महाराजा सुहेल देव विश्वविद्यालय, आजमगढ़

Choice Based Credit System (C.B.C.S.)

4 YEARS UG (HONS.) PROGRAMME
4 YEARS UG (HONS. WITH RESEARCH) PROGRAMME
M.Sc. PHYSICS TWO YEAR (SEMESTER SYSTEM)

COURSE STRUCTURE AND SYLLABUS

Effective from 2024-25

07.10.24

PHYSICS

राष्ट्रीय शिक्षा नीति - 2020 आधारित

Syllabus

Semester Courses of 4th Year UG(Hons.)/ 4th Year UG(Hons. with Research)/M.Sc. PHYSICS Based on CBCS

Course Objectives and Outcomes:

- To provide a supportive and cooperative environment to the students to impart systematic and core knowledge of the subject matter based on sound theoretical, experimental and computational foundation.
- To provide a course of the highest academic quality in various disciplines of Physics: Core/Optional/Elective/Allied courses in an atmosphere of relatively less number of specialized faculties, insufficient lab facilities, basic infrastructure and local geographical conditions so as to produce teachers and researchers and technical hands of high excellence to beat with frontiers of international repute.
- To develop transferable skills of critical discussion, solving complex, unseen and open ended problems.
- To develop transferable technical and teaching skills to the serve the human kind.
- To develop a temperament of working in an organized and time bound manner so as to achieve the academic/research target within given time line with all due consideration of practical realities.
- To motivate the students to know the scope and significance of Physics Education in the real world that the Physics is the most basic of all sciences which enables us to understand the nature, natural phenomenon and the governing laws at their most fundamental levels.
- To make the students realize to establish a Nation of scientifically and technically literate fellows with a rigid moral ground by contributing through their own developed skills and knowledge.
- Above all, to produce good human beings holding science and technology as tools ready to serve the world beyond all the boundaries.

The fourth year of undergraduate degree (Hons.) / undergraduate degree (With Hons. Research) degree consist of two Semesters in a year and M.Sc. PHYSICS Course consists of four Semesters (02 Semesters in each year). The Examinations of Semester-I and Semester-II will be held in the months of December and April, respectively. Each Semester Examination will consist of Theory Papers of that Semester as well as One Practical Examination (Lab). Each Theory paper will be of three hours duration and of 4 credits (Maximum Marks 75) and the Practical Examination will be of two hours (Maximum Marks 100). There will be 25% internal evaluation in theory as shown below:

25% Internal Assessment in Theory	
Attendance/Interaction	5 Marks
Sessional Test	10 Marks
Assignment	10 Marks

Format of the Question Paper:

There will be Section-A of one Compulsory Question consisting of 10 parts of Very Short answer type question. Each part will have to be answered in about 50 words. Section-B will consist of eight short answer type questions .Any five questions from section –B will have to be attempted. Each question will have to be answered in about 200 words. Section-C will consist of five Long Answer type questions. Any two questions from Section-C will have to be attempted. Each question will have to be answered in about 500 words.

Note:

Four-year undergraduate degree (Hons.), Four-year undergraduate degree (Hons. with Research) and Postgraduate course outline

Eligibility:

1. For the four-year undergraduate (Hons.) and undergraduate (Hons. with Research) degree, in the fourth year, the student will select any one of the above two major subjects in undergraduate (which the student has compulsorily studied in the previous three years/six semesters) and will study the same subject in the seventh and eighth semesters as well. But for the Bachelor (Hons. with Research) degree, the student must have obtained 75% marks from the first to the sixth semester. For undergraduate (Hons. with Research) degree, student must choose one research project in place of optional paper choice in seventh and eighth semesters.
2. After three years of graduation, a student can take admission in Masters in any new subject (in which he is eligible as per the pre-requisites), but after one year of Masters/fourth year studies, he will not get any degree or diploma. He will get Masters Degree in that subject only after completing and passing two years.
3. After completing three years of undergraduate study, for a four year degree, the student will have to take fresh admission in Masters course in that subject which will be done on the available seats of Masters as per the admission process prevalent in the University.

4th Year UG (Hons.)/ 4th Year UG (Hons. with Research)/M.Sc. (Physics)

Year	Semester	Category/Type of the Courses	Course Code	Paper Title	Theory / Practical	Credits
4th Year UG (Hons.)/ 4th Year UG(Hons.with Research)/M.Sc. First Year	VII	Major/Compulsory	B010701T	Mathematical Physics	Theoretical	4
			B010702T	Classical Mechanics	Theoretical	4
			B010703T	Quantum Mechanics	Theoretical	4
			Optional	**Choose any one of the following**		
			B010704T	(A) Analog & Digital Electronics	Theoretical	4
			B010705T	(B) Experimental Techniques	Theoretical	4
			B010706P	**General Lab**	Practical	4
	VIII	Major/Compulsory	B010801T	Classical Electrodynamics	Theoretical	4
			B010802T	Statistical Physics	Theoretical	4
			B010803T	Advanced Quantum Mechanics	Theoretical	4
			Optional	**Choose any one of the following**		
			B010804T	(A) Plasma Physics	Theoretical	4
			B010805T	(B) Laser & Modern Optics	Theoretical	4
			B010806P	**Electronics Lab**	Practical	4
M.Sc. Second Year	IX	Major/Compulsory	B010901T	Nuclear and Particle Physics	Theoretical	4
			B010902T	Solid State Physics	Theoretical	4
			Optional	**Choose any one of the following**		
			B010903T	(A) Quantum Field Theory	Theoretical	4
			B010904T	(B) Atomic and Molecular Physics	Theoretical	4
			B010905P	**General & Optics Lab**	Practical	4
		Research Project	B010906R	Research Project	Project	4
		Major/Compulsory	**Optional**	**Choose any one of the following**		
			B011001T	(A) Electronic communication systems	Theoretical	4
			B011002T	(B) Analog and Digital Communication	Theoretical	4

	X		**Optional**	**Choose any one of the following**		
			B011003T	(A) Advanced Solid State Physics	Theoretical	**4**
			B011004T	(B) Liquid Crystal Physics	Theoretical	**4**
			Optional	**Choose any one of the following**		
			B011005T	(A) Astrophysics	Theoretical	**4**
			B011006T	(B) High Energy Physics	Theoretical	**4**
			B011007P	**Special Lab**	Practical	**4**
		Research Project	B011008R	Research Project	Project	**4**

Research Project (UG with research, PG Physics):

Instructions regarding research project:

1. The research supervisor will encourage students (UG with research and PG) to select contemporary and research oriented topic of the concerned subject.
2. Academic institutions are free to choose research projects in the form of Industrial Training, Internship, and Survey Work etc.
3. The details (indicative) of the study done on the selected topic in the research paper (Report/Dissertation) will be as follows
   A. Identification of Problem
   B. Reviews of literature
   C. Research Methodology/Materials and Methods
   D. Findings
   E. Conclusion
4. Report / Dissertation of research projects should be in legible handwritten or printed a copy, which will be the educational institution's copy, will be submitted by the student for evaluation. The student may make another copy separately for himself.

S. N.	Name	Designation	Department	College/University	Email/Phone	Signature
1	Prof.M.Imran Aziz (Convener)	Professor	Physics	Shibli National College, Azamgarh	azizimran33@gmail.com	
2	Prof.S.Tahir Husen (Dean)	Professor	Physics	Shibli National College, Azamgarh	sthasan0265@gmail.com	
3	Dr. Kamlesh Kumar	Assistant Professor	Physics	S.G.Govt.P.G. College,Gohna,Mau	Kamleshku79@gmail.com	
4	Dr.Avinash Chand Yadav	Assistant Professor	Physics	S.G.Govt.P.G. College,Gohna,Mau	avinashchandy@gmail.com	
5	Mr.Sartaz Ahmad	Assistant Professor	Physics	D.A.V.College, Azamgarh	mohdsirtaz95@gmail.com	
6	Prof.Shamshad Ahmad Khan (External Expert)	Professor	Physics	St.Andrew's College Gorakhpur	shamshad_phys@yahoo.com	
7	Dr.Kaushlendra Chaturvedi (External Expert)	Associate Professor	Physics	Siddharth University, Siddharth Nagar	kaushalchaturvedi@suksn.edu.in	

Syllabus developed and approved by: B.O.S. (Physics)

07/10/24

Model Paper

M.M-75

Section – A
खण्ड – अ
(Very Short Answer Type Questions)
(अति लघु उत्तरीय प्रश्न)

ttempt all 10 questions of this part. Give answer in about 50 words. 10X2=20

ड के सभी 10 प्रश्नों उत्तर दीजिए। प्रत्येक प्रश्न का उत्तर अधिकतम 50 शब्दों मे दीजिए ।

1. i.
   ii.
   iii.
   iv.
   v.
   vi.
   vii.
   viii.
   ix.
   x.

Section – B
खण्ड – ब
(Short Answer Type Questions)
(लघु उत्तरीय प्रश्न)

Note : Attempt any **five** questions. Give answer of each question in about 200 words. 5X7=35

किन्हीं पाँच प्रश्नों के उत्तर दीजिए। प्रत्येक प्रश्न का उत्तर अधिकतम 200 शब्दों में दीजिए ।

2.
3.
4.
5.
6.
7.
8.
9.

Section – C
खण्ड – स
(Long Answer Type Questions)
(दीर्घ उत्तरीय प्रश्न)

Note : Attempt any **two** questions. Give answer of each question in about 500 words. 2X10=20

किन्हीं दो प्रश्नों के उत्तर दीजिए। प्रत्येक प्रश्न का उत्तर अधिकतम 500 शब्दों में दीजिए ।

10.
11.
12.
13.

Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VII**
Subject: **Physics**		
Course Code: **B010701T**	Course Title: **Mathematical Physics**	

Course Objectives & Outcomes

Objective: To sharpen the Mathematical acumen of the students so that they can apply Mathematical ideas and tools wherever needed.

Outcomes: After completing this course the students will be able to apply ideas of Group Theory to Solid State Physics, of partial differential equations specially the Bessel functions to understand the phenomenon of diffraction, frequency modulation and theory of Klystron amplifiers, etc.

Credits:**4**	Course: **Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks:

Total No.of Lectures-Tutorials-Practical (in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Matrices** Basic properties of matrices (Review only), Orthogonal matrices, Hermitian and Unitary matrices, Similarity and unitary transformations, Eigen values and Eigen vectors, Cayley Hamilton Theorem, Diagonalization of matrices.	**10**
II	**Functions of Complex Variables and Special functions** Analytic functions, Cauchy-Reimann conditions, Cauchy's integral theorem and integral formula, Taylor and Laurent series, singularity, poles, residues and evaluation of integrals. Special functions (Bessel, Hermite and Legendre functions) Green's function for 2-and 3-dimensions, Dirac delta function	**15**

III	**Computational Techniques** Root of a function, finite difference method, inter-polation, integration by trapezoid and Simpsons rules.	**10**
IV	**Fourier Series and Transforms** Fourier series, Fourier sine and cosine series, applications, Fourier Transform and its properties, Fourier Transform of rectangular, triangular and exponential functions.	**10**
V	**Group Theory** Symmetry elements and symmetry operations, Point group and their representation, , Matrix representation, Great Orthogonality theorem (statements and interpretation only), Reducible and irreducible representations, character tables of C_{2v} ,characterization of electronic states and vibrational model of polyatomic molecules	**15**

Suggested Readings

1. Matrices and tensors - A.W. Joshi, 3rd Ed,New Age International
2. Mathematical Methods for Physicists- G.B.Arfken, H.J.Weber, 7th Ed, Academic Press.
3. Mathematical Methods for Physics - J. Mathews,R.Walker, 2nd Ed, Pearson Addison-Wesley
4. Advanced Engineering Mathematics - Erwin Kreyzig, 9th Ed, Wiley.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/Web Links

1. MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning(NPTEL),https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Internal Evaluation(CIE)Methods

20 marks for Test/Quiz/Assignment / Seminar

05 marks for Class Interaction

Course Prerequisites

Passed Degree Course in Physics

Suggested Equivalent Online Courses

1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
2. edX,https://www.edx.org/course/subject/physics
3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/
4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics
5. National Programmeon Technology Enhanced Learning (NPTEL),https://nptel.ac.in/course.html

Further Suggestions

- Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities.
- In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VII**
Subject: **Physics**		
Course Code: **B010702T**	Course Title: **Classical Mechanics**	

Course Objectives & Outcomes

Course Objective: To provide a course of the highest academic quality with deep knowledge and understanding in an atmosphere of relatively less facilities, basic infrastructure and odd geographical conditions so as to produce teachers and researchers of high excellence to beat with frontiers of international repute.

Course Outcomes: The students will be able to solve complex problems with larger degrees of freedom using the elegant and simpler approach of this course including Lagrangian, Hamiltonian and other formalisms.

Credits:**4**	Course: **Major (Compulsory)**
Max.Marks: **25+75**	Min.Passing Marks:

Total No. of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No. of Lectures
I	**Lagrangian and Hamiltonian Formalism** Review of Galilean and Newtonian concept of motion, types of constraints, generalised coordinates, principle of virtual work, D'Alembert's principle, calculus of variations; Hamilton's principle; principle of stationary/least action, shortest distance, brachistochrone problem, Lagrange's equation from Hamilton's principle, velocity-dependent potentials, generalised momentum and generalised force, phase space, canonical equations of motion (Hamilton's equations), cyclic coordinate and conservation laws, Lagrangian and Hamiltonian for central forces, electromagnetic forces.	**14**
II	**Canonical transformations** Poisson bracket formalism, infinitesimal canonical transformations, examples of canonical transformation, conservation theorems in Poisson bracket formalism; invariance of Poisson bracket under canonical transformations, Poisson bracket relations, angular momentum Poisson bracket relations,	**14**

III	**Symmetry and Conservation Laws** Concept of Symmetry, Noether's theorem, spatial translations, temporal translation, and spatial rotations and the related conservation laws.	**10**
IV	**Rigid Body Motion** Independent coordinates; orthogonal transformations and rotations (finite and infinitesimal), Euler's angles and Euler's theorem on the motion of a rigid body, angular momentum and the kinetic energy about a point, moment of inertia tensor, symmetrical top, precession of Earth's axis of rotation and a charged particle in magnetic field.	**14**
V	**Small Oscillations** General formalism of small oscillations, Eigen value equation and the principal axis transformation, frequencies of free vibration and normal coordinates idea of coupled oscillators.	**8**

Suggested Readings

1. H. Goldstein, C. Poole, J. Safko, Classical Mechanics, (Pearson, 2001).
2. L. Landau, E.M. Lifshitz, Mechanics (Pergamon, 1976).
3. N.C. Rana, P. S. Joag, Classical Mechanics (Tata McGraw-Hill, 2017).
4. T.W.B. Kibble, F.H. Berkshire,Classical Mechanics (Prentice Hall, 1996)

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks

1. MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd
3. Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx
4. Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Internal Evaluation (CIE) Methods

20 marks for Test/Quiz/Assignment /Seminar

05marks for Class Interaction

Course Pre-requisites

Passed Degree Course in Physics

Suggested Equivalent Online Courses

1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
2. edX,https://www.edx.org/course/subject/physics
3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/
4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics
5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html

Further Suggestions

- Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities.
- In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VII**
Subject:**Physics**		
Course Code: **B010703T**	CourseTitle: **Quantum Mechanics**	

Course Objective & Outcomes

Course Objective:

1. To acquire knowledge of mathematical tools which is applied to understand the Quantum Mechanics
2. To acquire the knowledge of postulates of Quantum Mechanics, angular momentum, addition of angular momentum, and identical particles

Course Outcomes:

1. To understand the significance of mathematical tools in Quantum Mechanics
2. The student recognizes that learning these topics are stepping stone to understand advanced quantum mechanics.

The topics covered in the syllabus show an understanding of postulates of Quantum Mechanics, angular momentum, addition of angular momentum, and identical particles

Credits:**4**	Course: **Core (Compulsory)**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Mathematical Tools of Quantum Mechanics:** Linear Vector Spaces. Elements of Hilbert Space. Dirac Notation. Operators: Hermitian and Projection Operators, Inverse and Unitary Operators, Eigenvalues and Eigenvectors of Operators. Commutator Algebra. Unitary Transformations and Change of Basis. Matrix Representation of Operators. Continuous Basis, Position and Momentum Representation and their Position Connection. Parity Operator.	15
II	**Postulates of Quantum Mechanism:** Basic Postulates of Quantum Mechanics. Measurement in Quantum Mechanics. Time Evolution of System's State. Connecting Quantum to Classical Mechanics: Poisson Brackets and Commutators, The Ehrenfest Theorem.	15
III	**Angular Momentum:** Orbital Angular Momentum Operators and their Commutation Relations. Eigenvalues and Eigen functions of L^2 and L_z. Spin Angular Momentum: Stern-Gerlach Experiment. Spin Angular Momentum Operators, Pauli's Spin Matrices and Their Commutation Relations. General Formalism of Angular Momentum. Matrix Representation of Angular Momentum.	7

Suggestive Digital Platforms/WebLinks
1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar/ 05marks for Class Interaction
Course Pre-requisites
Passed Degree course in Physics
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VII**
Subject: **Physics**		
Course Code: **B010704T**	Course Title: **Analog and Digital Electronics**	

Course Objective & Outcomes

Course Objective:

To understand the course of transition from analog to digital world. To apply the gained knowledge in understanding the working of daily-life electronic systems.

Course Outcomes:

After completing the course, the candidate will be able to:

(i) Understand how Op-amp and Timers can serve as a source of an infinite train of pulses (Clock).
(ii) Understand the limitations of Op-amp.
(iii) Understand how data is converted from analog to digital form for instance in a digital multimeter.
(iv) How counting machines utilize binary counters.
(v) Know the data storage capacity of a semiconductor memory. To understand the terms Kilobyte, Megabyte, Gigabyte, Terabyte etc.
(vi) know how two smaller capacity memory units can be combined to produce a larger memory unit.

Credits: **4**	Course: **Core (Compulsory)**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Analog Electronics:** Differential Amplifier, d.c. and a.c. analysis, Integrated circuit operation amplifier, Ideal op-Amp, Basic characteristics, Negative feedback, Inverting and non-inverting amplifier, Closed loop gain, Concept of virtual short, Voltage follower, Difference amplifier, Summation amplifier, Integrator and differentiator, Open loop comparator, Schmitt Trigger, Astable and mono stable multi vibrator, Triangular wave generator. 555 Timer. **Non ideal properties of op-Amp:** Output saturation levels, offset voltages and currents, Input bias current, slew rate limitation, Finite CMRR, Finite frequency response, Gain-band width product.	15
II	**Interfacing the analog and digital worlds.** D/A Converter, Binary weighted resistor D/A converter, R-2R Ladder D/A converter, Sample and hold circuit, basic idea of quantization and sampling, converter specifications, A/D converter, Ramp, Flash and Successive Approximation A/D converter, Voltage to frequency and frequency to voltage converter.	10
III	**Digital Electronics: Sequential Circuits** Review of Flip-Flop Characteristic table and characteristic equation, Ripple counter, Mod number, Frequency division, Counter with Mod No $< 2^N$. Change of Mod number. Synchronous counter design, Ring counter, Johnson counter, Counter applications, Digital Clock.	10

Suggested Readings

1. Electronic Principles – A. Malvino, D.J. Bates 7th Ed TMH, N. Delhi.
2. Microelectronic Circuit and Devices – Mark N. Horenstein, Pearson 2nd Ed.
3. Fundamentals of Analog Circuits – Floyd, Buchla 2nd Ed, Pearson – 2017.
4. Digital System – R.J. Tocci, PHI 6th Ed, 2000.
5. Digital Logic and Computer Design – M. Morris Mano, PHI, Delhi 1996.
6. Integrated Electronics: Analog and Digital circuits and Systems, J. Millman, C. C. Halkias, TMH, Edition 1991.
7. Operational Amplifiers with Linear Integrated Circuits– William D. Stanley, 4th Ed, Pearson.
8. Operational Amplifiers and Linear Integrated Circuits – Robert F. Coughlin, Frederick F. Driscoll, 6th Ed, PHI.

Course Books published in Hindi may be prescribed by the Universities.

PHYSICS

IV	**Integrated circuit Logic Family** Classification of IC's on the basis of packing density and family, Logic family characteristics, Transistor as a switch, RTL, DTL and TTL, Open collector, Totem-pole output TTL, Current sourcing and sinking action of TTL output, ECL.	**10**
V	**Memory Devices and Microprocessors** Memory terminology, General memory operation, ROM architecture, Read operation, ROM types, Flash memory, ROM applications, Programmable Logic Devices, Semiconductor RAM, RAM architecture, Read and write operations, Static RAM and Dynamic RAM, Expanding word size and capacity. Introduction to 8085, microprocessor architecture,assembly language programming	**15**

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1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar/ 05marks for Class Interaction
Course Pre-requisites
Passed Degree course in Physics
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
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Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05marks for Class Interaction
Course Pre-requisites
Passed Degree course in Physics
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
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Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VII**
Subject: **Physics**		
Course Code: **B010705T**	Course Title: **Experimental Techniques**	

Course Objectives and Outcomes

Course Objectives:

This course focuses on pumps, gauges, and techniques employed for morphological study of various materials.

Course outcomes:

After studying this course the students will be able to distinguish between the techniques and tools employed for investigating various properties/characteristics of materials.

Credits:**4**	Course: **Major (Compulsory)**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**VacuumTechniques** Units and basic definitions, Roughing pumps, High vacuum Vacuum guages - Pirani gauge, Thermocouple gauge, penning guage (Cold cathode Ionization guage) and Hot filament ionization gauge	**15**
II	**Thin film techniques** Introduction, Fabrication of thin films, Technological Applications of thin films.	**10**
III	**Morphological study** Scanning tunneling microscopy (STM), Atomic Force Microscopy (AFM),Scanning Electron microscope(SEM),Scanning Tunneling Spectroscopy(STS).	**10**

IV	**X- Ray Diffraction Technique** Introduction, Lattice planes and Bragg's Law, Diffractometer - Instrumentation, Single crystal and Powder diffraction, Scherrer equation, Structure factor, Applications of XRD.	**10**
V	**Tools for Maths and visualisation in Python (The Numpy and PylabModules)** Numpy module:- Arrays and Matrices–creation of arrays and matrices (arange, linspace,zeros,ones,random,reshape,copying),ArithmeticOperations,crossproduct,dot product,Data visualization- The Matplotlib, Module- Plotting graphs, Multiple plots, Polar plots, Pie Charts, Plotting mathematical functions, Sine and other functions.	**15**

Suggested Readings

1. Scientific foundations of vacuum techniques - S. Dushman, J.M. Laffer, 2nd Ed,Wiley–Blackwell
2. Thin film technology - R. Berry, P.M. Hall, M.T. Harris, Van Nostrand-1968.
3. Elements of X-ray diffraction - B.D. Cullity,Addison-Wesley Publishing Company, Inc.-1956.
4. IntroductiontoNanoscience&Technology- Chathopadhyay,Banerjee,Prentice Hall India-2009
5. Advanced Experimental Techniques in Modern Physics –M. Varier,Pragati Prakashan-2021.
6. Core Python Programming –W. J. Chun, 1st Ed, Prentice Hall.
7. Numerical Methods in Engineering with Python –J. Kiusalaas, 3rd Ed, Cambridge University Press.

Course Books published in Hindi may be prescribed by the Universities.

Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VII**
Subject: **Physics**		
Course Code: **B010706P**	Course Title: **General Physics Lab**	

Course Objective & Outcomes

Course Objective: The experiments are an essential and inseparable part of Physics Course. The validity of various Laws and observations are tested through experiments in the Lab.

Course Outcomes: The results of an experiment (in agreement/deviated from the established pattern) enable the students to recognise the faults/errors in his approach and encourages to repeat the experiment with an improved approach.

Credits:**04**	Course: **Core (Compulsory)**
Max.Marks: 100 One Practical: 50 Marks Record: 20 Marks Viva-Voce: 25 Marks Attendance: 05 Marks.	Min. Passing Marks:

Total No. of Lectures-Tutorials-**Practical(in hours per week)**:L-T-P: 0-0-**4**

	Topics	**No. of Hours**
1.	Hall Effect: Determination of carrier concentration, Hall coefficient and mobility of carriers in a semiconductor sample.	**60**
2.	Determination of Lande's g – factor of a free electron by E.S.R spectrometer (sample: DPPH).	
3.	Magnetic susceptibility by Quincke's tube mehod.	
4.	Measurement of forbidden energy gap in a semiconductor.	
5.	Refractive index of glass by Brewster's law.	
6.	V-I characteristics of solar cell and determination of fill – factor and efficiency.	
7.	Determination of Planck's constant using incandescent bulb, colour filters and solar cell.	
8.	Y. by Newton's ring method.	
9.	R – C coupled amplifier.	

10. Boltzman Constant.
11. Thickness of wire using Laser.

Note:

- The student has to do a minimum of six experiments from the given list.
- In the practical examination the student will be asked to perform one experiment of two hours duration.

Suggested Readings

1. Manuals of Concerned Experiments and Texts for Theoretical Support.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks
1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar/ 05marks for Class Interaction
Course Pre-requisites
Passed Degree Course in Physics
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VIII**
Subject: **Physics**		
Course Code: **B010801T**	Course Title: **Classical Electrodynamics**	

Course Objectives and Outcomes

Course Objective: To provide a systematic and core knowledge of Relativistic Mechanics and Classical Electrodynamics based on firm theoretical foundation with particular emphasis on Relativistic generalization of the subject matter. To produce academic teachers and researchers of highest calibre for the future.

Course Outcomes: The students will be able to develop a knowledge and understanding of the concepts and covariant formulation of the underlying principles of the course.

Credits:**4**	Course: **Major (Compulsory)**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Review of basic concepts of STR and Tensors** Minkowski space, event, world line, light cone, concept of invariant interval, Lorentz transformation as 4-vector transformation, metric tensor, symmetric and anti-symmetric tensors, 4-scalors, 4-vectors, 4-tensors, 4-displacement, 4-velocity and acceleration; 4-momentum and 4-force, 4- potential, proper time, covariant form of equation of motion.	**08**
II	**Dynamics of Charged Particles in Electromagnetic Fields** Motion in uniform static E-field, uniform static B- field, crossed E- and B- fields, particle drifts (velocity and curvature) in non-uniform static B- field.	**06**
III	**Field, Potential and Radiation from Moving Charges** Retarded Potential and Lienard-Wiechert potentials, fields due to a charge moving with uniform velocity; fields due to an accelerated charge; near and far zone fields, dipole radiation, Larmor's formula and its relativistic generalisation (Lienard's formula), power radiated by a point charge, angular distribution of radiated power for linearly and circularly accelerated charges, reaction force of radiation, electromagnetic mass of the electron, radiative damping.	**16**

IV	**Relativistic Formulation of Electrodynamics** Four dimensional formulation of Euler-Lagrange equation of motion, covariance of Lorentz force equation and the equation of motion of a charged particle in an electromagnetic field, electromagnetic 4-potential and gauge invariance, energy-momentum tensor and the conservation laws for the electromagnetic field, electromagnetic field tensor in four dimensions, transformation properties of electric and magnetic fields, invariants of electromagnetic fields, dual field tensor, the equation of continuity, wave equation for vector and scalar potential and solution, relativistic particle in electromagnetic field, four dimensional formulation of Maxwell's equations.	**16**
V	**Lagrangian Formulation of Electrodynamics** Lagrangian and Hamiltonian for a free relativistic particle, Lagrangian for a charged particle in an electromagnetic field, for a free electromagnetic field, for interacting charged particles and fields (minimal coupling prescription), action of a relativistic charged particle, energy-momentum tensor and related conservation laws, generalised momentum and Hamilton equation of motion.	**14**

Suggested Readings

1.J.D. Jackson, Classical Electrodynamics (Wiley, 1998).
2.W.K.H. Panofsky, M. Phillips, Classical Electricity and Magnetism (Dover Publications, 2012).
3.L.D. Landau, E.M. Lifshitz, Classical theory of fields (Butterworth-Heinemann, 1987).
4.D. J. Griffiths, Introduction to Electrodynamics (Cambridge University Press, 2017).

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks

1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/
2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd
3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx
4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test/Quiz/Assignment /Seminar 05marks for Class Interaction
Course Pre-requisites
Passed UG (Hons.)/ UG (Hons.with Research)7th semester/ M Sc. (Physics) 7th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VIII**
Subject:**Physics**		
Course Code: **B010802T**	CourseTitle: **Statistical Physics**	

Course Objectives and Outcomes

Course Objective: This course makes the students realize the beauty of Statistical Mechanics, which predicts the bulk properties of matter without considering properties of individual constituents from first principle.

Course Outcome: After completing this course, the students will be able to:

1. derive the familiar gas law by using Maxwell Boltzman statistics.
2. understand the distinction between classical and the quantum systems.
3. understand how specific heats of solids approaches the value of 3R nearroom temperature in both Einstein & Debye's models.
4. learn how energies fluctuate with particle number.

Credits:**4**	Course: **Core (Compulsory)**
Max.Marks: **25+75**	Min.Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week):L-T-P:**4-0-0**

Unit	Topics	No. of Lectures
I	**Ensemble Theory:** Counting the micro-states of (free particles in 1D and 3D box, N-non-interacting particles in 3D box, Einstein solid and Ising spins), equilibrium of an isolated system, Micro canonical ensemble, monatomic ideal gas in Micro-canonical formalism (Sackur-Tetrode equation, equation of state, chemical potential), Gibbs paradox. Schottky defects, ideal paramagnet and Einstein solid under Micro-canonical formalism, canonical ensemble, Boltzmann probability distribution, partition function, connection with thermodynamics, energy fluctuation, Boltzmann definition of entropy. Two level system, ideal gas and Einstein solid in canonical formalism, partition function for diatomic gases, Grand canonical ensemble, Gibbs probability distribution, grand partition function, grand potential, connection with thermodynamics.	**22**
II	**The Heat Capacity of Solids:** Dulong-Petit Law, Einstein's & Debye's theory of specific heats of solids, Comparison with experimental results.	**6**

III	**The Perfect Classical Gas:** The Definition of perfect Classical gas, Translational, rotational and vibrational partition functions, Expressions for Helmholtz free energy and chemical potential, Validity condition for classical regime, Equation of State of perfect classical gas.	8
IV	**The Perfect Quantum Gas:** Fermi gas, thermodynamic properties (entropy, pressure and chemical potential), properties at zero K (Fermi energy, and Fermi pressure), Application to electron gas in metals, electronic heat capacity, white dwarf stars, liquid helium (He^3) problem, Pauli paramagnetism and semi-conductors. Relativistic electron gas. Ideal Bose gas, Bose-Einstein condensation, critical temperature, internal energy, pressure and heat capacity, λ-point in ^4He. photongas, Partition function for photons, photon density of states, Planck's law, Wien's displacement law, Stefan's Boltzmann Law, thermodynamic properties of photon gas.	16
V	**Phase-transition and Fluctuations** First and second-order phase-transitions, The Bragg-William's approximations, Ising in one dimension, Fluctuations in Ensembles, concentration fluctuations inquantum gases, Langevin Theory of Brownian motion.	8

Suggested Readings

1. Statistical Physics - F. Mandl, 2nd Ed,ELBS JohnWiley-1988.
2. Statistical Physics Part-I, - Landau and Lifshitz, Pergamon Press, Oxford.
3. Introduction to Statistical Physics - Silvio R. A.Salinas, Springer.
4. Statistical Mechanics - B.K. Agarwal, Melvin Eisner, 3rdEd, New Age.
5. Fundamentals of Statistical Mechanics -B.B. Laud, New Age.
6. Introduction to Statistical Mechanics - R. Bowley,M. Sanchez, 2nd Ed, OxfordScience Publications.
7. Thermodynamics and Statistical Mechanics- Greiner, Neise, Stocker, 1995, Springer.
8. Statistical and Thermal Physics with Computer Applications- Harvey Gould, Jan Tobochnik, Princeton University Press, 2010.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks
1. MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 2. National Programme on Technology Enhanced Learning(NPTEL),https://www.youtube.com/user/nptelhrd 3. Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 4. Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation(CIE)Methods
20 marks for Test / Quiz / Assignment / Seminar 05marks for Class Interaction
Course Pre-requisites
Passed UG (Hons.)/ UG (Hons.with Research)7th semester/ M Sc. (Physics) 7th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VIII**
Subject: **Physics**		
Course Code: **B010803T**	Course Title: **Advanced Quantum Mechanics**	

Course Objectives and Outcomes

Course Objective:

1. To acquire knowledge of Approximation Method for Stationary and Non-Stationary States.
2. To have the knowledge of Elementary Theory of Scattering, Semi-Classical Theory of Radiation, & Relativistic Quantum Mechanics

Course Outcomes:

1. Understand the significance of Approximation Method for Stationary and Non-Stationary States.
3. The topics covered in the syllabus show an understanding of Elementary Theory of Scattering, Semi-Classical Theory of Radiation, & Relativistic Quantum Mechanics
2. After completion of the course, students have knowledge and ability to apply Quantum mechanics to particles and fields

Credits:**4**	Course: **Optional**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Approximation Methods for Stationary States** Time-Independent Perturbation Theory, Perturbation Theory of Non-Degenerate States: First and Second Order Correction. Perturbation Theory of Charged Oscillator in an Electric Field, The Stark Effect, Degenerate Perturbation Theory, Fine Structure and Zeeman Effect, Variational Method, WKB Approximation Method.	**15**
II	**Time-Dependent Perturbation Theory** The Picture of Quantum Mechanics: Schrodinger, Heisenberg, and interaction Pictures, Heisenberg Equation of Motion. Time –Dependent Perturbation Theory: Transition Probability. Fermi Golden Rule. Adiabatic and Sudden Approximations.	**10**
III	**Elementary Theory of Scattering** The Differential and Total Cross-section. The Born Approximation. Partial Wave Analysis. Phase Shift.	**10**

IV	**Semi-Classical Theory of Radiation** Absorption and Induced Emission: Transition Probability, Interpretation in Terms of absorption and Emission, Electric Dipole Transition, Forbidden Transition. Spontaneous Emission: Classical Radiation Field, Asymptotic Form. Radiated Energy. Dipole Radiation. Line Breadth	**10**
V	**Relativistic Quantum Mechanics** The Klein-Gordon Equation: Plane Wave Solutions, Charge and Current Densities, Interaction with Electromagnetic Fields, Non-relativistic Limit. The Dirac Equation: Dirac's Relativistic Hamiltonian. Position Probability Density. Plane Wave Solution of Dirac Equation. The Probability Density. Plane Wave Solution of Dirac Equation. The Spin of Dirac Particle. Significance of Negative Energy States. The Spin Orbit Energy.	**15**

Suggested Readings

1. Quantum Mechanics: Concepts and Applications: N. Zettili, 2nd Ed, Wiley.
2. Quantum Mechanics: L. I. Schiff, 4th Ed, McGraw Hill.
3. Quantum Mechanics: P. M. Mathews and K. Venkatesan, 2nd Ed,McGraw Hill.
4. Modern Quantum Mechanics: J. J. Sakurai, 3rd Ed, Cambridge University Press.
5. Relativistic Quantum Mechanics: J.D. Bjorken and S.D. Drell. McGraw-Hil-1964.
6. Principles of Quantum Mechanics: P. A. M. Dirac, 4th Ed,Clarendon Press.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks
5. MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 6. National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 7. Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 1. Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05marks for Class Interaction
Course Pre-requisites
Passed UG (Hons.)/ UG (Hons.with Research)7th semester/ M Sc. (Physics) 7th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VIII**
Subject: **Physics**		
Course Code: **B010804T**	Course Title: **Laser and Modern optics**	

Course Objectives and Outcomes

Course Objective: The primary goal to design this course is to provide the students valuable information about the various naturally occurring phenomena that were not clearly understood. To explain these concepts and theories through a wider range of current applications and examples.

Course Outcome: After completing this course the students shall:

1. Understand the particle aspect of radiation , Lasers and Masers.
2. Get the knowledge of how atoms interact and how their energies change under non linear properties of materials.
3. Get the knowledge of quantum nature of optics and holography.
4. Gain the information and knowledge of how LASERS have enabled us to restudy and investigate Raman Scattering with greater precision.

Credits:**4**	Course: **Optional**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Basic Laser Theory and Optical Resonators** Einstein coefficients , Evaluation of transition rates, Line broadening mechanisms, Laser rate equations for three level system, Cavity Modes, Q of cavity, Q Switching, Mode locking , Analysis of optical resonators using geometrical optics	**10**
II	**Types Of Lasers and Applications** Ruby laser, Helium-Neon laser, Nd-YAG Laser, N2 lasers,CO2lasers ,Organic Dye lasers, Semiconductor lasers, Laser induced fusion **Masers and Applications** Theory of Masers, Ammonia Maser, Solid State Masers.	**15**

III	**Quantum Optics** Basic idea of quantum coherence correlation function, coherent states and its properties	**10**
IV	**Non-Linear Optics** Non-linear Polarizability tensors, Coupled amplitude equation, Manely-Rowe's relationships; Parametric amplification and parametric oscillation, Phase matching, Phase conjugation, Second harmonic generation. Simulated Raman effect, Hyper Raman effect, Coherent anti stokes Raman scattering.	**10**
V	**Holography** Basic principle of holography ,methods of hologram recording, reconstruction of object waveform by hologram Typical arrangement for hologram reconstruction, practical consideration of holography and its application.	**15**

Suggested Readings

1. Lasers and Non-Linear Optics by B.B. Laud (Wiley Est. Ltd., New Delhi).
2. Quantum Optics by S.H. Kay and A. Maitland (Academic Press, London).
3. Non-Linear Optics by P.G. Harper and B.S. Wherret (Academic Press, London).
4. Laser and holographic Data processing by N.G. Bosov (Mir Publisher, Moscow).

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks
1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05marks for Class Interaction
Course Pre-requisites
Passed UG (Hons.)/ UG (Hons.with Research)7th semester/ M Sc. (Physics) 7th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VIII**
Subject: **Physics**		
Course Code: **B010805T**	Course Title: **Plasma Physics**	

Course Objectives and Outcomes

Course Objectives: This course takes into account the fourth state of matter called the plasma.

Course Outcome: The students will come to know the role of plasma particularly in bringing nuclear fusion reaction into practical reality.

Credits:**4**	Course: **Optional**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Plasma State & its Properties** Elementary ideas of plasma state of matter Existence of plasma, Debye shielding, Applications of Plasma (in brief), Motion of charge, Particles in uniform E&B fields, non-uniform fields, drift motion, electrostatic and magnetostatic lenses, Adiabatic invariants, Plasma confinements (Pinch effect, Mirror confinement, Van Allen Belts).	**20**
II	**Hydrodynamical Description of Plasma** Hydroynamical description, Equation of magneto-hydrodynamics, High frequency plasma oscillations, Short wavelength limit and Debye-screening distance	**10**
III	**Kinetic Theory of Plasma** The meaning of f(v), Equations of kinetic theory ,Boltzmann-Vlasov equation, Landau damping, Collision damping	**10**

IV	**Wave Phenomenon in Magneto-Plasma** Electromagnetic waves perpendicular to B0,Phase velocity, Polarization, Cut-off and resonances, Electromagnetic waves parallel to B0, Magnetosonic and Alfven wave	**10**
V	**Introduction to Controlled Fusion** The problem of controlled fusion, Magnetic confinements such as Toruses, Mirrors, Pinches, Laser Fusion, Plasma heating, Fusion Technology	**10**

Suggested Readings

1. Introduction to Plasma Physics - F. F. Chen, Plenum Press, New York.
2. Plasma Physics - A. Bittencourt, 3rd Ed, Springer.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks

1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/
2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd
3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx
4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Internal Evaluation (CIE) Methods

20 marks for Test / Quiz / Assignment / Seminar

05marks for Class Interaction

Course Pre-requisites

Passed UG (Hons.)/ UG (Hons.with Research)7th semester/ M Sc. (Physics) 7th semester

Suggested Equivalent Online Courses

1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
2. edX,https://www.edx.org/course/subject/physics
3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/
4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics
5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html

Further Suggestions

- Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities.
- In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **U.G.(4th Year)/M.Sc. PHYSICS**	Year: **U.G.(4th Year)/M.Sc. First**	Semester: **VIII**
Subject: **Physics**		
Course Code: **B010806P**	Course Title: **Electronics Lab**	

Course Objective & Outcomes

Course Objective: The experiments are an essential and inseparable part of Physics Course. The validity of various Laws and observations are tested through experiments in the Lab.

Course Outcomes: The results of an experiment (in agreement/deviated from the established pattern) enable the students to recognise the faults/errors in his approach and encourages to repeat the experiment with an improved approach.

Credits:**04**	Course: **Core (Compulsory)**
Max.Marks: 100 One Practical: 50 Marks Record: 20 Marks Viva-Voce: 25 Marks Attendance: 05 Marks.	Min. Passing Marks:

Total No. of Lectures-Tutorials-**Practical (in hours per week)**:L-T-P: 0-0-**4**

Topics	**No.of Hours**
1. Study of half – wave and full wave rectifiers and measurement of ripple factor. 2. Study of Timer 555 in Astable and Monostable modes. 3. Operational amplifiers: Measurement of Input bias current and gain in inverting and non – inverting modes. 4. Operational amplifiers as summing amplifier, Integrator and differentator. 5. Study of (a) Zener Regulated (b) Pass. transistor regulated and (c) regulated power supply and measurement of percentage regulation. 6. Triggering characteristics of SCR. 7. Study of wave shaping circuits – clippers and clampers. 8. Study of multi vibrators. 9. Emitter Follower. 10. Study of voltage and current regulation by VR tube (OA2)	**60**

Note:

- The student has to do a minimum of six experiments from the given list.
- In the practical examination the student will be asked to perform one experiment of two hours duration.

Suggested Readings

1. Electronic Principles – A. Malvino, D.J. Bates 7th Ed TMH, N. Delhi.
2. A First Lab in Circuits and Electronics – Yannis Tsvidis, John Wiley and Sons.
3. Fundamentals of Analog Circuits – Floyd, Buchla 2nd Ed, Pearson – 2017.
4. Practical Electronics for Inventors – Paul Scherz, McGraw Hill.
5. Practical Electronics Handbook – Ian Sinclair, John Dunton, 6Th Ed, Newnes.
6. Experiments in Electronics Fundamentals & Electric Circuit Fundamentals.– David Buchla, 4th Ed, Prentice Hall USA.

Course Books published in Hindi may be prescribed by the Universities.

PHYSICS

Suggestive Digital Platforms/WebLinks
8. MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 9. National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 10. Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 1. Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar/ 05marks for Class Interaction
Course Pre-requisites
Passed UG (Hons.)/ UG (Hons.with Research)7th semester/ M Sc. (Physics) 7th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **M.Sc. PHYSICS**	Year: **Second**	Semester:**IX**
Subject: **Physics**		
Course Code: **B010901T**	Course Title: **Nuclear and Particle Physics**	

Course Objectives and Outcomes

Course Objective:

This course discusses the fundamental concepts of nuclear, particle, cosmic rays and comprehension of the cosmos and their recent trends including neutrinos.

Course Outcomes:

After the completion of this course, students will be able to:

1. Develop an understanding of essential nuclear characteristics and associated nuclear models, nuclear decays and nuclear reactions.
2. Learn about the basic building blocks of matter and the fundamental forces of nature, particle accelerators and detectors.
3. Gain ideas about properties of cosmic rays.

Credits:**4**	Course: **Major (Compulsory)**
Max.Marks: **25+75**	Min. Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Properties of Nuclei and Nuclear Models** Review of some important properties of nuclei, Nuclear (radius &its measurement using muonic X-rays and α–scattering, Nuclear shell model, Concept of magic numbers, Prediction of energy levels in harmonic oscillator potential, Spin-orbit coupling, Prediction of ground state spin and parity of nucleus. Q-values, threshold energy, concept of nuclear cross-section, Briet-Wigner's dispersion single level formula.	**15**
II	**Radioactive Decays** Review of α, β, & γ decay, Selection rules, Gamow theory of alpha decay, Fermi theory of Beta-decay, Parity Non-Conservation in β decay, Wu's Experiment, Kurie plots & Comparative half-lives, Allowed &Forbidden Transitions,	**10**
III	**Two Body Problem** Investigation of nature of nuclear forces from simple two body problems. Ground state of a Deuteron, S and D state, neutron–proton and Spin dependence of nuclear forces.	**10**

IV	**Introduction to Elementary Particle Physics** Types of fundamental forces, Classification of elementary particles and their quantum numbers (Hyper charge, Isospin, Color), Quark flavors.Quark model of hadrons, Baryon decuplet and octet, Charge(C), Parity (P) & Time Reversal (T) invariance, CPT Theorem, Parity non- conservation in weak interactions, QCD, QGP.	**15**
V	**Cosmic Rays, Particle Accelerators and Detectors** Properties of primary cosmic ray (Energy &Charge Spectrum) & idea of origin of secondary cosmic rays, Cascade &extensive showers,Need for accelerator of charged particles, Classification of accelerators, Proton Synchrotron, Betatron, Introduction of modern Colliders (LHC and RHIC).	**10**

Suggested Readings

1- Halliday, D.:Introductory Nuclear Physics (JohnWiley)
2- Roy, R.R. & Nigam, B.P.: Nuclear Physics (JohnWiley).
3- Enge, H.A.:Introduction to Nuclear Physics (Addison Wesley)
4- Evans, R.D.:Atomic Nucleus (McGraw Hill)
5- Ghosal, S.N.:Atomic & Nuclear Physics (S. Chand Company Ltd.)
6- Segre, E.: Nuclei &Particles (2nd Ed). (Benjamin/Cummings).
7- Perkins. D.H.:Introduction to High Energy Physics(Addison Wesley).
8- Wong, S. S. M.:Introductory Nuclear Physics Second Edition (Wiley VCH)
9- Nuclear& Particle Physics: W. Burcham & M. Jobes.
10- Harynes, R.C.: Introduction to Space Science (JohnWiley).
11- Karttunen, H.Kroger, P. Oja, H. Poutenon. Mand Donner K.J.: Fundamental of Astronomy (Springer-Verlag).
12- Bhatia V.B.:Text Book of Astronomy & Astrophysics with Elements of Cosmology. (Narosa Publishing House).
13- Ryan S.G. & Norton, A.J.:Stellar Evolution of Nuclear synthesis (Cambridge).
14- Rossi, B.: Cosmic rays (George Allenand Unwin).

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks
11. MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 12. National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 13. Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 1. Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05marks for Class Interaction
Course Pre-requisites
Passed M.Sc. (Physics) First Year/ 8Th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

V	**Optical Properties** Optical reflectance, Kramers-Kronig relations; Conductivity and dielectric function of collision electron gas	**10**

Suggested Readings

1. Solid State Physics – C. Kittel, 8th Ed,Wiley.
2. Solid State Physics - J.D. Patterson, B.C. Bailey, Springer-2006.
3. Elementary Solid State Physic - Ali Omar, 1st Ed, Pearson India.
4. Solid State Physics – A. J. Dekkar, Laxmi Publications-2008.
5. Solid State Physics – F. W. Ashckroft, N. D. Mermin, 1st Ed, Cengage.
6. Solid State Physics-An Introduction – Phillip Hofmann, 2nd Ed, Wiley-VCH.

Course Books published in Hindi may be prescribed by the universities.

Programme/Class: **M.Sc. PHYSICS**	Year:**Second**	Semester:**IX**
Subject:**Physics**		
Course Code: **B010902T**	CourseTitle: **Solid State Physics**	

Course Objectives and Outcomes

Course Objective: To provide the information about how the different properties of matter are determined by their structure.

Course Outcome: The students will come to know various applications of solid state of matter and job opportunities.

Credits:**4**	Course: **Major (Compulsory)**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Crystal Structure:** Space lattice and basis, Lattice types, Miller indices, Crystal structures of NaCl, CsCl, ZnS, graphite and diamond, Reciprocal Lattice and Brillouin Zone, Elementary idea of crystal structure analysis and crystal defects.	15
II	**Lattice Dynamics And Thermal Properties** Lattice vibrations of mono and diatomic chains, Infrared absorption of ionic crystals, quantization of lattice vibration and phonon, Einstein and Debye theories of specific heat, Anharmonicity and Thermal expansion	10
III	**Free Energy And Energy Band Theories** Density of states, Fermi and mean energy at zero and finite temperatures, specific heat and origin of energy bands, Bloch theorem, Kroning Penny model, concept of electron dynamics in crystalline lattice, Tight binding approximation	10
IV	**Magnetic Properties** Diamagnetism, Paramagnetism, Ferromagnetism: Magnetic domains, Basic features and their explanation by molecular field theory, Heisenberg explanation of internal magnetic field, spin wave theory and magnons, Basic features and Neel's two sub-lattice models of antiferro and ferrimagnetic materials.	15

Suggestive Digital Platforms/WebLinks
1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05marks for Class Interaction
Course Pre-requisites
Passed M.Sc. (Physics) First Year/ 8Th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
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Programme/ Class: **M.Sc. PHYSICS**	Year:**Second**	Semester:**IX**
Subject:**Physics**		
Course Code: **B010903T**	Course Title: **Quantum Field Theory**	

Course Objectives and Outcomes

Course Objective: To develop a basic understanding of Quantum Field Theory which states the discrete nature of the fields- that is every field has its corresponding quantum of energy/particle. A novel and strange idea of quantum particle completely distinct from its counterpart as described in Classical field theory. A particular emphasis is done on Quantum Electrodynamics that describes the fundamental processes between light and matter via Feynman diagrams.

Course Outcomes: The students will be able to develop a better, simpler and broader understanding of the interactive processes taking place between fields and particles in terms of quantum-the force particles and matter particles.

Credits:**4**	Course: **Optional**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Basic conception of Fields and Particles** General concept and formalism of a field, classical field, Lagrangian for a particle and Lagrangian density for a field, Hamiltonian for a particle and Hamiltonian density for a field, Number/Fock space representation and number operator, creation and annihilation operators,	**15**
II	**Quantisation of Bosonic, Radiation and Dirac Fields** Path integral formulation of quantisation, harmonic oscillator problem, Feynman diagrams,Canonical quantisation of Klein Gordon and charged scalar fields, radiation/electromagnetic fields, Dirac fields,	**15**
III	**Discrete Symmetries** C, P and T symmetries of free scalar and charged scalar fields, radiation and Dirac fields, intrinsic parity, CPT transformation, invariance principles, Lorentz invariance of free field theory.	**08**

IV	**Basics of Gauge Theories** Gauge invariance of charged scalar and Dirac fields, conservation of charge, and interaction of charged fields with Maxwell field	**08**
V	**Interacting Fields** Interaction picture, time evolution operator, S-matrix and Schwinger Dyson expansion, time ordered product and Wicks theorem, Feynman diagrams for fundamental processes	**14**

Suggested Readings

1. L. Landau, E.M. Lifshitz, Classical Theory of Fields (Butterworth Heinmann, 1975).
2. V. B. Berestetskii, E. M. Lifshitz, L.P. Pitaevskii, Quantum Electrodynamics (Pergamon Press Ltd. England, 1982).
3. M.E. Perkins, D.V. Schroeder, An Introduction to Quantum Field Theory (Addison Wesley Publishing Company, 1996).
4. J.D. Bjorken and S.D. Drell, Relativistic Quantum Fields (McGraw Hill, 1964).
5. F. Mandl, G. Shaw, Quantum Field Theory (Wiley India, 2016).
6. C. Itzykson and J.B. Zuber, Quantum Field Theory (Tata McGraw-Hill, 1980).
7. A. Zee, Quantum Field Theory in a Nutshell (Princeton University Press, 2016).
8. M. Imran Aziz,Fundamentals of Quantum Electrodynamics, (Ayushman Publications, New Delhi.)

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks

1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/
2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd
3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx
4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Internal Evaluation (CIE) Methods

20 marks for Test/Quiz/Assignment /Seminar

05marks for Class Interaction

Course Pre-requisites

Passed M.Sc. (Physics) First Year/ 8Th semester

Suggested Equivalent Online Courses

1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
2. edX,https://www.edx.org/course/subject/physics
3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/
4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics
5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html

Further Suggestions

- Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities.
- **In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.**

Programme/Class: **M.Sc.PHYSICS**	Year:**Second**	Semester:**IX**
Subject:**Physics**		
Course Code: **B010904T**	CourseTitle: **Atomic and Molecular Physics**	

Course Objectives and Outcomes

Course Objectives:

This course puts emphasis on atomic, molecular, electronic, Raman and X-ray spectroscopy.

Course Outcome:

After completing this course, the students will be able to get information about energy levels of atoms and molecules and the transitions between them.

Credits:**4**	Course: **Optional**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Vector Atomic Model** Vector Atom model , Atomic structure, electronic angular momentum, many electron atoms, angular momentum of many electron atoms ,L S coupling & J J coupling, effect of electric & magnetic field on atoms and molecules; Zeeman effect, Paschen Back effect and stark effect	**15**
II	**Molecular Spectroscopy** IR and Raman spectra of rigid rotator and harmonic oscillator, IR and Raman spectra of non-rigid rotator, anharmonic oscillator and vibrating rotator, Isotope effect in rotation and vibration spectra.	**15**
III	**Electronic Spectra** Electronic energy and total energy ,Vibrational Analysis of band systems, Deslander's table, Progressions & sequences, Rotational fine structure and P,Q and R Branches,Fortrat Diagram,Franck Condon Principle and its quantum mechanical formulation	**10**

IV	**Raman Spectroscopy** Raman Spectroscopy – Raman effect, Rotational Raman Spectra, vibrational Raman Spectra, structure determination using Raman spectroscopy.	**10**
V	**X-ray Spectroscopy and Spin Spectroscopy** Electron spectroscopy of molecules. Spin resonance spectroscopy, NMR.	**10**

Suggested Readings

1. Molecular Structure & Spectroscopy - G.Aruldhas, 2nd Ed, Prentice Hall India.
2. Fundamentals of Molecular Spectroscopy - C. N. Banwell & E.M. McCash, 4th Ed,McGraw Hill.
3. Introduction to atomic spectra - H. E. White,McGraw-Hill-1934.
4. Molecular Spectra and Molecular Structure - G. Herzberg (Dover Publication, London).
5. Introduction to Molecular Spectroscopy - G.M.Barrow, McGraw-Hill-1962.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks
1MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05marks for Class Interaction
Course Pre-requisites
Passed M.Sc. (Physics) First Year/ 8Th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
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Programme/Class: **M.Sc. PHYSICS**	Year: **Second**	Semester:**IX**
Subject: **Physics**		
Course Code: **B010905P**	Course Title: **General and Optics Lab**	

Course Objective & Outcomes

Course Objective: The experiments are an essential and inseparable part of Physics Course. The validity of various Laws and observations are tested through experiments in the Lab.

Course Outcomes: The results of an experiment (in agreement/deviated from the established pattern) enable the students to recognise the faults/errors in his approach and encourages to repeat the experiment with an improved approach.

Credits:**04**	Course: **Core (Compulsory)**
Max.Marks: 100 One Practical: 50 Marks Record: 20 Marks Viva-Voce: 25 Marks Attendance: 05 Marks.	Min. Passing Marks:

Total No.of Lectures-Tutorials-**Practical(in hours per week)**:L-T-P: 0-0-**4**

Topics	**No. of Hours**
1. Zeeman effect 2. Michelson interferometer 3. Franck – Hertz experiment 4. e/m by Thomson's method 5. Planck's constant by LED's. 6. Solar Trainer 7. V-I Characteristics of U.J.T. 8. Speed of sound by C.R.O 9. Design of Regulated Power Supply, Audio amplifier and alarm circuits. 10. Design of voltage Doubler, Tripler and quadrupler circuits. 11. Miscellaneous experiments on Bread Board and discrete electronic components. 12. Study of Lattice Dynamics 13. Study of combinational circuits. 14. Phase Shift Oscillator 15. G.M. Counter.	**60**

Note:

- The student has to do a minimum of six experiments from the given list.
- In the practical examination the student will be asked to perform one experiment of two hours duration.

Suggested Readings

1. Electronic Principles – A. Malvino, D.J. Bates 7thed TMH, N. Delhi.
2. Microelectronic Circuit and Devices – Mark N. Horenstein, Pearson 2nd ed.
3. Fundamentals of Analog Circuits – Floyd, Buchla 2nd ed, Pearson – 2017.
4. Digital System – R.J. Tocci, PHI 6th ed, 2000.
5. Digital Logic and Computer Design – M. Morris Mano, PHI, Delhi 1996.
6. Integrated Electronics: Analog and Digital circuits and Systems, J. Millman, C. C. Halkias, TMH, Edition 1991.
7. Electronic Circuits and Devices Theory– Boylested, Pearson.
8. B.Sc. Practical Physics– C. L. Arora, S. Chand & Company-2010.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks
1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar/ 05marks for Class Interaction
Course Pre-requisites
Passed M.Sc. (Physics) First Year/ 8Th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **M.Sc. PHYSICS**	Year: **Second**	Semester:**X**
Subject: **Physics**		
Course Code: **B011001T**	Course Title: **Electronic communication systems**	

Course Objectives and Outcomes

Course Objective:
This course makes student aware of microwaves, antennas, transmission cables and optical fibres. Antennas are the chief devices that transmit and receive the signals.

Course Outcomes:
After learning this course, the students will be able to:
(i) get an idea of various tube based and semiconductor based sources of microwaves.
(ii) understand the principle of velocity modulation and bunching.
(iii) know how an infinitesimal current element becomes source of Electromagnet radiation.
(iv) understand how optical fibres carry light from one end to the other.
(v) understand the behaviour of parallel wire and coaxial cables.

Credits:**4**	Course: **Major (Compulsory)**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Microwaves** Limitations of conventional vacuum tubes, MW sources, Two cavity Klystron, principle of velocity modulation and bunching, output power and Maximum efficiency, operating principle of a TWT, Gunn Oscillator, Tunnel diode.	**15**
II	**Antenna** Review of spherical polar coordinates, Radiation fields of a current element, Average radiated power and radiation resistance, Half – wave antenna radiating in space, Antenna Gain, Antenna Array, 2-element and N-element Array, Broadside and End – Fire array, Effective length and effective area of antenna. Relationship between effective length, effective area and Gain.	**15**
III	**Optical Fibre** Optical fibre structure, Light propagation, Numerical aperture acceptance angle, step and graded index fibre, Losses in optical fibre, Dispersion in an optical fibre, Optical fibre communication system.	**10**

IV	**Transmission Lines** General Transmission Line equations, wave characteristics on an infinite Transmission Line, characteristic impedance, Loss-less, low-loss, and distortion-less lines, Transmission line parameters, wave characteristics on finite transmission Line, transmission line as circuit element, Lines with resistive and arbitrary terminations	**10**
V	**Propagation of Waves** Ground wave propagation, Space waves through Troposphere, Path curvature and refractive index; Sky waves through Ionosphere, reflection and refraction, Maximum usable frequency, Skip distance, Effect of Earth's magnetic field, Faraday rotation and measurement of total electron content.	**10**

Suggested Readings

1. Microwave Devices and Circuits 3rd edition – Samuel Y. Liao Pearson – 2003
2. Electronic Communication Systems, Fourth Edition – Kennedy. Davis TMH edition 1999.
3. Networks, Lines and Fields, J. D. Ryder, PHI
4. Optical Fibres and Fibre Optic Communication Systems – Subir Kumar Sarkar, S. Chand 2003.
5. Field & wave Electromagnetics 2nd Edition – D.K. Cheng, Pearson Education.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks
1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05marks for Class Interaction
Course Pre-requisites
Passed M.Sc. (Physics) Second Year/ 9Th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **M.Sc. PHYSICS**	Year:**Second**	Semester:**X**
Subject: **Physics**		
Course Code: **B011002T**	CourseTitle: **Analog and Digital Communication**	

Course Objectives and Outcomes

Course Objective: The objective of this course is to make one understand the concept of electrical noise, its causes and effects on the electronic circuits. Also, to understand the techniques of transmission of information from one place to the other.

Course Outcomes: After completing this course the students will be able to:
(i) understand the concepts of generation and reception of information.
(ii) be familiar with the harmful effects of ever present "noise" on the working of electronic communication system.
(iii) grasp the concept of various techniques of digital transmission.
(iv) understand the relationship between the probability of message and the amount of information contained.

Credits:**4**	Course: **Optional**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Signals and Spectra** Time domain and frequency domain representation of waveforms, Fourier Transform and its properties. Delta function and its application in communication. Spectra of sinusoid, rectangular and triangular pulses. Power spectral density, Line spectra and PSD of periodic wave forms, Band limited waveform and sampling theorem (Proof needed).	**15**
II	**Noise** Thermal noise, shot noise, partition noise, series and parallel resistors as noise sources, mean square noise voltage in an RC circuit, available power, noise temperature, noise bandwidth, noise figure, noise figure of a Cascade. S/N ratio.	**10**
III	**Pulse Modulation** Pulse Amplitude Modulation, Natural sampling, PAM spectrum, Sampling Theorem, Pulse Code Modulation; Sampling, Quantization and Encoding, PCM transmitter and receiver, Transmission bandwidth of PCM, Effect of noise, 6dB rule, DPCM, Delta Modulation, Adaptive Delta Modulation.	**15**

Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test/Quiz/Assignment /Seminar 05marks for Class Interaction
Course Pre-requisites
Passed M.Sc. (Physics) Second Year/ 9Th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

IV	**Digital Modulation Techniques** ASK (OOK), Power spectral density and transmission bandwidth, Non coherent and coherent detection of OOK, BPSK generation and detection, spectrum of BPSK, PSD of BPSK, Differential Phase Shift keying, PSD of MSK, Generation and Reception of MSK.	**10**
V	**Information Theory** Discrete messages, concept of amount of information, Average information, Entropy, Information Rate, Channel Capacity, Shannon Theorem, Discrete communication channels, Rate of information transmission over a discrete channel, capacity of a discrete memory less channel Shannon – Hartley Theorem and its implications.	**10**

Suggested Readings

1. Digital and Analog Communication Systems – Leon W.Couch, 8th edition, Pearson.
2. Electronic Communication – Dennis Roddy. John Coolen, 4th edition, PHI.
3. Principles of Communication Systems – Taub Schilling, 2nd Edition, TMH 1991.
4. Digital and Analog Communication Systems – K. Sam Shanmugam, Wiley.
5. Communications Systems – Symon Haykin, 2nd Ed, Wiley, 1983.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks

1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/
2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd
3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx
4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8

PHYSICS

Programme/Class: **M.Sc.PHYSICS**	Year:**Second**	Semester:**X**
Subject:**Physics**		
Course Code: **B011003T**	CourseTitle: **Advanced Solid State Physics**	

Course Objectives and Outcomes

Course Objective:
This course lays emphasis on the various properties change due to structure and other external factors including electric field, temperature, etc.

Course Outcomes:
This class of materials will open the door for a number of opportunities especially in the field on nano-materials and technology.

Credits:**4**	Course: **Optional**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Energy bands and Charge carriers in Semiconductors** Formation of energy bands, direct and indirect band gap semiconductors, Effective mass of electrons and holes in quantum wells, the Fermi level, electron and hole concentrations at equilibrium, temperature dependence of carrier concentrations, electrical conductivity and mobility.	**15**
II	**Ferroelectric behaviour of Materials** Ferro-electric crystals, Order-disorder type of Ferro-electrics, Properties of $BaTiO_3$, Polarisation catastrophe, Landau theory of Ferro-electric phase transitions, Ferro-electric domain, Anti-ferro-electricity, Piezo-electricity, Applications of Piezoelectric Crystals.	**10**
III	**Superconductivity** Meissner effect, Type I and Type II superconductors, London equation and penetration of magnetic field, Cooper pairs and B C S Theory (qualitative treatment), Flux quantization, SQUID, DC and AC Josephson effects, High Tc Superconductors.	**10**

IV	**Luminiscence and Colour Centres** Basic Theories and models of luminiscence, Phosphorescence, Thermo-luminiscence, Electro-luminiscence and Photo-conductivity, Colour centres.	**10**
V	**Nano Science andTechnology** Conceptual development of nano-science, Nano-science in nature, Size effect on properties of nano- structures, Concepts of 2D nano-structures (quantum wells), 1D nano-structures (quantum wires) 0D nanostructures (quantum dots).	**15**

Suggested Readings

1. Solid State Physics: Structure and Properties of Materials - A. M. Wahab, Narosa Publishing House, India, 2nd Ed,2005.
2. Elements of Solid State Physics -J. P. Srivatsava, 4thEd,PHI.
3. Introduction to Nano: Basics to Nano science and Nanotechnology - Sengupta, Amretashis et.al, Springer, 2015.
4. Solid State Physics - Ashcroft & Mermin, 1st Ed,Cengage.
5. Solid State Physics - A.J.Dekker, Prentice-Hall-1958.
6. Solid State Physics - C. Kittel, 7th Ed, Willey.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks
1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar 05marks for Class Interaction
Course Pre-requisites
Passed M.Sc. (Physics) Second Year/ 9Th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **M.Sc. PHYSICS**	Year:**Second**	Semester:**X**
Subject:**Physics**		
Course Code: **B011004T**	CourseTitle: **Liquid Crystal Physics**	

Course Objectives and Outcomes

Course Objectives: This course makes one awares of substances that are in crystalline states yet they flow.

Course Outcomes: The students will learn how LCD readouts function in wrist watches, calculator, multimeter, mobile phones screen etc.

Credits:**4**	Course: **Optional**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Classification of Liquid Crystals** Introduction, classification of liquid crystals, thermotropic liquid crystals (rod like molecules), chirality in liquid crystals, nematic, cholesteric and smectic mesophases, polymorphism in thermotropic liquid crystals, polymer liquid crystals, applications of polymer liquid crystals	10
II	**Phase transitions in Liquid Crystals** Melting of molecular crystals, distribution functions and order parameters, measurement of order parameters by X-ray diffraction. Nature of phase transitions and critical phenomena in liquid crystals, optical properties of cholesteric liquid crystals, the blue phases	15
III	**Liquid Crystals in Electric and Magnetic** Liquid crystals in electric and magnetic fields, magnetic coherence length, Freederick transitions, Effect of solid boundaries on liquid crystals	10
IV	**Other Types of Liquid Crystals** Ferroelectric, Discotic and Lyotropic Liquid Crystals Ferroelectreic liquid crystals, applications of ferroelectric liquid crystals, discotic liquid crystals, discotic mesophase structures-the columnar liquid crystal, the discotic nematic phase. Lyotropic liquid crystals, constituents of lyotropic liquid crystals, structures of lyotropic liquid crystal phases, biological membranes	15

V	**Applications of Liquid Crystals** Identification of Liquid Crystal Phases and Liquid Crystal Technology Identification of nematic, smectic and chiral liquid crystal phases by optical polarizing microscopy (Visual appearance and texture), liquid crystal displays, the twisted nematic liquid crystal displays, nematic liquid crystal displays, liquid crystal displays using polymers, applications of liquid crystals	**10**

Suggested Readings

1. Liquid Crystals - S.Chandrasekhar, 2nd Ed, Cambridge University Press.
2. Thermotropic Liquid Crystals - Vertogen and Jeu,Springer-1988.
3. The Physics of Liquid Crystals –P.G. de Geenes and J. Prost, 2nd Ed, Clarendon Press.
4. Ferroelectric Liquid Crystals - Goodby et al. IntechOpen,2011.
5. Introduction to Liquid Crystals Chemistry and Physics – P. J.Collings, M. Hird, 2nd Ed, C.R.C. Press.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks

1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/
2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd
3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx
4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test/Quiz/Assignment /Seminar 05marks for Class Interaction
Course Pre-requisites
Passed M.Sc. (Physics) Second Year/ 9Th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
• Other digital platforms /web links and Equivalent online courses may be suggested /added to the respective lists by individual Universities. • In End-semester University Examination, equal weightage should be given to each unit 1-V while framing the questions.

Programme/Class: **M.Sc. PHYSICS**	Year: **Second**	Semester:**X**
Subject: **Physics**		
Course Code: **B011005T**	Course Title: **Astrophysics**	

Course Objectives and Outcomes

Course Objectives:

The objective of this course is to make the students aware of the planets, their sizes, shapes, atmosphere and their satellites, How stars evolve and what is the source of stellar energy etc is.

Course Outcomes:

After completing this courses the students will be able to get the answers of:

1. how astronomical distances are measured?
2. what are composition, atmosphere, etc. of planets?
3. how many satellites are their around different planets?
4. how do stars (including sun) emit energy?
5. birth and death of stars.

Credits:**4**	Course: **Optional**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Measurement Techniques** Methods of measurement of astronomical distances, measurement of mass, temperature, radius and velocity.	08
II	**Planets and their satellites** The earth; shape, dimension and its interior. Atmosphere of earth, magnetic field and gravity, rotation and revolution; earth's precession, earth's distance from sun, perihelion and aphelion, Mercury as morning and evening star, Venus and its atmosphere. The red planet, rotation & Mass, surface features, Hazy atmosphere, Climate and satellites of Mars, Asteroids and their orbits, Jupiter; Saturn and its rings, Constitution of Saturn, Discrete nature of rings, Origin of Saturn's rings.	18
III	**Classification of stars** Classification of stellar spectra, Luminosity of stars, Mass – luminosity relation, stars of Main Sequence, Giant and dwarf stars, white dwarf stars.	10

IV	**Evolution of stars** Protostar Jeans mass, hydrostatic equilibrium, equations of stellar structure, scaling relations sources of stellar energy, Gravitational collapse, Nuclear fusion reactions, proton – proton and carbon cycle, formation of heavy elements; r and s processes, evolution of low mass and high mass stars, white and brown dwarfs, Chandrashekhar limit, pulsars and neutron star.	**12**
V	**Galaxies** Types and structural features, The Milky way Galaxy, stellar population in the galaxy, position of Sun, effect of rotation, interaction between galaxies. Active galatic nuclei and quasars.	**12**

Suggested Readings

1. Theoretical Astrophysics (vol. 1 – 3) – T. Padmanabhan, Cambridge University Press, South Asian Ed.
2. Astronomy – Robert H. Baker, 10th Ed, D. Van Nostrand Company, Inc.-1976.
3. Introduction to Stellar Evolution and Nuclosynthesis– A. J. Norton, Sean G. Ryan, 1st Ed, Cambridge University Press,
4. The Early Universe – E. W. Kolb, M. S. Turner, C.R.C. Press, Special Indian Ed-1994.

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks
1.MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/
2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd
3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx
4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test/Quiz/Assignment /Seminar
05marks for Class Interaction
Course Pre-requisites
Passed M.Sc. (Physics) Second Year/ 9Th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
2. edX,https://www.edx.org/course/subject/physics
3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/
4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics
5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
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Programme/Class: **M.Sc. PHYSICS**	Year: **Second**	Semester:**X**
Subject: **Physics**		
Course Code: **B011006T**	Course Title: **High Energy Physics**	

Course Objectives and Outcomes

Course Objectives:

The main purpose of high energy physics course also known as (particle physics) is to identify the most fundamental building components of matter and to comprehend their interactions. Further understanding and mechanism of multi-particle production can be acquired by attempting to comprehend what happens through the collisions of nuclei at relativistic energies, where new particles may be produced.

Course Outcomes:

After the completion of this elective course, students will have the following capability and skills:

1. Understand the concept and applications of natural units, fundamental interactions, Feynman diagrams, quark structure of hadrons and knowledge of experimental error analysis.
2. They can use the concept of relativistic kinematics in solving different problems and can explain the mechanism of multi-particle production in hadronic and ion-ion collisions.
3. Knowledge of different theoretical models of high energy nuclear collisions and can explain and describe the important physics scenario of modern detectors used in world class mega experiments such as ALICE, CMS CBM etc.

Credits:**4**	Course: **Optional**
Max.Marks: **25+75**	Min.Passing Marks:

Total No.of Lectures-Tutorials-Practical(in hours per week):L-T-P:**4-0-0**

Unit	Topics	No.of Lectures
I	**Natural Units and Fundamental Interactions** Introduction to natural units, Review of (classification of elementary particles and conservation laws, Quark model of hadrons), Eight fold way classification of mesons and baryons, Fundamental interactions and Feynman diagrams, The Standard model of particle physics and its shortcomings, Experimental errors, Random, Systematic and Statistical errors, Gaussian distribution.	**10**
II	**Relativistic Kinematics of High Energy Collisions** Lorentz transformations for energy and momentum, four-vectors and invariants, Laboratory and Centre-of-momentum systems, calculation of energy, momentum and angle of particles produced in nuclear reactions in Lab and centre-of-momentum frames and their transformations and calculation of threshold energies for particle production, Mandelstam variables, Fermi Golden Rule, Brief discussion on Differential and total scattering cross sections, Lorentz invariant phase space.	**14**

III	**Discussion on Relativistic Hadron-Nucleus Interactions and Approaches to Study Correlation and Fluctuations** Rapidity and pseudorapidity variables, Lab and CM-rapidity, Maximum and minimum rapidities, Pseudorapidity distribution in projectile, target and central fragmentation regions. Fluctuations and Correlations: Two-particle correlations, Short- and long-range multiplicity correlations, Entropy and its generalization, Shanon and Renyi Entropies, Characteristics of non-statistical fluctuations,Approaches to study non-statistical fluctuations using Intermittency (Scaled Factorial Moments),Multifractality (G-Moment and Takagi Moment) and Multifractal specific heat, Non-thermal phase transition.	**14**
IV	**Models of High-Energy Nuclear Collisions, Formation of QGP and it's Signatures** Participant-Spectator, Bjorken and Lund Model, Space-time evolution of heavy-ion collisions, Phase diagram of strongly interacting matter, De-confinement phase transition, Promising signals of Quark-Gluon Plasma formation, Dilepton production, Drell-Yan Process in nucleus-nucleus collision, Direct photon production, De-bye screening in the QGP, J/Ψ suppression in the QGP.	**12**
V	**Modern Detectors in High Energy Physics Experiments** Fundamental features of detectors, Sensitivity, Energy resolution and fano factor, Detector efficiency and dead time, Multiwire and Drift Chambers, Ionization, drift and diffusion of charges in gases, Pulse formation and its shape in proportional counters, Multiwire proportional counter:-Working principle and Construction, Di-Muon Spectrometer of ALICE andQualitative discussion on(MuCh of CBM, Physics scenarios at RHIC and LHC energies).	**10**

Suggested Readings

1. Pilkuhn, H.: The Interactions of Hadrons
2. Martin, L.P.: High Energy Hadron Physics (John Willey)
3. Collins, P.D.B. & Martin, A.D.: Hadron Interactions (Adam Hingler)
4. Hagedorn, R. : Relativistics Kinematics (Benjamin)
5. Perkins, D.H. : Introduction to High Energy Physics (Addison Wesley)
6. Halzen, F. and Martin, A.: Quarks and Leptons (John-Wiley)
7. Wong, C.Y.: Introduction to High Energy Heavy Ion Collisions (World Scientific)
8. Ferbel, T. : Experimental Techniques in High Energy Physics (Addison Wesley)
9. Leo, W.R.: Techniques for Nuclear and Particle Physics Experiments (Narosa)
10. Kleinknecht, W.: Detectors for Particle Radiation (Cambridge)

Course Books published in Hindi may be prescribed by the Universities.

Suggestive Digital Platforms/WebLinks

1MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/

2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd

3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx

4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8

Suggested Continuous Internal Evaluation (CIE) Methods

20 marks for Test/Quiz/Assignment /Seminar

05marks for Class Interaction

Course Pre-requisites

Passed M.Sc. (Physics) Second Year/ 9Th semester

Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
Further Suggestions
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Programme/Class: **M.Sc. PHYSICS**	Year: **Second**	Semester: **IV**
Subject: **Physics**		
Course Code: **B011007P**	Course Title: **Special Lab**	

Course Objective & Outcomes

Course Objective: The experiments are an essential and inseparable part of Physics Course. The validity of various Laws and observations are tested through experiments in the Lab.

Course Outcomes: The results of an experiment (in agreement/deviated from the established pattern) enable the students to recognise the faults/errors in his approach and encourages to repeat the experiment with an improved approach.

Credits:**04**	Course: **Core (Compulsory)**
Max. Marks: 100 One Practical: 50 Marks Record: 20 Marks Viva-Voce: 25 Marks Attendance: 05 Marks.	Min.Passing Marks:
Total No. of Lectures-Tutorials- **Practical (in hours per week)**:L-T-P: 0-0-**4**	

Unit	Topics	No. of Hours
	1. D/A Converter 2. A/D Converter 3. Multiplexer 4. De Multiplexer 5. Active Filter 6. Transistor feed back Amplifier 7. Microprocessor 8085 8. A.L.U 9. Pulse Amplitude Modulation. 10. Study of OP – amp741 as summer, differentiator and integrator. 11. Astronomical Telescope 12. Four probe 13. Study of Combinational Circuits **Note:** ➢ The student has to do a minimum of six experiments from the given list. ➢ In the practical examination the student will be asked to perform one experiment of two hours duration.	**60**

PHYSICS

Suggested Readings

1. Electronic Principles – A. Malvino, D.J. Bates 7th Ed TMH, N. Delhi.
2. Microelectronic Circuit and Devices – Mark N. Horenstein, Pearson 2nd ed.
3. Fundamentals of Analog Circuits – Floyd, Buchla 2nd Ed, Pearson – 2017.
4. Digital System – R.J. Tocci, PHI 6th Ed, 2000.
5. Digital Logic and Computer Design – M. Morris Mano, PHI, Delhi 1996.
6. Integrated Electronics: Analog and Digital circuits and Systems, J. Millman, C. C. Halkias, TMH, Edition 1991.
7. Microprocessor Architecture, Programming, and Applications with the 8085– Ramesh S. Gaonkar, 5th Ed,Prentice Hall-2002.

Course Books published in Hindi may be prescribed by the Universities.

PHYSICS

Suggestive Digital Platforms/WebLinks
1MIT Open Learning-Massachusetts Institute of Technology,https://openlearning.mit.edu/ 2.National Programme on Technology Enhanced Learning (NPTEL),https://www.youtube.com/user/nptelhrd 3.Uttar Pradesh Higher Education Digital Library,http://heecontent.upsdc.gov.in/SearchContent.aspx 4.Swayam Prabha-DTH Channel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
Suggested Continuous Internal Evaluation (CIE) Methods
20 marks for Test / Quiz / Assignment / Seminar/ 05marks for Class Interaction
Course Pre-requisites
Passed M.Sc. (Physics) Second Year/ 9Th semester
Suggested Equivalent Online Courses
1. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy 2. edX,https://www.edx.org/course/subject/physics 3. MIT Open Course Ware-Massachusetts Institute of Technology,https://ocw.mit.edu/courses/physics/ 4. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics 5. National Programme on Technology Enhanced Learning(NPTEL),https://nptel.ac.in/course.html
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07.10.24