SOMAIYA VIDYAVIHAR

K J Somaiya College of Science & Commerce

Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

Learning Outcomes based Curriculum Framework

(LOCF)

For

S.Y.B.Sc. Physics (MINOR)

Undergraduate Programme

From

Academic year

2024-25

Vision & Mission

Mission:

- Equip the student with knowledge and skills of their chosen vocation,
- Inculcate values.
- Provide them opportunities for all round growth and prepare them for life.

Vision:

- To equip the students with advanced knowledge and skills in their chosen vocation.
- To provide value-based education and opportunities to students.
- To help them to face challenges in life.
- To nurture a scientific attitude, temperament and culture among the students.
- To continually review, develop and renew the approach to build India of the Founder's dream.

Goals and Objectives:

- To build a strong Academia-Industry bridge.
- To provide flexibility in the courses offered and proactively adapt to the changing needs of students and the society.
- To establish a centre for multidisciplinary activities.
- To mould individuals who would nurture the cultural heritage of our country and contribute to the betterment of the society.

Board of studies in Physics

	Name	Designation	Institute/Industry
Head of the Department			
1	Dr. Deepak More	Chairman	K J Somaiya College of Science and Commerce
Subject Expert nominated by Vice-Chancellor			
1	Dr. Anita Kanwar	Principal	VES College, Chembur
Subject experts			
1	Dr. Nigvendra Sharma	Head of the Department	Maharashtra College of Arts, Science &Commerce
2	Dr Dinesh Kala	Head of the Department	G N Khalsa College of Arts, Science & Commerce
3	Dr. Paresh Joshi	Academic Program coordinator JSO	HBCSE,Mumbai
Representative from Industry/corporate sector/allied area			
1	Mr. R. Venkataraman	Director	Tej Control System PVT LTD. Thane 400064
Meritorious Alumnus			
1	Mr. Vikrant Jadhav	Founder Member	Panacea Intech PVT LTD
Experts other than parent university			
1	Dr. Raghunath Chelakkot	Associate Professor	Department of Physics, IITB, Mumbai
2	Dr. R. R. Deshmukh	Professor	Department of physics, ICT, Mumbai
3	Dr. Pruthul Desai	Principal	P T Sarvajanik College, Surat
Student Representative			
1	Mr Mahindra Santra	Student	M.Sc-II

Faculty of the specialisation			
1	Dr. Geeta Nair	Associate Professor	K J Somaiya College of Science and Commerce
2	Mr. A M Shaker	Associate Professor	K J Somaiya College of Science and Commerce
3	Dr. Jitendra Pendharkar	Associate Professor	K J Somaiya College of Science and Commerce
4	Dr. Smita Survase	Associate Professor	K J Somaiya College of Science and Commerce
5	Mr. Anshul Gupta	Assistant Professor	K J Somaiya College of Science and Commerce
6	Mr. Deepak Jalla	Assistant Professor	K J Somaiya College of Science and Commerce
7	Mr. Amit More	Assistant Professor	K J Somaiya College of Science and Commerce
8	Dr. Pallavi Raote	Assistant Professor	K J Somaiya College of Science and Commerce
9	Mr. Ketankumar Gayakwad	Assistant Professor	K J Somaiya College of Science and Commerce
10	Dr. Rucha Naik	Assistant Professor	K J Somaiya College of Science and Commerce
11	Dr. Shruti Barve	Assistant Professor	K J Somaiya College of Science and Commerce

Foreword

Autonomy reflects efforts for excellence in academic performances, capability of self-governance and enhancement in the quality of education. In the year 2012, the UGC and University of Mumbai conferred the Autonomous Status to K J Somaiya College of Science and Commerce. Post this recognition and having several accolades to our credit, we made significant changes to our existing syllabi to reflect the changing business, industrial and social needs. A holistic education that provides opportunities to gain and share knowledge, experiment and develop beyond curriculum, is offered at our College.

Autonomous college carries a prestigious image for the students and the teachers and we have made a collaborative attempt to maintain a high level of quality in the standard of education that we impart.

Structured feedback obtained from the students, alumni and the experts from the industry and the changes suggested by them were duly incorporated in the syllabi. The Board of Studies constituted for each department meets to carry out in depth discussions about different aspects of the curriculum taking into cognizance the recent trends in the discipline.

The IQAC team has facilitated the conduct of a number of workshops and seminars to equip the faculty with the necessary skill set to frame the syllabi and competencies to deliver the same. Training was also provided to employ innovative evaluation methods pertaining to higher cognitive levels of revised Bloom's taxonomy. This ensured the attainment of the learning outcomes enlisted in the syllabus. Audits are conducted to critically review the practices undertaken in teaching, learning and evaluation. Innovative learning methodologies such as project-based learning, experiential learning and flip- class learning practiced by a committed fleet of faculty, supported by several hands have been our unique outstanding

propositions. All efforts have been made to nurture the academic ambitions as well as the skills in co-curricular activities of the most important stakeholder i. e. student.

With sincere gratitude, I acknowledge the constant support and guidance extended by Shri Samir Somaiya, President- Somaiya Vidyavihar, and all the esteemed members of the Governing board and Academic council of the College. I also would like to acknowledge the Heads of the Departments and all the faculty members for their meticulous approach, commitment and significant contribution towards this endeavour for academic excellence.

Dr. Pradnya Prabhu

Principal

Acknowledgement

To begin with, I, on behalf of my department would like to place on record our indebtedness towards Principal Dr Pradnya Prabhu for her advice and encouragement during the entire process of curriculum restructuring. I am also grateful to all the esteemed members of the Board of Studies, for their valuable suggestions and inputs.

Above all, the young and dynamic colleagues in the Department of Physics need a special mention of appreciation for putting in the long hours of strenuous efforts during the compilation of the restructured syllabus.

Dr. Deepak More

Chairperson

Board of Studies in Physics

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Preamble

Physics is the most basic of all sciences. It seeks to understand natural phenomena in a quantitative manner, and to answer some of the oldest and deepest questions ever asked by human beings: What are things made of? Is there a limit to the smallest things that we can think of? Did the world have a beginning? Will it have an end? At the same time, it provides the base of much of the technology that we take for granted in the 21st century: computers, artificial satellites, mobile phones, TV, microwave ovens. Indeed, it will not be an exaggeration to say that modern human life is shaped by technologies that are largely based on a foundation of physics.

Education is one of the most critical yardsticks in any country's development. The new National Education Policy (NEP) 2020 is an essential and comprehensive policy framework that aims to revamp the country's educational system from its foundation and to bring it at par with global standards. The larger aim of this policy is to transform the Indian education system by making it more inclusive, flexible and relevant to the changing needs of the society. Some of the key features of this policy are the introduction of vocational training, elective courses, emphasis on cultural studies, development of global skill sets and the promotion of multilingualism.

The policy seeks to bring about significant changes in the Higher Education structure, such as introducing a four-year undergraduate degree Programme, establishing multidisciplinary education and research universities, pooled credit bank and creating a National research Foundation to promote and support research activities in various fields. The new education policy enables every student to get quality education irrespective of their socio-economic background, gender or disability. NEP 2020 enables teachers to use a variety of learning techniques and experiments.

In the current fast paced world, simply cascading the knowledge in the classroom is not sufficient especially when the global requirements keep changing. Every learner should be

encouraged to exchange ideas and thoughts in a collaborative approach. This leads to develop an environment which is cognitive in nature and not a one-way information flow. Keeping all this in mind, the curriculum under Learning Outcome-based Curriculum Framework (LOCF) is designed.

This Learning Outcome-based Curriculum Framework (LOCF) supports the fundamental principle of providing quality education in India. Our focus is to involve young minds to participate, contribute and add value at each stage in the field of their study. The introduction of Choice Based Credit System (CBCS) has maximized the benefits of the newly designed curriculum in multiple folds.

The LOCF will certainly help teachers to envisage the outcome expected from the learners at the end of the programme. For students, it will be a guide which shows how this curriculum will help them acquire all the skills and knowledge which are essential in their personal and academic growth. Higher education qualifications such as Bachelor's Degree Programme are awarded on the basis of demonstrated achievement of outcomes and academic standards; and this is the very essence of this curriculum.

1. Introduction

Since the discipline of physics has existed for three hundred years, its "core" body of knowledge is larger than that of many other branches of learning. It was, therefore, difficult to fit this knowledge into limited number of courses. Naturally, we would aim to include as much of basic physics as possible, while introducing the student to the applied aspects of physics. We also need to keep in view the role of physics as a training ground for the mind. Not all Learners who complete B.Sc. in Physics will go on to become professional physicists; nevertheless, the study of physics is likely to make them good at logical thinking, quantitative argumentation, etc. Finally, we need to remember that this is an era of interdisciplinary studies. The physics student will benefit by the study of fields that overlap with other domains of knowledge. The syllabus presented here represents an attempt to balance all these requirements.

This curriculum framework is developed on the principles of student centric learning pedagogy. The platform intends to empower graduates with the skills required for pursuing Physics-related careers, higher education in Physics and allied subjects. The programme also aims at equipping future teachers with a thorough grounding in the subject. Since physics is the base of much of modern technology, the programme also gives adequate hands-on experience to learners who may go on to work in applied fields. The syllabus is based on a basic and applied approach with vigour and depth. At the same time precaution is taken to make the syllabus comparable to the syllabi of other universities and the needs of industries and research.

Various graduate attributes are emphasised in this framework such as critical thinking, basic psychology, scientific reasoning, moral ethical reasoning etc. While designing these frameworks, an important aspect was taken into consideration that was the measurable teaching-learning outcomes to ensure employability of the graduates. Implementation of modern pedagogical tools and concepts such as flip-class, hybrid learning, MOOCs and other

e-learning platforms are suggested through this framework. The framework also focuses on issues relevant to India and also of the rest of the world.

The systematic and planned curricula from first year to the third year shall motivate and encourage the Learners for pursuing higher studies in Physics and for becoming an entrepreneur. It covers the basic concepts of Physics to establish a strong foundation of the subject and helps Learners to explore the subject more. Topics varying from Mechanics, Electricity and Magnetism, Electronics, Atomic and Nuclear Physics, Electrodynamics, Statistical Physics, Quantum Mechanics and Classical Mechanics, Optics, Material science, Solid State Physics etc are taught. Semester V and Semester VI while focusing on the depth and applications of the above topics, also includes topics on assembly language programming and C++ programming.

Much like other natural sciences, physics is based on rational discussions, experimental evidence and criticism. The essence of learning physics revolves around experimentation. With experimentation, Learners can enhance their learning of physics. Apart from that, practical physics goes a long way in developing learners planning, evaluation, observation and analysis skills. The practical curriculum is designed in such a way that it will help in connecting “Hands On” to “Brains On”. As mentioned in the syllabus, practical form an integral part of B Sc Physics program. Students are also encouraged to improve their scientific writing skills through various assignments. The research-based project work in the curriculum ensures team building attitude within students and utilise every aspect of the team members in the success of any project. The project evaluation method is designed in such a way that it helps in creating a strong background for the research, skills to generate systematic reports and create effective presentation.

2. Learning Outcome based Curriculum Framework

LOCF focuses on curriculum framework, curriculum aims, learning targets and objectives. The curriculum framework also provides examples of effective learning, teaching and assessment practices. As the curriculum development is a collaborative and an on-going enhancement process, the LOCF instructs periodic reviews and revisions of the curriculum in accordance with the everchanging needs of students, teachers and society.

The framework describes how students are given exposure towards core knowledge of the subject, specialisation, choice based learning and other skill enhancement courses ensuring development of an integrated personality and employability. The template defines expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-solving, analytical, reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness along with specific learning course outcomes at the starting of each course. The Learning Outcomes based Curriculum Framework (LOCF) for B.Sc. with Physics will certainly be a valuable document in the arena of outcome-based curriculum design.

2.1 Nature and extent of B.Sc. Physics

Physics is the branch of science which deals with matter and its relation to energy. It involves study of physical and natural phenomena around us. Various branches of physics help us to understand natural processes in details with proper analysis. Few branches of physics are classical physics, modern physics, astrophysics, electromagnetism, thermodynamics, atomic physics, nuclear physics and optics. The degree program in Physics is designed to include topics from the above-mentioned areas in a perfect balance.

The B.Sc. Physics programme is of three years duration. Each year is divided into two semesters. The total numbers of semester are six. The teaching and learning in the B.Sc. Physics programme will involve theory classes (lectures) and practical. The curriculum will be taught through formal lectures with the aid of power-point presentations, audio and video

tools and other teaching aids can be used as and when required. Wherever possible RBPT approach will be adopted to make the process of learning more learner-centric. ICT-based teaching-learning tools will be incorporated through which even the mundane aspects could be made more interesting and relevant.

2.2 Programme Education Objectives (PEOs)

The overall aims of bachelor's degree programme in Physics are to:

1. Demonstrate the ability to use skills in Physics and its related areas of technology for formulating and tackling Physics-related problems and identifying and applying appropriate physical principles and methodologies to solve a wide range of problems associated with Physics.
2. Recognize the importance of mathematical modeling simulation and computing, and the role of approximation and mathematical approaches to describing the physical world.
3. Plan and execute Physics-related experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate software such as programming languages.
4. Demonstrate relevant generic skills and global competencies.
5. Demonstrate professional behaviour such as being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behaviour such as fabricating, falsifying or misrepresenting data or committing plagiarism.

3. Graduate Attributes in Physics

Attributes expected from the graduates of B.Sc. Physics Programme are:

GA 1: Capable of demonstrating good knowledge and understanding of major concepts, theoretical principles and experimental findings in Physics and its different subfields.

GA 2: Ability to transmit complex technical information relating all areas in Physics in a clear and concise manner.

GA 3: Ability to employ critical thinking and efficient problem-solving skills in all the basic areas of Physics.

GA 4: Capability for asking relevant/appropriate questions relating to the issues and problems in the field of Physics, and planning, executing and reporting the results of a theoretical or experimental investigation.

GA 5: Capable of working effectively in diverse teams in both classroom, laboratory, Physics workshop and in industry and field-based situations.

GA 6: Enthusiasm for working individually and in diverse teams through interdisciplinary projects

GA 7: Capable of identifying/mobilizing appropriate resources required for a project, and manage a project.

GA 8: Capable of using computers for simulation studies in Physics and computation and appropriate software for numerical and statistical analysis of data.

GA 9: Capable of demonstrating ability to think and analyze rationally with modern and scientific outlook and identify ethical issues.

GA 10: Able to develop a national as well as international perspective for their career in the chosen field of the academic activities.

4. Qualification descriptors

Undergraduate degree programmes of either 3 or 4-year duration, with multiple entry and exit points and re-entry options, with appropriate certifications such as:

- a UG certificate is awarded to students who opt to exit after completing 1 year (2 semesters) of study in the chosen fields of study with having secured 44 credits and in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.
- a UG diploma is awarded to students who opt to exit after 2 years (4 semesters) of study with having secured 88 credits and in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.
- a Bachelor's degree is awarded after a 3-year (6 semesters) programme of study in major discipline with having secured 132 credits and minimum credit requirements as follows

Sr. No.	Category of Courses	Minimum credit requirements
1	Major Core Course	48
2	Minor Stream Course	20
3	Discipline Specific Elective Course	06
4	Ability Enhancement Course	08
5	Skill Enhancement Course	06

6	Value Education Course	04
7	Vocational Skill Course	08
8	Indian Knowledge System	02
9	Co-curricular Course	20
10	Open Elective Course	10
Total		132

- After completing the requirements of three-year Bachelor's degree, candidate who meet the minimum CGPA of 7.5 shall be allowed to continue studies in the fourth year of undergraduate program to pursue and complete Bachelor's degree with honours/research (subject to change).
- a 4-year Bachelor's degree (honours) is awarded after eight semesters programme of study with having secured 176 credits and minimum credit requirements as follows:

Sr. No.	**Category of Courses**	**Minimum credit requirements**
1	Major Core Course	76
2	Minor Stream Course	24
3	Discipline Specific Elective Course	14
4	Ability Enhancement Course	08
5	Skill Enhancement Course	06
6	Value Education Course	04

7	Vocational Skill Course	08
8	Indian Knowledge System	02
9	Co-curricular Course	24
10	Open Elective Course	10
Total		176

- They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the major discipline. The students who secure 176 credits, including 12 credits from a research project/dissertation, are awarded UG Degree with Research.

The 4-year Bachelor's degree programme is considered a preferred option since it would provide the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student.

Upon successful completion of the programme, students receive B.Sc. degree in the Physics. B.Sc. Physics graduates of this department are expected to demonstrate the extensive knowledge of various concepts of Physics and its application thus contribute in research, development, teaching, government and public sectors. This programme will establish a foundation for student to further pursue higher studies in Physics. The list below provides a synoptic overview of possible employment areas provided by an undergraduate training in Physics.

The list below provides a synoptic overview of possible career paths provided by an undergraduate training in Physics:

1. Academics
2. Research
3. Defence
4. Information Technology
5. Space Research Centers
6. Health Physics
7. Forensic science department
8. Oil and gas sectors
9. Packaging industry
10. Geophysics and meteorology
11. Energy sector
12. Telecommunications
13. Environmental monitoring and analysis
14. Sound Engineering

Job Roles for B.Sc. Physics graduate:

After graduation one can seek a professional career as:

1. Research Assistants
2. Academician
3. Radiologist
4. Laboratory Technician
5. System Analyst
6. Data Analyst
7. Accelerator operator
8. Laser Engineer
9. Web developer

10. Astronomer
11. Meteorologist
12. Aerospace systems engineer

Higher Education options for B.Sc. Physics graduate:

1. M.Sc.
2. Integrated M.Sc.-Ph.D. in Physics
3. PG Diploma:
    i. PG Diploma in Data Science / Astronomy /Nanotechnology / Learning /Artificial Intelligence
4. MBA
5. B.Ed

5. Programme Specific Outcomes (PSOs)

After the successful completion of modules in different courses of B.Sc. Physics, the learner will be able to:

PSO I: Understand basic mechanics and properties of matter.

PSO II: Illustrate the principles of electricity, magnetism, thermodynamics, optics and spectroscopy.

PSO III: Identify, formulate and analyze complex problems using basic principles of mathematics, physics and statistics.

PSO IV: Design, construct and analyze basic electronic and digital circuits

PSO V: Understand the basics of programming language and apply it to various numerical problems.

PSO VI: Develop experimental skills and independent work culture through a series of experiments that compliment theories and projects.

5.1Course Mapping

Semester	PSO / Course	I	II	III	IV	V	VI
III	MJ I						
	MJ II						
	MN				√	√	√
	SEC						
	VSC						
	AEC						
	IKS						
	CC						
	OE						
IV	MJ I						
	MJ II						
	MN		√	√			√
	SEC						
	VSC						
	CC						
	OE						

6. Structure of B.Sc. Physics programme

The curriculum frame work is designed around the choice-based credit system (CBCS). The programme consists of three years UG having six semesters (two semesters per year) or four years UG (Honours) having eight semesters (two semesters per year). Credit Distribution for Eight Semester is as follows:

Semester	MJ	DSE	SEC	VSC	MN	AEC	VEC	IKS	CC	FP	INT/ APT	OE	Total
I	6	-	-	-	6	4	2	-	2	-	-	2	22
II	6	-	-	-	6	3	2	1	2	-	-	2	22
III	6	-	3	2	4	1	-	1	2	-	-	3	22
IV	6	-	3	2	4	-	-	-	2	2	-	3	22
V	12	-	-	-	-	-	-	-	-	2	8	-	22
VI	12	6	-	4	-	-	-	-	-	-	-	-	22

BSc with Honours – 22 credits in Sem VII and VIII

BSc with Research – 22 credits in Sem VII and VIII

To acquire a degree in B.Sc. Physics a learner must study

1. **Major Core Courses (MJ):**

a) A course which is required to be opted by a candidate as a major core course. The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular subject or discipline.

b) Students may be allowed to change major within the broad discipline at the end of the second semester by giving her/him sufficient time to explore interdisciplinary courses during the first year.

c) There are twenty-four Major Core courses (MJ), two each, in semesters I to IV; and four each in semesters V and VIII.

d) Each Major Core Courses is compulsory.

e) Each Major Core Course from semester I to VI is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 1 credit for practical of two hours per week in every semester.

f) Each Major Core Course from semester VII and VIII is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 1.5 credit for practical of three hours per week in every semester.

g) The purpose of fixing major core papers is to ensure that the institution follows a minimum common curriculum to adhere to common minimum standards with other universities/institutions.

2. Minor Stream Course (MN):

a) A course is chosen by a candidate from interdisciplinary stream as a minor course. Minor Stream course helps a student to gain a broader understanding beyond the major discipline.

b) Students who take a sufficient number of courses in interdisciplinary area of study other than the chosen major will qualify for a minor in that discipline.

c) Students may declare the choice of the minor stream course at the end of the second semester after exploring various courses.

d) There are two each Minor stream course (MN), in semesters I and II. This Minor stream is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 1 credit for practical of two hours per week in every semester.

e) There is one each Minor stream course (MN) in semester III and IV. This Minor stream is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 2 credits for practical of four hours per week in every semester.

f) Each Minor stream Courses is compulsory.

3. Ability Enhancement Courses (AEC)

a) The courses aim at enabling the students to acquire and demonstrate the core linguistic skills, including critical reading and expository and academic writing skills, that help students articulate their arguments and present their thinking clearly and coherently and recognize the importance of language as a mediator of knowledge and identity.

b) Students are required to achieve competency in a Modern Indian Language (MIL) and in the English language with special emphasis on language and communication skills.

c) There are five AE courses in spread over three semesters (I to III).

d) Each student is supposed to take two AE in semester I - English language and Modern Indian language of 2 credits each.

e) There are two AE in semester 2 - English language of two credits and Modern Indian language of 1 credit.

f) There is one AE in semester 3 - Modern Indian language of 1 credit.

4. Value Education Courses (VEC)

a) The course seeks to equip students with the ability to apply the acquired knowledge, skills, attitudes and values required to take appropriate actions for mitigating the effects of environmental degradation, climate change, and pollution, effective waste management, conservation of biological diversity, management of biological resources, forest and wildlife conservation, and sustainable development and living.

b) The VEC courses offered are:

VEC I- Environmental Science I (2 credits) (Semester I),

VEC II- Environmental Science II (2 credits) (Semester II).

5. Co-Curricular courses (CC):

a) They are designed to provide skill-based knowledge and contain both lab/hands on training/field work.

b) The main purpose of these courses is to provide life skills in hands-on mode to increase employability.

c) There are two CC each in semester I and II – NCC (compulsory 1 credit course) and other one from Music/Sports training program/Yoga/ Study Circle.

d) CC in semester III is Emotional Intelligence and in semester IV – NCC (compulsory 1 credit course) and sports of 1 credit.

6. Open Elective (OE)

a) They are designed to provide multidisciplinary education.

b) Students can opt for one interdisciplinary Open Elective Course (OE) in each of the semester I and II of two credit each.

c) Students can opt for one interdisciplinary Open Elective Course (OE) in each of the semester III and IV of three credit each.

d) Open courses are offered in cognate disciplines by different departments in the college.

7. Indian Knowledge System (IKS)

a) They are designed to recognizes the rich heritage of ancient and eternal Indian knowledge and thought as a guiding principle.

b) Students can opt for one General IKS in semester I – Indian cultural Heritage of one credit.

c) There is one IKS based on major subject in semester III of 1 credit.

8. Skill Enhancement Course (SEC):

a) They are designed to provide skill-based knowledge pertaining to the Major course to the learner.

b) The main purpose of these courses is to provide life skills in hands on mode to increase employability.

c) There are Two skill enhancement courses offered. Each student is supposed to take one SEC in each semester III and IV of 3 credit each (2 credit theory and 1 credit practical).

9. Discipline Specific Elective Courses (DSE):

a) Elective courses offered under the major course subject of study.

b) There are two discipline specific elective courses (DSE), offered in semesters VI of 2 credits theory and 1 credit practical.

c) There is one discipline specific elective course (DSE), offered in semesters VII and VIII each of 2 credits theory and 2 credit practical.

d) There is one advance level disciplinary course – Research Methodology of 4 credits offered in semester VII.

10. **Vocational Skill Course (VSC)**

a) Vocational courses are designed to provide practical, hands-on training, competencies, and proficiency to students, ultimately enhancing their skills and employability.

b) These courses are tailored to prepare individuals for specific careers and industries.

c) There are two VSC offered one each in semester III to IV, each one is of two credits.

d) There is one VSC offered in semester VI of 4 credits.

11. On Job Training (OJT)

a) On Job training of 4 credits is offered in semester VIII to enhance the specific skills and competencies required for a particular job

b) OJT bridges the gap between theory and practical application, promoting a deeper understanding of concepts.

12. Field Projects/ Internship/ Apprenticeship/ Community Engagement.

a) Field projects require students to participate in field-based learning activity generally under the supervision of an expert of the given external entity.

b) The curricular component of 'community engagement and service' will involve activities that would expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems.

c) Internships involve working with local industry, government or private organizations, business organizations, artists, crafts persons, and similar entities to provide opportunities for students to actively engage in on-site experiential learning.

6.1 Content

Sr. No	Semester	Course number	Course Code	Course title
1	III	MJ I		Course from Chemistry / Mathematics / Botany / Zoology / Geology
2		MJ II		Course from Chemistry / Mathematics / Botany / Zoology / Geology
3		MJ P		Based on MJ I and MJ II
4		MN	24US3PHMNELE	Electronics
5		MN P	24US3PHMNP	Based on Minor
6		SEC		Course from Chemistry / Mathematics / Botany / Zoology / Geology
7		SEC P		Course from Chemistry / Mathematics / Botany / Zoology / Geology
8		VSC		Course from Chemistry / Mathematics / Botany / Zoology / Geology
9		AEC I		Modern Indian Language Level 1 (Hindi/Marathi)
10		CC	24US3CCEMI	Emotional Intelligence
11		IKS		Course from Chemistry / Mathematics / Botany / Zoology / Geology

12		OE	24US3OEFHR / 24US3OEIFM / 24US3OESCW	Fundamentals of Human Rights / Introduction to Financial Market /Scientific Writing
13	IV	MJ I		Course from Chemistry / Mathematics / Botany / Zoology / Geology
14		MJ II		Course from Chemistry / Mathematics / Botany / Zoology / Geology
15		MJ P		Based on MJ I and MJ II
16		MN	24US4PHMNOPT	Optics
17		MN P	24US4PHMNP	Based on Minor
18		SEC		Course from Chemistry / Mathematics / Botany / Zoology / Geology
19		SECP		Course from Chemistry / Mathematics / Botany / Zoology / Geology
20		VSC		Course from Chemistry / Mathematics / Botany / Zoology / Geology
21		FP		Course from Chemistry / Mathematics / Botany / Zoology / Geology
22		CC I	24US4CCSOL	Science of Life
23		CC II	24US4CCSPT	Sports Training Program

24		OE	24US4OEIWC / 24U43OEEGI / 24U43OEISS	Basic Of Investment And Wealth Creation / Emerging Gender Issues in India / Introduction to Soft Skills

6.2 Credit distribution for B.Sc. Physics

Semester	Course number	Course title	Credits		
			Theory	Practical	Total
III	MJ I	Course from Chemistry / Mathematics / Botany / Zoology / Geology	2	1	3
	MJ II	Course from Chemistry / Mathematics / Botany / Zoology / Geology	2	1	3
	MN	Electronics	2	2	4
	SEC	Course from Chemistry / Mathematics / Botany / Zoology / Geology	2	1	3
	VSC	Course from Chemistry / Mathematics / Botany / Zoology / Geology		2	2
	AEC II	Modern Indian Language	1		1
	IKS	Course from Chemistry / Mathematics / Botany / Zoology / Geology	1		1
	CC I	Emotional Intelligence	2		2

	OE	Fundamentals of Human Rights / Introduction to Financial Market /Scientific Writing	3		3
	Total				**22**
IV	MJ I	Course from Chemistry / Mathematics / Botany / Zoology / Geology	2	1	3
	MJ II	Course from Chemistry / Mathematics / Botany / Zoology / Geology	2	1	3
	MN	Optics	2	2	4
	SEC	Course from Chemistry / Mathematics / Botany / Zoology / Geology	2	1	3
	VSC	Course from Chemistry / Mathematics / Botany / Zoology / Geology		2	2
	FP	Course from Chemistry / Mathematics / Botany / Zoology / Geology	2		2
	CC I	Science of Life		1	1
	CC II	Sports training Program		1	1
	OE	Basic Of Investment And Wealth Creation / Emerging Gender Issues in India / Introduction to Soft Skills	3		3
	Total				**22**

6.3 Semester Schedule

Semester	Major Core Courses (MJ)	Minor Stream Courses (MN)	Ability Enhancement Courses (AEC)	Field Project (FP)	Indian Knowledge System (IKS)	Co-Curricular Course (CC)	Open Elective (OE)
III	1] MJ I Course from Chemistry / Maths / Botany/ Zoology/ Geology 2] MJ II Course from Chemistry / Maths/ Botany/ Zoology/ Geology 3] SEC Course from Chemistry / Maths/ Botany/ Zoology/ Geology 4] VSC Course from Chemistry / Maths/ Botany/ Zoology/ Geology	1] MN Electronics	1] AECI Modern Indian Language		Course from Chemistry/ Mathematics/ Botany/ Zoology/ Geology	1] Emotional Intelligence	Fundamentals of Human Rights / Introduction to Financial Market Introduction to Financial Market / Scientific Writing

IV	1] MJ I Course from Chemistry / Maths/ Botany/ Zoology/ Geology 2] MJ II Course from Chemistry / Maths/ Botany/ Zoology/ Geology 3] SEC Course from Chemistry / Maths/ Botany/ Zoology/ Geology 4] VSC Course from Chemistry / Maths/ Botany/ Zoology/ Geology Zoology/ Geology	1] MN Optics		Course from Chemistry/ Maths/ Botany/ Zoology / Geology		1] Science of Life II] Sports Training Program	Basic Of Investment And Wealth Creation / Emerging Gender Issues in India / Introduction to Soft Skills

6.4. Course Learning Objectives

The three-year undergraduate Physics programme is designed to familiarize students with significant developments in Physics. The objective of structured syllabus in Physics is to make the concepts and basics of Physics clear and interesting to students and also to ensure the development of vertical growth in the subject. The idea behind this is to enable students to develop analytical skills and critical thinking.

It is our attempt that students achieve this objective through systematic reading and class lectures and through feedback on their written work-assignments, project/research papers, presentations, discussions, debates, etc. our intention is to enable students to formulate cogent arguments, presenting the necessary evidence to establish these, based on a training in Physics.

7. Detailed B.Sc. Physics Syllabus

S. Y. B.Sc. Syllabus with effect from the Academic year 2023–2024

Syllabus -S. Y. B.Sc. Physics

Course No.	Course Title	Course Code	Credits	Periods (1 Hr)	Module	Lectures per module (1 hr)	Examination		
							Internal Marks	External Marks	Total Marks
SEMESTER III									
Minor Stream Courses THEORY									
I	Electronics	24US3PHMN1ELE	2	30	2	15	20	30	50
Minor Stream courses PRACTICAL									
I	Physics Practical - MN	24US3PHMNP	2	60			CIA		50

SEMESTER IV									
Minor Stream courses THEORY									
I	Optics	24US4PHMN1OPT	2	30	2	15	20	30	50
Minor Stream courses PRACTICAL									
I	Physics Practical - MN	24US4PHMNP	2	60			CIA		50

S.Y. B. Sc. (PHYSICS) SEMESTER III

Minor Stream Course- I

COURSE TITLE: Electronics

COURSE CODE: 24US3PHMNELE [CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: 1. Illustrate about working of transistors, transistor-based amplifiers and its biasing. 2. Explain the concepts of feedback and oscillations and construct feedback amplifiers. 3. Understand basic building blocks of an op-amp and its parameters for various applications design. 4. Elucidate and design the linear and non-linear applications of an op-amp.		
Module 1	**Bipolar Junction Transistor**	**[15L]**
Learning Objectives: The module is intended to 1. Familiarize the student with the analysis and design of basic transistor amplifier circuits, oscillators and wave shaping circuits.		
Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Classify various configurations and biasing technique of BJT. 2. Explain the principles of oscillation and design various oscillator circuits.		
1.1	Transistor fundamentals: The load line, operating point, recognizing saturation, transistor switch, Base Bias method,	4L

	Emitter biased method, Voltage divider bias method, load line and Q-point.	
1.2	Transistor amplifiers: Base-biased amplifiers, Emitter-biased amplifier, small-signal operation, Current gain, AC resistance of the emitter diode, two (pi and T)) transistor model, categorizing an amplifier, voltage gain, frequency response of an ac amplifier, decibel voltage gain.	6L
1.3	Negative feedback- principles, Gain, advantages Positive feedback-oscillator, essentials of transistor oscillator and Barkhausen criterion for self-sustained oscillations, Colpitts's oscillator, Phase Shift Oscillator.	5L
Module 2	**Operational Amplifiers**	**[15L]**
Learning Objectives: This module is intended to: 1. Study Operational Amplifier working, characteristics and its applications. 2. Design simple linear and non-linear circuits using Op-Amp		
Learning Outcomes: After the successful completion of the module, the learner will be able to: 1. Design and analyse Op-Amp based circuits.		
2.1	Differential amplifier-Dual input balanced output differential amplifier, block diagram of typical Op-Amp, schematic symbol, interpreting data sheet, the ideal Op-Amp, equivalent circuit of an Op-Amp, Op-Amp Parameters-Input Impedance, Output	6L

	impedance, input offset voltage, Open Loop Voltage gain, input bias current, slew rate, open loop Op-Amp configurations	
2.2	Inverting and noninverting amplifiers, Summing and Difference Amplifier, Differentiator, Integrator, Wein bridge oscillator, Comparator and Zero- crossing detector, and Active low pass and high pass Butterworth filter (First and Second order only)	[9L]

References:

- A P Malvino and David J Bates Electronics principles: 7th Ed. The McGraw-Hill companies.
- V K Mehta, Rohit Mehta. Principles of Electronics
- Malvino and Leach Digital Principles and Applications: fifth Edition
- D. Chattopadhyay & P. C. Rakshit Electronics Fundamental and applications (8th Ed.) (New Age International)
- Robert Boylestand & Louis Nashelsky Electronic Devices and Circuit theory, (PHI)
- Allen Mottershead Electronic devices and circuits – An introduction (PHI Pvt. Ltd.– EEE – Reprint – 2007)
- Ramakant Gayakwad: Op-Amp and linear integrated circuits

Question paper Template

S.Y. B. Sc. (PHYSICS) SEMESTER III

Minor Stream Course- I

COURSE TITLE: Electronics

COURSE CODE: 24US3PHMNELE [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	-	5	10	10	-	-	25
II	-	5	10	10	-	-	25
Total marks per objective	-	10	20	20	-	-	50
% Weightage	-	20	40	40	-	-	100

S. Y. B. Sc. (PHYSICS)

SEMESTER III - Practical

COURSE CODE: 24US3PHMNP Credits- 02

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Demonstrate practical skills. 2. Correlate their physics theory concepts through practical. 3. Connect the circuits and test them.
Learning Objectives: The Practical is intended to 1. Familiarize students to various measuring instruments. 2. Sketch the graph from the observed data.
Learning Outcomes: After the successful completion of the practical, the learner will be able to: 1. Demonstrate their practical skills. 2. Use apparatus with ease. 3. Correlate their physics theory concepts through practical. 4. Estimate errors in the measurements
Group A
1. Op-Amp as Inverting amplifier 2. Op-Amp as non-inverting amplifier 3. CE amplifier: Frequency response 4. Passive low pass filter 5. Passive high pass filter

6. Colpitts's oscillator
7. Full adder using EX-OR
8. Difference amplifier

Group B

1. Temperature Coefficient and Band gap of thermistor
2. Verification of Stefan's Law
3. Determination of thermal conductivity of poor conductor using Lee's Method. -I (observations)
4. Determination of thermal conductivity of poor conductor using Lee's Method. -II (data analysis and error calculation)
5. Experimental determination of Planck's constant
6. Resonance pendulum.
7. Cauchy's Constant using spectrometer.
8. Y- by Bending

Skill Experiments

1. Connecting simple circuit using bread board.
2. Phase shift measurement using dual trace CRO.
3. Estimation of experimental error.
4. Designing & soldering of simple Circuits. (e.g., Filter circuits)
5. Data sheet reading for common ICs

Minimum of 6 experiments from each group should be completed in odd semester.

Minimum 3 skill experiments must be performed and reported in the journal.

Certified journal is must to be evaluated in practical.

S.Y. B. Sc. (PHYSICS) SEMESTER IV

Minor Stream Course- I

COURSE TITLE: Optics

COURSE CODE: 24US3PHMNOPT [CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Infer and use phenomenon of thin film interference in real life. 2. Understand Interferometry techniques and its various application. 3. Identify and analyse diffraction type, pattern and able to solve related problems, 4. Elaborate polarization, methods of production of polarized light and its real-life application.

Module 1	Thin Film Interference and Interferometer	[15L]

Learning Objectives:

The module is intended to

1. Study the phenomenon and application of thin film Interference.
2. Understand working of single beam and multiple beam interferometer and application in real life.
3. Use the knowledge to solve the problems related to interference and interferometry.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Understand the phenomenon of interference and various techniques used to obtained interference.
2. Explain occurrence due to thin film and understand its applications in real life.
3. Elaborate construction and working of Michelson interferometer.

4. Solve application-oriented problems based on Michelson interferometer.		
1.1	Interference: Superposition of waves, Theory of Interference, Condition for interference, techniques to obtaining interference: amplitude division, waveform division, non-localized fringes, Visibility of fringes.	3L
1.2	Interference in thin films: parallel thin film interference, wedge shape film interference and Newton's rings (With necessary mathematical modelling) Applications of thin film interference determination of thickness of film, refractive index, Antireflective coating, interference filter etc.	6L
1.3	Michelson's interferometer: Principle, construction, & working, circular fringes, localised fringes, Visibility of fringes, Application of Michelson's interferometer: Measurement of wavelength, Determination of the difference in wavelengths of two waves, Thickness of thin transparent sheet. Related case studies of recent application of Michelson's Interferometer (Eg LIGO, application in medical field)	6L
Module 2	**Diffraction and Polarization**	**[15L]**

Learning Objectives:

This module is intended to:

1. Explain theory of Fresnel and Fraunhoffer diffraction and study diffraction patterns using single slit and multiple slits.
2. Elaborate on polarization and the method to obtain action and its application.
3. Use the knowledge to solve numerical based on diffraction and polarization.

Learning Outcomes:

After the successful completion of the module, the learner will be able to:

1. Distinguish between interference and diffraction pattern.
2. Differentiate between Fresnel and Fraunhoffer types of diffraction.
3. Explain single slit and multiple slits diffraction patterns.
4. Elaborate the phenomenon of polarization, and use of Brewster's law as well as double refraction to produced polarized light.
5. Explain concept of wave plates and its applications.
6. Solve various numerical based on diffraction and polarization.

2.1	Fresnel diffraction: Introduction, Huygen's-Fresnel's theory, Fresnel's assumptions, Fresnel's half period Zones, Zone plates, diffraction due to straight edge shadow	5L
2.2	Fraunhoffer diffraction: Introduction, Fraunhoffer diffraction at a single slit, intensity distribution in diffraction pattern due to single slit, Fraunhoffer diffraction at N slit, Plane diffraction grating, theory of plane transmission grating, width of principal maxima	5L
2.3	Polarization: Introduction, type of polarization, polarization by reflection, Brewster's law, polarization by double refraction, Theory of λ/2 and λ/4 plates. Application of polarization in Polaroid filters, 3D Movies etc.	5L

References:

- SBA: Subramanyam, Brij Lal, Avadhanulu A textbook of Optics — S. Chand & Co. Multicoloured Ed. 2007.
- Optics – Ajay Ghatak (3rd Ed) Mc. Graw Hill Co

- Optics – Eegan Hetch (2015) Pearson Education

Question paper Template.

S.Y. B. Sc. (PHYSICS) SEMESTER IV

Minor Stream Course- I

COURSE TITLE: Optics

COURSE CODE: 24US4PHMNOPT [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	5	5	5	5	-	25
II	5	15	5	-	-	-	25
Total marks per objective	10	20	10	5	5	-	50
% Weightage	20	40	20	10	10	-	100

S. Y. B. Sc. (PHYSICS)

SEMESTER IV - Practical

COURSE CODE: 24US4PHMNP

Credits- 02

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: 1. Operate various instruments proficiently. 2. Evaluate and illustrate data through analysis. 3. Draw conclusions and apply the skill set during physics experiments
Learning Objectives: The Practical is intended to 3. Familiarize students to various measuring instruments. 4. Sketch the graph from the observed data.
Learning Outcomes: After the successful completion of the practical, the learner will be able to: 1. Efficiently operate optical instruments and record accurate measurements. 2. Establish connections for integrated circuits (ICs) and verify circuit functionality. 3. Evaluate data, create graphs, and provide interpretations.
Group A
1. Determination of wavelength of source using diffraction grating 2. Newtons rings experiment – I (Setup and observations) 3. Newtons rings experiment – II (Data analysis and error calculation) 4. Determine the Refractive index of liquid using laser. 5. Study of single slit diffraction using laser.

6. Verification of Brewster's law.
7. R.P. of telescope
8. R.P of Grating

Group B

1. LCR parallel resonance.
2. LCR transient response.
3. JK flip flop.
4. Passive band pass filter
5. Summing amplifier using Op-Amp
6. RS FF-Debounce circuit
7. Active low pass filter (first order)
8. Active high pass filter (first order)

Demonstration Experiments

1. Concept of beats
2. Double Refraction
3. Equation solving and graph plotting using computers (excel)
4. Coupled Oscillations

Minimum of 6 experiments from each group should be completed in even semester.

Minimum 3 demonstration experiments must be performed and reported in the journal.

Certified journal is must to be evaluated in practical.

8. Teaching learning process

The pedagogic methods adopted, involve direct lectures, tutorial discussions, as well as technology- supported presentations. We believe that education is interactive and all sessions between students and teachers are based upon reciprocity and respect.

1) The lectures (of 1 hr duration) delivered to one whole class at a time systematically deal with the themes of the syllabus. This constitutes the core of the teaching- learning process. The students are provided with bibliographic references and encouraged to go through at least some readings so that they could be more interactive and ask more relevant questions in the class. This also helps obtain knowledge beyond the boundaries of the syllabi.

2) Wherever needed, teachers use audio-video based technology devices (e. g. power point, YouTube videos) to make their presentations more effective. Some courses require that students see a documentary or feature film and course themes are structured so that discussions of these will further nuance the critical engagement of students with ideas introduced in their textual materials.

3) Remedial coaching, bridge courses are adopted to enhance the scope of learning for the learners. Remedial sessions are conducted to help on certain advanced topics. Bridge courses facilitate to develop a concrete basis for the topics to be learnt in the coming academic year.

9. Assessment Methods

Evaluation Pattern: Theory

- Assessments are divided into two parts: Continuous Internal (CIA) and Semester End Examination (SEE).
- The CIA shall be conducted at the department level in the form of tests/assignments/presentations etc.
- The End Semester Examination shall be conducted by the College at the end of each semester. (30M) Duration: 1 hour

  End Semester Examination Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	25 M	15 M
2	II	25 M	15 M

Evaluation pattern: Practical

- Continuous Assessment for 50 Marks throughout entire semester.
- 50 Marks Evaluation as per the following rubrics

Major Stream Course	CIE	Journal	Viva	Total
MJ I	15 M	5 M	5 M	25 M
MJ II	15 M	5 M	5 M	25 M

10. Programme and Course Code Format

The course is coded according to following criteria:

1. First two numbers in each course code indicates year of implementation of syllabus (23- year of implementation is 2023-24)
2. Third letter 'U' designates undergraduate
3. Fourth letter 'S' designate Science discipline and the digit followed is for semester number (S1 – 1st Semester)
4. Letter 'PH' is for Physics discipline (PH- Physics). This forms the programme code 23USPH. For the further course codes programme code is amended as follows
5. To represent Major Core Course (MJ) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
6. To represent Minor Stream Course (MN) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
7. For Ability enhancement course code, (AE) alphabets followed by a digit (1/2) followed by three lettered codes representing the title of the course.
8. For Value Education course code, (VE) alphabets followed by a digit (1/2) followed by three lettered codes representing the title of the course.
9. For Indian Knowledge System course code, (IKS) alphabets followed by a digit (1/2) followed by 'ICH'- Indian Cultural Heritage is used.
10. For Co-curricular course code, (CC) alphabets followed by a digit (1/2) followed by three lettered codes representing the title of the course.
11. For Open Elective course code, (OE) alphabets followed by a digit (1/2) followed by three lettered codes representing the title of the course.
12. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course.