTS TAKING PHYSICS AS MAJOR SUBJECT

	DSC	Minor	SEC	AEC	CVAC	IDC		Total Credit
SEM-1	M1-DSC-1 + M2-DSC1 3T+1L (@4C=8C)		SEC-1 @4L=4C	Eng-1 @2TH=2C	ENVS-1 Constitution @2TH=4C	Sub1 2TH+1Tu @3=3C	Summer Internship @3=3C in any of either 2 or 4 or 6 for exit otherwise at 6th semester	21
SEM-2	M1-DSC-2 + M2-DSC2 3T+1L (@4C=8C)		SEC-2 @4L=4C	Eng-2 @2TH=2C	ENVS-2 Optional @2TH=4C	Sub 2 2TH+1Tu @3=3C		21
SEM-3	M1-DSC-3 + M2-DSC-3 3T+1L (@4C=8C)	MDC-Minor-1 3T+1L (@4C=4C)	SEC-3 @4L=4C	MIL/ Alt Eng-1 @2TH=2C		Sub3 2TH+1Tu @3=3C		21
SEM-4	M1-DSC-4,5 + M2-DSC-4,5 3T+1L (@4C=16C)	MDC-Minor-2 3T+1L (@4C=4C)		MIL/ Alt Eng-1 @2TH=2C				22
SEM-5	M1-DSC-6,7 + M2-DSC-6 3T+1L (@4C=12C)	MDC-Minor-3,4 3T+1L (@4C=8C)						20
SEM-6	M1-DSC-8 + M2-DSC-8,9 3T+1L (@4C=12C)	MDC-Minor-5,6 3T+1L (@4C=8C)						20

Here, two subjects can be taken as major e.g., a student can pursue with Physics and Chemistry as major subjects. Then M1-DSC-1 stands for DSC-1 of Physics and M2-DSC-1 stands for DSC-1 for Chemistry for first semester. Minor subject may be chosen from science discipline or from humanity discipline.

Again if a student accepts Physics and Education as major subjects then M1-DSC-1 will be DSC-1 of Physics and M2-DSC-1 for DSC-1 of Education. However, in that situation minor subject must be chosen from science or home science disciplines to get B.Sc. degree as two subjects among major and minor must belong to science category.

Optional CVAC can be taken from the pull offered from the university.

COURSES FOR THE STUDENTS TAKING PHYSICS AS MINOR SUBJECT

	Minor		Total Credit
SEM-1	No minor	Same as DSC-1 of Physics Major	
SEM-2	.No minor	Same as DSC-2 of Physics Major	
SEM-3	MDC-Minor-1 3T+1L (@4C=4C) Basic Physics-I	Same as DSC-1 of Physics Major	4
SEM-4	MDC-Minor-2 3T+1L (@4C=4C) Basic Physics-II	Same as DSC-2 of Physics Major	4
SEM-5	MDC-Minor-3,4 3T+1L (@4C=8C) Waves and Optics Mathematical Physics I	Same as DSC-3.4 of Physics Major	8
SEM-6	m1-Minor-5,6 3T+1L (@4C=48) Modern Physics Electromagnetism	Same as DSC-5,6 of Physics Major	8

THREE YEARS MULTIDISCIPLINARY U.G PHYSICS PROGRAMME UNDER THE UNIVERSITY OF CALCUTTA

STRUCTURE OF THE COURSE

1st Semester: **A) MDC-1 (Level-100) for students choosing Physics as one of their core papers** **B) SEC – 1**: Introduction to Graph plotting & Programming **C) Interdisciplinary Course (IDC)** will be offered for students of other disciplines who do not have Physics as a major or minor subject, in any one of the first three semesters.	***2nd Semester:*** **A) MDC-2 (Level-100) for students choosing Physics as one of their core papers.** **B) SEC – 1**: Introduction to Graph plotting & Programming **C) Interdisciplinary Course (IDC)** will be offered for students of other disciplines who do not have Physics as a major or minor subject, in any one of the first three semesters.
3rd Semester: **A) MDC-3 (Level-200) for students choosing Physics as one of their core papers.** **B) SEC – 1**: Introduction to Graph plotting & Programming. **C) Interdisciplinary Course (IDC)** will be offered for students of other disciplines who do not have Physics as a major or minor subject, in any one of the first three semesters. **D) MDC Minor 1: for students choosing Physics as minor subject.**	***4th Semester:*** **A) MDC-4 & MDC -5 (Level-200) for students choosing Physics as one of their core papers.** **B) MDC Minor 2: for students choosing Physics as minor subject.**
5th Semester: **A) MDC-6 & MDC -7 (Level-200) for students choosing Physics as CC1.** **B) MDC Minor 3 & 4: for students choosing Physics as minor subject.** **If the students choose to study Physics as CC2, he/she shall study only MDC-6 paper.**	6***th Semester:*** **A) MDC-8 & MDC -9 (Level-200) for students choosing Physics as CC2.** **B) MDC Minor 5 & 6: for students choosing Physics as minor subject.** **If the students choose to study Physics as CC1, he/she shall study only MDC-8 paper.**

- **SEC course can be studied in any one of the Semesters 1, 2 and 3.**

CURRICULUM STRUCTURE

ODD SEMESTERS (JULY TO DECEMBER)			
SEMESTER-I		***CREDITS***	***MARKS***
MDC-1	Basic Physics-I (Level-100)	3T+1L=4	100
SEC-1	Introduction to Graph plotting & Programming	0T+4L=4	100
IDC	Frontiers of Physics	2T+1Tu	75
SEMESTER-III		***CREDITS***	***MARKS***
MDC-3	Waves & Optics (Level-200)	3T+1L=4	100
SEC-1	Introduction to Graph plotting & Programming	0T+4L=4	100
MDC Minor 1	Basic Physics-I (Level-100)	3T+1L=4	100
IDC	Frontiers of Physics	2T+1Tu	75
SEMESTER-V		***CREDITS***	***MARKS***
MDC 6	Analog Electronics (Level-200)	3T+1L=4	100
MDC 7	Nuclear & Particle Physics (Level-200)	3T+1Tu=4	100
MDC Minor 3	Waves & Optics (Level-200) Same as MDC 3		
MDC Minor 4	Mathematical Physics – I (Level-200)		

EVEN SEMESTERS (JANUARY TO JUNE)			
SEMESTER-II		***CREDITS***	***MARKS***
MDC-2	Basic Physics-II (Level-100)	3T+1L=4	100
SEC-1	Introduction to Graph plotting & Programming	0T+4L=4	100
IDC	Frontiers of Physics	2T+1Tu	75
SEMESTER-IV		***CREDITS***	***MARKS***
MDC 4	Modern Physics (Level-200)	3T+1L=4	100
MDC 5	Electromagnetism (Level-200)	3T+1L=4	100
MDC Minor 2	Basic Physics-II (Level-100)	3T+1L=4	100
SEMESTER-VI		***CREDITS***	***MARKS***
MDC 8	Digital Electronics (Level-200)	3T+1L=4	100
MDC-9	Instrumentation (Level-200)	3T+1L=4	100
MDC Minor 5	Modern Physics (Level-200) Same as MDC 4		
MDC Minor 6	Electromagnetism (Level-200) Same as MDC 5		

PAPER: MDC-1/MDC Minor-1: BASIC PHYSICS-I

THEORY [3 Credits, 50 Lecture Periods]

(A) Mathematical Physics: [20 Lecture Periods (LP)]

1. Preliminaries: SI system of units, dimensional analysis. Plotting of functions (both cartesian and polar), Limits, Intuitive ideas about continuity and differentiability of a function. Taylor series of one variable and binomial series (statements only); Maxima and minima for functions of one variable. Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. [5 LP]

2. Ordinary Differential Equations: First order linear differential equations and integrating factor. Linear second order homogeneous equations with constant coefficients. Simple harmonic motion as an example. [2 LP]

3. Vectors: Dot, cross, scalar triple and vector triple products of cartesian vectors. Vector differentiation. Scalar and vector fields --- gradient, divergence, curl and Laplacian (for Cartesian coordinates), solenoidal and irrotational vector field. Statement of Divergence theorem and Stokes' theorem; application to simple cases. [7 LP]

4. Curvilinear coordinates: Plane polar, spherical polar and cylindrical polar coordinates: their unit vectors, role of unit vectors as basis vectors. Surface and volume element (from geometry). Line, surface and volume integrals. Form of the gradient operator in curvilinear coordinates. Velocity and acceleration of point particle in Cartesian, plane polar, spherical polar, cylindrical polar coordinates. [6 LP]

(B) Classical Mechanics: [30 Lecture Periods]

1. Review of Newton's Laws: Concepts of Inertial frames; force and mass. Galilean transformations and Galilean invariance; Newton's laws of motion, principle of conservation of linear momentum, Simple problems involving motion under resistive forces. Rotational motion: Angular velocity, angular acceleration, angular momentum, torque, principle of conservation of angular momentum. [6 LP]

2. Work Kinetic Energy Theorem. Conservative Forces: Force as the gradient of a scalar field. Concept of potential and potential energy. Other equivalent definitions of a conservative force. Conservation of energy. Qualitative study of one-dimensional motion from potential energy curves. Stable and unstable equilibrium. [4 LP]

3. Dynamics of a system of particles: The problem of solving equation of motion; Action-reaction kind of forces and the two body problem; Reduced mass & centre of mass; Properties of the centre of mass; Effect of torque; Linear momentum, angular momentum & total energy of a system of particles. [4 LP]

4. Central force: Newton's Law of Gravitation; Kepler's Laws; Conservation of angular momentum, Gauss's law for Gravitation (integral form); Gravitational potential and intensity due

to uniform spherical shell , solid sphere of uniform density and infinite flat sheet. Differential equation for the path in a central force field. Motion under an inverse square force, calculation of orbits. [8 LP]

6. Scattering: Two body collision and scattering [2 LP]

7. Mechanics of Continuum: Kinematics of Moving Fluids: Idea of compressible and incompressible fluids, Equation of continuity; streamline and turbulent flow, Reynold's number. Stokes' law from dimensional analysis; Euler's Equation and the special case of fluid statics. Simple applications (e.g: Pascal's law and Archimedes principle). Bernoulli's Theorem. [6 LP]

Recommended Texts for Theory:

Recommended Texts for Theory:

(For Mathematical Preliminaries portion)

1. Mathematical Methods in the Physical Sciences, M. L. Boas, 2005, Wiley
2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier
3. Essential Mathematical Methods, K.F.Riley and M.P.Hobson, 2011, Cambridge Univ. Press
4. Vector Analysis and an introduction to Tensor Analysis, S. Lipschutz, D. Spellman, M. R. Spiegel, Schaum's Outline Series, Tata Mc Graw Hill Education Private Limited, edition 2009

(For Mechanics portion)

1. An Introduction to Mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw- Hill
2. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
3. Classical Mechanics and General Properties of Matter. S.N. Maiti and D.P. Raychaudhuri, New Age
4. Introduction to Classical Mechanics, R. G. Takwale and P.S.Puranik, Tata McGraw-Hill Publishing Company Ltd.
5. Theory and Problems of Theoretical Mechanics, M. R. Spiegel, McGraw Hill Education
8. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill. Physics
9. Mechanics, Resnick, Halliday and Walker 8/e. 2008, Wiley
10. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
11. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
12. Classical Mechanics, J C Upadhyay, Himalaya Publishing.

PRACTICAL [1 Credit, 30 Laboratory Periods]

Pre-requisites: Measurements using slide calipers, screw gauge & travelling microscope; Ideas about rounding off experimental data in conformity with the least count of the measuring instrument; Idea of systematic & random errors introduced in different instruments. It is expected that the necessary theory for each of the experiments, for this and the subsequent semesters, will be discussed in brief in the laboratory itself.

1. Measurement of the diameter of a wire using screw gauge a number of times and to determine the mean, median, mode & standard deviation for study of random error in observation.

2. Measurement of a suitable vertical height using Sextant.

3. Determination of the Moment of Inertia of a metallic cylinder / rectangular rod about an axis passing through its centre of gravity

4. Determination of modulus of rigidity of the material of a suspension wire by dynamical method.

5. To determine the coefficient of viscosity of water by Poiseuille's method.

Recommended Texts for Practical:

1. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press
2. B.Sc. Practical Physics, C.L. Arora, S Chand and Company Limited
3. Physics in Laboratory, Mandal, Chowdhury, Das, Das, Santra Publication
4. Advanced Practical Physics Vol 1, B. Ghosh, K. G. Majumder, Sreedhar Publisher
5. Practical Physics, P.R. Sasi Kumar, PHI Learning Private Limited
6. B.Sc. Practical Physics, Harnem Singh, P.S. Hemne, S Chand and Company Limited
7. Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd

PAPER: SEC-1: INTRODUCTION TO COMPUTER PROGRAMMING AND GRAPH PLOTTING

PRACTICAL [4 Credits, 60 Laboratory Periods]

1. Introduction to Graph Plotting (2D only, using GNUPLOT)

(a) **Plotting 2D graphs:** both functions and data files. Changing plot range and plot styles: the options- with points (w p), with dots (w d), with lines (w l), with linespoints (w lp), linetype (lt), linewidth (lw). Using the set command for samples, xrange, yrange, xlabel , ylabel, title etc. The using option.

2. **Introduction to programming in python** (Version 3.x):
(a) Introduction

• Using the python interpreter as a calculator
• Variable and data types (int, float, complex, list, tuple, set, string, the type() function)
• Basic mathematical operations
• Compound statements in python
– Conditionals (if, elif, else)
– Loops (for, while)
– User defined functions def: (return statement, default values for arguments, keyword arguments), lambda function.
• Importing modules with math and cmath as examples
• Using help and dir command to use the inbuilt manual
• Python scripts, I/O operations (including opening and writing to files)

The python data types
• List: defining lists, reading and changing elements from lists, slicing, list comprehension.

– built in functions involving lists: range(), len(), sum(), min(), max() – list methods: append(), extend(), count(), index(), sort(), insert(), pop(), remove(), reverse()
• Tuples: Contrast and compare with lists, packing/unpacking using tuples (including a,b=b,a to swap variables)
• Strings: defining strings, the use of single, double or triple quotes as string delimiters, len(), indexing, slicing, string concatenation, some string methods: split(), join(), find(), count(), replace()

Recommended Texts:

1. Gnuplot in Action understanding data and Graphs, Phillipp K. Janert
2. Scientific Computing in Python. Abhijit Kar Gupta, Techno World
3. Computational Physics, Mark Newman, Amazon Digital.
3. Physics in Laboratory including Python Programming (Semester I), Mandal, Chowdhury, Das, Das, Santra Publication
4. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd
5. Numerical Methods, Arun Kr Jalan, Utpal Sarkar, University Press
6. Numerical Mathematical Analysis, J. B. Scarborough, OXFORD and IBH Co. Pvt. Ltd.
7. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition
8. Gnuplot 5, Lee Phillips, Alogus Publishing, edition 2012.
9. Python Programming, Satyanarayana, Radhika Mani, Jagdesh, University Press
10. Python 2.1 Bible Dave Brueck, Stephen Tanner, Hungry Minds Inc, New York

SEMESTER- 2

PAPER: MDC-2/MDC Minor-2: BASIC PHYSICS - II

THEORY [3 Credits, 50 Lecture Periods]

(A) Basic Electricity and Magnetism [22 LP]

1. Electrostatics: Coulomb's law, Electric field, Electric field lines. Superposition Principle. Electric flux. Idea of charge density (linear, surface, volume) and continuous charge distributions. Gauss' Law (in integral form) with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Introduction to electrostatic potential, Equipotential surfaces. Calculation of potential for linear, surface and volume charge distributions: simple cases (e.g.: uniform line charge, disc, spherical shell, sphere etc). Potential and field due to a physical dipole; Torque, force and Potential Energy of an electric dipole in a uniform electric field.

Electrostatic energy of a system of charges, a charged sphere. Conductors in an electrostatic Field. Mechanical force on the surface of a charged conductor. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Capacitance for parallel-plate, cylindrical, spherical capacitors (without dielectrics). Energy stored in the Electrostatic field. [11 LP]

2. Lorentz force: Force on a moving charge in simultaneous electric and magnetic fields, force on a current carrying conductor in a magnetic field. Trajectory of charged particles in uniform electric field, crossed uniform electric and magnetic fields. Basic principle of cyclotron. [3 LP]

3. Magnetostatics: Concept of current density (linear, surface, volume). Equation of continuity. Biot and Savart's law, magnetic field due to a straight conductor, circular coil, Helmholtz coil, solenoid. Ampere's circuital law with applications (Infinite long wire, infinite solenoid, infinite current sheet). Magnetic field due to a small current loop - concept of magnetic dipole. Torque and force on magnetic dipole in a uniform magnetic field. [8 LP]

(B) Introduction to Thermodynamics [28 LP]

1. *Kinetic theory*: Macroscopic and microscopic description of matter, Postulates of molecular kinetic theory of an ideal gas, Relation between microscopic and macroscopic state variables, Maxwell's velocity distribution, Concept of pressure and temperature. [3 LP]

2. *Zeroth and First Law of Thermodynamics*: Extensive and intensive thermodynamic variables. Thermodynamic equilibrium, zero-th law of Thermodynamics & concept of temperature. Concept of work & heat, State Functions, internal energy and first law of Thermodynamics, its differential form, first law & various processes. Applications of first law: General relation between C_P and C_V, work done during isothermal and adiabatic processes, compressibility and expansion coefficient. [9 LP]

3. *Second Law of Thermodynamics*: Reversible and irreversible process with examples. Interconversion of work and heat. Heat engines. Carnot's cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, Kelvin-Planck and Clausius statements for the second law and their equivalence. Carnot's Theorem. Applications of second law of Thermodynamics: Thermodynamic scale of temperature and its equivalence to perfect gas scale. [10 LP]

3. *Entropy*: Concept of Entropy, Clausius theorem. Clausius inequality, Second law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of increase of Entropy. Entropy changes in reversible and irreversible processes with examples. Entropy of the universe. Principle of increase of Entropy. Temperature- Entropy diagrams for different cycles. Third law of Thermodynamics. Unattainability of absolute zero. [6 LP]

Recommended Texts for Theory:

(For Electromagnetism portion)

1. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
2. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings
3. Electricity and Magnetism, D.Chattopadhyay and P.C.Rakshit, New Central Book Agency, 2011
4. Fundamentals of Electricity and Magnetism, B. Ghosh, Books and Allied (P) Ltd., 4th edition, 2015.
5. Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw Hill
6. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
7. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press

8. Classical Electromagnetism, Jerrold Franklin, Pearson Education
9. Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press
10. Electricity and Magnetism, D. C. Tayal, Himalayan Publisher

(For Thermal portion)

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill
2. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa
3. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
4. Thermodynamics, E. Fermi, 2007, Sarat Book House
5. Basic Thermodynamics, E. Guha, 2010, Narosa
6. Kinetic theory of gasses, Loeb, Radha Publishing House
7. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press
8. Thermodynamics and an introduction to thermostatistics, H. B. Callen, 1985, Wiley
9. Elements of Classical Thermodynamics A.B. Pippard , 1957, Cambridge University Press
10. গ্যাসের আণবিক তত্ত্ব, প্রতীপ চৌধুরী, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ।
11. তাপগতিতত্ত্ব, অশোক ঘোষ, পশ্চিমবঙ্গ রাজ্য পুস্তক পর্ষদ।

PRACTICAL [1 Credit, 30 Laboratory Periods]

Pre-requisites: Ideas about handling electrical apparatus & components; Safety against electrical hazards; Use of digital multimeter; Reading colour codes for carbon resistors etc.

1. Conversion of an ammeter to voltmeter and vice versa.

2. Determination of an unknown low resistance using Carey-Foster's Bridge.

3. Measurement of current by potentiometer.

4. Measurement of pressure coefficient of expansion of air by Jolly's apparatus.

5. Measurement of coefficient of thermal expansion of a metallic rod by optical lever arrangement.

Recommended Texts for Practical:

1. Advanced Practical Physics (Vol 2), B. Ghosh, Sreedhar Publication

PAPER: IDC (INTERDISCIPLINARY): FRONTIERS IN PHYSICS

1. Nature of Science: Role of proper reasoning and experiments, with examples. Inductive and deductive logic. The character of physical laws, including universality. Difference between science and pseudoscience.

2. Universe: The Copernican revolution, Kepler's laws and the Solar system, Galileo and birth of Telescopic Astronomy, Modern observations: Stars and galaxies, Life cycle of stars. Birth of the Universe, Big Bang and Hubble expansion, Dark matter and dark energy.

3. Matter:
Atoms and molecules: The physical basis of the Periodic table.
Heat and Thermodynamics: Basic idea about the kinetic theory of gases; Distinction between ideal and real gases; The three laws of thermodynamics. Concept of Entropy.
Radioactivity: Alpha, beta & gamma decay; X-Rays – Properties.
Structure of the atom: Electron, Nucleus: proton and neutron. Mention of the Standard Model of particles & interactions.

4. Forces: Laws of falling bodies, Inertia, Gravitation, Electricity and Magnetism, Light and its dual property.
The microscopic world of Quantum Mechanics.
Special and General Theory of Relativity (brief and qualitative ideas only)

[No Mathematical derivation beyond simple algebra should be used]

Suggested Texts:

1. Six Easy Pieces – Richard P. Feynman
2. The first three minutes – Steven Weinberg
3. The character of physical laws – Richard P. Feynman
4. Introduction to Astronomy: From Darkness to Blazing Glory – J. W Scott, JAS Educational Publications
5. আধুনিক বিজ্ঞানের ক্রমবিকাশ, সম্পাদনা সুশান্ত মজুমদার, ভূপতি চক্রবর্তী, অনুষ্টুপ প্রকাশনী।

DETAILED SYLLABI OF THE COURSES OF SEMESTERS III-VII WOULD BE PROVIDED AFTERWARDS.