Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce, and Science College, Ahmednagar (Autonomous)

(Affiliated to Savitribai Phule Pune University, Pune)

National Education Policy (NEP)
Choice Based Credit System (CBCS)

Programme Skeleton and Syllabus of

M.Sc. Physics (Major)

Implemented from

Academic Year 2023-24

Distribution of credits

Type of Courses	Total Credits	Credits/ Semester
Discipline-Specific Core Courses (DSC)	54	14 /12
Discipline Specific Elective Courses (DSE)	16	04
Research Methodology (RM)	04	Semester I only
On-Job Training/ Internship (OJT/I	04	Semester II only
Project (PR)	10	Semesters III and IV only
Total	88	22

Master of Science (M.Sc.) Course Distribution

Class	Semester	Subjects	Courses	DSC		DSE		RM/OJT/ Internship etc.		Project *	Total Credits
				T	P	T	P	T	P		
M. Sc. I	I	01	09	03	03	01	01	01*		00	22
M. Sc. I	II	01	09	03	03	01	01	00	01	00	22
M. Sc. II	III	01	07	02	02	01	01	00	00	01	22
M. Sc. II	IV	01	07	02	02	01	01	00	00	01	22

* RM: Theory and Practical credits in RM paper shall be decided by the Department. The final marks/grade point shall be calculated by considering theory and practical marks.

Master of Science (M. Sc.) Credit Distribution

Class	Semester	Subjects	Courses	DSC		DSE		RM/OJT/ Internship etc.		Project *	Total Credits
				T	P	T	P	T	P		
M. Sc. I	I	01	09	08	06	02	02	04*		00	22
M. Sc. I	II	01	09	08	06	02	02	00	04	00	22
Exit Option: PG Diploma											
M. Sc. II	III	01	07	08	06	02	02	00	00	04	22
M. Sc. II	IV	01	07	08	04	02	02	00	00	06	22
				32	**20**	**08**	**08**	**02**	**06**	**12**	**88**

Master of Science (M. Sc.) Distribution of Courses

Class	Semester	Course and their credits in the bracket			
		DSC	DSE	RM/OJT/ Internship etc.	Project *
M. Sc. I	I	DSC -01 (03)	DSE -01 (02)	RM-01(04)	NA
M. Sc. I	I	DSC -02 (03)	DSE -02 (02)		
M. Sc. I	I	DSC -03 (02)			
M. Sc. I	I	DSC -04 (02)			
M. Sc. I	I	DSC -05 (02)			
M. Sc. I	I	DSC -06 (02)			
M. Sc. I	II	DSC -07 (03)	DSE -03 (02)	OJT-01 (04)	NA
M. Sc. I	II	DSC -08 (03)	DSE -04 (02)		
M. Sc. I	II	DSC -09 (02)			
M. Sc. I	II	DSC -10 (02)			
M. Sc. I	II	DSC -11 (02)			
M. Sc. I	II	DSC -12 (02)			
M. Sc. II	III	DSC -13 (04)	DSE -05 (02)	NA	PR-01(04)
M. Sc. II	III	DSC -14 (04)	DSE -06 (02)		
M. Sc. II	III	DSC -15 (03)			
M. Sc. II	III	DSC -16 (03)			
M. Sc. II	IV	DSC -17 (04)	DSE -05 (02)	NA	PR-02(06)
M. Sc. II	IV	DSC -18(04)	DSE -06 (02)		
M. Sc. II	IV	DSC -19 (02)			
M. Sc. II	IV	DSC -20 (02)			

Programme Framework (Courses and Credits): M. Sc. Physics

Sr. No.	Year	Semester	Level	Course Type	Course Code	Title	Credits
1.	I	I	6.0	DSC-01	MS-PH111T	Mathematical Methods in Physics	03
2.	I	I	6.0	DSC-02	MS-PH112T	Classical Mechanics	03
3.	I	I	6.0	DSC-03	MS-PH113T	Python Programming	02
4.	I	I	6.0	DSC-04	MS-PH114P	Basics Physics Lab 1	02
5.	I	I	6.0	DSC-05	MS-PH115P	Electronics Lab 1	02
6.	I	I	6.0	DSC-06	MS-PH116P	Python Programming Lab	02
7.	I	I	6.0	DSE-01	MS-PH117T	Laser and Applications	02
8.	I	I	6.0	DSE-02	MS-PH118P	Laser and Applications Lab	02
9.	I	I	6.0	RM-01	MS-PH119T/P	Research Methodology	04
10.	I	II	6.0	DSC-07	MS-PH121T	Quantum Mechanics	03
11.	I	II	6.0	DSC-08	MS-PH122T	Electrodynamics	03
12.	I	II	6.0	DSC-09	MS-PH123T	Electronics	02
13.	I	II	6.0	DSC-10	MS-PH124P	Basics Physics Lab 2	02
14.	I	II	6.0	DSC-11	MS-PH125P	Electronics Lab 2	02
15.	I	II	6.0	DSC-12	MS-PH126P	Computational Physics using Python	02
16.	I	II	6.0	DSE-05	MS-PH127T	Nanotechnology	02
17.	I	II	6.0	DSE-06	MS-PH128P	Nanotechnology Lab.	02
18.	I	II	6.0	OJT-01	MS-PH129P	On Job Training	04
19.	II	III	6.5	DSC-13	MS-PH131T	Atomic, Molecular Physics	04
20.	II	III	6.5	DSC-14	MS-PH132T	Statistical Mechanics	04
21.	II	III	6.5	DSC-15	MS-PH133P	Advanced Physics lab	03
22.	II	III	6.5	DSC-16	MS-PH134P	Sensors Lab.	03
23.	II	III	6.5	DSE-05	MS-PH135T	Energy Studies I	02
24.	II	III	6.5	DSE-06	MS-PH136P	Energy Studies I Lab	02
25.	II	III	6.5	PR-01	MS-PH137P	Research Project I	04
26.	II	IV	6.5	DSC-17	MS-PH131T	Solid State Physics	04
27.	II	IV	6.5	DSC-18	MS-PH132T	Nuclear Physics	04
28.	II	IV	6.5	DSC-19	MS-PH133P	Particle Physics Lab.	02
29.	II	IV	6.5	DSC-20	MS-PH134P	Electronic Instrumentation Lab.	02
30.	II	IV	6.5	DSE-07	MS-PH135T	Energy Studies II	02
31.	II	IV	6.5	DSE-08	MS-PH136P	Energy Studies II Lab	02
32.	II	IV	6.5	PR-02	MS-PH137P	Research Project II	06

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar (Autonomous)

Board of Studies in Physics

Sr. No.	Name	Designation
1.	Prof. (Dr.) Avinash V. Mancharkar	Chairman
2.	Dr. Ashok A. Jadhavar	Member
3.	Dr. Anand A. Surse	Member
4.	Mr. Pankaj P. Bhosale	Member
5.	Miss. Rupin H. Ranu	Member
6.	Mr. Dipak A. Magar	Member
7.	Miss. Vaishali B. Sawane	Member
8.	Miss. Asmita A. Shirsat	Member
9.	Mr. Vishal V. Kapase	Member
10.	Miss. Ashwini S. Jagdale	Member
11.	Miss. Bhagitra D. Chede	Member
12.	Miss. Mayuri A. Late	Member
13.	Dr. Appasaheb Torane	Academic Council Nominee
14.	Dr. Vijay M. Mayekar	Academic Council Nominee
15.	Prof. (Dr.) Arun G. Banpurkar	Vice-Chancellor Nominee
16.	Prof. (Dr.) Nandu B. Chaure	Alumni
17.	Dr. Vinay Hasabnis	Industry Expert
18.	Dr. Shrikrushna B. Gaikwad	Member (Co-opt)
19.	Mr. Dattatray K. Sonwane	Member (Co-opt)
20.	Mr. Dipak S. Shelar	Member (Co-opt)

1. Prologue/ Introduction of the programme:

This curriculum for the M. Sc. in Physics designed for the requirement of implementation of New Eduation Policy – 2020 (NEP 2020) following the University Grants Commission (UGC) and Savitribai Phule Pune University guidelines under Choice Base Credit System (CBCS) Pattern..

As per the guidelines, we proposed structure including Core courses, Discipline specific elective courses, along with Discipline specific Special elective courses. In the CBCS pattern, continuous assessment of the students is an integral part. This continuous assessment carried out through systematic based on better understanding of the subject.

During the curriculum designing and formulating, we have added the skill oriented courses to encourage students for achieving fruitful skills while completing their master degree in Physics. Curriculum designed to motivate students for the pursuing career in research and inculcate enough skills for becoming an entrepreneur.

This curriculum is designed such way that, it intended to provide help to create an academic base that responds to the need of the students to understand the basics of Physics and its ever evolving nature of applications in explaining all the observed natural phenomenon as well as predicting the future applications to the new phenomenon with a global perspective.

In this curriculum, we have mainly focused on the development of scientific attitudes and values appropriate for rational reasoning, critical thinking and developing skills for problem solving and initiating research, which are competitive globally.

This curriculum emphasizes the discipline of Physics to be the most important branch of science for pursuing the interdisciplinary and multidisciplinary higher education and/or research in interdisciplinary and multidisciplinary areas.

It also emphasizes the importance of Physics as the most important discipline for sustaining the existing industries and establishing new ones to create job opportunities at all levels of employment.

In view of opening the new windows in higher education and research and opening job opportunities at all levels from technicians to innovator scientists and engineers, this postgraduate M.Sc. Physics program offered in our institute.

This programme strongly focused on the problems solving, project work, research project work, etc. such way that students should acquire some the skills like demonstrate, problem solver, etc. which will help students to become good educator as well as the good human being.

2. Programme Outcomes (POs)

After successful completion of this program, they will train for essential skills and abilities required for the bright future. They will have the opportunity to master the following objectives.

1. Motivate students for participation in scientific events such as Conferences, Webinars and Seminars.
2. Motivate to visit national scientific institutes so that they will get status of the research in the field of physics.
3. Motivate students to pursue project work in nearby industries so that they can understood scientific and technological aspects of Physics in the industries.
4. Enhanced knowledge through scientific problem solving using latest programming language, seminar presentation, participation in science exhibition, mini and major projects, etc.
5. Motivate students to peruse career in research and development science.
6. Chance to conduct various experiments; this will help students to learn various concepts of Physics through experiments.

7. Give experimental and computational hands on experience to develop ability to scientific problems.
8. Train students in get skills related to research, education and industry for bright future.
9. Help students to build-up a progressive and successful career in Physics.
10. Capable of identifying/mobilizing appropriate resources required for a project, and manage a project through to completion, while observing responsible and ethical scientific conduct; and safety and laboratory hygiene regulations and practices.
11. Capable of using computers for simulation studies in Physics and computation and appropriate software for numerical and statistical analysis of data, and employing modern e-library search tools like Inflibnet, Shodhganga, etc.
12. The graduate should be capable of demonstrating ability to think and analyze rationally with modern and scientific outlook and identify ethical issues related to one's work, avoid unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights, and adopting objectives, unbiased and truthful actions in all aspects of work.
13. The graduates should be able to develop a national as well as international perspective for their career in the chosen field of the academic activities.
14. Capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and reskilling in all areas of Physics.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: Mathematical Methods in Physics								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-1	MS-PH111T	03	00	03	45	30	70	100

Learning Objectives:

1. Provide a solid mathematical foundation for the budding Physicist eager to climb the ladder of self-learning.
2. Motivate students to use of mathematical methods to solve physics problems.
3. Provide students with basic skills necessary for the application of mathematical methods in physics.
4. Teach special functions and their recurrence relations.

Course Outcomes (Cos):

1. Study various mathematical concepts used in the study of Physics
2. Understand basic theory of Complex algebra Analysis, Linear Algebra, Matrix algebra
3. Understand Special functions, Fourier series and integral transforms.
4. Demonstrate quantitative problem solving skills in all the topics covered.
5. Fearlessly solve problems in physics.

Detailed Syllabus: Example

Unit I: Complex Analysis **(15 Hrs.)**

Complex number, Complex function (polynomial, Exponential, Trigonometric complex function, Logarithm), Limit and Continuity, differentiation, Analytical function, Cauchy-Riemann condition, Line integrals, Cauchy integral formula, Derivative of analytical functions, Power Series, Taylor's theorem, Laurent's theorem, Calculus of residues, Evaluation of real definite integrals

Unit II: Vector Space and Matrix Algebra **(15 Hrs.)**

Revision on Vector space: Vectors (dependent and independent), Vector space, Dimension of vector space, Matrix representation, Similarity transformation, Eigen values and Eigen vectors, Inner product, Orthogonality, Introduction only to Gramm-Schmidt orthogonalization procedure, Self adjoint and unitary transformation, Diagonalization

Unit III: Special Functions and Fourier Series **(15 Hrs.)**

Bessel function, Legendre, Hermite, and Laguerre functions – Generating function, Recurrence relations and their differential equations, Orthogonality properties, Bessel's function of first kind, Associated Legendre function.

Fourier series: Definition, Dirichlet's Condition, Convergence, Fourier Integral and Fourier transform, convolution theorem, Parseval's identity, Fourier transform and Laplace transform of Dirac Delta function

Suggested Readings/Material:

1. Complex Variables and Application- J. W. Brown, R. V. Churchill - McGraw Hill
2. Complex Variables – Seymour Lipschutz
3. Mathematics for Physical Sciences – Mary Boas, John Wiley and Sons
4. Mathematical methods in Physics- B. D. Gupta
5. Mathematical methods in Physics- Satyaprakash
6. Linear algebra – Seymour Lipschutz, Schaum Outline Series McGraw Hill Edition
7. Mathematical Method for Physicists, Arfken and Weber, 6th Edition, Academic Press, New York.
8. Mathematical methods in Physics- H. K. Dass
9. Mathematical Methods in Physics 2, By Prof. Auditya Sharma | IISER Bhopal https://onlinecourses.nptel.ac.in/noc21_ma48/preview
10. Mathematical Methods and its Applications, Prof. P. N. Agrawal, Prof. S. K. Gupta, IITR, https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-ma14/

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
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Syllabus
M.Sc. Physics

Title of the Course: Classical Mechanics								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-2	MS-PH112T	03	00	03	45	30	70	100

Learning Objectives:

1. Explain drawbacks of Newtonian approach and necessity of new approaches to solve advanced problems involving the dynamic motion of classical mechanical systems.
2. Introduce constraints, degree of freedom and Lagrangain to determine the motion of complex system.
3. Explain about the Hamiltonian; use Hamiltonian to determine the motion of the complex system.
4. Explain inertial frame and non-inertial frame of reference and solve numerical problems associated with them.
5. Explain canonical transformation, Legendre transformation and applications.

Course Outcomes (Cos):

1. Understand the drawbacks of Newtonian approach and necessity of new approaches to solve advanced problems involving the dynamic motion of classical mechanical systems.
2. Determine the constraints, degree of freedom for given system and determine equation of motion using Lagrangain.
3. Calculate Hamiltonian and use it to determine the motion of the complex system.
4. Understand the difference between the inertial frame and non-inertial frame of reference and solve numerical problems associated with them.
5. Understand the canonical transformation, Legendre transformation and applications.

Detailed Syllabus:

Unit I: Lagrangain Dynamics (10 Hrs.)

Introduction, Basics Concepts: Degree of freedom, Constraints, Generalized coordinates. Principle of Virtual work done, Lagrange's equation of motion, D'Alembert's principle, Lagrange Equation of motion in non-conservative force field.

Lagrangain for a charged particle in moving electromagnetic field, Hamilton's Principle, Theorem of total energy, Symmetry properties of space and time, conservation laws, Invariance under Galilean transformation.

Unit II: Hamiltonian Dynamics (08 Hrs.)

Generalized momentum and cyclic coordinates, Conservation Theorems (Linear Momentum, Angular Momentum), Jacobi's Integral, Hamilton's Equations in different

coordinate systems, Examples of Hamiltonian dynamics (Harmonic Oscillator, Central force filed, Charged particle in EM field)

Unit III: Variational Principle (06 Hrs.)

Variational principle: Calculus of Variation and Euler-Lagrange's Equation, Modified Hamiltons Principle, Principle of Least Action, Shortest distance, Brachistochrone, Geodesics.

Unit IV: Central force and Rotating Frame of Reference (08 Hrs.)

One body equivalent problem, Equation of motion under central force field, Inverse square law of force. Kepler's Laws of Planetary motion and their deduction, Stability of orbit, Virial Theorem. Rotating frames of reference, Coriolis force and examples, banking of rivers, Foucault's pendulum.

Unit V: Small Oscillations (06 Hrs.)

Potential Energy and Equilibrium – 1D Oscillator, Two coupled Oscillators, Small Oscillations theory, Examples (Two Coupled Pendulum, Double Pendulum), Normal modes and normal coordinates.

Unit VI: Canonical transformations and Poisson brackets (07 Hrs.)

Canonical Transformations, Legendre transformations, Generating function, Application of Canonical Transformations.

Poisson Brackets, Lagrange Brackets, Relation between the Lagrange bracket and Poisson Brackets, Invariance of Poisson Bracket under canonical transformation.

Suggested Readings:

1. Classical Mechanics by H. Goldstein, C. Poole and J. Safko
2. Classical Mechanics by J.C. Upadhhay
3. Classical Mechanics by N. C. Rana and P.S. Joag
4. Mechanics by L. D. Landau and E.M. Lifshitz
5. Classical Mechanics by J. R. Taylor
6. Classical Mechanics by P. V. Panat
7. Problems in classical mechanics, by N. L. Katkar
8. Introduction to Classical Mechanics Prof. Anurag Tripathi IIT,Hyderabad, https://onlinecourses.nptel.ac.in/noc21_ph29/preview
9. Classical Mechanics: From Newtonian to Lagrangian Formulation Prof. Debamalya Banerjee, IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc21_ph32/preview

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
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Syllabus
M.Sc. Physics

Title of the Course: Python Programming								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-3	MS-PH113T	02	00	02	30	15	35	50

Learning Objectives:

1. Explain all basic things related to Python language.
2. Explain the concept of String, Tuples and Sets.
3. Explain terms like Dictionary and files.
2. Explain importance of Function and Python Classes.

Course Outcomes (Cos)

1. Understand the basic concept of Python language.
2. Understand the concept of String, Tuples and Sets.
3. Understand importance of Dictionary and files.
4. Understand importance of the Function and Python Classes and their use.

Unit 1: Basic Python **(06 Hrs.)**

Python identifiers and reserve words, Lines and Indentation, multiline statements, Comments, Input / Output with print and input functions, Command line arguments and Processing command line argument, Standard data type – Basic, None, Boolean, Numbers, Python strings, Data type conversion, Python basic operators (Arithmetic, Comparison, Assignment, Bitwise, Logical), Python Membership operators (in and not in), Python Identity operators (is and is not), Operator Precedence, Control statements, Python Loops, Interacting by subsequence index loop control statements (break, continue, pass).

Unit 2: Python Strings **(06 Hrs.)**

Concept escape characters, String special operations, String formatting operator, Single quotes, double quotes triple quotes, Raw string, Unicode string built in string methods, Python lists- concept creating and accessing elements, updating and deleting list, basic list operators, reverse, Indexing, slicing and matrices, Built in functions.

Unit 3: Python Tuples and Sets **(04 Hrs.)**

Creating and Deleting tuples, accessing values in a tuple, updating tuples deleting tuple elements, Basic tuple operations, Indexing, slicing and matrices built-in functions, Sets-concept, operations.

Unit 4: Python Files and Dictionary **(04 Hrs.)**

Creating files, Operations on files (open, close, read, write), File object attributes file positions, Testing file types, removing files, copying and renaming files, Concept mutable, Creating and accessing values in a dictionary, Update in dictionary, deleting dictionary elements, Properties of dictionary keys, Built in dictionary functions and methods.

Unit 5: Functions **(05 Hrs.)**

Defining a functions def., Calling a function, Function arguments- pass by value keyword arguments default argument, Scope and variable basic rules, Documentation string, Variable number of arguments, Call by reference, Order by arguments (positional, extra and keyword), Anonymous functions, Recursion, Treatment of input and output arguments, Unpacking, argument list, Lambda forms, Function objects, Function ducktyping and polymorphism , Generators (function and expression) and iterators, list comprehensions.

Unit 6: Python Classes/Objects **(05 Hrs.)**

Object oriented programming and classes in Python- creating classes instances objects accessing members, Data hiding (the double underscore prefix), Built-in class attributes, Garbage collection: the constructor, Overloading methods and operators, Inheritance-implementing subclass overriding methods, Recursive calls of methods, Class variables, class methods and static methods.

Suggested Readings/Material:

1. Mark Lutz, Programming Python, O`Reilly, 4th Edition, 2010.
2. Dive into Python, Mike.
3. Learning Python, 4th Edition by Mark Lutz.
4. Programming Python, 4th Edition by Mark Lutz.
5. Python Programming: An introduction to computer, John Zelle,3rd Edition
6. NPTEL Video: https://onlinecourses.nptel.ac.in/noc22_cs32/preview , Python for Data Science, Prof. Ragunathan Rengasamy, IIT Madras.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
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Syllabus
M.Sc. Physics

Title of the Course: Basics Physics Lab 1								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-4	MS-PH114P	00	02	02	60	15	35	50

Learning Objectives:

1. To give knowledge of some basic of laboratory experiments.
2. Give hands on skill for physics lab work.
3. Inculcate experimental cultural in students.
4. Develop skill to find out the possible errors during practical.
5. Motivate students for experiments

Course Outcomes (Cos)

1. Understand the physics concept with the help of actual experiments.
2. Handle scientific instruments during the practical.
3. Have hands-on practice of the basic physics theory and its applications.
4. Able to analyze their result and analyze them.
5. Able to analyze the error in their measurement

Detailed Syllabus: Any 12 Experiments

Sr. No.	Title of Experiment
1.	To study absorption spectra of Iodine molecule and to determine its dissociation energy using spectrometer
2.	Michelson's interferometer :To determine the wavelength of He-Ne LASER by using Michelson's interferometer apparatus
3.	Gouy's method-Measurement of magnetic susceptibility of MnSO4
4.	Rydberg's constant using constant deviation prism
5.	Fabry-Parrot Etalon
6.	Specific heat of solids: To determine the specific heat of Copper, Lead and Glass at three different temperatures
7.	Clausius -Mossotti equation using sugar solution (Determination of polarization)
8.	Electron spin resonance: To study the electron spin resonance and to determine Lande's g- factor
9.	Study of Compton scattering
10.	Study of dielectric constant and curie temperature measurement of ferroelectric ceramics

11.	Determine the charge on electron using Millikan oil drop apparatus
12.	Speed of light: To determine speed of light using transit time of light pulse as a function of a reflecting mirror
13.	Determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law
14.	Determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus
15.	Determine the Planck's constant using LEDs of at least 4 different colors.
16.	Determine Refractive index and Cauchy's Constant
17.	Analyze I-V characteristics of Photo diode, LED, Phototransistor and LDR

Additional Activity

Study Tour Visit Report / Mini Project / Science Exhibition Participation / Poster or Oral presentation in Conference or any other activity related to this course is equivalent to **Two** practical.

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New Arts, Commerce and Science College, Ahmednagar
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Syllabus
M.Sc. Physics

Title of the Course: Electronics Lab 1								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-5	MS-PH115P	00	02	02	60	15	35	50

Learning Objectives:

1. To give knowledge of some basic electronic components and circuits.
2. Give hands on skill for circuit designing.
3. Inculcate experimental sense of the various circuits.
4. Develop skill to find out the error in the designed circuit.

Course Outcomes (Cos):

1. Have hands-on practice of the theory course and its applications.
2. Design a circuit for the required output-using breadboard and PCB.
3. Understand working of various electronic circuits.
4. Understand how to use the basic test and measuring instruments to test the circuits

Detailed Syllabus: Any 12 Experiments.

Sr. No.	Title of Experiment
1.	DAC (Digital to Analogue Converter) using R-2R and Binary ladder
2.	Active filters using OP-AMP
3.	Crystal Oscillator
4.	Foldback Current Power Supply
5.	Constant Current Source using OPAMP
6.	Precision Rectifier : Half wave, Full wave
7.	OPAMP Logarithmic Amplifier
8.	Mono-stable and Astable Multivibrator using IC555
9.	Low/High voltage power supply using IC-723
10.	Inverting and non-inverting Amplifier using IC741
11.	Function generator using IC-8038
12.	Adder/Subtractor using IC- 741
13.	Integrator / Differentiator using IC 741
14.	OPAMP as Comparator

Additional Activity

Study Tour Visit Report / Mini Project / Science Exhibition Participation / Poster or Oral presentation in Conference or any other activity related to this course is equivalent to **Two** practical.

Suggested Readings/Material:

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 7th Ed., Mc-Graw Hill, 2001.
2. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, Prentice Hall, 2015.
3. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
4. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson
5. Operational Amplifier by G.B Clayton, 5th Edition, Newnes, 2003.
6. Principles of Digital Electronics by Malvino, Leach,Saha , 8 th Edition, McGraw Hill Education, 2014.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
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Syllabus
M.Sc. Physics

Title of the Course: Python Programming Lab.								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-6	MS-PH116P	00	02	02	60	15	35	50

Learning Objectives:

5. Give depth in knowledge of the core courses in Physics.
3. Inculcate theoretical sense of the science through problem solving.
4. Guide to develop logic for problem solving.
5. Motivate students for solving problems with programming.

Course Outcomes (Cos)

1. Learn scientific concepts through C-Programming Language.
2. Able to solve numerical problems.
3. Get quantitative problem skills in Mathematical Methods in Physics, Classical Mechanics, Electrodynamics, etc.
2. Develop logic for problem solving.
3. Write their own c-Program; compile and execute.

Detailed Syllabus: Any 12 Experiments

Sr. No.	Title of Experiment
1.	Legendre Polynomial using Standard Recurrence Relation
2.	Bessel function of first Kind using standard recurrence relation
3.	Generate and Print first hundred Prime numbers
4.	Find out the value of Pi using Monte- Carlo simulation Method
5.	Lagrange Interpolation Method
6.	Find out largest/Smallest from a given set of numbers
7.	Trapezoidal/Simpsons rule to integrate a given function
8.	Find out Armstrong number
9.	Gauss Elimination method to solve simultaneous equations
10.	Least square approximation i.) Linear fit ii.) Fitting an exponential
11.	Obtain weight of a person at different points in our solar system
12.	Fibonacci series

13.	De-Broglie wavelength of Proton, Neutron and electron for a fixed potential
14.	Obtain electric field of a unit charge at 10 different distances
15.	Runge-Kutta method of solving a differential Equation

Additional Activity

Study Tour Visit Report / Mini Project / Science Exhibition Participation / Poster or Oral presentation in Conference or any other activity related to this course is equivalent to **Two** practical.

Suggested Readings/Material:

1. Byron.S. Gottfried Schaumm's outline of theory and problems of Programming with C. Tata Mc. Graw Hill Publication. 1991.
2. Suresh Chandra Applications of Numerical Techniques with C.New Delhi. Narosa Publishing House 2006.
3. Brain.W. Kernighan and Dennis M. Ritchie. The C-Programming language. 2nd ed. New Delhi Prentice Hall of India 1998.
4. E-Balagurusamy Numerical Methods New Delhi Tata Mc. Graw Hill Publication.1999.
5. A.K.Ghatak.,T.C. Goyal, S.J. Chua. Mathematical Physics New-Delhi Mc. Millan 1995.
6. http://www.physics.ntua.gr/~konstant/ComputationalPhysics/C++/Book/ComputationalPhysicsKNA2ndEd_nocover.pdf

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: LASER and Applications								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-1	MS-PH117T	02	00	02	30	15	35	50

Learning Objectives:

1. Explain basic principle of MASER and LASER.
2. Explain mathematical treatment on LASER action.
3. Introduce Quantum theory of the LASER.
4. Explain information about the LASER process and types of LASERS.
5. Explain various applications of LASER in our day-to-day life.

Course Outcomes (Cos):

1. Understand basic principle of the MASER and LASER.
2. Understand actual functioning of various types of LASER.
3. Understand the spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser in details.
4. Learn to apply basic quantum physics to various types of LASER.
5. Qualitative understanding of basic lasing mechanism, types of Lasers, characteristics of Laser Light, types of Lasers, and its applications

Detailed Syllabus:

Unit I: Introduction (10 Hrs.)

The MASER and LASER principle, Absorption, spontaneous and stimulated emission, population inversion, Metastable state, gain, absorption coefficient, Einstein's coefficient, stimulated emission cross section, threshold condition.

The problems of LASER theory, Rate equations, Semi classical theory, Quantum theory of the LASER, Quantum classical correspondence, Optical bistability, Two-photon LASER, Structure of LASER theory and its representation.

Unit II: LASER Process and Materials (10 Hrs.)

LASER condition, Properties of LASER light, LASER processes, Types of LASERs- Solid state LASERs: Nd:YAG LASER, Gas LASERs : He-Ne LASER, CO_2 LASER, Liquid LASER : Tunable dye LASER (Principle, Construction, Energy level diagram, working)

Unit III: Applications of LASER **(10 Hrs.)**

Industrial applications: Cutting, melting, welding, And drilling, surface hardening Medical applications: Skin therapy, LASER eye surgery, LASER surgery, tumor ablation Military applications: Range finders, LASER radar, and LASER gyro.

Scientific applications: In spectroscopy, LASER deposition, optical fiber communication. LASER in Defense Applications.

Suggested Readings/Material:

1. LASER Light Dynamics, Light-II, H. Haken, North Holland Publication, (1985).
2. Solid State Engineering Vol-I – W. Koechner Springer Verlag(1976).
3. LASERs Fundamentals – W.T. Silfvast.
4. Principles of LASERs – O.Svelto – Plenum,1982
5. LASER Parameters -Heard
6. LASER and Non-Linear Optics – B.B. Laud (2nd Edition)
7. LASERs --Nambiar
8. Introduction to Fiber Optics – A. Ghatak, K. Thyagarajan – Cambridge University Press
9. Principles of LASER and Their Applications – Callen O'Shea Rhodes.
10. An Introduction to LASER Theory And Application – M.N. Avdhanulu, S. Chand Publication
11. Experiments With LASER –Sirohi

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: LASER and Applications Lab								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-2	MS-PH118P	00	02	02	60	15	35	50

Learning Objectives:

1. Aware about the risk factors associated with LASER.
2. Explain students to develop basic skill in using and handling LASER and its components.
3. Explain various optical phenomena of LASER by the experiments.
4. Explain various properties and characteristics of LASER through the experiments.
5. Give hands on training for the handling of the LASER.

Course Outcomes (Cos):

1. Understand risk factors associated with LASER and gain basic skills using and handling LASER.
2. Understand various optical phenomena of LASER through the experiments.
3. Understand various properties and characteristics of LASER through the experiments.
4. Able to use types of LASER for specific application.

Detailed Syllabus: Any 12 Experiments

Sr. No.	Title of Experiment
1.	Determination of wavelength of He-Ne LASER using grating element
2.	Determination of wavelength of He-Ne LASER using measuring scale
3.	Determine spot size of LASER using knife-edge
4.	Determine divergence of LASER beam
5.	Determine energy and power of LASER beam
6.	Determine diameter of wire using LASER
7.	Measurement contamination in liquid sample using LASER beam
8.	Use of LASER in optical fiber communication
9.	Determine the wavelength of Laser sources by Single slit experiments
10.	Determine wavelength of Laser sources by Double slit experiments
11.	Determine wavelength and angular spread of He-Ne Laser using plane diffraction grating

12.	Determination of grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser
13.	To find the width of the wire or width of the slit using diffraction pattern obtained by a He- Ne or solid state laser
14.	Find the polarization angle of laser light using polarizer and analyzer
15.	Study the diffraction patterns of single and double slits using laser and measure its intensity variation using Photo sensor
16.	Michelson Interferometer-Determination of wavelength of laser
17.	Determination of wavelength of laser, etalon spacing, Fineness and Free spectral range of the etalon
18.	Verification of law of refraction and finding refractive index of water using laser

Additional Activity

Study Tour Visit Report / Mini Project / Science Exhibition Participation / Poster or Oral presentation in Conference or any other activity related to this course is equivalent to **two** practical.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: Research Methodology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
RM-1	MS-PH119T/P	02	02	04	90	30	70	100

Learning Objectives:

1. Explain an important dimension relating to research, namely, that of research methodology.
2. Explain planning and development, that the significance of research lies in its quality and not in quantity.
3. Explain important research analysis techniques in the scientific research.
4. Explain basics of the characterization techniques like XRD, SEM and AFM.

Course Outcomes (Cos):

1. Understand important dimension relating to research, namely, that of research methodology.
2. Able to planning and development that the significance of research lies in its quality and not in quantity.
3. Understand important research analysis techniques in the scientific research.
4. Understand basics of the characterization techniques like XRD, SEM and AFM.

Detailed Syllabus:

Unit I: Research Methodology and Research Design (10 Hrs.)

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Research Methods versus Methodology, Research and Scientific Method, Importance of Research Process, Criteria of Good Research, Problems Encountered by Researchers in India. Selection of Problem, Necessity of Defining Problem, Technique Involved in Defining a Problem, Conclusion.

Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Conclusion.

Unit II: Methods of Data Collection and Report Writing (11 Hrs.)

Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Difference between Questionnaires and Schedules, Some Other Methods of Data Collection, Collection of Secondary Data.

Interpretation, Technique of Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

Unit III: Structural Characterization (05 Hrs.)

X-ray Diffraction–Production of X-rays, Types (continuous and characteristics), Bragg's diffraction condition, principle, instrumentation (with filters) and working, Techniques used for XRD–Powder method, Derivation of Scherrer formula for size determination.

Unit IV: Spectroscopic Analysis (05 Hrs.)

Spectroscopic characterization (principle, instrumentation and working): Infra-Red (IR), Fourier Transform Infra-Red (FTIR) advantages and disadvantages between IR and FTIR, Raman Spectroscopy, Ultraviolet-Visible (UV-VIS).

Unit V: Morphological Analysis (05 Hrs.)

Electron Microscopy: Principle, Instrumentation and Working of Scanning Electron Microscope (SEM),Transmission Electron Microscope(TEM), SAED pattern, Probe Microscopy :Principle, Instrumentation and Working of Atomic Force Microscope (AFM)

Suggested Readings/Material:

1. C.R. Kothari, Research Methodology, Methods and techniques, 2nd Edition, New Age International Publishers.
2. Ackoff, Russell L., The Design of Social Research, Chicago: University of Chicago Press, 1961.
3. Ackoff, Russell L., Scientific Method, New York: John Wiley & Sons, 1962.
4. Allen, T. Harrell, New Methods in Social Science Research, New York: Praeger Publishers, 1978.
5. Bailey, Kenneth D., "Methods of Social Research," New York, 1978.
6. Instrumentation: Devices and Systems, C. S. Rangan, G. R. Sarma, V. S. V. Mani, Tata McGraw Hill Publishing Co. Ltd., 1983.
7. Characterization of Materials, John B. Wachtman, Zwi. H. Kalman, Pub.Butter worth Heinemann, 1992.
8. Elements of X-ray Diffraction, B. D. Cullity, S. R. Stock, Print Ice Hall Publication, 3rd Edition, 2001.
9. Instrumental Methods of Analysis, H. H. Willard, l. L. Merritt, J. A. Dean, CBS Publishers, 7th Edition, 1988.
10. NPTEL Video: https://nptel.ac.in/courses/105/106/105106200/, Structural Characterization and Thermal Analysis, Prof. Manu Santhanam, IIT Madras, 2019.
11. NPTEL Video: https://nptel.ac.in/courses/104/106/104106122/, Spectroscopic Analysis, Physical and material chemistry Division, Dr. Sayan Bagchi, NCL Pune, 2019.

Any 12 Experiments:

Sr. No.	Title of Experiment
1.	Write a short review of the given research paper
2.	Thickness measurement of thin film by Tolansky method
3.	Measurement of resistance of thin film by two probe method with variation in temperature

4.	Measurement of reflectivity and transferability of thin films by using He-Ne laser and Determination of refractive index of a transparent film by Abe's method
5.	Determine band gap of deposited thin film by Tauc plot
6.	Determine thickness of thin film using Swanpoel Method
7.	Study of magnetic nanoparticles using hysteresis
8.	Optical Verification of nanoparticles
9.	Determine the Morphology of thin films(SEM)
10.	Calculate roughness of the thin films with the help of AFM
11.	Study the Cyclic voltammetry technique
12.	Use TEM image to calculate the particle size
13.	Use TEM image and study the given film is monocrystalline or polycrystalline in nature
14.	Use Selected area electron diffraction (SAED) pattern to analyze the structural properties of given sample
15.	Analyze various modes of vibrations in the given silicon sample using Raman Spectroscopy
16.	Use of Raman Spectroscopy to determine the crystalline volume fraction of the given silicon sample

Additional Activity

Study Tour Visit Report / Mini Project / Science Exhibition Participation / Poster or Oral presentation in Conference or any other activity related to this course is equivalent to **Two** practical.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar (Autonomous)

Syllabus

M.Sc. Physics

Title of the Course: Quantum Mechanics								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-7	MS-PH121T	03	00	03	45	30	70	100

Learning Objectives:

1. Introduce students with the quantum mechanics formulation.
2. Explain the limitations of the Classical Mechanics and need of the Quantum mechanical formulation to explain microscopic phenomena.
3. Introduce quantum theory through Schrodinger equation.
4. Explain and interpret need of the wave function to solve the problem associate with quantum particle and probabilistic nature of its location and subtler points of quantum phenomena
5. Explain behavior of quantum particle encountering a i) barrier, ii) potential and motivate students to solve non-relativistic hydrogen atom, for its spectrum and Eigen functions.
6. Explain influence of electric and magnetic fields on atoms, which will help in understanding Stark effect and Zeeman Effect respectively.
7. Motivate students to solve many body problems with quantum mechanical formulation.

Course Outcomes (Cos):

1. This course will enable the student to get familiar with quantum mechanics formulation.
2. After an exposition of inadequacies of classical mechanics in explaining microscopic phenomena, quantum theory formulation is introduced through Schrodinger equation.
3. The interpretation of wave function of quantum particle and probabilistic nature of its location and subtler points of quantum phenomena are exposed to the student.
4. Through understanding the behavior of quantum particle encountering a i) barrier, ii) potential, the student gets exposed to solving non-relativistic hydrogen atom, for its spectrum and Eigen functions.
5. Study of influence of electric and magnetic fields on atoms will help in understanding Stark effect and Zeeman Effect respectively.
6. This basic course will form a firm basis to understand quantum many body problems.
7. This course shall develop an understanding of how to model a given problem such as particle in a box, hydrogen atom, and hydrogen atom in electric fields, many electron atoms, and L-S and J-J couplings.
8. These skills will help in understanding the different Quantum Systems in atomic and nuclear physics.

Detailed Syllabus:

Unit I: The Wave Function and General Formalism (12 Hrs.)

Limitations of classical Physics, wave packets, Schrodinger Equation, Statistical interpretation, probability, normalization, momentum, Uncertainty Principle, Postulates of Quantum Mechanics. Linear Algebra (Vectors, Inner Products, Linear Transformation, Eigenvalues and Eigen functions, Hermitian Transformation) functions Spaces (Legendre polynomials, Operators, Hilbert Space), Statistics Interpretation, proof of Uncertainty Principle.

Unit III: Time Independendent Schrondinger Equation (12 Hrs.)

Stationary States, Infinite Square well, Harmonic Oscillator (Algebraic Method, Analytic Method), Free Particle, and Finite well.

Unit III: Representation of States – Dirac notation (10 Hrs.)

Dirac's bra and ket notation, linear operators, projection operators, unit operator, unitary operator, matrix representation of an operator, unitary transformation, Eigen values and Eigen functions of simple harmonic oscillator by operator method.

Unit IV: Quantum Mechanics in Three Dimensions (11 Hrs.)

Schrodinger Equation in Spherical polar coordinates, separation of variables, angular equation, radial equation, Hydrogen Atom, Angular momentum, spin.

Suggested Readings/Material:

1. Introduction to Quantum Mechanics, David Griffith, 1st Edition, Prentice Hall, 1995.
2. Quantum Mechanics: Concepts and Applications, Nouredine Zettili, 1st Edition, Wiley Publication, 2009.
3. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, R. Eisberg and R. Resnick, 2nd Edition, Wiley Publication, 2006.
4. A Text-book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2nd Edition, McGraw Hill, 2017.
5. Quantum mechanics by A. Ghatak and S. Lokanathan
6. Quantum Mechanics by L.I. Schiff
7. Modern Quantum mechanics by J. J. Sakurai Principles of Quantum Mechanics, IInd Edition, R. Shankar (Plenum, 1994)
8. Quantum Mechanics and Applications by Prof. Ajoy Ghatak, Department of Physics, IIT Delhi, http://www.nptelvideos.in/2012/11/quantum-mechanics-and-applications.html
9. Quantum Physics by Prof. V. Balakrishnan, Department if Physics, IIT Madras, https://nptel.ac.in/courses/122/106/122106034/
10. Quantum Mechanics by Prof. P. Ramadevi, Department of Physics, IIT Bombay, https://nptel.ac.in/courses/115/101/115101107/

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: Electrodynamics								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-8	MS-PH122T	03	00	03	45	30	70	100

Learning Objectives:

1. Explain and demonstrate Gauss law, Coulomb's law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges.
2. Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.
3. Explain Gauss's law of electrostatics to solve a variety of problems.
4. Articulate knowledge of electric current, resistance and capacitance in terms of electric field and electric potential.
5. Explain the magnetic field produced by magnetic dipoles and electric currents.
6. Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields.
7. Explain the dielectric properties, magnetic properties of materials and the phenomena of electromagnetic induction.

Course Outcomes (Cos):

1. Understand and demonstrate Gauss law, Coulomb's law for the electric field, and apply it to various charge distribution systems.
2. Differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.
3. Apply Gauss's law of electrostatics to solve a variety of problems.
4. Understand the concepts like electric current, resistance and capacitance in terms of electric field and electric potential.
5. Describe the magnetic field produced by magnetic dipoles and electric currents.
6. Apply Faraday-Lenz and Maxwell laws to learn electric and magnetic fields.
7. Understand the dielectric properties, magnetic properties of materials and the phenomena of electromagnetic induction.
8. This course will help in understanding basic concepts of electricity and magnetism and their applications.

Detailed Syllabus:

Unit I: Electrostatics **(08 Hrs.)**

Coulomb's law, Electric Field, Charge Distribution, Divergence and Curl og Electric field, Gauss's law, Applications of Gauss's Law, Electric potential, Poisson's equation and Laplace's equation, Electrostatic Boundary Conditions, Work and Energy in Electrostatics, Conductors.

Unit II: Special Techniques **(08 Hrs.)**

Laplace's equation in 1D, 2D and 3D Boundary Conditions and uniqueness theorem, Methods of images, Separation of variables, Multipole expansions, Potential at large distance, Monopole and Dipole, Electric Filed of dipole.

Unit III: Electric Filed in Matter **(10 Hrs.)**

Dielectrics, Induced Dipoles, Alighment of Polar Molecules, Polarization, Bound Charges, Filed inside Dielectrics, Electric Displacement, Gauss's Law in presence of Dielectrics, Boundary Conditions, Linear Dielectrics, Susceptibility, Permitivity, dielectric constant, Boundary Value problem in Linear Dielectrics, Energy and Force in Dielectrics.

Unit IV: Magntostatics **(10 Hrs.)**

Magnetic Field (B), Lorentz Force Law, Biot-Savart Law, Divergence and Curls of B, Ampere's law and applications, Magnetic Vector Potential, Diamagnets, Paramagnets, Ferromagnets, Magnetization, Bound Currents, Magnetic Susceptibility and permeability, Ferromagetism.

Unit V: Electrodynamics **(09 Hrs.)**

Ohm's Law, Electromotive Force, Faraday's law, induced E Filed, Inductance, Maxwell's Equations, Magnetic Charge, Maxwell's Equations in Matter, Boundary Conditions, Continuty Equation, Poynting's Therorem, Newton's Third law in Electrodynamics, Stress Tensor, Conservation of Momentum.

Suggested Readings/Material:

1. Introduction to Electrodynamics, (4^{th} Ed.) by David J. Griffith, Publication: Prentice-Hall of India, New Delhi, 2015.
2. Introduction to Electrodynamics, by A.Z. Capri and P.V. Panat, Narosa Publishing House, 2000.
2. Foundations of Electromagnetic Theory (4^{th} Ed.), J.R. Reitz, F.J. Milford, R.W. Christy, Pearson, 2008.
3. Classical Electrodynamics (3^{rd} Ed.), by J.D. Jackson, 3rd Edition JohnWiley, 2007.
4. Matrices and Tensors in Physics, A.W. Joshi, 3rd Edition, New Age International
5. Electrodynamics by Kumar Gupta and Singh
6. Electrodynamics, By Dr. Amol Dighe, IIT Bombay, https://nptel.ac.in/courses/115/101/115101004/
7. Electromagnetism, Dr. Nirmal Ganguli, IISER Bhopal, https://nptel.ac.in/courses/115/106/115106122/
8. Introduction to Electromagnetic Theory, Prof. Manoj Harbola, IIT Kanpur, https://nptel.ac.in/courses/115/104/115104088/

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: Electronics								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-9	MS-PH123T	02	00	02	30	15	35	50

Learning Objectives:

1. This course will provide deep explaination of the special function IC's
2. Students will learn applications of special functions IC's
3. Students will learn the electronics behind the regulated power supply.
4. Students will understand the working of power supply and their uses.

Course Outcomes (Cos)

1. Learn special function ICs like OPAMP, IC555 and their applications.
2. Learn special function ICs like IC565 and IC 566 and their applications
3. Learn 3 pin regulators like IC 78XX/79XX, IC LM 317.
4. Understand basics of voltage regulator and foldback current limiting using IC 723.
5. Learn concept and applications of SMPS and DC - DC converter.

Detailed Syllabus: Example

Unit I: Special Function ICs and their Applications (08 Hrs.)

Operational Amplifier: Function generator using two OPAMPS with variable controls, Astable and Monostable multivibrators using OPAMPs, Precision rectifiers (Half wave and Full wave), Instrumentation amplifier. Modulation: Need For Modulation, Classification, FM and FSK generator, Voltage Controlled Oscillator (IC566), Phase Locked Loop (IC565) and its applications.

Unit II: Regulated power supply (07 Hrs.)

Concept of Voltage Regulator using discrete components. Types of power supplies, CVCC, SMPS. Three pin regulators, Basic low and high voltage regulator and foldback current limiting using IC 723, DC - DC converter.

Unit III: Digital Logic Circuits (08 Hrs.)

Combinational Logic: Review of Boolean identities and its use to minimize Boolean expressions. Use of Karanaugh Map. Sequential Logic: Study of IC 7490, UP-DOWN counter, Study of IC 7495.

Unit IV: Data Converters (07 Hrs.)

Digital to Analog converters: Binary weighted and R-2R ladder type with practical circuit (Using Input switches, Level amplifiers, Control gates and Buffer amplifier), Analog to

Digital converters: Single slope, Dual slope, Flash (Simultaneous) type, Counter ramp type, Continuous type and Successive approximation type.

Suggested Readings/Material:

1. Electronic Devices and Circuits: An Introduction by Allen Mottershed
2. Operational Amplifiers, 5th Edition by G.B. Clayton
3. Linear Integrated Circuits, 4th edition by Roy Choudhari
4. Op-Amps and Linear Integrated Circuits, Fourth Edition, Ramakant A. Gaikwad\
5. Power supplies by B.S.Sonde
6. Digital Electronics by R.P. Jain
7. Digital Principles and Applications by Leach and Malvino
8. Digital Electronics by T. L. Floyd
9. Digital Electronic Circuits by Prof. Goutam Saha, Department of E and EC Engineering, Indian Institute of Technology, Kharagpur, https://nptel.ac.in/courses/108/105/108105132/
10. Digital Circuits and Systems, Prof. S. Srinivasan, Department of Electrical Engineering, Indian Institute of Technology Madras, https://nptel.ac.in/courses/117/106/117106086/

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: Basics Physics Lab 2								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-10	MS-PH124P	00	02	02	60	15	35	50

Learning Objectives:

1. To give knowledge of some basic of laboratory experiments.
2. Give hands on skill for physics lab work.
3. Inculcate experimental cultural in students.
4. Develop skill to find out the possible errors during practical.
5. Motivate students for experiment

Course Outcomes (Cos)

1. Understand the physics concept with the help of actual experiments.
2. Handle scientific instruments during the practical.
3. Have hands-on practice of the basic physics theory and its applications.
4. Able to analyze their result and analyze them.
5. Able to analyze the error in their measurement

Detailed Syllabus:

Sr. No.	Title of Experiment
1.	Frank- Hertz experiment : To study the discrete energy levels using Frank – Hertz experiment
2.	G.M. Counter : Counting statistics, characteristics of G.M.tube and determination of end point energy of B- ray source
3.	G.M. counter: Determination of dead time of GM tube and by double source method.
4.	Skin depth: Skin depth in Al using electromagnetic radiation
5.	Thermionic Emission-To determine work function of Tungsten filament
6.	Hall effect : To determine charge concentration conductivity of Ge-semiconductor
7.	Four probe method :Temperature variation and Bandgap of Ge- semiconductor
8.	Stefan's constant: Black body radiation
9.	Ionic conductivity of NaCl
10.	Zeeman effect

11.	Determination of ionization potential of mercury
12.	Determination of Stefan-Boltzmann Constant
13.	Young's modulus by Newton's rings
14.	Determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film
15.	Determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT)
16.	Determine elastic constant using the Cornu's elliptical and hyperbolic fringes
17.	Verification of Malu's law of Polarization
18.	Draw the BH Curve of Ferromagnetic Material Using Solenoid

Additional Activity

Study Tour Visit Report / Mini Project / Science Exhibition Participation / Poster or Oral presentation in Conference or any other activity related to this course is equivalent to **Two** practical.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: Electronics Lab 2								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-11	MS-PH125P	00	02	02	60	15	35	50

Learning Objectives:

1. To give knowledge of some basic electronic components and circuits.
2. Give hands on skill for circuit designing and motivate to design circuit.
3. Inculcate experimental sense of the various circuits.
4. Develop skill to find out the error in the designed circuit.

Course Outcomes (Cos):

1. Have hands-on practice of the theory course and its applications.
2. Design a circuit for the required output-using breadboard and PCB.
3. Understand working of various electronic circuits.
4. Understand how to use the basic test and measuring instruments to test the circuits.

Detailed Syllabus:

Sr. No.	Title of Experiment
1.	Function generator using IC-741
2.	Optocoupler using ICMCT-2E
3.	Voltage Control oscillator using IC-566
4.	Voltage to frequency/ Frequency to Voltage converter using OPAMP
5.	DC-to-DC Converter
6.	Phase locked loop (PLL) applications using IC-565
7.	Schmitt Trigger using IC-555 / IC 741
8.	Multiplexer and Demultiplexer
9.	Noise performance of an amplifier
10.	Analog to digital converter
11.	Monostable and Astable multivibrator using IC741
12.	Study of Counters
13.	Shift Registers

14.	Clippers and Clampers circuits using junction diode
15.	Resistance Temperature Device (RTD)

Additional Activity

Study Tour Visit Report / Mini Project / Science Exhibition Participation / Poster or Oral presentation in Conference or any other activity related to this course is equivalent to **Two** practical.

Suggested Readings/Material:

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 7th Ed., Mc-Graw Hill, 2001.
2. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, Prentice Hall, 2015.
3. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
4. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson
5. Operational Amplifier by G.B Clayton, 5th Edition, Newnes, 2003.
6. Principles of Digital Electronics by Malvino, Leach,Saha , 8 th Edition, McGraw Hill Education, 2014.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: Computational Physics using Python								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSC-12	MS-PH126P	00	02	02	60	15	35	50

Learning Objectives:

1. Give depth in knowledge of the core courses in Physics.
2. Inculcate theoretical sense of the science through problem solving.
3. Guide to develop logic for problem solving.
4. Motivate students for solving problems with programming.

Course Outcomes (Cos):

1. Learn scientific concepts, numerical methods through Python Language.
2. Able to use Python to solve Physics problems using numerical methods.
3. Get quantitative problem skills in M.M.P, C.M etc.
4. Develop logic for problem solving.
5. Write their own Programs in Python; compile and execute.

Sr. No.	Title of Experiment
1.	Legendre Polynomial using Standard Recurrence Relation.
2.	Bessel function of first Kind using standard recurrence relation
3.	Generate and Print first hundred Prime numbers
4.	Find out the value of Pi using Monte- Carlo simulation Method.
5.	Lagrange Interpolation Method
6.	Find out largest/Smallest from a given set of numbers.
7.	Trapezoidal/Simpsons rule to integrate a given function
8.	Find out Armstrong number
9.	Gauss Elimination method to solve simultaneous equations
10.	Least square approximation i.) Linear fit ii.) Fitting an exponential
11.	Obtain weight of a person at different points in our solar system
12.	Fibonacci series
13.	De-Broglie wavelength of Proton, Neutron and electron for a fixed potential

14.	Obtain electric field of a unit charge at 10 different distances.
15.	Runge-Kutta method of solving a differential Equation

Additional Activity

Study Tour Visit Report / Mini Project / Science Exhibition Participation / Poster or Oral presentation in Conference or any other activity related to this course is equivalent to **Two** practical.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: Nanotechnology								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-3	MS-PH127T	02	00	02	30	15	35	50

Learning Objectives:

1. Provide in depth knowledge of scientific and technological aspects of nanoscience.
2. Explain the nanoscale paradigm in terms of dimensions.
3. Make aware of various types of nanostructures and their basic properties.
4. Hands on training in skills related to research, education, industry and market of nanotechnology.
5. Create foundation for research and development in nanoscience and technology.

Course Outcomes (Cos)

1. Hands on training for nanomaterials for various synthesis techniques.
2. Understand the basics of characterization techniques used for nanomaterials.
3. Understand various types of nanostructures and their basic properties
4. Learn the approaches for characterization of nanomaterials.
5. Learn to analyze the various properties like optical, structural properties of the synthesized nanomaterials.

Detailed Syllabus:

Unit I: Introduction to Nanotechnology (08 Hrs.)

Introduction to Nanomaterials and Structures, Surface Effect, Modelling of quantum size effect Synthesis Methods: Top-Down and Bottom-Up Approach, Hydrothermal Method, Sol Gel Method, Biological Method.

Unit II: Properties and Application of Nanomaterials (07 Hrs.)

Mechanical Properties, Size and Shape Dependence of Mechanical, Magnetic and Catalytic Properties, Thermal Electrical and Optical Properties, Magnetic Properties, Graphene, Carbon Nanotubes and Their Applications, Mechanical and Biomedical Applications.

Unit III: Introduction to Thin Films (08 Hrs.)

Comparison of thin and thick films, Theory of growth of thin films: Nucleation, Condensation, various stages of film growth, Physical Vapor Deposition, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sputtering, Spray pyrolysis, Photolithography, Electron –beam Deposition, Pulsed Laser Ablation.

Unit IV: Properties and Applications of Thin films (07 Hrs.)

Optical properties: - absorption coefficient, band gap, Anti reflection, refractive index, Mechanical properties: - film thickness, residual stresses, elastic and plastic properties, Deformation, Electrical properties: - IV graph, CV graph, Structural properties: - Various, Structures, hkl planes, crystallite size, Morphological properties. Applications: - Resistors, capacitors, Junction devices (Metal semiconductor junction), Solar cells, ICs, Optical coating, Thin film sensors (gas and humidity), thin films for information storage, electro acoustics and telecommunication.

Suggested Readings/Material:

1. Nanotechnology: Principal and Practices; by Sulbha Kulkarni; Springer Publication, 2015.
2. Nanostructures and Nanomaterials: Synthesis, Properties and Application; 2nd Ed., Guozhong Cao; Imperical College Press, Londen, 2011.
3. Nanomaterials: Synthesis, Properties and Application; 2nd Ed., A. S. Edstein and R.C. Commorta; Institute of Physics publishing Bristol and Philadephia, 1996.
4. Introduction to Nanotechnology: by C. P. Poole, Jr. Frank J. Owens: Willey student Edition
5. Nanotechnology, Timp, G., Springer-Verlag (1999).
6. Nanostructures and Nanomaterials: Characterization and Properties, Dr. Anandh Subramaniam, and Dr. Kantesh Balani Department of Materials and Metallurgical Engineering IIT Kanpur, https://nptel.ac.in/courses/118/104/118104008/
7. Nanomaterials and their Properties, By Prof. Krishanu Biswas, IIT Kanpur, https://onlinecourses.nptel.ac.in/noc21_mm38/preview

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: Nanotechnology Lab.								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
DSE-4	MS-PH128P	00	02	02	60	15	35	50

Learning Objectives:

1. Provide in depth knowledge of scientific and technological aspects of nanoscience.
2. Explain the nanoscale paradigm in terms of dimensions.
3. Make aware of various types of nanostructures and their basic properties.
4. Hands on training in skills related to research, education, industry and market of nanotechnology.
5. Create foundation for research and development in nanoscience and technology.

Course Outcomes (Cos)

1. Hands on training for nanomaterials for various synthesis techniques.
2. Understand the basics of characterization techniques used for nanomaterials.
3. Understand various types of nanostructures and their basic properties
4. Learn the approaches for characterization of nanomaterials.
5. Learn to analyze the various properties like optical, structural properties of the synthesized nanomaterials.
6. Choose career in the nanotechnology field for the development of science.

Detailed Syllabus:

Sr. No.	Title of the Experiment
1.	Synthesis of ferrites nano particles by sol gel method
2.	Synthesis of nanomaterial by hydrothermal method
3.	Synthesis of nanomaterial by chemical bath deposition
4.	Synthesis of silver nanoparticles using plant extract
5.	Morphological study of synthesized nanoparticles
6.	Study of magnetic nanoparticles using hysteresis
7.	Optical Verification of nanoparticles
8.	Deposition of thin films by spray pyrolysis method
9.	Thin film formation by Electro-chemical deposition technique
10.	Deposition of thin films by spin coating method and resistance measurement

11.	Deposition of thin film by chemical bath deposition method and thickness measurement
12.	Thickness measurement of thin film by Tolansky method
13.	Deposition of thin films by SILAR method
14.	Determine band gap of deposited thin film by Tauc plot
15.	Determine thickness of thin film using Swanpoel Method

Additional Activity

Study Tour Visit Report / Mini Project / Science Exhibition Participation / Poster or Oral presentation in Conference or any other activity related to this course is equivalent to **Two** practical.

Ahmednagar Jilha Maratha Vidya Prasarak Samaj's

New Arts, Commerce and Science College, Ahmednagar
(Autonomous)
Syllabus
M.Sc. Physics

Title of the Course: On Job Training								
Year: I				**Semester: I**				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
OJT-1	MS-PH129P	00	04	04	120	30	70	100

Detailed Instructions:

Detailed instructions will be provided by the College Authorities.