NAAC GRADE A+
ACCREDITED UNIVERSITY

REVA UNIVERSITY
Bengaluru, India

School of Applied Sciences

M.Sc (Physics) Programme

Handbook 2024-26

RUKMINI EDUCATIONAL
Charitable Trust

www.reva.edu.in

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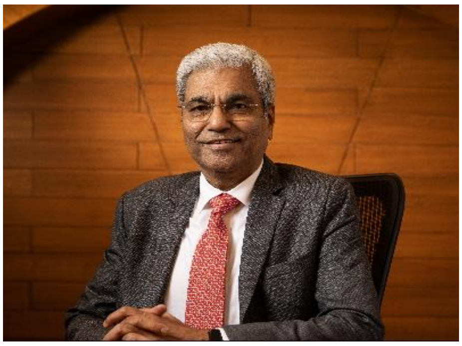
Chancellor's Message

"Education is the most powerful weapon which you can use to change the world."

- Nelson Mandela.



There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it. Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look for information and those who look for knowledge.

It is deemed virtuous to serve seekers of knowledge and as educators it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect, and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts in to develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally, and intellectually elite. They practice the art of teaching with a student-centered and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me, and I believe, it takes teamwork to build successful institutions. I welcome you to REVA University to join hands in laying the foundation of your future with values, wisdom, and knowledge.

Dr. P. Shyama Raju

The Founder and Hon'ble Chancellor, REVA University

Vice-Chancellor's Message

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum "Knowledge is Power", REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this 'temple of learning' has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - many faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of REVA University.
At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome of the research is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students. REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks the effectiveness of these programs. The entrepreneurship development activities and establishment of "Technology Incubation Centers" in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

With firm faith in the saying, "Intelligence plus character –that is the goal of education" (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavour to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS".

Welcome to the portals of REVA University!

Dr. N. Ramesh

Vice-Chancellor
REVA University

Message from HoD

Physics is a basic science which enables the students to think beyond their comfort level and brings new and deeper concepts about the Atoms, Molecules, Nanoscale, Microscale and Bulk materials physical properties. The present day buzzing “quantum computers” also rely on the principles of physics like Quantum Mechanics, Electrodynamics and Optics. The Physical sciences deals with subatomic particles to Galaxies. It also gave birth to high end sophisticated technologies like Atomic Force microscope, Tunnelling Electron microscope and other advanced technologies which help the people to visualize the unexplored world. Few of the topics are interdisciplinary in nature subject assimilates in itself a number of disciplines and as such has grown rapidly. M Sc in Physics offered by REVA University aims to provide the required skills and knowledge necessary to pursue a successful career in Research, Teaching and Industry relevant jobs. This program imparts need based, practical education in contemporary world to develop global competence among students. It strives to prepare students to become leaders in the field of Physical Sciences in general and Condense matter physics/Optics/Electronics in particular by encouraging them to inculcate scientific thinking coupled with creative and innovative ideas.

The program provides hands on training and practical skills in the field of Condense matter physics, Optics and Electronics. This course also covers fundamental aspects of Physics in every aspect. The special emphasis on experiments related electricity, magnetism, lasers, spectral analysis and studying other materials properties by varying different parameters help the student to equip with required knowledge in the field of research, teaching & industry.

As far as employment is concerned physics courses are gaining attention in the field of data science, data analysis, statistical modelling and programming are some of the fast-growing sectors. Employment record shows that physics has a great scope in future. Physicist can find careers with electronic, optics and material science related and allied companies. They can be employed in the areas of programming, production and management of sensors and other related industries. There is a large scale employment in research laboratories run by the government as well as the corporate sectors. Further, there is great demand for physicists in numerous industries and sectors after the completion of M.Sc Physics course,

This handbook provides an outline of regulations for master’s degree, scheme of instruction, and detailed syllabus. I am sure the students choosing M.Sc Physics at REVA University will enjoy the curriculum, teaching and learning environment, the vast infrastructure and the experienced teacher’s involvement and guidance. We will strive to provide all needed comfort and congenial environment for their studies. I wish all students a pleasant stay at REVA and grand success in their career.

Dr. D.V.Sunitha

Head of the Department

RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of Rukmini Educational Charitable Trust (RECT), in the year 2002. Rukmini Educational Charitable Trust(RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfil its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right and the Chairman and Managing Director of the DivyaSree Group of companies. The idea of creating these top notched educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond road park, building and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 15,000+ students study various courses across REVA’s three campuses equipped with exemplary state-of-the-art infrastructure and conducive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette No. 80 dated 27th February, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempe Gowda International Airport and Bangalore city, has a sprawling green campus spread over 45 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, custom-built teaching facilities, fully air-conditioned library and central computer centre, the well planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

REVA consistently ranked as one of the top universities in various categories because of the diverse community of international students and its teaching excellence in both theoretical and technical education in the fields of Engineering, Management, Law, Science, Commerce, Arts, Performing Arts, and Research Studies. REVA offers 28 Undergraduate Programmes, 22 Full-time and 2 Part-time Postgraduate Programmes, 18 Ph.D. Programmes, and other Certificate/ Diploma/Postgraduate Diploma Programmes in various disciplines. The curriculum of each program is designed with a keen eye for detail by giving emphasis on hands-on training, industry relevance, social significance, and practical applications. The University offers world-class facilities and education that meets global standards.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program.

Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the capabilities to surpass others. These programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners so as to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has also entered into MOUs with many industries, business firms and other institutions seeking their help in imparting quality education through practice, internship and also assisting students' placements.

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, Fuel

Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor& Dean, and supported by well experienced Trainers, Counsellors and Placement Officers.

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognized as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal VikasYojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Okalahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC^2, VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitates students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

The University has also given greater importance to quality in education, research, administration and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal

Quality. The division works on planning, designing and developing different quality tools, implementing them and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat RatnaProf. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr.Balaram, Former Director IISc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defence Dr.Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

REVA organizes various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVAMP conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another important event is ShubhaVidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognised by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga class’s everyday to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

ABOUT THE SCHOOL OF APPLIED SCIENCES

The School of Applied Sciences offers graduate and post graduate programs in Biotechnology, Biochemistry, Chemistry, Physics and Mathematics which are incredibly fascinating. It aims to attract talented youth and train them to acquire knowledge and skills useful to industrial sectors, research laboratories, and educational institutions. The School presently offers M.Sc. degree programs in Bio-Chemistry, Bio-Technology, Chemistry, Physics, Mathematics and B Sc with various combinations viz, Physics Chemistry and Mathematics, Mathematics , Physics and Statistics, Mathematics Statistics and Computer Science, and Biology Mathematics & Computer Science and also Post Graduate Diploma in Clinical Research Management. The School also facilitates research leading to PhD in Biotechnology, Biochemistry, Physics, Chemistry, Mathematics and related areas of study.

The School of Applied Sciences is shouldered by well qualified, experienced and highly committed faculty. The state-of-the-art infrastructure digital classrooms, well equipped laboratories, conference rooms and the serene academic atmosphere at REVA University will enhance the transfer as well as creation of knowledge. The school provides an interactive, collaborative peer tutoring environment that encourages students to break down complex problems and develop strategies for finding solutions across a variety of situations and disciplines. The school aims to develop a learning community of critical thinkers who serves as models of innovative problems solving in the university environment to enrich their academic and professional careers.

Vision

To nurture intellect, creativity, character and professionalism among students and impart contemporary knowledge in various branches of Chemical, Biological, Physical and Mathematical Sciences that are socially relevant and transform them to become global citizens.

Mission

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centers
- To provide student-centric learning environment through innovative pedagogy and education reforms
- To encourage research and entrepreneurship through collaborations and extension activities
- To promote industry-institute partnerships and share knowledge for innovation and development
- To organize society development programs for knowledge enhancement in thrust areas
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism and moral values.

Objectives

- Creation, preservation and dissemination of knowledge and attainment of excellence in different disciplines
- Smooth transition from teacher - centric focus to learner - centric processes and activities
- Performing all the functions of interest to its major constituents like faculty, staff, students and the society to reach leadership position
- Developing a sense of ethics in the University and Community, making it conscious of its obligations to the society and the nation
- Accepting the challenges of globalization to offer high quality education and other services in a competitive manner

PREFACE

Higher education across the globe is opening doors of its academic disciplines to the real-world experiences. The disciplinary legitimacy is under critical review. Trans-border mobility and practice learning are being fore-grounded as guiding principles. Interactive learning, bridging disciplines and facilitating learners to gain different competencies through judicious management of time is viewed as one of the greatest and fascinating priorities and challenges today.

The M.Sc. in Physics is designed keeping in view the current situation and possible future developments, both at national and global levels. This course is designed to give greater emphasis on Research. There are ample number of courses providing knowledge in specialized areas of Quantum Mechanics, Electrodynamics, Electronics, Materials Science, etc. Facilitating the students to choose specialized areas of their interest. Adequate attention is given to provide students the basic concepts of analysis and modern computation techniques to be used and knowledge on application of such concepts in practical field. The project, being part of the curriculum will certainly provide students the research experience.

The L: T: P structure of teaching and learning under Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) would certainly help our students learn and build competencies needed in this knowledge based society.

This handy document containing brief information about M.Sc. Physics, scheme of instruction, course content, CBCS-CAGP regulations and its advantages and calendar of events for the year will serve as a guiding path to students to move forward in a right direction. It would mould them with knowledge, skill and ethical values to face the challenges of this competitive world with greater confidence in becoming proud citizens of mother India.

M. Sc. (Physics) Program

Program Overview

Physics is a branch of natural sciences. It deals with physical matter and energy; and the natural laws that govern the behavior of matter. The core theories of Physics are: Classical Mechanics, Electromagnetism, Thermodynamics and Statistical Mechanics, Quantum Mechanics and Relativity. There are many more branches of Physics including nuclear and particle physics

Physics plays a key role in the future progress of humankind. The physics education and research in all countries is important because:

1. Physics is an exciting intellectual adventure that inspires the young people and expands the frontiers of our knowledge about Nature.
2. Physics generates fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the world.
3. Physics contributes to the technological infrastructure and provides trained personnel needed to take advantage of scientific advances and discoveries.
4. Physics is an important element in the education of chemists, engineers and computer scientists, as well as practitioners of the other physical and biomedical sciences.
5. Physics extends and enhances our understanding of other disciplines, such as the earth, agricultural, chemical, biological, and environmental sciences, plus astrophysics and cosmology - subjects of substantial importance to all peoples of the world.
6. Physics improves our quality of life by providing the basic understanding necessary for developing new instrumentation and techniques for medical applications, such as computer tomography, magnetic resonance imaging, positron emission tomography, ultrasonic imaging, and laser surgery.

Thus, physics is an essential part of the educational system of an advanced society. Indian Society has embraced knowledge economy and its economic growth rate is one of the highest in the world. India has shown highest level of progress in engineering, space, nuclear, aeronautics and information and communication technologies. The subject of physics has played a major role in the development of country and India has produced 2 Nobel laureates in Physics.

In this context, University across the country offer Physics as a subject at undergraduate and physics as a program at postgraduate level.

M. Sc. (Physics) at REVA UNIVERSITY has been designed to meet the human resources needs of existing and futuristic research establishments, industries and academic institutions. The program is designed to produce graduates with higher order critical, analytical, problem solving and research skills; ability to think rigorously and independently to meet higher level expectations of industries, research organization and academic institutions. The program deals with courses in classical mechanics, quantum mechanics, material science, semiconductors, electrodynamics and related areas.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

The aim of the program is to produce postgraduates with - advanced knowledge and understanding of Physics; higher order critical, analytical, problem solving and attitudinal skills (transferable) to meet expectations of research establishments, relevant industry and academia or to take up entrepreneurial route. Hence,

The Program Educational objectives are to prepare the students to:

1. Pursue higher education through continuous learning with effective communication skills.
2. Have successful professional careers in academia, industry and government.
3. Start own enterprise and provide solutions to scientific research problems.
4. Exhibit skills as a member of a team in national and international organizations with highest ethics through lifelong learning.

PROGRAMME OUTCOMES (POS)

After undergoing this program, a student will be able to:

1. **Domain knowledge**: Apply the knowledge of physics and fundamentals for the solution of complex problems in day to day life.
2. **Problem analysis**: Identify, formulate, research literature, and analyze problems to arrive at substantiated conclusions using principles of physical sciences.
3. **Design/development of solutions**: Design solutions for real time problems to meet the specifications with consideration for the public health and safety, the cultural and societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge, for analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Apply appropriate techniques, resources, and IT tools including prediction and modeling to complex activities with an understanding of the limitations.
6. **Environmental and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional practice.
7. **Environment and sustainability**: Understand the impact of the solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to ethics, and responsibilities and norms of the professional practice
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively with the professional community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.
11. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Apply the fundamentals of mathematical physics, classical mechanics, electrodynamics, Quantum mechanics, statistical mechanics and astrophysics to arrive at substantiated conclusions of physical phenomena and the energy quantization concepts.
2. Identify, compare and and synthesis of materials of the materials best suited for futuristic scientific applications.
3. Explore the knoweledge of basic concepts of atomic, molecular, nuclear physics to analyse the spectra obtanied from various bodies.
4. Demonstrate the knowledge of fundamentals of electronic devices and photonics.

(Framed as per the provisions under Section 35 (ii), Section 7 (x) and Section 8 (xvi) & (xxi) of the REVA University Act, 2012)

1. Title and Commencement:

1.1 These Regulations shall be called **"REVA University Academic Regulations – 2 years Master's Degree Programs2024-26 Batch subject to amendments from time to time by the Academic Council on recommendation of respective Board of Studies and approval of Board of Management**

1.2 These Regulations shall come into force from the date of assent of the Chancellor.

2. The Programs:

These regulations cover the following 2 years Masters Degree Programs of REVA University offered during 2024-26:

Biotechnology
Bioinformatics
Microbial Technology
Biochemistry
Chemistry
Physics
Mathematics

3. Duration and Medium of Instructions:

3.1 Duration: The Two Year Masters degree program is of 4Semesters duration. A candidate can avail a maximum of 8 semesters - 4 years as per double duration norm, in one stretch to complete the Two Year Masters Degree, including blank semesters, if any. Whenever a candidate opts for blank semester, s/he has to study the prevailing courses offered by the School when s/he resumes his/her studies.

3.2 The medium of instruction shall be English.

4. Definitions:

4.1 Course: "Course" means a subject, either theory or practical or both, listed under a programme; Example: "Documentary & New Production" in MA in Journalism &Communication Program, "Immunology" in M.Sc. in Biochemistry program are examples of courses to be studied under respective programs.

Every course offered will have three components associated with the teaching-learning process of the course, namely:

L	**Lecture**
T	**Tutorial**
P	**Practice**

Where:

L stands for **Lecture** session consisting of classroom instruction.

T stands for **Tutorial** session consisting participatory discussion / self-study/ desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.

P stands for **Practice** session, and it consists of Hands-on Experience / Laboratory Experiments / Field Studies / Case Studies / Project Based Learning or Course end Project/Self Study/ Online courses from listed portals that equip students to acquire the much-required skill component.

4.2 **Classification of Courses**

Courses offered are classified as: Core Courses, Hard Core Courses, Soft Core Courses, Open Elective Courses, Project work/Dissertation

4.2.1 **Core Course:** A course which should compulsorily be studied by a candidate choosing a particular program of study

4.2.2 **Hard Core Course (HC) simply core course:** The **Hard Core Course** is a Core Course in the main branch of study and related branch(es) of study, if any, that the candidates have to complete compulsorily

4.2.3 **Soft Core Course (SC) (also known as Professional Elective Course)**

A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main branch of study or from a sister/related branch of study which supports the main branch of study

4.2.4 **Open Elective Course (OE):**

An elective course chosen generally from other discipline / subject, with an intention to seek exposure to the basics of subjects other than the main discipline the student is studying is called an **Open Elective Course.**

4.2.5 **Project Work / Dissertation:**

School can offer project work/dissertation as a course. Depending on the duration required for completing the project/dissertation work, credits can be assigned. Normally, a minor project carries 4-6 credits and a major project carries double the number of credits of a minor project.

4.2.6 **“Program”** means the academic program leading to a Degree, Post Graduate Degree, Post Graduate Diploma or such other degrees instituted and introduced in REVA University.

5. Eligibility for Admission:

5.1. The eligibility criteria for admission to **Two Years Master Degree Program** (4 Semesters) is given below:

Sl. No.	Program	Duration	Eligibility
1	Masters of Commerce	4 Semesters (2 years)	B.Com. /BBM /BBA /BBS with 45% (40% in case ofcandidates belonging to SC/ST) of Semestersmarks in aggregate of any recognized University /Institution or any other qualification recognized asequivalent there to.
2	Masters of Arts in English	4 Semesters (2 years)	i) Bachelors Degree of 3 years duration in Arts withEnglish as a major / optional subject with aminimum 45% (40% in case of candidates belongingto SC/ST) marks in aggregate from any recognizedUniversity/ Institution; OR ii) Any Degree of 3 years duration with minimum50% (45% in case of candidates belonging to SC/ST)of marks in English language or English minor fromany recognized University or Institution or any otherqualification recognized as equivalent there to.
3	Masters of Artsin Journalism & Mass Communications	4 Semesters (2 years)	Bachelors degree of three years in any stream orBE / B.Tech. with 50% (45% in case of candidatesbelonging to SC/ST) marks in aggregate from anyrecognized University / institution or any other qualification recognized as equivalent there to.
4	Masters of Science in	4 Semesters	B E / B.Tech. in ECE / IT / EEE / CSE / ISE / TE / BCA/ M.Sc. or B.Sc. in Computer Science /

	Computer Science	(2 years)	Mathematics/ Information Science / Information Technology witha minimum of 50% (45% in case of SC/ST) marks inaggregate of any recognized University / Institutionor AMIE or any other qualification recognized asequivalent there to.
5	Masters of Science in Psychology	4 Semesters (2 years)	55% or equivalent CGPA in B.A/B.Sc. degree with Psychology as one of the core papers.
6	Masters of Science in Biotechnology	4 Semesters (2 years)	B.Sc. graduates with any Life Science subjects securing at least 45% (40% in case of candidates belonging to SC/ST) marks in aggregate of all optional subjects from any recognized University/Institute or any other qualification recognized as equivalent there to.
7	Masters of Sciencein Biochemistry	4 Semesters (2 years)	Bachelors Degree of 3 years with Biochemistry, Chemistry, Microbiology, Agricultural Sciences, Animal Sciences or Life Sciences as biochemistry asprincipal or subsidiary subjects with 45% (40% incase of SC / ST) of marks in aggregate from anyrecognized University/ Institution or any otherqualification recognized as equivalent there to.
8	Masters of Science. in Physics	4 Semesters (2 years)	Three years Bachelor's Degree in Science with Physics as one of the major / optional Subjects with45% (40% in case of SC / ST) of marks in aggregatefrom any recognized University / Institution or anyother qualification recognized as equivalent there to.
9	Masters of Sciencein Chemistry	4 Semesters (2 years)	Bachelors Degree of 3 years with Chemistry as oneof the major / optional Subjects with 45% (40% incase of SC / ST) of marks in aggregate from anyrecognized University / Institution or any otherqualification recognized as equivalent there to.
10	Masters of Sciencein Mathematics	4 Semesters (2 years)	Bachelors Degree of 3 years with Mathematics asone of the major / optional subjects with 45% (40% incase of SC / ST) marks in aggregate from anyrecognized University / Institution or any otherqualification recognized as equivalent there to.

11	Masters in Performing Arts	4 Semesters (2 years)	A graduate in any degree from a recognizedUniversity along with any Govt. conductedExamination certificate in Karnataka (or anequivalent body from other States). A minimum of 5years of learning experience from a reputed danceinstitution or guru/ an under graduate in Dance

5.2 Provided further that the eligibility criteria are subject to revision by the Government Statutory Bodies, such asUGC from time to time.

6. Courses of Study and Credits

6.1 Each course of study is assigned with certain credit value

6.2 Each semester is for a total duration of 20 weeks out of which 16 weeks dedicated for teaching and learning and the remaining 4 weeks for IAs and final examination, evaluation and announcement of results.

6.3 The credit hours defined as below:

In terms of credits, every one hour session of L amounts to 1 credit per Semester and a minimum of two hour session of T or P amounts to 1 credit per Semester or a three hour session of T / P amounts to 2 credits over a period of one Semester of 16 weeks for teaching-learning process.

1 credit = 13 credit hours spread over 16 weeks or spread over the semester

The total duration of a semester is 20 weeks inclusive of semester-end examination.

7. Different C**ourses of Study**:

Different C**ourses of Study** are labeled as follows:

a. Core Course (CC)
b. Hard Core Course (HC)
c. Soft Core course (SC)
d. Open Elective Course (OE)
e. Project Work / Dissertation: School can offer project work/dissertation as a course. Depending on the duration required for completing the project/dissertation work, credits can be assigned. Normally, a minor project carries 4-6 credits and a major project carries double the number of credits of a minor project

8. Credits and Credit Distribution

Registered candidates are required to earn the credits stated in the below table for the award of degree in the respective programs:

Credits	**Programs**
90 credits	M Com and M Sc in Computer Science
90 credits	MA English, MA in Journal & Mass Communication and M Sc in Psychology, M.Sc. in Biotechnology, M.Sc. in Biochemistry, M.Sc. in Chemistry, M.Sc. in Physics andM.Sc. in Mathematics
120 credits	Masters of Performing Arts

8.2. The concerned BoS based on the credits distribution pattern given above shall prescribe the credits to various types of courses and shall assign title to every course including project work, practical work, field work, self-study elective, as **Foundation course (FC), Hard Core (HC) or Soft Core (SC), Open Elective (OE).**

8.3. Every course including project work, practical work, field work, self-study elective should be entitled **Hard Core (HC) or Soft Core (SC) or Open Elective (OE)** or **Core Course** (**CC**) by the BoS concerned.

8.4**.** The concerned BoS shall specify the desired Program Educational Objectives, Program Outcomes, Program Specific Outcomes and Course Outcomes while preparing the curriculum of a particular program.

8.5. A candidate can enrol during each semester for credits as prescribed in the scheme of the program.

8.6. Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to VI semester and complete successfully prescribed number of credits for the award of the degree for three year program in 6 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and are eligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities.

9 Assessment and Evaluation

9.1 The Scheme of Assessment will have two parts, namely;

i. Internal Assessment (IA); and
ii. Semester End Examination (SEE)

9.2 Assessment and Evaluation of each Course shall be for 100 marks. The Internal Assessment (IA) and Semester End Examination (SEE) of for 2 year Masters degree programs shall carry 50:50 marks respectively (i.e., 50 marks internal assessment; 50 marks semester end examination).

9.3 There shall be **two Internal Tests** conducted as per the schedule announced below. **The Students' shall attend both the Tests compulsorily.**

- 1st test is conducted for 15 marks during **8th week** of the Semester;
- 2nd test is conducted for 15 marks during **16th week** of the of the Semester;
- Suitable number of Assignments/quizzes/presentations are set to assess the remaining 20 marks of IA at appropriate times during the semester

9.4 The coverage of syllabus for the said tests shall be as under:

- Question paper of the**1st test should be based on first 50%of the total syllabus**;
- Question paper of the **2nd test should be based on second 50%of the total syllabus**;

9.5 The Semester End Examination for 50 marks shall be held in the 18th and 19th week of the beginning of the semester and the syllabus for the semester end examination shall be entire syllabus.

9.6 A test paper is set for a maximum of 30 marks to be answered as per the pre-set time duration (1 hr / 1 hr 15 minutes / 1 hr 30 minutes). Test paper must be designed with School faculty members agreed pattern and students are assessed as per the instructions provided in the question paper. Questions must be set using Bloom's verbs. The questions must be set to assess the students outcomes described in the course document.

9.7 The question papers for internal test shall be set by the internal teachers who have taught the course. If the course is taught by more than one teacher all the teachers together shall devise a common question paper(s). However, these question papers shall be scrutinized by School specific Question Paper Scrutiny Committee formed by the respective School Head /Director to bring in the uniformity in the question paper pattern and as well to maintain the necessary standards.The evaluation of the answer scripts shall be done by the internal teachers who have taught the course and set the test paper.

9.8 The evaluation of the answer scripts shall be done by the internal teachers who have taught the course and set the test paper.

9.9 Assignment/seminar/Project based learning/simulation based problem solving/field work should be set in such a waystudents be able to apply the concepts learnt to a real life situation and students should be able to do some amount self-study and creative thinking. While setting assignment care should be taken such that the students will not be able to plagiarise the answer from web or any other resources. An IA1 and IA2 assignment / Quiz can be set each for a maximum of 5 marks, totals to 10 marks.Course instructor at his/her discretion can design the questions as a small group exercise or individual exercise. This should encourage collaborative learning and team learning and also self-study.

9.10 Internal assessment marks must be decided well before the commencement of Semester End examinations

9.11 Semester End Examination: The Semester End Examination is for 50 marks shall be held in the 19th and20th week of thesemester and the entire course syllabus must be covered while setting the question paper.

9.12 Semester End Examination paper is set for a maximum of 100 marks to be answered in 3 hours duration. Question paper must be prepared as per the respective School set format.

9.13 Each question is set using Bloom's verbs. The questions must be set to assess the students outcomes described in the course document. (Please note question papers have to be set to test the course outcomes)

9.14 There shall be three sets of question papers for the semester end examination of which one set along with scheme of examination shall be set by the external examiners and two sets along with scheme of examination shall be set by the internal examiners. All the three sets shall be scrutinized by the Board of Examiners. It shall be responsibility of the Board of Examiners particularly Chairman of the BOE to maintain the quality and standard of the question papers and as well the coverage of the entire syllabus of the course.

9.15 There shall be double evaluation, viz, first valuation by the internal evaluator who has taught the course and second evaluation shall be an external examiner who is familiar with the course. The average marks of the two evaluations (internal examiner & external examiner) shall be the marks to be considered for declaration of results

9.16 Board of Examiners, question paper setters and any member of the staff connected with the examination are required to maintain integrity of the examination system and the quality of the question papers

9.17 There shall also be an **Program Assessment Committee (PAC)** comprising at-least 3 faculty members having subject expertise who shall after completion of examination process and declaration of results review the results sheets, assess the performance level of the students, measure the attainment of course outcomes, program outcomes and assess whether the program educational objectives are achieved and report to the Director of the School. **Program Assessment Committee (PAC)** shall also review the question papers of both Internal Tests as well as Semester End Examinations and submit to the Director of the respective School about the scope of curriculum covered and quality of the questions.

9.18 The report provided by the **Program Assessment committee (PAC**) shall be the input to the Board of Studies to review and revise the scheme of instruction and curriculum of respective program

9.19 During unforeseen situation , the tests and examination schedules, pattern of question papers and weightage distribution may be designed as per the convenience and suggestions of the board of examiners in consultation with COE and VC

9.20 University may decide to use available modern technologies for writing the tests and SEE by the students instead of traditional pen and paper

9.21 Any deviations required to the above guidelines can be made with the written consent of the Vice Chancellor

9.22 Online courses may be offered as per UGC norms.

For online course assessment guidelines would be as follows:

1. If the assessment is done by the course provider, then the School can accept the marks awarded by the course provider and assign the grade as per REVA University norms.

2. If the assessment is not done by the course provider then the assessment is organized by the concerned school and the procedure explained in the regulation will apply

3. In case a student fails in an online course, s/he may be allowed to repeat the course and earn the required credits

9.23 The online platforms identified could be SWAYAM, NPTEL, Coursera, Edx.org, Udemy, Udacity and any other internationally recognized platforms like MIT online, Harvard online etc.

9.24 Utilization of one or two credit online courses would be:

4 week online course – 1 credit – 15 hours
8 week online course / MOOC – 2 credits – 30 hours
12 week online course / MOOC – 3 credits – 45 hours

9.25 **Summary of Internal Assessment, Semester End Examination and Evaluation** Schedule is provided in the table given below.

Summary of Internal Assessment and Evaluation Schedule

Sl. No.	Type of Assessment	when	Syllabus Covered	Max Marks	Reduced to	Date by which the process must be completed
1	Test-1	During 8^{th} week	First 50%	30	15	8^{th} week
2	Assignment 1	On or before 8^{th} week (5 marks)				
3	Presentations 1	On or before 8^{th} week (5 marks)				
4	Test -2	During 16^{th} Week	Second 50%	30	15	16^{th} Week
5	Assignment 2	On or before 16^{th} Week (5 marks)				
6	Presentations 2	On or before 16^{th} Week (5 marks)				
7	SEE	19/20^{th} Week	100%	100	50	20^{th} Week

Note: 1. Examination and Evaluation shall take place concurrently and Final Grades shall be announced as per notification from the Controller of Examination.

2. Practical examination wherever applicable shall be conducted after 2nd test and before semester end examination. The calendar of practical examination shall be decided by the respective School Boards and communicated well in advance to the Controller of Examination who will notify the same immediately

10 Assessment of Students Performance in Practical Courses

The performance in the practice tasks / experiments shall be assessed on the basis of:

a) Knowledge of relevant processes;
b) Skills and operations involved;
c) Results / products including calculation and reporting.

10.1 The 50 marks meant for Internal Assessment (IA) of the performance in carrying out Practical shall further be allocated as under:

i	Conduction of regular practical / experiments throughout the semester	20 marks
ii	Maintenance of lab records	10 marks
iii	Performance of mid-term test (to be conducted while conducting second test for theory courses); the performance assessments of the mid-term test includes performance in the conduction of experiment and write up about the experiment.	20 marks
	Total	**50 marks**

10.2 The50 marks meant for Semester End Examination (SEE), shall be allocated as under:

i	Conducting of semester end practical examination	30 marks
ii	Write up about the experiment / practical conducted	10 marks
iii	Viva Voce	10 marks
	Total	**50 marks**

The duration for semester-end practical examination shall be decided by the concerned School Board.

11. Evaluation of Minor Project / Major Project / Dissertation:

Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the supervisor. At the end of the semester, the candidate has to submit final report of the project / dissertation, as the case may be, for final evaluation. The components of evaluation are as follows:

Component – I	Progress Report 1 (25%)
Component – II	Progress Report 2(25%)
Component – III	Evaluation of Report and final viva voce (50%)

All assessments must be done by the respective Schools as per the guidelines issued by the Controller of Examinations. However, the responsibility of announcing final examination results and issuing official transcripts to the students lies with the office of the Controller of Examinations.

12. Requirements to Pass a Course:

A candidate's performance from all 3 components will be in terms of scores, and the sum of all three scores will be for a maximum of 100 marks (25 + 25 + 50). A candidate who secures a minimum of 40% in the SEE and an overall 40% (IA1+IA2+SEE) in a course is said to be successful.

The Grade and the Grade Point: The Grade and the Grade Point earned by the candidate in the subject will be as given below:

Marks, P	**Grade, G**	**Grade Point (GP=V x G)**	**Letter Grade**
90-100	10	v*10	O
80-89	9	v*9	A+
70-79	8	v*8	A
60-69	7	v*7	B+
55-59	6	v*6	B
50-54	5.5	v*5.5	C+
40-49	5	v*5	C
0-39	0	v*0	F
ABSENT			AB

O - Outstanding; A+-Excellent; A-Very Good; B+-Good; B-Above Average; C+-Average;

C-Satisfactory; F – Unsatisfactory.

Here, P is the percentage of marks (P=[IA + SEE]) secured by a candidate in a course which is r**ounded to nearest integer**. V is the credit value of course. G is the grade and GP is the grade point.

a. **Computation of SGPA and CGPA**

The Following procedure to compute the Semester Grade Point Average (SGPA).

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in a given semester, i.e :**SGPA (Si) = ∑(Ci x Gi) / ∑Ci** where C_i is the number of credits of the i^{th} course and G_i is the grade point scored by the student in the i^{th} course.

Examples on how SGPA and CGPA are computed

Example No. 1

Course	**Credit**	**Grade Letter**	**Grade Point**	**Credit Point (Credit x Grade)**
Course 1	4	A+	9	4x9=36
Course 2	4	A	8	4x8=32
Course 3	4	B+	7	4x7=28
Course 4	3	O	10	3x10=30
Course 5	3	C	5	3x5=15
Course 6	3	B	6	3x6=18
	21			**159**

Thus, **SGPA = 159 ÷ 21 = 7.57**

Example No. 2

Course	**Credit**	**Grade letter**	**Grade Point**	**Credit Point (Credit x Grade point)**
Course 1	4	A	8	4x8=32
Course 2	4	B+	7	4x7=28
Course 3	4	A+	9	4x9=36
Course 4	4	B+	7	4x7=28
Course 5	4	B	6	4x6=24
	20			**148**

Thus, **SGPA = 148 ÷ 20 = 7.4**

b. **Cumulative Grade Point Average (CGPA):**

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits for the respective programs are calculated taking into account all the courses undergone by a student over all the semesters of a program, i. e :**CGPA = ∑(Ci x Si) / ∑Ci** Where S_i is the SGPA of the i^{th} semester and C_i is the total number of credits in that semester.

Example:

CGPA after Final Semester

Semester (ith)	No. of Credits (Ci)	SGPA (Si)	Credits x SGPA (Ci X Si)
1	21	7.57	21 x 7.57 = 158.97
2	20	7.4	20 x 7.4 = 148.00
3	23	8.11	23 x 8.11 = 186.53
4	26	7.40	26 x 7.40 = 192.40
Cumulative	**90**		**685.90**

Thus, CGPA = 685.90/90 = 7.62

c. **Conversion of grades into percentage:**

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10

Example: CGPA Earned 7.62 x 10=76.2

d. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

13. Classification of Results

The final grade point (FGP) to be awarded to the student is based on CGPA secured by the candidate and is given as follows.

CGPA	Grade (Numerical Index)	Letter Grade	Performance	FGP
	G			Qualitative Index
9 >= CGPA 10	10	O	Outstanding	Distinction
8 >= CGPA < 9	9	A+	Excellent	
7 >= CGPA < 8	8	A	Very Good	First Class
6 >= CGPA < 7	7	B+	Good	
5.5> = CGPA < 6	6	B	Above average	Second Class
>5 CGPA< 5.5	5.5	C+	Average	
>4 CGPA<5	5	C	Satisfactory	Pass
< 4 CGPA	0	F	Unsatisfactory	Unsuccessful

Overall percentage=10*CGPA

a. **Provisional Grade Card**: The tentative / provisional grade card will be issued by the Controller of Examinations at the end of every semester indicating the courses completed successfully. The provisional grade card provides **Semester Grade Point Average (SGPA).**

b. **Final Grade Card:** Upon successful completion of two year Degree a Final Grade card consisting of grades of all courses successfully completed by the candidate will be issued by the Controller of Examinations.

14. Attendance Requirement:

14.1 All students must attend every lecture, tutorial and practical classes.

14.2 In case a student is on approved leave of absence (e g:- representing the University in sports, games or athletics, placement activities, NCC, NSS activities and such others) and / or any other such contingencies like medical emergencies, the attendance requirement shall be minimum of 75% of the classes taught.

14.3 Any student with less than 75% of attendance in aggregate of all the courses including practical courses / field visits etc., during a semester shall not be permitted to appear to the end semester examination and such student shall seek re-admission

15. Re-Registration and Re-Admission:

15.1 In case a candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University, such a candidate is considered as dropped the semester and is not allowed to appear for semester end examination and s/he shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

15.2 In such case where in a candidate drops all the courses in a semester due to personal reasons, it is considered that the candidate has dropped the semester and s/he shall seek re-admission to such dropped semester.

16. Absence during Internal Test:

In case a student has been absent from an internal tests due to the illness or other contingencies s/he may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Director of the School, for conducting a separate internal test. The

Director of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and arrange to conduct a special internal test for such candidate(s) well in advance before the Semester End Examination of that respective semester. Under no circumstances internal tests shall be held / assignments are accepted after Semester End Examination.

17. Provision for Appeal

If a candidate is not satisfied with the evaluation of Internal Assessment components (Internal Tests and Assignments), s/he can approach the Grievance Cell with the written submission together with all facts, the assignments, and test papers, which were evaluated. S/he can do so before the commencement of respective semester-end examination. The Grievance Cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the University on the candidate if his/her submission is found to be baseless and unduly motivated. This Cell may recommend for taking disciplinary/corrective action on an evaluator if s/he is found guilty. The decision taken by the Grievance committee is final.

18. Grievance Committee:

In case of students having any grievances regarding the conduct of examination, evaluation and announcement of results, such students can approach Grievance Committee for redressal of grievances. Grievance committees will be formed by CoE in consultation with VC

For every program there will be one grievance committee. The composition of the grievance committee is as follows:-

- ❖ The Controller of Examinations - Ex-officio Chairman / Convener
- ❖ One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the school / department/discipline and/or from the sister schools / departments/sister disciplines – Member.
- ❖ One Senior Faculty Members / Subject Experts drawn from outside the University school / department – Member.

19. Eligibility to Appear for Semester End Examination (SEE)

Only those students who fulfil a minimum of 75% attendance in aggregate of all the courses including practical courses / field visits etc., as part of the program shall be eligible to appear for Semester End Examination

20. Provision for Supplementary Examination

In case a candidate fails to secure a minimum of 40% (20 marks) in Semester End Examination (SEE) and a minimum of 40% marks together with IA and SEE to declare pass in the course, such candidate shall seek supplementary examination of only such course(s) wherein his / her performance is declared unsuccessful. The supplementary examinations are conducted after the announcement of even semester examination results. The candidate who is unsuccessful in a given course(s) shall appear for supplementary examination of odd and even semester course(s) to seek for improvement of the performance.

21. Provision to Carry Forward the Failed Subjects / Courses:

A student who has failed in a given number of courses in odd and even semesters shall move to next semester of immediate succeeding year and final year of the study. However, s/he shall have to clear all courses of all semesters within the double duration, i.e., with four years of admission of the first semester failing which the student has to re-register to the entire program.

With regard to any specific case of ambiguity and unsolved problem, the decision of the Vice-Chancellor shall be final.

M.Sc. (Physics) Program

Scheme of Instructions (Effective from Academic year 2024-25)

COURSE STRUCTURE - M.SC. PHYSICS

SEMESTER-I

Sl. No.	Course Code	Title of the Course	Course Type	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1	M24SP0101	Mathematical Physics	HC	4	0	0	4	4
2	M24SP0102	Classical Mechanics	HC	4	0	0	4	4
3	M24SP0103	Electronic devices	HC	4	0	0	4	4
4	M24SP0104	Quantum Mechanics I	HC	4	0	0	4	4
5	M24SP0105	Solid state physics 1	HC	4	0	0	4	4
	Practical Courses							
6	M24SP0106	General Physics lab - I	HC	0	0	2	2	4
7	M24SP0107	Electronics lab	HC	0	0	2	2	4
8	M24SP0108	Computational physics Lab	HC	0	0	1	1	2
Total Credits				**20**	**0**	**5**	**25**	**30**

SEMESTER-II

Sl. No.	Course Code	Title of the Course	Course Type	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1	M24SP0201	Quantum Mechanics II	HC	4	0	0	4	4
2	M24SP0202	Statistical Mechanics	HC	4	0	0	4	4

3	M24SP0203	Classical Electrodynamics	HC	4	0	0	4	4
4	M24SP0204	Modern optics, Atomic and Molecular Physics	HC	4	0	0	4	4
5	M24SP0205	Solid state Physics -II	HC	4	0	0	4	4
6	M24PTM01	Soft skill training	MC	0	0	0	0	2
	Practical Courses							
7	M24SP0206	Lab View introduction and interfacing	HC	0	0	1	1	2
8	M24SP0207	General Physics lab - II	HC	0	0	2	2	4
9	M24SP0208	Atomic and Molecular Physics Lab	HC	0	0	2	2	4
Total Credits				**20**	**0**	**5**	**25**	**32**

SEMESTER-III

Sl. No.	Course Code	Title of the Course	Course Type	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1.	M24SP0301	Nanoscience and Nanotechnology	HC	4	0	0	4	4
2.	M24SP0302	Nuclear and Particle physics	HC	4	0	0	4	4
3.	M24SPS311	Electronics I	SC[1]	4	0	0	4	4
4.	M24SPS312	Condensed matter Physics - I						
5.	M24SPS313	Photonics -I						
6.	M24SPS314	Advanced Materials and technology - I						
7.	M24SPS321	Electronics - II	SC[2]	4	0	0	4	4

8.	M24SPS322	Condensed matter Physics – II						
9.	M24SPS323	Photonics – II						
10.	M24SPS324	Advanced Materials and technology - II						
11.	M24SPO301	Astrobiology and Extraterrestrial Life	OE	4	0	0	4	4
	Practical Courses							
12	M24SP0303	General Physics Lab-III	HC	0	0	2	2	4
13	M24SPS331	Electronics Lab	SC#	0	0	2	2	4
14	M24SPS332	Condensed Matter Physics Lab						
15	M24SPS333	Photonics Lab						
16	M24SPS334	Advanced Materials and technology Lab						
17	**M24SP0304**	**Mini Project**	HC	0	0	0	2	4
Total Credits				**22**	**0**	**4**	**26**	**32**

SEMESTER-IV

Sl. No.	Course Code	Title of the Course	Course Type	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1	M24SP0401	Research methodology	HC	2	0	0	2	2
1	M24SP0402	Astrophysics and cosmology	HC	4	0	0	4	4
2	M24SP0403	Major Project	HC	0	0	8	8	16
Total Credits				**6**	**0**	**8**	**14**	**22**
Total Credits of I to IV Semesters				**70**	**0**	**20**	**90**	**116**

Semester-wise Summary of Credit Distribution

Semesters	No. of Credits	No. of Hours
First Semester	25	30
Second Semester	25	32
Third Semester	26	32
Fourth Semester	14	22
Total Credits	**90**	**116**

Distribution of Credits Based on Type of Courses

Semester	HC	SC	OE	MC	TOTAL
I	25	-	-	-	25
II	25	-	-	0	25
III	**10**	12	4	-	26
IV	6	8	-	-	14
Total	**68**	**18**	**4**	**0**	**90**

HC=Hard Core; SC=Soft Core; OE=Open Elective

Distribution of Credits Based on L: T: P

Semester	L	T	P	Total Credits	Total Hours
I	20	0	5	25	30
II	20	0	5	25	32
III	22	0	4	26	32
IV	6	0	8	14	22
Total	**70**	**0**	**20**	**90**	**116**

DETAILED SYLLABUS

(Effective from Academic Year 2024-25)

FIRST SEMESTER

<table>
<tr><td>Course Title</td><td colspan="4">Mathematical Physics</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
<tr><td>Course Code</td><td>M24SP0101</td><td>Credit</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment weightage</td></tr>
<tr><td>Lecture</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

The course on mathematical physics typically provides an overview of the mathematical methods and techniques used to describe and analyze physical phenomena. Students will learn about various mathematical tools such as vector calculus, differential equations, complex analysis, Fourier series, transforms, tensors, and more. The course aims to develop students' ability to apply mathematical concepts to solve problems in physics, ranging from classical mechanics to quantum mechanics. Additionally, students will gain an understanding of how mathematical models are used to describe and predict physical phenomena, as well as the importance of mathematical rigor in theoretical physics. Overall, the course on mathematical physics provides a solid foundation in mathematical techniques essential for understanding and advancing in the field of physics.

COURSE OBJECTIVES:

The objectives of this course is to develop students' ability

1. Work with vector quantities in three-dimensional space, understand vector fields, and apply vector analysis techniques to describe physical phenomena accurately.
2. Work with higher-dimensional objects and understand the geometric interpretation of tensors in mathematical physics.
3. Analytical and problem-solving skills in the context of mathematical physics using matrix theory as a tool.
4. Represent functions in terms of trigonometric or exponential series, analyze signals in the frequency domain, and solve complex problems in mathematical physics using these techniques.
5. Importance of differential equations in describing natural phenomena and developing theoretical frameworks in physics

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Enhancing problem-solving skills and analytical thinking through the application of vector analysis in mathematical physics scenarios.	1,2	1
CO2	Development of analytical and problem-solving skills through the application of tensor theory to various mathematical physics problems.	1,2	1
CO3	Apply matrix theory to solve problems in mathematical physics, such as systems of linear equations, transformations, and quantum mechanics.	1,2	1
CO4	Developing skills in transforming functions between time and frequency domains, and understanding the applications of these transforms in various fields such as signal processing, control theory, and quantum mechanics.	1,2	1
CO5	Developing the ability to solve various types of differential equations, including first-order, second-order, and higher-order equations.	1,2	1
CO6	apply special functions in mathematical physics to describe wave phenomena, quantum mechanics, and other physical systems with special mathematical structures	1,2	1

Course Content:

Unit-1: **12 hrs**

Vectors & Tensors:

Review of Vector analysis, Gradient, Divergence and Curl operations, Gauss' and Stokes' theorems, applications, Gradient, Curl, divergence and Laplacian in spherical polar and cylindrical polar co-ordinates, Definition of tensors, contravariant and covariant components of tensors, raising and lowering of tensor indices, sum, outer, inner products and contraction of tensors, Quotient law, symmetric, antisymmetric tenors, Levi-civita symbol, Tensor application: moment of inertia.

Unit - 2: **12 hrs**

Linear vector spaces and operators: Vector spaces and subspaces, Linear dependence and independence, Inner product, Orthogonality, Gramm-Schmidt orthogonalization procedure, Basis and Dimensions, linear operators. Matrix representation, Similarity transformations, Characteristic polynomial of a matrix, Eigen values and eigenvectors, Self adjoint and Unitary transformations, Hermitian and Unitary transformations, diagonalization, application of matrices.

Unit - 3: **12hrs**

Fourier series integral transforms Fourier Series: Definition, Properties, Convergence, Application of Fourier series, Fourier Integral and Fourier transform, Convolution theorem, Parseval’s theorem, Laplace transform and its properties, convolution theorem, inverse Laplace transforms, solution of differential equations using Laplace transforms.

Unit - 4: **12hrs**

Ordinary differential equations and Special Functions: Linear ordinary differential equations, Separation of Poisson and Helmholtz equations in spherical polar and cylindrical polar coordinates, Series solutions – Frobenius’method, Series solutions of the differential equations of Bessel and Legendre polynomials, Generating functions, Some recurrence relations, orthogonality properties of these functions.

Reference Books:

1. Mathematical methods for physicists, Arfken G. B and Weber H.J, 4th Edition, Prism Books Pvt Ltd, India (1995).
2. Mathematical Physics, Sathya Prakash, Sultan Chand and Sons, (1985).
3. Mathematical Physics, Chattopadhyaya P.K, Wiley Eastern, (1980).
4. Methods of Mathematical Physics, Bose H.K and Joshi M.C, Tata McGraw Hill, (1984).
5. Vector Analysis, Murray R Spiegel, Schaum's Outline Series, McGraw Hill International Book Company, Singapore (1981).
6. Tensor Analysis — Theory & Applications. Sokolnikoff LS, 211: Edition, John Wiley Sons (1964).
7. Mathematical Methods in the Physical Sciences, Mary L. Boas, 2nd Edition, John Wiley & Sons (1983).
8. Matrices and Tensors in Physics, A.W. Joshi, 4th Edition, New Age International Publishers (1995).

<table>
<tr><td>Course Title</td><td colspan="4">Classical Mechanics</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
<tr><td>Course Code</td><td>M24SP0102</td><td>Credit</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment weightage</td></tr>
<tr><td>Lecture</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

The course classical mechanics provides an overview of the Lagrangian Dynamics to describe and to write equations of motion for varies bodies. This course also focuses on central force problems, stability of orbits and artificial satellites. Students will learn about varies calculation methods such Hamilton- Jacobi methods. The course helps to develop the students' ability to apply the concepts of classical methods to solve problems in modern Physics.

COURSE OBJECTIVES:

The objectives of this course are to:

1. To give students a solid foundation in classical mechanics.
2. To introduce general methods of studying the dynamics of particle systems.
3. To give experience in using mathematical techniques for solving practical problems.
4. To lay the foundations for further studies in physics.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Apply the Lagrangian methods to analyze and explain the problems in classical Mechanics	1,2	1
CO2	Analyse the Central force problems to explain the Classification of orbits, Kepler's laws in planetary motion.	1,2	1
CO3	Apply the concept of the centre force fields to analyse the stability of artificial satellites and Rutherford scattering.	1,2	1
CO4	Apply the concept of Hamilton's equations to derive the expression for different principles in classical mechanics	1,2	1
CO5	Analyse the Poisson bracket equations to apply solve problem related to transformations	1,2	1
CO6	Solve problems related to the mechanics of rigid bodies, the precession of rotation of earth and communicate scientific information of classical mechanics.	1,2	1

Course Content:

Unit - 1: **12 hrs**

The Lagrangian Dynamics: Constraints and their classifications, Generalized coordinates, Virtual displacement and work, D'Alembert's principle, Lagrangian equation from D'Alembert's principle, Lagrangian equations for conservative system, Derivation of Lagrangian equations: For(I) A particle in (a) Cartesian coordinates, (b) Spherical polar coordinates and (c) Cylindrical polar coordinates, d) motion under Central force (II) Atwood's machine, (III) simple pendulum, Derivation of Lagrange equation from Hamilton principle, applications of Hamilton principle, conservation of Linear, Momentum and Kinetic energy

Unit - 2 **12 hrs**

Central force problem: Central force and Motion in plane, Equation of motion under the central force and first integrals, Differential equation for an orbit, Inverse square law of force, Kepler's laws of planetary motion and deduction, Stability and closure of orbit under central force, Artificial satellites, Scattering in a central force field, Rutherford scattering, Impact parameter, Problems.

Unit - 3: **12 hrs**

Hamilton's equations : Derivation of Hamilton's principle, Derivation of Hamilton's equations from the variational principle, Examples (i) the simple harmonic oscillator (ii) Hamiltonian for a free particle in plane and spherical Co-ordinates. Cyclic coordinates, Canonical tranformations, examples of Canonical transformations, Poisson brackets, properties of Poisson brackets, angular momentum and Poisson brackets relations, Equation of motion in the Poisson bracket notation, The Hamilton-Jacobi equation, the example of the harmonic oscillator treated by the Hamilton-Jacobi method.

Unit– 4 **12 hrs**

Mechanics of rigid bodies: Generalized co-ordinates of a rigid body, Degrees of freedom, Angular Velocity, Angular momentum, inertia tensor, principal moments of inertia, kinetic energy of rigid body, Euler equations of motion for a rigid body, Torque free motion of a rigid body, motion of symmetrical top-rotational motion, Precession of earth's axis of rotation, Coriolis force, coriolis force acting on free fall body on earth's surface.

References Books:

1. Classical Mechanics, J.C Upadhyaya, Himalaya Publishing house.(2005)
2. Classical mechanics, H. Goldstein, C. Poole, J. saflco. 3rd edition. Pearson Education inc. (2002).
3. Classical mechanics. K. N. Srinivasa Rao, University press (2003).
4. Classical mechanics, N. C. Rana and P.S. Joag Tata McGraw-Hill (1991).
5. Classical dynamics of particles and systems, J. B. Marion, Academic press (1970).
6. Introduction to Classical mechanics. Takwale and Puranik, Tata McGraw-hill (1983)
7. Classical mechanics, L. D. Landau and E. M. Lifshitz, 4thedition, Pergamon Press (1985).

Course Title	Electronic Devices				Course Type		HC	
Course Code	M24SP0103	Credit	4		Class			
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment weightage	
	Lecture	4	4	4				
	Tutorial	-	-	-	Theory	Practical	CIE	SEE
	Practical							
	Total	4	4	4	48	-	50%	50%

COURSE OVERVIEW:

"Electronic Devices" course provides a comprehensive education in the principles, applications, and technologies of electronic components and systems. It equips students with the knowledge and skills necessary for both academic advancement and professional success in the field of electronics and related areas.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Study different types of electronic components such as diodes, transistors, and integrated circuits.
2. Understand the characteristics, functions, and applications of these components.
3. Learn methods for analyzing and designing electronic circuits.
4. Apply theoretical knowledge to practical circuit design and problem-solving.
5. Understand the role of electronic devices in modern technology and systems.
6. Study the integration of these devices in larger electronic systems and their real-world applications.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Analyse the operation, characteristics, and applications of BJT circuits.	1,2	1
CO2	Analyse the construction and working of FET and MOSFETs.	1,2	1
CO3	Design a DC bias circuitry of BJT, UJT, and SCR.	1,2	1
CO4	Construct an OPAMP circuit for different applications and develop the prototypes of electronic devices.	1,2	1
CO5	Solve the logic gates to design for the adder, decoder, and comparators.	1,2	1
CO6	Solve real-time examples of BJT, UJT, SCR, and OPAMP.	1,2	1

Course Content:

Unit 1: **12 hrs**

Transistors: Transistor configurations and characteristics, Methods of biasing-fixed bias, collector-to-base bias and voltage divider bias, DC load line, Transistor as an amplifier-Single stage and multistage amplifier, frequency response, Push-pull amplifier, Astable multi-vibrator using transistors.

Unit 2: **12 hrs**

Field Effect Transistors (FET): JFET: Construction, working, Characteristics and parameters. MOSFET: Construction, working, Characteristics and parameters.

Thyristors: Types of thyristors, working and characteristics of Silicon Controlled Rectifier (SCR), Characteristics and application of TRIAC, Working and characteristics of Unijunction Transistor (UJT), UJT relaxation oscillator.

Unit 3: **12 hrs**

Operational amplifier: Block diagram of an operational amplifier, Characteristics of an ideal operational amplifier, Parameters of an op-amp, Operational amplifier as a feedback amplifier: Inverting and Non-inverting amplifiers, Applications of an operational amplifier: Instrumentation amplifier, Active filters- First order Butterworth low pass and high pass filter.

Unit 4: ` **12 hrs**

Boolean operations and expressions: Introduction, Logic Operators, Postulates and theorems, properties –Product of Sums and Sum of Products– Karnaugh Map method – Two, three, four K-variable K-maps, Converting Boolean expressions to Logic and Vice versa, NAND and NOR implementation – Don't-Care conditions – The tabulation method. Half and full Adder – Half and full Subtractor – Binary parallel adder – BCD Adder, Decimal adder – Magnitude comparator – Encoders & Decoders.

Reference Books

1. Basic Electronics and Linear Circuits, NN Bhargava, DC Kulashreshtha and SCGupta,Tata Mc Graw Hill.1983.
2. Electronic Devices and Circuits: An Introduction, Allen Mottershead**,** Prentice Hall of India, 1973.
3. Semiconductor Optoelectronic Devices, PallabBhattacharya,Pearson Education Taiwan Limited, 2003.
4. Electronic Principles, A P Malvino, (Sixth Edition, 1999), Tata McGraw Hill, New Delhi.
5. A Textbook of Electronic Circuits, RS Sedha, S Chand & Company Ltd.2014.
6. Op-Amps and Linear Integrated Circuits, Remakant A Gayakwad, (Third Edition, 2004), Eastern Economy Edition.
7. Linear Integrated Circuits, D Roy Choudhury and Shail Jain, New Age International Limited.2003.

Course Title	**Quantum Mechanics - I**				**Course Type**		**HC**	
Course Code	**M24SP0104**	**Credit**	**4**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	4	4	4				
	Tutorial	-	-	-	**Theory**	**Practical**	**CIE**	**SEE**
	Practical							
	Total	**4**	**4**	**4**	**48**	**-**	**50%**	**50%**

Course Overview

This course provides an in-depth understanding of the foundational principles of quantum mechanics. It covers the formalism of quantum mechanics, one-dimensional quantum problems, angular momentum and spin, and three-dimensional quantum problems, including the hydrogen atom.

Course Objectives:

1. To illustrate the inadequacy of classical theories and the need for a quantum theory.
2. To explain the basic principles of quantum mechanics.
3. To develop solid and systematic problem-solving skills.
4. To apply quantum mechanics to simple systems occurring in atomic and solid-state physics.

Course Outcomes:

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Explore mathematical tools essential in understanding Quantum mechanics.	1,2	1
CO2	Postulate the basics of quantum mechanics.	1,2	1
CO3	Be able to use Matrix and wave formulations of quantum mechanics to find the energy spectrum and the states of quantum systems	1,2	1
CO4	Apply Schrodinger wave equation for one dimensional problem like, particle in a box, harmonic Oscillator etc and three dimensional problems in quantum mechanics.	1,2	1
CO5	Solve numerical based on angular momentum	1,2	1
CO6	Use spin operators and analyze the result obtained in Stern-Gerlach experiment.	1,2	1

Course Content:

UNIT I: FORMALISM OF QUANTUM MECHANICS **12 hrs**

Postulates of Quantum Mechanics: Basic Postulates of Quantum Mechanics, State of a System, Observables and Operators, Measurement in Quantum Mechanics, Time Evolution of the System's State, Symmetries and Conservation Laws, Connecting Quantum to Classical Mechanics.

Mathematical Tools of Quantum Mechanics: Hilbert Space and Wave Functions, Dirac Notation, Operators, Representation in Discrete Bases, Representation in Continuous Bases, Matrix and Wave Mechanics.

UNIT II: ONE DIMENSIONAL PROBLEMS **12 hrs**

free particle (Unbound state-continuous spectrum), potential wells: Infinite square well potentials- symmetric and asymmetric wells; finite square well potentials- scattering and bound state solutions.

Potential barriers: square potential barrier, single step potential barrier, Tunneling, Transmission andReflection co-efficient, Alpha decay, Ramsauer-Townsend effect, Simple Harmonic Oscillator: wave function and operator approach.

UNIT III: ANGULAR MOMENTUM AND CONCEPT OF SPIN **12 hrs**

Angular Momentum*:* Angular momentum operators and their Algebra, Eigen functions and Eigen values of $\mathbf{L^2}$ and $\mathbf{L_z}$ using Schrodinger wave mechanics and matrix mechanics, angular momentum operators.

Uncertainty relations: Stern-Gerlach experiment and the concept of spin, Pauli-spin matrices, Additionof angular momentum: Clebsch-Gordan coefficients for two particles.

UNIT IV: THREE DIMENSONAL PROBLEM **12 hrs**

Separation of Schrodinger equation inCartesian coordinates, Simple harmonic oscillator in 3-dimensions, Free particle in 3d box – Effects ofthe exclusion principle on non-interacting fermions in a box,
Central potential, Schrodinger equation inSpherical coordinates-separation of variables r, Φ, Θ. The hydrogen atom, radial equation; energy spectrum; degeneracy of the spectrum; radial wave functions and probability density P(r), evaluation of expectation values of r.

Reference textbooks:

1. N. Zettili, Quantum Mechanics: Concepts and Applications, 2nd edition, John Wiley (2009)
2. G. Aruldhas, Quantum mechanics, 2nd edition, PHI Learning PVT Ltd (2009)
3. Gupta, Kumar and Sharma, Quantum mechanics, 34th edition, Jai Prakash nath Publications (2017)
4. A Ghatak and S Lokanathan, Quantum Mechanics, Theory and Applications, Macmillan(2004).
5. Stephen Gasiorowicz, Quantum Physics, 3rd edition, John Wiley (2003).
6. E. Merzbacher, Quantum Mechanics. 3rd edition, John Wiley(1994).
7. V.K. Thankappan, Quantum Mechanics, Wiley Eastern (1985)
8. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, TMH(1977).
9. B.Bransden, C.Joachain, Quantum Mechanics, 2nd ed, Pearson/Prentice Hall, (2000).
10. R.L.Liboff, Introduction to Quantum Mechanics, Pearson Education(2003).
11. J.S.Townsend, A Modern Approach to Quantum Mechanics, 2nd ed, McGraw Hill publishers, 2012.
12. C.Cohen-Tannoudji, B.Diu, F.Laloe, Quantum Mechanics (2 vol. set), Wiley Interscience (1996).

Course Title	**Solid state Physics - I**				**Course Type**		**HC**	
Course Code	**M24SP0105**	**Credit**	**4**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	**4**	**4**	**4**				
	Tutorial	**-**	**-**	**-**	**Theory**	**Practical**	**CIE**	**SEE**
	Practical	**-**	**-**	**-**				
	Total	**4**	**4**	**4**	**48**	**-**	**50%**	**50%**

COURSE OVERVIEW:

This Course introduces the Crystal structure, analysis, symmetry operations. The formation of crystals with different bondings like ionic, covalent, metallic and Vander-wall in solids. The concept of lattice dynamics to familiarize the lattice vibration (Phonon) and associated thermal properties is introduced. The course covers the band theory to give students an idea of valence band, conduction band and band gap formation and correlating with the crystal structure.

COURSE OBJECTIVES:

The objectives of this course are to:

1. To introduce the basic principles underlying the structural properties, defects, symmetry and method of determining the crystal structure.
2. To make the students understand the lattice vibration, phonon dispersion curve and thermal properties of materials.
3. To provide scientific foundation for understanding the relations among electrical properties & optical properties and band structure of materials.
4. To provide students with the knowledge to calculate the density of energy states, understand Fermi energy, and apply the Fermi-Dirac distribution.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Identify the crystal system and analyses the crystal structure, symmetry and defects.	1, 2, 5	1,3
CO2	Differentiate different atomic bonding and calculate the cohesive energy in ionic crystals and Nobel gases.	1,2	1, 2
CO3	Describe the vibration in crystal and understanding the phonon dispersion.	1,4,5	1, 3
CO4	Describe the classical and quantum theory of phonon heat capacity and analyze the phonon density of states.	1, 2	1
CO5	Interpret the lattice expansion because of thermal vibration and ionic radius of the substituent.	1, 2	1,2
CO6	Analyze the Band structure and density of states and correlate with the electrical properties.	1, 2	1, 4

Course Content:

Unit - 1: 12 hrs

Structure and symmetry of solids

Classification of solids: crystalline. Crystalline solids: crystal structure primitive lattice cell, translation vector, Crystal systems and Bravais lattice, Index system. Point groups and space group. Diffraction of waves by crystals: Bragg's law, Fourier analysis and reciprocal lattice-Geometrical construction & Brillouin zones. Structure factor and atomic form factor. Crystal Defects (point defects, line defects, plane defects) and Non-stoichiometry. Atomic packing in Crystals. Numerical and applications.

Unit 2 : 12 hrs

Atomic Bonding: Interatomic forces: Cohesion of atoms, (attractive and repulsive interaction). Bonding in solids (ionic, covalent, Metallic and Vander Wall bond), cohesive energy in ionic crystal and in Nobel gas (Lennard-Jones Potential). Atomic radii v/s lattice constant.

Lattice dynamics: Vibrations of crystals with monatomic basis- Dispersion curve (first Brillouin zone), group velocity, long wavelength limit. Diatomic primitive basis- dispersion curve (acoustic and optical branch), quantization of elastic waves/lattice vibration, Phonon momentum, inelastic scattering by phonons (measurement of Dispersion curve by neutron scattering),

Unit - 3: 12 hrs

Thermal properties:

Phonon heat capacity- Classical theory (Dulong-Petits law), Quantum theory of specific heat capacity-Einstein model, Phon density of states, Debye Continuum model, Debye T^3 law. Other contributions to heat capacity-Free carrier contribution, Anomalous heat capacity. Anharmonic effects in lattice-Thermal expansion. Phonon collision/scattering – (phonon-phonon, phonon-electron, Mass fluctuation and Boundary scattering), Phonon thermal conductivity.

Unit 4: 12 hrs

Band theory and Electrical properties

Electron motion in a periodic potential (Bloch theorem), Nearly free electron model, existence and magnitude of band gap. Kroning penny model, tight binding models approximation, Zone Scheme (E v/s K relation). Band structure in Metals, semiconductors and insulators; electrical conductivity, electron mobility, free electron gas in three dimensions, heat capacity of the electron gas, Effective mass and concept of holes. Density of energy states, Fermi energy, Fermi-Dirac distribution, effect of temperature.

References

1. Introduction to solid state physics**, C. Kittel,** Wiley Eastern (1993).
2. Introduction to solids**, L. V Azaroff,** Mc Graw Hill (1977).
3. Crystallography applied to solid state physics, **Verma and Srivastava,** New age international (2005).
4. Elements of Solid State Physics, **J. P. Srivastava,** PHI, (2016).
5. Solid State Physics, **Neil W. Ashcroft and N. David Mermin,** Saunders College Publishing, (1976).
6. Solid State Physics, **S. O. Pillai**, New age International, (2015)

<table>
<tr><td>Course Title</td><td colspan="3">General Physics Lab –I</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
<tr><td>Course Code</td><td>M24SP0106</td><td>Credit</td><td colspan="2">2</td><td colspan="2">Class</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment weightage</td></tr>
<tr><td>Lecture</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td>2</td><td>4</td><td>4</td></tr>
<tr><td>Total</td><td>2</td><td>4</td><td>4</td><td>-</td><td>48</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

This course aims to familiarize students with the fundamentals of experimental physics, providing hands-on experience in conducting experiments and using instrumentation. It covers concepts in thermodynamics and heat, enabling students to explore fundamental principles and practical applications. Modern optics is introduced to help students understand light and its properties, while also delving into the structural properties of crystalline and amorphous solid systems. Advanced techniques and instrumentation are practiced to enhance precision in measurements and analysis, preparing students for deeper scientific inquiry and practical application in the field of experimental physics.

COURSE OBJECTIVES:

The objectives of this course are to:

1. To make the student familiarize with the basics of experimental physics.
2. To enable the student to explore the concepts involved in the thermodynamics and heat.
3. To make the student understand the basic concets in modern optics.
4. To allow the student to understand the fundamentals of instruments involved.
5. To analyse the structural properties of crystalline and amorphous solid system
6. To Get introduced to and practice advanced techniques and instrumentation for precise measurements.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Verify various laws of physics related to optics.	1	1
CO2	Determine the physical parameters through experiments.	5	1
CO3	Analyze the concepts of physics through experiments	2,3	3
CO4	Improve ability to measure, analyze, and interpret experimental data accurately,	4	1
CO5	Enhance problem-solving skills by designing and troubleshooting experiments, and developing critical thinking	2,3	5

CO6	Master advanced measurement techniques and instrumentation, including the Four probe method, Forbes method, and diode characteristics, to gain precision in experimental physics.	5	1

LIST OF EXPERIMENTS:

1. Study the thermo emf and hence to determine inversion temperature.
2. Measurement of resistivity of a semiconductor by Four probe method at different temperature and determination of energy gap.
3. Design and study of the frequency response of CE transistor amplifier.
4. Determination of Stefan’s constant and Verification of Stefan’s fourth power law by electrical method.
5. Determination of Energy band gap of two different semiconductors.
6. Determination of solar constant.
7. Thermal Conductivity of a rod by Forbe’s method.
8. Determination of temperature sensitivity of a thermocouple and its Calibration.
9. Determination of work function of filament of a directly heated diode and hence verify the Richardson and Dushman equation.
10. Determining e/K from Diode Characteristics.
11. Study of Vibration of a stretched string (AC frequency)
12. Analysis of X-ray diffraction data.
13. Determination of the efficiency of Solar Cell.

Course Title	**Electronics lab**				**Course Type**		**HC**	
Course Code	**M24SP0107**	**Credit**	**2**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	-	-	-				
	Tutorial	-	-	-	**Theory**	**Practical**	**CIE**	**SEE**
	Practical	2	4	4				
	Total	**2**	**4**	**4**	**-**	**48**	**50 %**	**50 %**

COURSE OVERVIEW:

The Electronics Lab course aims to equip students with practical skills in designing, building, and testing electronic circuits. The course covers a range of experiments involving diodes, transistors, operational amplifiers, digital circuits, and microcontrollers. Emphasis is placed on understanding circuit behavior, troubleshooting, and using electronic measurement instruments.

COURSE OBJECTIVES:

The objectives of this course are to:

1. To familiarize the students with the basics of electronics.
2. To enable the students to explore the concepts involved in the oscillators.
3. To make the students understand the basic concepts in ICs and digital devices.
4. To allow the students to understand the fundamentals of multi-vibrators.

Course Outcomes:

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Analyze the characteristics of MOSFET and SCR.	1,2	1
CO2	Verify the outputs of astable, monostable and VCO circuits using ICs.	1,2	1
CO3	Design and construct the Single Stage BJT and FET Amplifier circuits.	1,2	1
CO4	Design voltage regulator using Zener diode and regulated power supply using IC.	1,2	1
CO5	Design, construct, and test various analog circuits such as amplifiers, oscillators, and filters.	1,2	1
CO6	Analyze the performance of analog circuits using oscilloscopes and other measurement tools.	1,2	1

List of Experiments

1. Study of MOSFET input and output characteristics and to calculate input resistance and output resistance.
2. Design the UJT relaxation oscillator (Spike generator) circuit and calculate the frequency of oscillations.
3. Set up the SCR circuit and study the I-V Characteristics of SCR.
4. Design of an Astable, and monostable multivibrator using an IC 555 timer.
5. Design first-order Low pass and High pass filters using 741 studying the characteristics.
6. Design of Zener regulator circuit and calculation of load and line regulation
7. Design and implementation of regulated power supply using regulator IC and calculation of load and line regulations.
8. Solving Boolean expressions
9. Implementation of Half adder and full adder circuits.
10. Design of inverting and non-inverting amplifiers using OPAMP 741

<table>
<tr><td>Course Title</td><td colspan="4">Computational physics Lab</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
<tr><td>Course Code</td><td>M24SP0108</td><td>Credit</td><td colspan="2">2</td><td colspan="2">Class</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment weightage</td></tr>
<tr><td>Lecture</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td>2</td><td>4</td><td>4</td></tr>
<tr><td>Total</td><td>2</td><td>4</td><td>4</td><td>-</td><td>48</td><td>50%</td><td>50%</td></tr>
</table>

Course Overview: This course offers a comprehensive introduction to Python programming, focusing on essential programming concepts and practical applications. It is designed for beginners and those with basic programming knowledge who wish to deepen their understanding of Python and its capabilities. The course is divided into four units, each building on the previous one to provide a solid foundation in Python programming, data visualization, and AI integration.

Course objectives:
The objectives of this course are to:

1. Provide a foundational understanding of the Python programming language, its history, and key features.
2. Learn to use various operators and control structures such as loops and conditional statements.
3. The basics of data visualization using the Matplotlib library in Python.
4. Integration of Python with artificial intelligence (AI).

Course outcome:

CO#	Course Outcomes	POs	PSOs
CO1	Install and Configure Python Environment.	1,2	1
CO2	Implement Fundamental Programming Structures.	1,2	1
CO3	Apply Control Flow Mechanisms.	2,3	1
CO4	Create and Customize Data Visualizations Using Matplotlib.	3,4	2
CO5	Integrate Python Libraries for AI Development.	3,4	2

Course Content:

Unit 1

Introduction to Python: Overview – History of Python – Python features – Environment - Environment setup – Getting Python – Install Python – Setting up Path – Running Python – Basic

Syntax –Interactive mode programming – Script mode Programming – A simple Python example. Input, processing, and output. Editing saving and running a script.

Unit 2

Programming Basics of Python: Python Keywords –Identifiers – Rules for writing Identifiers – Reserved words – Lines and Indentation – Multiline statements – Python Variable – Variable Assignment – Multiple Assignment - Standard Data Types: Numbers: int, float and decimal – Basic Operators: Arithmetic Operators – Comparison (Relational) Operators – Assignment Operators – Logical Operators – Bitwise Operators – Membership Operators – Identity Operators – Loops: Types of loops – while – for Loops – Control statements: if …else – for loop – break and continue.

Unit 3: Introduction to Data Visualization with Matplotlib basics of data visualization -he Matplotlib library. - install and set up Matplotlib. - basic plotting techniques, including line plots, scatter plots, and bar plots, along with plot customization such as adding titles, labels, legends, and grids- save plots to files. - plotting simple datasets -advanced plotting with Matplotlib, covering subplots, customizing styles and colors, and adding annotations. different plot types like histograms, pie charts, and box plots, -creating interactive plots with Matplotlib.

Unit 4: AI and Python Integration: artificial intelligence- Intro, - machine learning, deep learning, and natural language processing. - supervised and unsupervised learning. - Python libraries that are essential for AI development. -NumPy for numerical computations, Pandas for data manipulation and analysis, Matplotlib and Seaborn for data visualization, and Scikit-learn for machine learning. - setting up the Python environment and installing these libraries.- implementing simple AI models using Scikit-learn. - load datasets, preprocess data, and apply basic machine learning algorithms like linear regression, classification, and clustering

Text Books :

1. Python Programming – Dr. R. Ravichandran, M.Sc., M.Phil., Ph.D., Mr. K.Thambi Prabhakaran, B.Tech., ME., Mr. M. Nanda Kumar. BE.
2. Fundamentals of Phython, by Juneja, CENGAGE
3. Python for Everybody: Exploring Data Using Python 3, by Charles Severance.
4. "Python Data Science Handbook" by Jake VanderPlas
5. "Matplotlib for Python Developers" by Sandro Tosi
6. "Interactive Data Visualization with Python" by Abha Belorkar.
7. "Automate the Boring Stuff with Python" by Al Sweigart
8. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
9. "Python Machine Learning" by Sebastian Raschka and Vahid Mirjalili
10. "Deep Learning with Python" by François Chollet

SECOND SEMESTER

Course Title	Quantum Mechanics - II				Course Type		HC	
Course Code	M24SP0201	Credit	4		Class			
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment weightage	
	Lecture	4	4	4				
	Tutorial	-	-	-				
	Practical				Theory	Practical	CIE	SEE
	Total	4	4	4	48	-	50%	50%

Course Overview

This course delves into advanced topics in quantum mechanics, focusing on approximation methods, the behavior of identical particles, the interaction of radiation with matter, and relativistic quantum mechanics. Through rigorous theoretical frameworks and practical applications, students will deepen their understanding of quantum systems and learn to apply advanced quantum mechanical methods to solve complex problems.

Course objectives:

The objectives of this course are to:

1. To familiarize students with the advanced quantum mechanical concepts for better understanding of behavior of sub-atomic particles.
2. To apply these methods to different quantum systems, understand their limitations, and interpret the physical significance of the results.
3. To explore the quantum mechanics of identical particles and introduce time-dependent perturbation theory
4. To provide an understanding of the interaction between radiation and matter.
5. Explores the properties of relativistic particles, including their spin, magnetic moment, and interaction with electromagnetic fields.

Course Outcomes: On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Use approximate methods for stationary states: to solve time-independent potentials (of real systems which may not be solved exactly), such as the variational method, and the WKB method Apply approximation methods for quantum mechanical problems.	1,2	1
CO2	Learn how identical particles are to be described consistent with the Pauli Exclusion Principle	1,2	1

CO3	Execute time dependent perturbation theory to evaluate resultant Hamiltonian	1,2	1
CO4	Gain knowledge of scattering of radiation beam with rigid and non-rigid targets	1,2	1
CO5	Know how an atom interacts with electromagnetic radiation.	1,2	1
CO6	Understand the concepts of relativistic quantum mechanics.	1,2	1

Course Content:

UNIT 1: APPROXIMATION METHODS: 12 hrs

The WKB method: one dimensional case, approximate solutions turning points and connection formulae, tunneling through a barrier.

The variational method: variation principle, application of vibrational approach to ground states of (i) Hydrogen atom and (ii) Helium atom.

Time independent perturbation theory: Perturbation theory for non-degenerate states, Applications. linear and quadratic stark effects in hydrogen atom, validity of time independent perturbation theory, Degenerate perturbation theory, examples: linear stark effect, Normal Zeeman effect.

UNIT 2: IDENTICAL PARTICLES AND TIME DEPENDENT PERTURBATION THEORY 12 hrs

Identical particles- Indistinguishability of Identical particles- Construction of Symmetric and Anti-symmetric wave functions for two and three particle systems - Pauli's Exclusion Principle- Hydrogen molecule- Spin-orbit interaction- Ortho and Para Helium- Spin statistics connection.

Time dependent perturbation theory: Time dependent perturbation -transition probability, transition to the Continuum-Fermi golden rule, Harmonic perturbation, sinusoidal perturbation on 1D simple harmonic oscillator.

UNIT 3 : INTERACTION OF RADIATION WITH MATTER 12 hrs

Elements of Field quantization: Quantization of electromagnetic radiation, transition rates for emission and absorption, Transition rate within dipole approximation, the electric dipole selection rules, spontaneous emission rate, Scattering: scattering cross-section, scattering amplitude, scattering by a spherically symmetric potential- partial wave analysis, optical theorem, scattering by a perfectly rigid sphere potential, Scattering cross section-Born approximation-integral method, Validity of Born approximation.

UNIT – 4: RELATIVISTIC QUANTUM MECHANICS 12 hrs

Klein -Gordan equation for a free particle and its drawbacks; probability density, Dirac equation for free particle, properties of Dirac matrices, solutions of free particle Dirac equation- ortho normality and completeness, spin of the Dirac particle, negative energy sea, covariant form of Dirac equation. Velocity operator of a free Dirac particle and Zitterbewegung, Spin -orbit energy. Dirac particle under the influence of a uniform external Electromagnetic field – magnetic moment for the Dirac particle.

Reference Books:

1. Quantum mechanics, B.H. Bransden and Joachain, 2nd Edition Pearson Education (2004).

2. Quantum mechanics: concepts and applications, NouredineZettili, 2nd Edition, Wiley (2018)
3. Introduction to Quantum mechanics, David J. Griffiths, 2nd Edition, Parson Education (2005).
4. Modern Quantum mechanics, J.J. Sakurai, Pearson Education, (2000).
5. Quantum mechanics, V.KThankappan, 2nd Edition 2004.Pri
6. Quantum Mechanics, E. Merzbacher, 3rd edition, John Wiley(1994).
7. Quantum mechanics, Stephen Gasiorowicz, john Wiley (2003).
8. Principles of Quantum mechanics ,R. Shankar, 2nd Edition, Premium press, NY (1994)
9. Relativistic Quantum mechanics and Relativistic Quantum fields, J.D. Bjorken and S.D. Drell, Mc. Graw-hill,New York (1968).
10. Quantum mechanics, L.I.Schiff Mc. Graw-hill, (1955).
11. C.Cohen-Tannoudji, B.Diu, F.Laloe, Quantum Mechanics (2 vol. set), Wiley Interscience (1996).

Course Title	**Statistical Mechanics**				**Course Type**		**HC**	
Course Code	**M24SP0202**	**Credit**	**4**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	4	4	4				
	Tutorial	-	-	-	**Theory**	**Practical**	**CIE**	**SEE**
	Practical							
	Total	**4**	**4**	**4**	**48**	**-**	**50%**	**50%**

COURSE OVERVIEW:

This course explores thermodynamic laws, potentials, and phase equilibria, alongside statistical mechanics covering ensembles, quantum statistics, and applications. Key topics include thermodynamic laws, phase transitions, statistical ensembles (microcanonical, canonical, grand canonical), quantum statistical mechanics (Fermi-Dirac, Bose-Einstein distributions), and their applications to physical systems.

COURSE OBJECTIVES:

1. Understand fundamental thermodynamic laws and their applications.
2. Analyze phase transitions and equilibrium using thermodynamic principles.
3. Grasp the basics of statistical mechanics, including ensembles and distributions.
4. Apply statistical mechanics to interpret quantum statistics in physical systems.
5. Develop problem-solving skills through practical applications of thermodynamics and statistical mechanics.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	**Course Outcomes**	**POs**	**PSOs**

CO1	Demonstrate a thorough understanding of the fundamental laws and principles of thermodynamics and statistical mechanics	1, 2	1,3
CO2	Apply thermodynamic laws and statistical mechanics concepts to solve complex problems related to phase transitions, equilibrium, and quantum statistics.	1,2	2
CO3	Analyze and interpret phase diagrams, thermodynamic potentials, and statistical ensembles to predict and explain physical phenomena.	1,4,5	1, 3
CO4	Use mathematical tools and statistical methods to quantify and model thermodynamic systems and their behavior.	1, 2	1
CO5	Evaluate and critique assumptions, methodologies, and conclusions in thermodynamic and statistical mechanical analyses.	1, 2	1,2
CO6	Apply thermodynamic and statistical mechanics principles to real-world scenarios in physics, engineering, and related disciplines.	1, 2,	2

Course Content:

Unit – 1: 12 hrs

Thermodynamics

Thermodynamic laws, Isothermal process, Adiabatic process, Isochoric process, Isobaric process, Relation between thermodynamic laws, Thermodynamic potentials, Maxwell relations, Examples & Numerical problems of thermodynamics process in day to day life: Thermodynamic description of phase transitions, Surface effects in condensation. Phase equilibria; Equilibrium conditions; Phase transitions; First order and second order phase transitions; phase diagrams; Clausius-Clapeyron equation, applications, Van der Wall's equation of state.

Unit-2 12 hrs

Classical statistical mechanics: The postulate of equal a priori probability; The Liouville theorem; Concept of Ensembles; Ensemble average, microcanonical ensemble; Ideal gas in microcanonical enesemble, Entropy, canonical ensemble; Ideal gas in canonical ensemble, Grand canonical ensemble; Ideal gas in grand canonical ensemble,; energy mean value and fluctuations, Reduction of Gibbs distribution to Maxwell and Boltzmann distribution, Entropy of an ideal gas; Gibbs paradox; Law of the equipartition theorem; Molecular partition function, translational and rotational and vibrational partition function and applications to solids, Chemical equilibrium. Numerical problems.

Unit-3 12 hrs

Quantum statistical mechanics

The postulates of quantum statistical mechanics – equal priori probability & Random phases, Symmetric & Antisymmetric of wave functions, The Liouville theorem in quantum statistical mechanics, The quantum distribution functions – Fermi-Dirac distribution and probability of electron at different temperatures, Bose-Einstein statistics, the derivation of the corresponding distribution functions, the Boltzmann limit of Boson and Fermion gases. Numerical problems on FD distribution & BE statistics.

Unit-4 **12 hrs**

Applications of quantum statistics

Application of Fermi-Dirac statistics – to derive Fermi energy & total energy, degeneracy and magnetic susceptibility, Application of Bose statistics to the photon gas, derivation of Planck's law, comments on the rest mass of photons, Thermodynamics of Black body radiation, Bose-Einstein condensation.

Reference Books

1. Agarwal B.K. and Eisner M., Statistica mechanics, New Age International Publishers, 2000.
2. Roy S.K., Thermal physics and statistical mechanics, New Age International Pub., 2000.
3. Huang K., Statistical mechanics, Wiley-Eastern, 1975.
4. Laud B.B., Fundamentals of statistical mechanics, New Age International Pub., 2000.
5. Schroeder D.V., An introduction to thermal physics, Pearson Education New Delhi, 2008
6. Salinas S.R.A., Introduction to statistical physics, Springer, 2004.

<table>
<tr><td>Course Title</td><td colspan="4">Classical Electrodynamics</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
<tr><td>Course Code</td><td>M24SP0203</td><td>Credit</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment weightage</td></tr>
<tr><td>Lecture</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50%</td><td>50%</td></tr>
</table>

Course overview:

Studying electrodynamics provides a deep insight into the fundamental principles governing electromagnetism, which is essential for physicists, engineers, and researchers working across various fields from telecommunications to astrophysics. In this present course the content covers the conservation laws, fields and potentials, dipole and multipole radiation properties.

Course Objectives:

Application of Maxwell's equations and boundary conditions to solve electrostatic and magnetostatic problems and also understand electromagnetic wave propagation in linear isotropic media, hollow metallic waveguides and radiations from different types of sources.

Course Outcomes:

On completion of this course the student will be able to

CO#	Course Outcomes	POs	PSOs
CO1	Apply Maxwel's equations to solve electrostatic and magnetostatic problems in different coordinate systems using special functions and vector calculus, and Perform multipole expansion of charge sources.	1,2	1
CO2	Apply Maxwell's Stress tensor and understand the Poynting's theorem.	1,2	1
CO3	Solve problems and understand EM wave propagation in linear isotropic dielectric and conducting media, hollow metallic waveguides.	1,2	1
CO4	Predict radiation from arbitrary charge distributions including oscillating electric dipoles, oscillating magnetic dipoles, and accelerating point charges, also Understand the need for gauge transformations in electrodynamics.	1,2	1
CO5	Analyze the propagation of electromagnetic waves in different media and structures, including waveguides and resonant cavities.	1,2	1
CO6	Apply concepts of potentials and fields to solve problems involving electromagnetic radiation from various sources.	1,2	1

Course Content:

Unit I: Maxwell’s equations and Boundary value problems in electrostatics: 12 hrs

Maxwell’s equations, Maxwell’s equations in matter, Boundary conditions.
Laplace equations: Laplace equations in 1-D, 2-D and 3-D; boundary conditions and uniqueness theorems; conductors and second uniqueness theorem.
The method of images: Induced surface charge; force and energy.
Separation of variables: Laplace equation in cartesian, spherical and cylindrical coordinates.

UNIT II : Electrostatic potentials and Conservation laws 12 hrs

Multipole expansion of electrostatic potential: Approximate potentials at large distance; multipole expansion; monopole and dipole terms; origin of coordinates in multipole expansion; electric field of a dipole; multipole expansion of energy of a charge distribution in an external field.

Conservation laws in electrodynamics: Continuity equation; Poynting’s theorem; Newton’s third law in electrodynamics; Maxwell’s stress tensor; conservation of momentum; angular momentum.

UNIT III : Electromagnetic waves, Wave guides and resonant cavities 12 hrs

Electromagnetic waves: Waves in 1-D**:** wave equation; sinusoidal waves; boundary condition- reflection and transmission; EM waves in vacuum**:** wave equation for E and B; monochromatic plane waves; energy and momentum in EM waves; EM waves in matter: propagation in linear media; reflection and transmission at normal incidence and oblique incidence. Absorption and Dispersion**:** EM waves in conductors; reflection at a conducting surface; frequency dependence of permittivity.

Wave guides and resonant cavities: Fields at the surface of and within a conductor; cylindrical cavities and wave-guides; the modes in a rectangular wave-guide; TE waves in a rectangular wave guide; the coaxial transmission line; energy flow and attenuation in wave guides; resonant cavities; power losses in a cavity- Q of a cavity.

UNIT IV : Potentials , fields and EM radiation **12 hrs**

Potentials and Fields: Scalar and vector potentials; gauge transformations; Coulomb and Lorentz gauge; retarded potentials; Jefimenko's equations; Lienard –Wiechart potentials; field of a moving point charge.
Electromagnetic radiation: Radiation from oscillating dipole (electric and magnetic dipoles), Radiation from linear antenna – Radiation resistance, electric quadruple radiation. radiation from an arbitrary source; power radiated by a point charge.

Reference text books

1. Griffiths, D. J.: Introduction to Classical Electrodynamics, Prentice Hall, Ed III, (1999).

2. Jackson, J.D: Classical Electrodynamics, (II Edition) Wiley Eastern (1975).

3. Heald, M.A., and Marion, J.B.: Classical Electromagnetic Radiation, (III Edition) Saunders (1995).

4. Jordan E.C., and Balmain, K.G, Electromagnetic Waves and Radiating Systems, (II Edition), Prentice Hall India (1987).

Course Title	**Modern Optics, Atomic and Molecular Physics**				**Course Type**		**HC**	
Course Code	**M24SP0204**	**Credit**	**4**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	4	4	4				
	Tutorial	-	-	-	**Theory**	**Practical**	**CIE**	**SEE**
	Practical							
	Total	**4**	**4**	**4**	**48**	**-**	**50%**	**50%**

COURSE OVERVIEW:

This course offers an in-depth exploration of lasers, nonlinear optics, holography, Fourier optics, and spectroscopy. Students will begin by understanding the fundamental principles of lasers, including different types and their operational mechanisms. The course also covers holography, including its theoretical foundations and practical applications, as well as Fourier optics and its significance in diffraction and image processing. Finally, the course provides comprehensive knowledge of atomic and molecular spectra, alongside various spectroscopic techniques such as microwave, infrared, Raman, and X-ray spectroscopy, equipping students with the skills to analyze and interpret molecular structures and properties effectively.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Understanding of the principles and mechanisms of lasers, including various laser types and their applications, and the fundamental concepts of nonlinear optics and their practical implications.
2. Providing students with in-depth knowledge of holography and Fourier optics, focusing on the theory, techniques, and practical applications in imaging and diffraction analysis.
3. Enabling students to understand the principles of atomic and molecular spectra, including the effects influencing spectral lines and the coupling schemes, and to analyze the rotational, vibrational, and electronic spectra of diatomic molecules.
4. Developing students' proficiency in various spectroscopic methods, including microwave, infrared, Raman, visible, ultraviolet, X-ray, Electron Spin Resonance, Nuclear Magnetic Resonance, and Mossbauer spectroscopy, and their applications in molecular analysis and research.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	To comprehend the fundamental principles of lasers, including the role of Einstein coefficients, the basic working principle of lasers, laser cavities, and gain mechanisms. s.	1,2	1,2
CO2	To gain knowledge of the origins of optical nonlinearity, including second and third harmonic generation, and will understand the significance of nonlinear optical materials.	1,2,3	1
CO3	To develop a thorough understanding of holography, including its basic theory, recording, and reconstruction processes, and applications.	1,2	1,2
CO4	To acquire the knowledge of the vector atom model, spectra of alkali elements, and coupling schemes.	1,2	1
CO5	To become proficient in the basic principles, instrumentation, and applications of various spectroscopic techniques.	1,2,3,5	1,2
CO6	To apply their knowledge of different spectroscopic methods to analyze and interpret the structure and properties of molecules.	1,2	2,3

UNIT 1: LASERS AND NONLINEAR OPTICS 12 hrs

Einstein coefficients, LASER basic principle, Laser Cavity, Attenuation coefficient, Gain threshold condition and Laser Gain coefficient. Gaussian nature of Laser beam, Laser modes (Longitudinal and Transverse). Two, Three and Four level Laser systems. RUBY Laser, Nd-YAG Laser, CO_2 Laser, Ar^+ ion Laser and Dye Lasers and Semiconductor Laser.

Origin of optical nonlinearity – Second and Third harmonic generation – Nonlinear optical materials, Phase matching condition, types of phase matching, Intensity dependent refractive index, Self-focusing of light, Optical Parametric Oscillation, Optical mixing, Saturable absorption, Kleinman's Symmetry, Contracted notation of susceptibility, Influence of Inversion symmetry and Spatial symmetry on the Second order nonlinear response.

UNIT II : HOLOGRAPHY AND FOURIER OPTICS 12 hrs

Introduction to Holography – Basic theory of Holography – Recording and reconstruction of Hologram – Diffuse object illumination – Speckle pattern – Fourier transform Holography – Applications of Holography.

Introduction to Fourier optics– Two dimensional Fourier transforms – Transforms of Dirac Delta function – Optical applications – linear systems- The convolution integral -convolution theorem- Spectra and correlation – Parsevel's formula – Auto correlation and cross-correlation – Apodization – Array theorem - Fourier methods in diffraction -Fraunhofer diffraction of single slit, double slit and transmission grating using Fourier method.

UNIT III : ATOMIC AND MOLECULAR SPECTRA 12 hrs

Introduction: Vector atom model – Spectra of Alkali elements-fine structure- Spectral terms and term symbols, - Coupling schemes – LS coupling - JJ coupling- Hund's rule of multiplicity. Magnetic moment of the atom and Lande's 'g'-factor - Zeeman effect, Normal and Anomalous Zeeman effects, Zeeman effect of hyperfine structure, Zeeman effect in sodium atom, Lande g-formula for LS and JJ couplings - Paschen-Back effect, Splitting of sodium lines and selection rules, Stark effect, Weak and strong field effects.

Introduction – Rotational, vibrational and electronic spectra of diatomic molecules. Rotational spectra of a diatomic molecule as rigid rotator and non-rigid rotor – Intensity of rotational lines - Rotational analysis of electronic spectra. Diatomic molecule as a simple harmonic oscillator, anharmonicity, Morse potential curves. vibrating rotator: energy levels and vibration spectra, PQR branches in vibronic spectra. Frank-Condon principle, Raman effect and theory of Raman effect.

UNIT IV: ANALYTICAL TOOLS OF SPECTROSCOPY 12 hrs

(Basic principle, instrumentation and applications)

Micro wave spectroscopy, Infrared absorption spectroscopy, Raman spectroscopy, Visible spectroscopy, Ultraviolet spectroscopy, X-ray absorption and fluorescence spectroscopy. Electron Spin Resonance Spectroscopy, Nuclear Magnetic Resonance spectroscopy, Mossbauer Spectroscopy.

Reference text books

1. Introduction to Electrodynamics, D.J. Griffiths, 4 th Edition, Prentice-Hall of India 2013.
2. Laser fundamentals, W.T. Silfvast, Foundation books, New Delhi, 1999.
3. Nonlinear Optics , Robert Boyd, Academic press, 2003.
4. Laser and Nonliner optics , B B Laud, New age, 3rd edition, 2020
5. Optics, E. Hecht, Addison Wiley, 1974. 9. Optical Fiber Communications, Gerel Keiser, McGraw Hill Book, 2000
6. Basics of Holography, P. Hariharan, Cambridge University Press, 2002
7. Atomic physics, S N Ghoshal, S. Chand publisher, 2007.
8. Fundamentals of Molecular spectroscopy , C N Ban Well, Mc GRAW Hill Book Company.
9. Instrumental methods of chemical analysis, Gurdeep R Chatwal and Sham K. Anand, Himalya Publishing house, New Delhi, 2005.

Course Title	**Solid State Physics - II**				**Course Type**		**HC**	
Course Code	**M24SP0205**	**Credit**	**4**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	4	4	4				
	Tutorial	-	-	-	**Theory**	**Practical**	**CIE**	**SEE**
	Practical							
	Total	**4**	**4**	**4**	**48**	**-**	**50%**	**50%**

Course Overview

This course covers magnetic properties, superconductivity, optical properties, semiconductor physics, and solid-state reactions. Topics include diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism, superconductivity (Meissner effect, BCS theory), optical properties (Drude theory, absorption, emission), semiconductor physics (band structure, carrier densities, PN junction), and solid-state reactions (nucleation, crystal growth methods).

Course objective

1. Understand the fundamental principles of magnetism, including diamagnetism, paramagnetism, ferromagnetism, and antiferromagnetism.
2. Explain the phenomena and theories behind superconductivity, including the Meissner effect, BCS theory, and the differences between Type I and Type II superconductors.
3. Analyze and interpret optical properties of solids, covering concepts such as Drude theory, optical coefficients, absorption, emission, and spectroscopic techniques.
4. Apply the principles of semiconductor physics, including band structures, carrier densities, PN junctions, and the practical applications of semiconductor devices.

Course outcome

CO#	Course Outcomes	POs	PSOs
CO1	Analyse diamagnetism, paramagnetism, ferromagnetism, and antiferromagnetism, applying theoretical concepts to practical scenarios.	1, 2	1,3
CO2	Demonstrate a thorough understanding of superconductivity, including the Meissner effect, BCS theory, and the distinctions between Type I and Type II superconductors	1,2	2
CO3	Interpret optical properties of solids, including Drude theory, absorption, emission, and spectroscopic techniques like Raman spectroscopy and UV-Visible-IR spectroscopy	1,4,5	1, 3
CO4	Apply Semiconductor Physics: Apply knowledge of semiconductor band structures, carrier densities, and PN junctions to analyze and design semiconductor devices.	1, 2	1
CO5	Analyze solid-state reactions, including reaction conditions, nucleation, crystal growth methods, Phase diagram and their implications in materials synthesis.	1, 2	1,2
CO6	Problem Solving and Application: Apply theoretical knowledge to solve problems related to advanced solid-state physics, preparing for further research or professional applications in the field.	1, 2,	2

Unit - 1: **12 hrs**

Magnetism and superconductivity

Diamagnetism and its origin, Expression for diamagnetic susceptibility, Paramagnetism, Quantum theory of Paramagnetism, Brillouin function, Ferromagnetism, Curie-Weiss law, Spontaneous magnetization and its variation with temperature, Ferromagnetic domains, Anti ferromagnetism, Susceptibility below and above Neel's temperature.

Superconductivity: Experimental facts, Meissner effect, BCS theory of superconductivity, Type I and type II superconductors, London equations, Thermodynamics of superconductors, Entropy and Specific heat in the superconducting state, Application-SQUID.

Unit 2 12 hrs

Optical properties:

Drude theory-Free carrier optical properties. Optical coefficients of solids (Refractive index, Absorption coefficient, Extinction coefficient) n, Optical process in solids-Interband transition-Insulator, metals and semiconductors (Direct and indirect), Intraband transition, Free carrier absorption, Phonon absorption. Absorption and emission, luminescence, photoconductivity, Raman spectroscopy, UV-Visible-IR spectroscopy, Color centers (types and methods of production), Interaction electromagnetic waves with optic phonons.

Unit 3: **12 hrs**

Semiconductor

Semiconductor definition, Classification of semiconductor, Band structure of Si and germanium, Intrinsic carrier densities, Extrinsic semiconductors and Fermilevel (n-type, p-type), Donar and Acceptor levels under thermal equilibrium. Carrier densities, Effect of temperature on electrical conductivity, Hall effect and Magnetoresistance, PN Junction (applications as diodes and lasers) Thermoelectric effects, Quantum hall effect.

Unit 4.

Solid state reactions **12 hrs**

General Principles-Reaction conditions, structural considerations, reaction rates, Wagner reaction mechanism, Surface area of solids, Reactivity of solids (nucleation and diffusion). Experimental procedure of solid-state synthesis, elements of the phase diagram. Crystallization of solutions, melts, glasses and gels. Structure modification by ion exchange and intercalation reaction. Growth of single crytals-Czochralski method, Bridgmen and stockbarger method, Zone melting, flux method.

Reference Books:

1. Introduction to solid Solid state physics**, C. kittel,** Wiley Eastern (1993).
2. Introduction to solids**, L. V Azaroff,** Mc Graw Hill (1977).
3. Elements of Solid State Physics, **J. P. Srivastava,** PHI, (2016).
4. Solid State Physics, **Neil W. Ashcroft and N. David Mermin,** Saunders College Publishing, (1976).
5. Solid State Chemistry and its Applications, **Anthony R. West,** Wiley, (2016)

<table>
<tr><td>Course Title</td><td colspan="4">Lab View Introduction and Interfacing</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
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<tr><td>Total</td><td>1</td><td>2</td><td>2</td><td></td><td>24</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

LabVIEW is an integrated development environment created primarily for engineers and scientists constructing measurement and control systems. LabVIEW is the software you need to build the optimal solution to meet your custom requirements and solve the challenges. It has a native graphical programming language, built-in IP for data analysis and signal processing, and an open architecture that allows you to integrate any hardware device and any software approach.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Acquire complete knowledge about LabVIEW environment.
2. Understand the use of control pallet and function pallets.
3. Understand basic data types; Numericals, Booleans and comparators and string.
4. Write, Test & Debug programs using case structure, for loop and while loops.
5. Handling data in different ways; Strings, Arrays, File IO, Clusters, Waveform and wave chart.
6. Interface hardware with LabVIEW.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Acquire complete knowledge about LabVIEW environment (front pannel and block diagram).	1,2	1,2,3
CO2	Write programs using control pallet and function pallets.	1,2,3	1,2,3
CO3	Execute programs using proper data types in LabVIEW program.	1,2	1,2,3
CO4	Write, Test & Debug programs using case structure and loops.	1,2,3	1,2,3
CO5	Handle the data in different ways; Strings, Arrays, File IO, Clusters, Waveform and wave chart.	1,3	1,2,3
CO6	Interface hardware with LabVIEW.	1,2,3,5	1,2,3

Unit-1 **6 hrs**

Introduction of LabVIEW: LabVIEW Environment: Definition Necessity of LabVIEW Definitions of VI, LabVIEW benefits, Programming and Execution methods, Introductions of 3rd party interfaces and toolkits.

Unit- 2 **6 hrs**

Designing the Software: How to start up the Vis, Front panel designing and working environment, Definitions of Control and Indicators, Types of Control and Indicators, Explanations of Controls Palette, Explanations Block Diagram and its working, Terminals, Functional Pallet.

Unit-3 **6 hrs**

Basic Programming: How to use Numerical functions, Designing of Boolean operations, Comparator applications, Exercises in basic programming, Programming Loops: About For loops While loop designing, Flat Sequences, Applications based on Loops.

Unit- 4 **6 hrs**

Data Handling and interfacing: Introduction of String, Arrays, Differentiations between Waveform charts and Waveform Graphs, Acquire and use the system files based on File I/O functions, External Interfaces: VISA explanations, GPIB communications, Serial communications and interfacing methods, LabVIEW instrumentation drivers.

References:

1. LabVIEW for Everyone: Graphical Programming Made Easy and Fun (3rd Edition) (National Instruments Virtual Instrumentation Series) Jeffrey Travis, Jim Kring , August 2006,
2. LabVIEW Student Edition, National Instruments, Inc., Robert H. Bishop, Pearson publishers, 2015.
3. Online courses, NPTEL and http://physics.wku.edu/phys318.

<table>
<tr><td>Course Title</td><td colspan="4">General Physics Lab – II (Practical)</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
<tr><td>Course Code</td><td>M24SP0207</td><td>Credit</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2"></td></tr>
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<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50 %</td><td>50 %</td></tr>
</table>

Course Overview

This course enhances students' proficiency in experimental physics through advanced experiments. Topics include Michelson interferometer applications in interference phenomena, operational amplifier-based electronic filter design, and spectroscopic methods for analyzing energy levels in materials. Practical skills are developed through studies on ferroelectric phase transitions, laser-based measurements for particle size determination, and the velocity of ultrasonic waves in liquids. Students also apply spectroscopic and astronomical data analysis to study molecular spectra and variable star data, reinforcing theoretical concepts with practical applications in radiation and absorption phenomena.

Course Objectives

1. Develop proficiency in performing advanced experiments in physics, focusing on topics such as interference phenomena with the Michelson interferometer, electronic filter design using operational amplifiers, and spectroscopic techniques for determining energy levels in conductors and semiconductors.

2. Acquire practical skills in experimental physics through investigations into materials science, including studies on ferroelectric phase transitions, measurement techniques using lasers for particle size determination, and ultrasonic wave velocity in liquids.
3. To Use spectroscopic and astronomical data analysis techniques to study molecular spectra and variable star data, linking theoretical knowledge to practical applications.
4. To Enhance understanding of radiation and absorption phenomena through practical measurement and analysis techniques.
5. Verify photoelectric equations and determine photonic work functions and Planck's constant, deepening knowledge of optical and photonic principles.
6. To analyse the Secondary experimental data of Condensed matter and Astrophysics

Course Outcomes

CO#	Course Outcomes	POs	PSOs
CO1	To gain proficiency in experimental techniques for precise measurements, such as determining wavelength differences using a Michelson interferometer, characterizing filters using op-amps for signal processing, and calculating Fermi energy in semiconductors and conductors.	1,2,3	1
CO2	To Develop skills in experimental physics by investigating phenomena like Ferroelectric phase transitions and verifying laws such as Curie-Weiss, measuring thin wire thickness using laser sources, and determining particle sizes via diffraction halos with lasers.	2,3	2
CO3	To Acquire practical knowledge through experiments such as determining the velocity of ultrasonic waves in liquids, measuring Rydberg constants using hydrogen spectra, and verifying laws like Wien's displacement and determining source temperatures through experiments with solar cells.	1,4	3
CO4	To Gain insights into fundamental physical properties such as wavelength, Fermi energy, and ultrasonic velocity through targeted experiments.	1,5	1,2
CO5	To measure physical properties such as laser wavelength, particle size, and wire thickness using advanced instruments like the Michelson interferometer and laser systems	2,3,4	1,2,3
CO6	To gain a deep understanding of electronic properties, including Fermi energy in conductors and semiconductors, and phase transitions in ferroelectric materials.	3,4	1,2

List of Experiments:

1. Determination of wave length of laser light using Michelson interferometer.
2. Determination of Fermi Energy of given conductor/semiconductor.
3. Determination of end point energy of half value methods or absorption energy by GM counter
4. Determination of Ferroelectric phase transition and verification Curie Weis law.
4. Determination of size of the particles and thickness of thin wire using Laser.
5. Determination of velocity of ultrasonic waves in liquid.

6. Verification of photoelectric equation and determination photonic work function and Planck's constant.

Replacing experiments

7. To verify Wien's displacement law and to find the temperature of the source.

8. Surface temperature of artificial star using Night Sky photometer (RGB filter)

9. Analysis of Rotation vibration spectra of HBr molecule.

10. Data analysis of telescopic data of a variable star.

<table>
<tr><td>Course Title</td><td colspan="4">Atomic and Molecular Physics (Practical)</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
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<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50 %</td><td>50 %</td></tr>
</table>

COURSE OVERVIEW:

This course provides hands-on experience with advanced experimental techniques in physics, focusing on the determination of fundamental constants and the analysis of molecular and atomic spectra. Students will engage in experiments such as the Millikan oil drop experiment to determine the electronic charge, use the Fabry-Perot interferometer to measure mirror separation, and employ the Babinet compensator to explore the nature of light. The course also includes recording the spectra of metal rods, analyzing the iodine absorption spectrum to determine dissociation energy and force constant, and estimating the rotational constant and bond length of molecules via Rotational Raman Spectroscopy.

COURSE OBJECTIVES:

1. To Equip students with the skills to perform fundamental measurements in physics, such as determining the electronic charge through the Millikan oil drop experiment and the separation of etalon mirrors using the Fabry-Perot interferometer.
2. To provide hands-on experience in recording and analyzing spectra, including the spectra of metal rods, the iodine absorption spectrum, and the hydrogen spectrum, to determine constants like dissociation energy, force constants, and the Rydberg constant.
3. To estimate the rotational constants and bond lengths of molecules by studying rotational Raman spectra and identify stretching and bending vibrational modes using FTIR spectroscopy.
4. To determine the absorption coefficients of various materials, enhancing their understanding of the interaction between light and matter.

5. To explore magnetic phenomena through experiments such as the Zeeman effect and Electron Spin Resonance (ESR), allowing students to determine the g-factor and understand the influence of magnetic fields on spectral lines.
6. To develop comprehensive practical skills in using sophisticated instrumentation and experimental techniques, fostering a deep understanding of molecular and atomic physics, and preparing students for advanced research and professional applications in the field.

COURSEOUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	To demonstrate proficiency in conducting a range of fundamental physics experiments, including the Millikan oil drop experiment and the use of the Fabry-Perot interferometer, enabling accurate measurements of physical constants.	1,2,3	1,2
CO2	To acquire the ability to record and interpret various spectra, such as metal rod spectra, iodine absorption spectra, and hydrogen spectra, facilitating the determination of dissociation energies, force constants, and the Rydberg constant.	1,2	1,2
CO3	To analyze rotational Raman spectra and FTIR spectroscopy, students will estimate molecular rotational constants and bond lengths, and identify vibrational modes, deepening their understanding of molecular structures and dynamics.	2,3,4	1
CO4	To determine the absorption coefficients of different materials, enhancing their capability to study the interaction of light with matter and apply this knowledge in material science and optics.	1,2,3, 5	2
CO5	To gain insight into magnetic effects on spectral lines through the Zeeman effect and Electron Spin Resonance (ESR) experiments, enabling them to calculate the g-factor and understand the impact of magnetic fields on atomic and molecular spectra.	1,2	1,2
CO6	Possessing strong analytical skills, enabling them to interpret complex experimental data, draw accurate conclusions, and apply these skills in advanced research or professional settings within physics and related fields.	1,2,3	1

List of Experiments:

1. Determination of electronic charge: Millikan’s oil drop experiment.
2. Determine the separation between the etalon mirror of Fabry Perot Etalon using spectrometer: Fabry Perot Interferometer.
3. Determination of nature of light emerging from a Babinet compensator: Babinet Compensator.
4. Recording the spectra of metal rods using Arc Spectrum.
5. Determine the dissociation energy and force constant of Iodine, using Iodine absorption spectrum.

6. Estimating the rotational constant and bond length of molecule by studying Rotational Raman Spectrum.
7. Determination of absorption Co-efficient of solution/ITO/FTO.
8. Identifying the stretching and bending vibrational modes in FTIR spectrum.
9. Determination of Rydberg constant using hydrogen spectrum.
10. Determination of molecular constants of hydrogen bromide (HBr) molecule.
10. Zeeman effect experiment
11. Determination of g-factor by Electron spin resonance (ESR)

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21PTM301	SOFT SKILL TRAINING	MC	0	0	0	0	2

Course Objective:
On successful completion of this course, the student shall be able to:

1. Understand Resume writing and preparation for interview

Course Outcome:

On successful completion of this course, the student shall be able to:

1. Write the resume, E-mails
2. Face the interview

Content
1.Group Discussion - Do's and Don'ts ,Prerequisites
2. Resume Writing - Types,Content and Tips to make an effective resume
3.Self Introduction - Video Screening, telephonic and Direct
4.Grooming
5. Presentation skills
6.Email Writing
7. Interview Facing Skills - Different kinds,rounds in Interview and tips to clear interviews,Mock Interviews
8.Softskills Assessments

THIRD SEMESTER

<table>
<tr><td>Course Title</td><td colspan="4">Nanoscience and Nanotechnology</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
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<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

This course is aimed at providing basic understanding of nanostructured materials, its geometry and types, its peculiar properties, their synthesis protocols, characterization tools, engineering nanostructures for device applications.

COURSE OBJECTIVES:

The objective of the course on Processing and Properties of Nanostructured Materials is to equip the M.Sc. students with the concepts of physics that he/she needs for understanding nanostructured materials in different courses taught in this class and for developing a strong background if he/she chooses to pursue research in Nanotechnology as a career. The objective of the course on Quantum Mechanics is to equip the M.Sc. students with the quantum techniques that he/she needs for developing basic understanding of matter at nanoscale and theoretical treatment required in different courses taught in this class and for developing a strong background if he/she chooses to pursue research in Nanotechnology as a career.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Understand the use of basic quantum concepts for describing nano systems and processes.	1,2	3
CO2	Understand advanced quantum techniques to describe the nano systems.	1,2	3
CO3	Understand the physical and chemical methods for synthesis of nanoparticles	1,2	3
CO4	Understand accurate description of optical properties of material at nanoscale.	1,2	3
CO5	Understand current research areas in electronics at nanoscale	1,2	3
CO6	Explore new areas of research in physics and allied fields of science and technology.	1,2	3

Course Content:

Unit– 1: **12 hrs**

NANOSCALE SYSTEMS: Definition and Scope, Bulk and Nano materials, Length, energy and time scales; Physics at nanoscale: surface to volume ratio and its effect, Quantum confinement of electrons in semiconductor nanostructures: Quantum confinement in 3D, 2D, 1D and zero dimensional structures; size effect and properties of nanostructures: structural, thermal, mechanical, chemical, electrical, optical and magnetic properties; Landauer Buttiker formalism for conduction in confined geometries.

Unit - 2: **12 hrs**

QUANTUM DOTS: Introduction to quantum dot**,** Excitons and excitonic Bohr radius, difference between nanoparticles and quantum dots, quantum dots preparation: through colloidal methods, epitaxial methods, MOCVD and MBE growth of quantum dots; current-voltage characteristics: magneto tunnelling measurements; spectroscopy of quantum Dots: absorption and emission spectra, photo luminescence spectrum; optical spectroscopy: linear and nonlinear optical spectroscopy in quantum dots.

Unit –3 **12 hrs**

SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach-Lithography techniques: Photolithography**, Gas** phase condensation – Vacuum deposition -Physical vapor deposition (PVD), sputtering, pulsed laser deposition, chemical vapor deposition (CVD), laser ablation, Sol-Gel, Ball milling –Electro deposition- electroless deposition, Chemical synthesis - spray pyrolysis – plasma-based synthesis process (PSP) – solvothermal, hydrothermal synthesis- advantages and disadvantages.

Nanostructured Materials Characterization Techniques: X-ray diffraction (XRD), SEM, EDAX, TEM, Elemental mapping, FTIR, UV-Visible spectrophotometer, Laser Raman Spectroscopy, Nanomechanical Characterization Using Nanoindentation, Differential Scanning Calorimeter (DSC), Differential Thermal Analyzer (DTA), Thermogravimetric Analysis (TGA), TEM, X-ray Photoelectron Spectroscopy (XPS), ICP-AES chemical analysis, Electrochemical Characterization measurements, particle size analyzer.

Unit – 4: **12 hrs**

NANOTECHNOLOGY APPLICATIONS: Applications of nanoparticles, 2-D materials, nanotubes and nanowires for nanodevice fabrication; Nanoelectronics-Single electron transistors, coulomb blockade effects in ultra small metallic tunnel junctions - nanoparticles based quantum dots based white LEDs; Optoelectronic devices, CNT based transistors; principle of dip pen lithography-types- electron beam lithography, ion beam lithography, optical lithography and their merits and demerits, applications. Nanophotonics, Application in MEMS.

Reference Books:

1. Nanotechnology, G. Timp. Editor, AIP press, Springer-Verlag, New York, 1999
2. Nanostructured materials and nanotechnology, Concise Edition, Editor:- Hari Singh Nalwa; Academic Press, USA (2002).
3. Hand book of Nanostructured Materials and Technology, Vol.1-5, Editor:- Hari Singh Nalwa; Academic Press, USA (2000).
4. Hand book of Nanoscience, Engineering and Technology (The Electrical Engineering handbook series), Kluwer Publishers, 2002.
5. Sol-Gel Science, C.J. Brinker and G.W. Scherrer, Academic Press, Boston (1994).
6. Nanoscale characterization of surfaces & interfaces, N John Dinardo, Weinheim Cambridge: Wiley-VCH, 2nd ed., 2000.

<table>
<tr><th>Course Title</th><th colspan="4">Nuclear and Particle Physics</th><th colspan="2">Course Type</th><th colspan="2">HC</th></tr>
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<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW: This is an introductory graduate-level course focused on the fundamental knowledge and applications of nuclear physics and elementary particles. This course presents background review of nuclei, and detailed analysis of interaction of ionizing radiation with matter. Emphasis on the design and working of nuclear detectors and their applications, different nuclear models to explain the nuclei properties, introduce the concept of elementary particle particles.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Learn the fundamentals of nuclei and the interaction of ionizing radiation with matter.
2. Explain the design and working of nuclear detectors and their applications to detect and identify the ionizing radiations.
3. Interpret the nuclei characteristics using different nuclear models.
4. Introduce the concept of elementary particles and associated physics.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Describe the basic structure and related physics of nucleus. Analyze the interaction of ionizing radiation with matter.	1,2	1,3
CO2	Construct nuclear and semiconductor detectors and have a working knowledge of their application to real-life problems.	1,3	1,3
CO3	In-depth knowledge of design, working and practical applications of particle accelerators.	1,3	1,3
CO4	Predictions of nuclear models to describe the shell structure, account for fission/fusion process, and collective behaviour.	1,2	1,3
CO5	Classify elementary particles, applications of quantum number, associated symmetries and their physical structure.	1,2	1,3
CO6	Able to apply nuclear physics knowledge to make connections with other physics disciplines, quantum mechanics, radiation physics etc.	1,2	1,3

Course Content:

Unit-1 **12 hrs**

Review of the concept of nuclei: Nuclear Mass,Binding energy, Nuclear forces, Yukawa theory of nuclear forces, Short range of nuclear forces, Numerical problems.

Nuclear reactions: Q-value of reaction, threshold energy, Compound nuclear reaction, Bohr's independence hypothesis of compound nucleus, Cross section for a nuclear reaction, Differential cross section, Numerical problems.

Interaction of radiation with matter: General description of interaction process, energy loss of heavy charged particles in matter, Bethe- Bloch formula, energy loss of fast electrons, Bremstrahlung radiation, Gamma ray attenuation- absorption coefficient, atomic absorption cross section, absorber, Gamma ray transmission versus absorber thickness, Interaction of directly ionizing radiation (gamma) - photo electric, Compton, and pair production processes. Numerical problems.

Unit-2 **12 hrs**

Nuclear fission and fusion: energy released in fission and fusion, neutron cycle in a thermal reactor.

Nuclear detectors: Scintillation detectors- NaI(Tl), plastic scintillation- scintillation spectrometer. Semiconductor detectors: P-N junction detectors, Surface barrier P-N detectors, Li-ion drifted P-N detectors, Numerical problems.

Particle Accelerators: Van de Graff, Linear Accelerator, Cyclotron, Microtron, Synchrotron

Unit-3 **12 hrs**

Nuclear models: Liquid drop model – Semi-empirical mass formula, Fermi gas model - Kinetic energy for the ground state, asymmetry energy, Potential depth, Nuclear Shell model - evidence for magic numbers, prediction of energy levels in an infinite square well potential, spin orbit interaction, prediction of ground state spin parity and magnetic moment of odd nuclei, Numerical problems.

Nuclear decay

Beta decay - Fermi's theory of beta decay, curie plots and ft values, selection rules. Gamma decay, internal conversion, Multi polarity of gamma rays, selection rules, Numerical problems.

Unit-4 **12 hrs**

Elementary particle physics: Classification of elementary particles based on mass and spin, types of interactions between elementary particles.

Quantum numbers and Conservation laws: Quantum numbers for charge , nucleon, spin, isospin, lepton, baryon, hypercharge and strange particles, law of conservation of charge , nucleon number, spin, isospin, lepton number conservation, conservation of strangeness in strong interactions, Baryon number conservation, Gell-Mann Nishijima formula, Numerical problems.

Symmetries: Parity, Parity symmetry, Wu experiment-violation of parity in weak interactions, Charge conjugation symmetry, CP violation in week interactions, Numerical problems.

Quark model: Quarks, properties of quarks, quark content of baryons and mesons, color degree of freedom, Numerical problems.

Reference books

1. Introduction to Nuclear Physics, H. Enge: Addison Wesley, 1971.
2. Atomic and Nuclear Physics, S. N. Goshal vol II 2000.
3. Introductory Nuclear Physics Kenneth S. Krane: John Wiely and Sons, 1987.
4. The Atomic Nuclease Evans R.D.: Tata Mc. Graw hill, 1955.
5. Nuclear Physics, R R Roy and Nigam: Wiley-eastern Ltd 1983.
6. Nuclear physics an introduction, S.B. Patel: New age international (P) limited 2000.
7. Radiation Detection and Measurements, G.F. Knoll: 3rd edition, John Wiely and sons, 2000.
8. Nuclear Radiation Detectors, S.S. Kapoor and V.S Ramamurthy: Wiley and sons. Introduction to High Energy Physics D.H. Perkins: Addison Wesley, London, 2000.
9. Introduction to Elementary Particles, D. Griffiths: John Wiley1984.
10. Nuclear Interactions, S.de Benedetti: John Wiley, New York, 1964.

<table>
<tr><td>Course Title</td><td colspan="4">Electronic –I
Digital Electronics and LIC's</td><td colspan="2">Course Type</td><td colspan="2">SC</td></tr>
<tr><td>Course Code</td><td>M24SPS311</td><td>Credit</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2"></td></tr>
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</table>

COURSE OVERVIEW:

The syllabus covers a range of topics in digital and analog electronics. It includes combinatorial and sequential circuits such as multiplexers, demultiplexers, various flip-flops (SR, JK, D, T), counters, registers, and shift registers. Additionally, it introduces the architectures of the 8085 microprocessor and the 8051 microcontroller. The course further explores A/D and D/A conversion circuits, detailing digital-to-analog and analog-to-digital converters, their types, specifications, modes of operation, and applications. It also covers operational amplifier configurations including differential, inverting, and non-inverting amplifiers, along with their applications like summing, integrating, differentiating, and logarithmic operations. Finally, the syllabus includes comparators, signal processing circuits like voltage limiters, clippers, clampers, rectifiers, and sample-and-hold circuits.

COURSE OBJECTIVES:

The objectives of this course are to:

1. To gain knowledge of combinational and sequential circuits.
2. To understand the lock diagrams of microprocessor (8085) and microcontroller (8051)
3. To design the applications of OPAMP as differentiators, integrators etc.
4. To design comparators and convertors.
5. To design various logic design of programmable devices, including PLDs and synchronous & Asynchronous counters and Universal Shift Registers.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Draw the logic circuits by simplifying Boolean expressions using theorems, laws and K-map.	1,2	1
CO2	Analyse the operation of Combinational and Sequential logic circuits	1,2	1
CO3	Analyse the architecture of Architecture of 8085, Architecture of 8051.]	1,2	1
CO4	Design of DAC, ADC, types, specifications and applications.	1,2	1
CO5	Analyse the applications of OPAMP as differentiators, integrators and convertors.	1,2	1
CO6	Design comparators and convertors circuits.	1,2	1

Unit 1: **12 hrs**

Combinational and Sequential circuits: Multiplexers–De-multiplexer Latches, Flip-flops, SR, JK- Flip-flop, JK Master-Slave, D, T flip-flops, counters, synchronous and asynchronous counters, ripple counters, registers, shift registers, timing sequences.

Basics of microprocessor and microcontroller: Architecture of 8085, Architecture of 8051.

Unit 2: **12 hrs**

A/D and D/A conversion circuits: Introduction, Digital to Analog Converters D/A converter Specifications, Types of D/A converters, Mode of Operation, BCD Input D/A converter, Integrated Circuit D/A Converters, D/A converter Applications, A/D converters, A/D Converter Specifications, A/D Converter Technology, Types of A/D converters, Integrated Circuit A/D Converters, A/D converter Applications.

Unit 3 **12 hrs**

OPERATIONAL AMPLIFIER CONFIGURATIONS & LINEAR APPLICATION: Open loop OP-AMP configurations- The differential amplifier, inverting amplifier, noninverting amplifier, negative feedback configurations - inverting and non-inverting amplifiers, voltage followers & high input impedance configuration, differential amplifiers, closed-loop frequency response & circuit stability, single supply operation of OP-AMP, summing, scaling and averaging amplifier, voltage to current & current to voltage converters, integrators & differentiators, logarithmic & anti logarithmic amplifiers

Unit 4. **12 hrs**

COMPARATORS & CONVERTERS: Basic comparator & its characteristics, zero crossing detector, voltage limiters, clippers & clampers, small signal half wave & full wave rectifiers, absolute value detectors, sample and hold circuit.

TEXTBOOKS:

1. OP-AMP and linear integrated circuits 2nd edition, PLHI by Ramakant A. Gayakwad.
2. Design with operation amplifiers and Analog Integrated circuits by Sergei Franco.
3. Integrated Electronics: Analog and Digital circuits & system by Millman & Halkias.
4. Linear Integrated Circuits by D.R.Chaudhary (WEL).

Reference Books:

1. John F. Wakerly, "Digital Design" 4 th edition,Pearson/PHI,2008.
2. John, M Yarbrough, "Digital Logic application and design", Thomson Learning, 2006.
3. Charles H, Roth, "Fundamentals of Logic Design", Thomson Learning, 2013.
4. Donald P, Leach and Albert Paul Malvino, "Digital Principles and Applications", 6th edition, TMH, 2006.
5. Thomas L. Floyd, " Digital Fundamentals", 10th Edition, Pearson Education Inc, 2011
6. Donald D, Givone, "Digital Principles and Design', TMH, 2003.

Course Title	Condensed Matter Physics - I				Course Type	SC
Course Code	M24SPS312	Credit	4		Class	
	LTP	Credit	Contact Hours	Work Load		Assessment weightage

<table>
<tr><td rowspan="4">Course Structure</td><td>Lecture</td><td>4</td><td>4</td><td>4</td><td colspan="2">Total Number of Classes Per Semester</td><td colspan="2"></td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50%</td><td>50%</td></tr>
</table>

Course Overview

This course explores advanced materials science topics with a focus on crystallography and X-ray diffraction techniques for structural analysis. Topics include various diffraction methods, X-ray powder diffraction, and applications in identifying crystal structures and phase changes. Students delve into disordered systems, thin film preparation, and characterization techniques for mechanical, electrical, and magnetic properties. Dielectric materials, their polarization behavior, and optical properties are studied alongside ferroelectric materials and their phase transitions. Practical applications in transducers, memory devices, and advanced technologies underscore the course's relevance in modern materials engineering.

Course Objective

1. Master crystallographic and X-ray diffraction techniques for structural analysis.
2. Analyze disordered systems and amorphous semiconductors, focusing on their properties and applications.
3. Explore thin film preparation methods and characterize their mechanical, electrical, and magnetic properties.
4. Study dielectric materials, including polarization behavior and optical properties.
5. Investigate ferroelectric materials, phase transitions, and their applications in devices like transducers and memory devices.

Course outcome

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate proficiency in various X-ray diffraction methods including Laue, rotating crystal, and powder diffraction, interpreting diffraction patterns to determine crystal structures and phase changes.	1, 2, 5	1,3
CO2	Analyze the behavior of disordered systems and amorphous semiconductors, including point defects, localized states, and the application of theoretical models like the Anderson model and density of states.	1,2	2
CO3	Utilize techniques such as thermal evaporation, sputtering, and microscopy to prepare and characterize thin films,	1,4,5	1, 3

	analyzing mechanical, electrical, and magnetic properties for diverse applications.		
CO4	Investigate dielectric constants, polarization behavior, and phase transitions in dielectric and ferroelectric materials, with practical insights into their applications in electronic and optical devices.	1, 2	1
CO5	Solve numerical problems related to crystallography, X-ray diffraction, and material characterization, enhancing proficiency in quantitative analysis and data interpretation.	1, 2	1,2
CO6	Apply theoretical concepts of materials science to practical scenarios, fostering skills in problem-solving, critical analysis, and innovation in advanced materials research and development.	1, 2	1, 4

Course content

Unit 1: **12 hrs**

The Laue method: Instrumentation, appearance of photographs. **Rotating crystal methods:** instrumentation, interpretation of photographs. **Moving film methods**: Weissenberg method, Precession method, interpretation of photographs. **Single crystal diffractometer:** parafocussing and goniometry, intensity measurements. Numerical problems.

Powder method: X-ray powder photographic methods, instrumentation, diffraction geometry, measurement of Bragg angles and interplanar spacings, index of powder patterns, precise lattice parameter determination with illustration, characteristics of powder pattern lines, application to identification of solid solution and phase changes, line broadening and particle size measurements. Numerical problems

Unit 2: **12 hrs**

Disordered systems: Point defects-shallow impurity states in semiconductors-Localizedlattice vibrational states in solids-Vacancies, interstitials in ionic crystals- Introduction- Short range order- Long range order- Orderedlattice- Disordered lattice- Compositional. Topological disorder-Magnetic disorder-Localized states- Anderson Model- Density of states. Concept of glass- Glass transition- Atomic correlation function and structural description of glasses and liquids. Amorphous semiconductors: Classification, band structure- electronic conduction- Optical absorption- Switching. Transport in disordered lattices- Transport in extended states, hopping and its types- amorphous semiconductors-Applications

Unit 3: **12 hrs**

Films and Surfaces: Methods of thin films preparation: Thermal evaporation- sputtering- DC,AC, diode, ion beam sputtering, Laser and electron beam evaporation technique. Chemical vapor deposition. Characterization of thin films- film thickness: optical methods- interferometry- Fizeau fringes- FECO Method. Mechanical techniques-Stylus method-weight measurement and crystal oscillators. Structural characterization Scanning electron microscopy, Transmission Electron microscopy.

Mechanical properties- stress and strain analysis. Electrical properties of thin films- Measurement of resistivity by four probe method, thin film resistors, Magnetic properties- film size effect on Memory Storage- films for memory devices and applications.

Unit 4: 12 hrs

Dielectrics and Ferroelectrics

Review dielectric constant and polarizability- internal field and macroscopic field. The Complex dielectric constant-dielectric losses and relaxation time-Debye equations- Theory of electronic polarization and optical absorption. Dielectric function. Soft Optical Phonons, LST Relationship, dielectric breakdown- Ferro electricity in KDP and barium titanate- order—disorder and displacement theories. Thermodynamics of ferroelectric phase transitions. General applications of dielectric materials. Ferroelectrics, antiferrolectric Materials, Piezoelectric, pyroelectric and ferroelectric materials,- transducer and applications.

References

1. Introduction to Solid state physics**, C. Kittel,** Wiley Eastern (1993).
2. Introduction to solids**, L. V Azaroff,** Mc Graw Hill (1977).
3. Crystallography applied to solid state physics, **Verma and Srivastava,** New age international (2005).
4. Elements of Solid State Physics, **J. P. Srivastava,** PHI, (2016).
5. Solid State Physics, **Neil W. Ashcroft and N. David Mermin,** Saunders College Publishing, (1976).

<table>
<tr><td>Course Title</td><td colspan="4">Photonics – I
Laser Systems and optoelectronic devices</td><td colspan="2">Course Type</td><td colspan="2">SC</td></tr>
<tr><td>Course Code</td><td>M24SPS313</td><td>Credit</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment weightage</td></tr>
<tr><td>Lecture</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50%</td><td>50%</td></tr>
</table>

Course overview: Photonics is a branch of physics and engineering that focuses on the study and applications of light (photons), particularly in generating, detecting, controlling, and manipulating light waves and their interactions with matter. In this present course we emphasize the principles and characteristics of Lasers. Some of the laser beam manipulation and modulation techniques such as acousto optic, magnetco optic and electro optic techniques were introduced.

Course objectives:

1. To provide knowledge about lasers and laser amplifiers used in Industry and research
2. To explain the basic laser radiation properties and switching mechanism
3. To demonstrate different technics of light modulation
4. To analyse and apply the knowledge of optoelectronic devices in research

Course outcomes:

CO#	Course Outcomes	POs	PSOs
CO1	To get knowledge of principle, mechanism and applications of LASERS	1,2	1
CO2	Demonstrate the properties LASER beam for various applications.	1,2	1
CO3	To illustrate non-linear optical properties and to gain knowledge of electro, acousto and magneto- optic effects	1,2	1
CO4	To apply optics and physics of materials knowledge in demonstrating optoelectronic devices	1,2	1
CO5	To elaborate the knowledge of light modulation by means of Electro-optic, Acousto-Optic and magneto-Optic processes.	1,2	1
CO6			

Course content

UNIT I : **12 hrs**

LASER systems and Applications

General description, Laser structure, Single mode laser theory, Excitation mechanism and working of: CO_2, Nitrogen, Argon ion, Excimer, X-ray, Free-electron, Dye, Nd:YAG, Alexanderite and Ti:sapphire lasers, Diode pumped solid state laser, Optical parametric oscilater (OPO) lasers. Optical amplifiers- Semiconductor optical amplifiers, Erbium doped waveguide optical amplifiers, Raman amplifiers, Fiber Lasers. Laser applications-Lasers in Isotope separation, Laser interferometry and speckle metrology, Velocity measurements.

UNIT - II: **12 hrs**

Properties of laser Radiation

Introduction, Laser linewidth, Laser frequency stabilization, Beam divergence, Beam coherence, Brightness, focusing properties of laser radiation, Gaussian nature of Laser beam intensity, Longitudinal and transverse modes of Lasers, Q-switching, Methods of Q switching: Rotating-mirror method, Electro-optic Q-switching, Acoustic-optic Q-switching, and Passive Q-switching, Mode locking, Methods of mode locking: Active and passive mode locking techniques, Frequency doubling and Phase conjugation.

UNIT - III: **12 hrs**

Opto-electronic Devices

Introduction, P-N junction diode, Carrier recombination and diffusion in P-N junction, Injection efficiency, Internal quantum efficiency, Hetero-junction, Double hetero-junction, Quantum well, Quantum dot and Super lattices; LED materials, Device configuration and efficiency, Light extraction from LEDs, LED structures-single heterostructures, double heterostructures, Device performances and applications, Quantum well lasers; Photodiode and Avalanche photodiodes (APDs), Laser diodes-Amplification, Feedback and oscillation, Power and efficiency, Spectral and spatial characteristics.

UNIT – IV: **12 hrs**

Modulation of Light

Introduction, Birefringence, Electro-optic effect, Pockels and Kerr effects, Electro-optic Phase modulation, Electro-optic amplitude modulation, Electro-optic modulators: scanning and switching, Acousto-optic effect, Acousto-optic modulation, Raman-Nath and Bragg modulators: deflectors and spectrum analyzer, Magneto-optic effect, Faraday rotator as an
optical isolator. Advantages of optical modulation.

Reference text books

1. Laser fundamentals, W.T. Silfvast, Foundation books, New Delhi, 1999.
2. Semiconductor opto electronics devices, P. Bhattacharya, Prentice – Hall of India, New Delhi, 1995.
3. Fundamentals of Photonics, B.E.A. Saleh, M.C. Teich, Wiley & Sons, 2007
4. Solid State Lasers: A graduate text book, Walter Koechner and Michael Bass, Springer, 2003.

Course Title	**Advanced Materials and Technology - I**				**Course Type**		**SC**	
Course Code	**M24SPS314**	**Credit**	**4**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	**4**	**4**	**4**				
	Tutorial	**-**	**-**	**-**	**Theory**	**Practical**	**CIE**	**SEE**
	Practical							
	Total	**4**	**4**	**4**	**48**	**-**	**50%**	**50%**

COURSE OVERVIEW:

This course introduces the basic concepts of synthesis of advanced materials and their applications in various fields such as cryogenic and space. This course also focuses on the application of biomimetics and Biomaterials in the medical and pharmacy fields. The course also consists of real-time applications and numerical examples, which makes the course interesting and attractive.

COURSE OBJECTIVES:

The objectives of this course are to:

1. To introduce the basic methods of synthesis of materials.
2. To provide scientific foundation for understanding of cryogenic and space application of materials, properties, microstructure, and behavior of materials.
3. To make the students familiar with the vocabulary for the description of the empirical facts and theoretical ideas about the various application of biomimetic and biomaterials and their structures from atoms through defects in crystals to larger scale morphology.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Apply the functional materials and carbon-based materials to practical applications.	1,2	3
CO2	Demonstrate a thorough understanding of properties of advanced materials for cryogenic and space applications.	1,2	3
CO3	Interpret the mechanical properties of various materials for heat resistance applications.	1,21	3
CO4	Describe the properties of Biomimetic materials for biosensor applications.	1,2	3
CO5	Analyze the role of advanced materials for the Biomedical applications.	1,2	3
CO6	Analyse the role of polymers in the drug delivery.	1,2	3

Course Content

Unit-1: **12 hrs**

Functional nanomaterials

Synthesis, properties and applications of organic, inorganic, hybrid nanomaterials – core-shells, nano shells, self-assembled nanostructures, superlattices, nanoceramics metallic, polymeric and ceramic nanocomposites, nanoporous materials, nanofluids, nanolayers and carbon-based nano materials - Occurrence, production, purification, properties and applications of fullerene, carbon nanotube, graphene, carbon onion, nanodiamond and films.

Unit-2: **12 hrs**

Materials for cryogenic and space applications

Materials for cryogenic applications: Metals for low temperature applications, Austenitic stainless steel, Nitrogen containing steel, Aluminium, Aluminium-lithium alloys, Titanium alloys, Cryo insulation materials, Polymers and adhesive for cryo temperature applications. Materials for space environment: Radiation shielding materials, Atomic oxygen resistant materials, Space suit materials and materials for life support systems, Evaluation of materials for space environment and space worthiness.

Unit-3: 12 hrs

Biomimetic nanomaterials

Introduction to biomimetics, mimicking mechanisms found in nature, synthesis and applications of bioinspired nanomaterials and self-assemblies. Properties and Application of nanomaterials in healthcare, biosensors, coatings environment, catalysis, agriculture, automotives, sensors, electronics and photonics.

Dental materials: Introduction to dental materials polymers, ceramics and metals, applications of dental materials, and implants.

Polymers in drug delivery: Introduction to polymeric drug delivery systems, Targeted drug delivery. Passive or active targeting, targeting tumor cells, polymer-protein conjugates, polymer drug-conjugates. Pharmacokinetics. Application of hydrogels in controlled drug delivery systems

Unit-4: 12 hrs

Biomaterials

Introduction to classes of materials used in medical applications: Metals, polymers, ceramics, bioresorbable and biodegradable materials, coatings, medical fibers.

Smart biomaterials: Stimuli responsive polymers (pH, temperature, light, magnetic and biomolecules) and their applications as biomaterials. Stimuli responsive hydrogels. Nano biomaterials: Interaction of biomolecules and nano particle surfaces. Biocompatible nanomaterials, Nanogels and microgels: preparation methods, characterization and applications.

Books

1. K. J. Klabunde and R.M. Richards (Eds.), Nanoscale Materials in Chemistry, 2nd Edn., John Wiley & Sons, 2009.
2. T. Pradeep, Nano: The Essentials, McGraw-Hill (India) Pvt Limited, 2008.
3. Bharat Bhushan, (Ed.), Handbook of Nanotechnology, Springer, 2007.
4. Carl C. Koch (Ed.), Nanostructured Materials: Processing Properties and Applications, William Andrew Inc., 2007
5. B.P.S. Chauhan (Ed), Hybrid Nanomaterials: Synthesis, Characterization, and Applications, Wiley-VCH Verlag GmbH, 2011.
6. J. Lei and F.Lin, Bioinspired Intelligent Nanostructured Interfacial Materials, World Scientific Publishing Company, 2010.
7. Challa S. S. R. Kumar (Ed.) Biomimetic and Bioinspired Nanomaterials, Wiley-VCH Verlag GmbH, 2010.
8. H.M. Flower, High Performance Materials in Aerospace, 1st ed., Chapman & Hall, 1995.
9. B.Horst, B. Ilschner, K.C. Russel, Advanced Aerospace Materials, Springer-Verlag, Berlin, 1992

<table>
<tr><td>Course Title</td><td colspan="4">Electronics - II: Analog and digital Communication</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
<tr><td>Course Code</td><td>M24SPS321</td><td>Credit</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment weightage</td></tr>
<tr><td>Lecture</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

This course provides a comprehensive understanding of analog and digital modulation techniques, essential for modern communication systems. The course covers Amplitude Modulation (AM) and Frequency Modulation (FM) techniques, examining their theory, transmission, reception, and performance in different noise environments. It also delves into various digital modulation schemes such as Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Quadrature Amplitude Modulation (QAM), and their applications in current digital communication systems. The course explores the fundamentals of microwave devices, including waveguides, microwave resonators, klystrons, and magnetrons, and their critical role in high-frequency communication systems.

COURSE OBJECTIVES:

The objectives of this course are to:

1. To understand the fundamental concepts of communication systems.
2. To compare AM and FM analog modulation schemes.
3. To analyze different digital modulation schemes.
4. To Analyze microwave devices and microwave communication systems.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Design Amplitude modulation and demodulation techniques for analog communication.	1,2	3
CO2	Design Frequency modulation and demodulation techniques for analog communication.	1,2	3
CO3	Convert analog signal into digital signal.	1,2	3
CO4	Distinguish between Analog and Digital Communication system and analyze various sampling methods and its reconstruction.	1,2	3

CO5	Compare digital modulation techniques.	1,2	3
CO6	Analyze microwave devices and microwave communication system.	1,2	3

Course content:

Unit 1: **12 hrs**

AM Transmitters and Receivers: Generation of AM, low level and high-level modulation, comparison of levels, AM transmitter block diagram, DSB S/C modulator. AM Receiver: Tuned radio frequency (TRF) receiver. Superheterodyne receiver, RF section and characteristics, mixers, frequency changing and tracking, IF rejection and IF amplifiers. Detection and automatic gain control (AGC), AM receiver characteristics.

Unit2. **12 hrs**

FM Transmitters and Receivers FM Transmitters: Basic requirements and generation of FM, FM Modulation methods: Direct methods, Variable capacitor Modulator, Varactor Diode Modulator, FET Reactance Modulator, Transistor Reactance Modulator, Pre-emphasis, Direct FM modulator, FM Receivers: Limiters, single and double-tuned demodulators, balanced slope detector, Foster-Seely or Phase Discriminator, De-emphasis, ratio Detector, Block diagram of FM Receivers, RF Amplifiers, FM Receiver characteristics.

Unit 3: **12 hrs**

Analog to Digital Conversion: Noisy communications channels, The sampling Theorem, low pass signals and band pass signals, Pulse Amplitude modulation (PAM), channel bandwidth for a PAM signal, Natural sampling, Flat top sampling, signal recovery & holding, Quantization of signal, Quantization error, Pulse Code modulation (PCM), Delta Modulation, adaptive delta modulation. Digital Modulation Techniques: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK).

Unit 4. **12 hrs**

Microwave devices and Satellite communication (qualitative) Multicavity klystron, reflex klystron, parametric amplifiers, Gunn diode, Microwave transistors & FETs. Communication subsystems, description of the communication system transponders, spacecraft antennas, frequency reuse antennas, multiple access schemes, frequency division multiple access, time division multiple access, and code division multiple access. Tracking geostationary satellites.

References:

1. Principles of Communication Systems – H Taub& D. Schilling, GautamSahe. TMH, 3rd Edition. 2007.
2. Communication Systems - Simon Haykin. John Wiley, 2r" Edition, 2008.
3. Electronics & Communication System - George Kennedy and Bernard Davis, 4th Edition TMH 2009

4. Analog Communications- KN Hari Bhat & Ganesh Rao, Pearson Publications, 2nd Edition 2008.
5. Communication Systems Second Edition - R.P. Singh. SP Sapre, TMH, 2007.
6. Electronic Communications – Dennis Roddy and John Coolean , 4th Edition , PEA, 2004
7. Communication Systems – B.P. Lathi, BS Publication, 2004.
8. Electronics & Communication System – George Kennedy and Bernard Davis, TMH 2004.
9. Analog and Digital Communications – Simon Haykin, John Wiley, 2005.
10. Analog and Digital Communication – K. Sam Shanmugam, Willey ,2005.
11. Electronics Communication Systems-Fundamentals through Advanced-Wayne Tomasi, 5th Edition, 2009, PHI.
12. Digital Communications - John G. Proakis .Masoudsalehi – 5th Edition, McGraw-Hill, 2008.
13. Digital Communication - Simon Haykin, Jon Wiley, 2005.
14. Digital Communications - Ian A. Glover, Peter M. Grant, Edition, Pearson Edu., 2008.

<table>
<tr><td>Course Title</td><td colspan="4">Photonics - II
Optical fibers ,Integrated optics and Photonic crystals</td><td colspan="2">Course Type</td><td colspan="2">SC</td></tr>
<tr><td>Course Code</td><td>M24SPS323</td><td>Credit</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment weightage</td></tr>
<tr><td>Lecture</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50%</td><td>50%</td></tr>
</table>

Course Overview

The course provides a detailed introduction to the optical fibers , fiber connectors , splicers and fiber opitc sensors. Also, Integrated optics briefly covered to understand the technology of creating optical systems in the form of miniature integrated circuits and photonic chips. The photonic-crystal technology by covering its fundamentals, the properties of light propagation in simple to complex photonic crystals are discussed thoroughly with appropriate theoretical tools.

Course objectives:

1. To provide knowledge about optical fibres and applications
2. To explain the basic components integrated optics, ex: optoelectronic devices
3. To demonstrate different tools and fundamental concepts in signal processing
4. To understand the modelling of photonics crystals

Course outcomes:

CO#	Course Outcomes	POs	PSOs
CO1	Demonstrate Optical fibres and its wave guiding mechanism.	1,2	3
CO2	Gain knowledge of components used in fibre optic communication and applications	1,2	3
CO3	Design and principles of the fiber optic sensors	1,21	3
CO4	Understand and demonstrate usage of different tools integrated optoelectronic devices	1,2	3
CO5	Demonstrate signal processing	1,2	3
CO6	Explain the modelling and properties of photonic crystals	1,2	3

Course content:

UNIT 1: Optical fibers, Fibre Optic Components and Sensors: 12 hrs

Total internal reflection - Optical fiber modes and configuration – Single mode fibers – Graded index fiber structure – Fiber materials and fabrication – Mechanical properties of fibers – Attenuation – Signal distortion on optical wave guides- Erbium doped fiber amplifiers – Solitons in optical fibers.

Connector principles, Fibre end preparation, Splices, Connectors, Source coupling, distribution networks, Directional couplers, Star couplers, Switches, Fiber optical isolator, Wavelength division multiplexing, Time division multiplexing, Fiber Bragg gratings.

Advantage of fiber optic sensors, Intensity modulated sensors, Mach-Zehnder interferometer sensors, Current sensors, Chemical sensors, Optical biosensors: Fluorescence and energy transfer sensing, molecular beacons and optical geometries of bio-sensing, bio-imaging.

UNIT II: Integrated Optics 12 hrs

Introduction – Planar wave guide – Channel wave guide – Y-junction beam splitters and couplers - FTIR beam splitters – Prism and grating couplers – Lens wave guide – Fabrication of integrated optical devices - Integrated photodiodes – Edge and surface emitting laser -Distributed Bragg reflection and Distributed feedback lasers - Wave guide array laser.

UNIT III: Optical Signal Processing 12 hrs

Introduction, Effect of lens on a wavefront, Fourier transform properties of a single lens, Optical transfer function, Vanderlugt filter, Image spatial filtering, Phase-contrast microscopy, Pattern recognition, blurring of Image, Photonic switches, Optical transistor, Optical Gates- Bistable systems, Principle of optical Bi-stability, Bistable optical devices, Self-electro-optic effect device.

UNIT IV: Photonic Crystals 12 hrs

Basics concepts, Theoretical modeling of photonic crystals, Features of photonic crystals, methods of fabrication, Photonic crystal optical circuitry, Nonlinear photonic crystals, photonic crystal fibers, Photonic crystals and optical communications, Photonic crystal sensors.

Reference text books

1. Fibre Optic Communication, Joseph C. Palais, Pearson Education Asia, India, 2001
2. Introduction To Fibre Optics, A.Ghatak And K.Thyagarajan, Cambridge University Press, New Delhi, 1999

3. Optical Guided Wave Signal Devices, R.Syms And J.Cozens. Mcgraw Hill, 1993.
4. Optical Electronics, A Ghatak and K. Thyagarajan, Cambridge University Press, NewDelhi, 1991
5. Fundamentals of Photonics, B.E.A. Saleh and M.C. Teich, John Willy and Sons,1991
6. Introduction to Fourier Optics, Joseph W. Goodman, McGraw-Hill, 1996.

Course Title	**Condensed Matter Physics II– Structural and Functional Materials.**				**Course Type**		**SC**	
Course Code	M24SPS324	**Credit**	**4**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	4	4	4				
	Tutorial	-	-	-				
	Practical				**Theory**	**Practical**	**CIE**	**SEE**
	Total	**4**	**4**	**4**	**48**	**-**	**50%**	**50%**

COURSE OVERVIEW:

This course provides an in-depth understanding of the fundamental principles and phenomena in condensed matter physics, emphasizing the structure, properties, and applications of various materials, including polymers, ceramics, glasses, and composite materials. The course covers theoretical concepts, experimental techniques, and real-world applications, preparing students for advanced research or professional work in material science and related fields.

COURSE OBJECTIVES:

The objectives of this course are to:

1. This course provides basic knowledge about Polymers, ceramics and glass materials.
2. To provide knowledge about synthesis of Polymers, ceramics, glass and its applications.
3. To explain the basic components of composite materials and their fabrication methods.
4. To provide knowledge about Concrete, concrete making materials, structure, composition and different types.
5. To demonstrate different testing tools used for characterization of Polymers, ceramics, glasses and composite materials.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	**Course Outcomes**	**POs**	**PSOs**
CO1	Identify the structure, classification, and polymerization processes of polymers.	1	1,2

CO2	Evaluate the optical and thermal properties of glasses and their applications.	1	1,4
CO3	Analyze the mechanical, thermal, and electrical properties of ceramics and their industrial applications.	1,2	1,4
CO4	Classify different types of composite materials and their fabrication techniques.	1,2	1,2
CO5	Analyse and examine the data obtained from Mechanical testing instruments, metallurgical and electron microscopes and NDT.	1.2	1,4
CO6	Integrate theoretical knowledge with practical skills to solve complex problems in condensed matter physics.	1,11	1

Course Content

Unit- 1 **12 hrs**

Elements of Polymer Science: Monomers- Polymers- Average molecular weight-weight average molecular weight and number average molecular weight. Classification of polymers (based on composition, thermal behavior, structure, isomerism). Microstructure of polymers- chemical, geometric, random alternating, block and graft polymers, stereo regular polymers, Synthesis of polymers- chain polymerization, step Polymerization, industrial polymerization methods(Bulk, Solution, Suspension, Emulsion methods). Polymer crystallinity, degree of crystallinity, Phase transition- polymer melting and glass transition; Forming methods of Plastic Materials- compression, injection, blow, extrusion, spinning molding.

Unit -2 12 hrs

Ceramics and Glasses: Ceramics and their structure- Silicate structure, Preparation and Processing of ceramics, Forming and thermal treatments, Classification of ceramics- traditional and engineering. Dielectric, ferroelectric and piezoelectric and Ceramic magnets, Properties of ceramics with specific examples, Mechanical properties- strength, toughness. Fatigue failure, abrasion. Basic refractory materials and their classification, Glasses: Preparation, (Float glass process, Pressed glass and blow moulding) and structure of glass Types of glasses- borates silicate, oxide, metallic and semiconducting glasses; tempered glass and chemically strengthened glass. Applications of Ceramics and glasses.

Unit - 3 12 hrs

Composite Materials: General Introduction, matrix Materials- Matrix Selection- polymer, metals, ceramics, Reinforcing materials- fibers, particles. Fabrication, structure, interface, properties, applications of polymer matrix composites, metal matrix composites, ceramic matrix composites and carbon fiber composites, wood-plastic composites. Particle reinforced, fiber and laminate reinforced composites with fabrication, interface, properties and applications Concrete-concrete making materials, structure, composition. Portland cement concrete, Reinforced Concrete, pre-stressed concrete. properties and applications. Cermets/Ceramal. Advantages and limitations of composites materials.

Unit-4 12 hrs

Testing of Materials: Mechanical Testing –Tensile strength By Universal Testing Machine. Hardness-Brinnel,Vicker and Rockwell machines, impact testing by Charpy methods,Fatigueand Creep Testing. Optical Microscopy- Metallurgical Microscopes-sample preparation and grain size Measurements. Electron microscopy-Transmission microscopy (TEM), scanning microscopy (SEM)- principle, sample preparation techniques and applications. Non - Destructive Testing- Ultrasonic Testing, X-ray radiography. Neutron radiography.

References:

1. Condensed Matter Physics by Michael P. Marder, Wiley, 2010.
2. Introduction to Polymers by Robert J. Young, Peter A. Lovell, CRC Press, 2011
3. Introduction to Condensed Matter Physics: Volume 1 by Duan Feng, Guojun Jin, World Scientific, 2018.
4. Physics of Polymer Surfaces and Interfaces by Isaac C. Sanchez, Springer, 2015
5. Ceramics Science and Technology: Volume 1 - Structures edited by Ralf Riedel, I-Wei Chen, Wiley-VCH, 2015.
6. Handbook of Glass Physics edited by Arun K. Varshneya, John C. Mauro, CRC Press, 2016.
6. Composite Materials: Engineering and Science by Krishan K. Chawla, Springer, 2019.
7. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods by Yang Leng, Wiley, 2013 (Revised Edition 2019)
8. Composite Materials: Science and Engineering by Krishan K. Chawla, Springer, 2012
9. Foundations of Materials Science and Engineering- William F. Smith, McGraw Hill international Editions, (1988).
10. Elements of Materials Science and Engineering. Lawrence H. Van Vlack, Addison Wesley (1975).
11. Introduction to Ceramics- W D Kingery, H K Bower and U R Uhlman, John Wiley (1960).
12. Principles of Neutron Radiography- N D Tyufyakav and A S Shtan, Amerind Publishers (1979).
13. Applied X-rays- George L Clark, Mc. Graw Hill, (1955)
14. Testing of Metallic Materials—AVK Suryanarayan , Prentice Hall India, (1990).

<table>
<tr><td>Course Title</td><td colspan="4">Advanced Materials and Technology-II
Energy conservation and storage devices</td><td colspan="2">Course Type</td><td colspan="2">SC</td></tr>
<tr><td>Course Code</td><td>M24SPS324</td><td>Credit</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment weightage</td></tr>
<tr><td>Lecture</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

This course introduces the basic concepts of synthesis of advanced materials and their applications in various fields such as energy and energy storage technology. This course also focuses on the application of materials in the field of baterries and super c. The course also consists of real-time applications and numerical examples, which makes the course interesting and attractive.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Comprehend the fundamentals of various renewable energy sources and their conversion mechanisms.
2. Understand the principles, materials, and fabrication processes of different types of solar cells.
3. Explore the technology behind hybrid solar cells and factors affecting their efficiency.
4. Gain knowledge about fuel cells, their types, materials used, and their efficiency.
5. Learn about different types of batteries, their chemistry, performance characteristics, and applications.
6. Understand the fundamentals and applications of supercapacitors and their integration with other energy storage devices.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Identify suitable materials and synthesis method for solar cell application.	1	1,2
CO2	Evaluate efficiency of photovoltaic cell and detectors	1	1,4
CO3	Analyze the characteristics of hybrid solar cells and their industrial applications.	1,2	1,4
CO4	Classify different types of Batteries and storage devices	1,2	1,2
CO5	Analyse and examine super capacitance properties of various materials.	1.2	1,4
CO6	Distinguish between different fuel cells and identify better material for energy generation.	1,11	1

Course content:

Unit-1: **12 hrs**

Renewable Energy Sources:

Overview of renewable energy sources: Hydroelectric, Wind, geothermal and Tidal Energy – Conversion, potential and limitations– Bio-energy-Safety, economic and Environmental Aspects. Solar Energy and Solar Cells: Solar Spectrum, Solar constant, Passive conversion – Materials for Renewable energy conversion- Photovoltaics --Silicon (Si) solar cells, Crystalline/ Semicrystalline/ Amorphous Si solar cells, Thin film solar cells, Fabrication of solar cells and characterization. Future energy economy Hydrogen economy – Materials for hydrogen storage.

Unit-2: **12 hrs**

Hybrid solar cells

Mechanism- electron transfer: Factors affecting electron transfer. Organic solar cells- bilayer, Bulk heterojunction, polymer solar cells, perovskite based solar cells, hybrid solar cells. Efficiency; limiting factors, Internal resistance, general causes for failure. Sustainable Energy Conversion: Fuel cells-, Various types, Materials- Fuels- Reforming, Electrodes, Catalyst, electrolyte -efficiency.

Unit-3: **12 hrs**

Cells and batteries

Reversible cells and irreversible cell reactions, Parameters for characterizing batteries Batteries: Primary and Secondary cells, Chemistry and materials used for various components (electrodes, electrolytes, separator and binders) of different types of batteries: Leclanche/Dry/Alkaline cell, Silver cell, Mercury cell, Lead-acid battery: safety and design; Edison Cell, Ni-Cd battery, Ni Metal Hydride (Ni-MH) battery, Ni-Hydrogen battery, Sodium-Sulfur battery, Lithium-ion/Lithium-polymer/ Li-S battery, Metal-air batteries and its applications (Qualitative). Classification of batteries: water, electrolyte, gas, and heat activated batteries with examples. Performance & Manufacturing of batteries: Charge-Discharge characteristics, Energy/power density, overcharging, Mechanics of battery cells and materials, Manufacturing of batteries. Battery safety and Abuse tolerance, Coupling with other energy storage devices.

Unit-4: **12 hrs**

Super/ultracapacitors: Fundamentals of Electrochemical Supercapacitors, Electrode and electrolyte interfaces and their capacitances, Charge-Discharge characteristics, Energy/power density, Design, Fabrication, operation and evaluation, Thermal management; Supercapacitor stack manufacturing and construction, Coupling with batteries and fuel cells.
Applications Fuel cells: Overview of key fuel cell technologies- various types of fuel cells, materials for electrodes, electrolytes and other components, working mechanisms, hydrogen generation and storage; limitations, recent progress in fuel cells.

References:

1. X. Moya David and Muñoz-Rojas(Ed.), Materials for Sustainable Energy Applications Conversion, Storage, Transmission, and Consumption, 2016, Pan Stanford Publishing Pvt. Ltd.
2. L. Liu and S.Bashir, Advanced Nanomaterials and their Applications in Renewable Energy, Elsevier Science, 2015
3. A.Yu, V. Chabot, and J. Zhang, Electrochemical Supercapacitors for Energy Storage and Delivery Fundamentals And Applications, Taylor & Francis Group, 2013.
4. F. Beguin and E. Frackowiak, Supercapacitors- Materials, Systems, and Applications. Wiley- VCH Verlag GmbH & Co. 2013.
5. V. Hacker, S. Mitsushima (Eds.), Fuel Cells and Hydrogen: From Fundamentals to Applied Research, Elsevier, 2018

<table>
<tr><td>Course Title</td><td colspan="3">Astrobiology and Extraterrestrial Life</td><td colspan="2">Course Type</td><td colspan="2">OE</td></tr>
<tr><td>Course Code</td><td>M24SPSO301</td><td>Credit</td><td colspan="2">4</td><td colspan="2">Class</td><td colspan="2"></td></tr>
<tr><td rowspan="5">Course Structure</td><td>LTP</td><td>Credit</td><td>Contact Hours</td><td>Work Load</td><td colspan="2" rowspan="2">Total Number of Classes Per Semester</td><td colspan="2" rowspan="2">Assessment weightage</td></tr>
<tr><td>Lecture</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>4</td><td>4</td><td>4</td><td>48</td><td>-</td><td>50%</td><td>50%</td></tr>
</table>

Course Overview

This course explores the characteristics and conditions necessary for habitable planets, including potential locations for life within our solar system such as Mars, Europa, and Enceladus. It covers methods for detecting exoplanets and analyzing bio-signatures in their atmospheres, preparing students for missions aimed at searching for signs of extraterrestrial life and intelligence, as well as the ethical considerations of contacting potential extraterrestrial civilizations.

Course Objectives:

1. Study the astrophysical universe, ranging from solar system objects through stars, to galaxies and the structure of the universe as a whole.
2. Explore the history of astrobiology and the development of theories surrounding the origins and conditions necessary for life, from early Earth to extreme environments and the rise of multicellularity.
3. Explore the history of astrobiology and the development of theories surrounding the origins and conditions necessary for life, from early Earth to extreme environments and the rise of multicellularity.
4. know the formation of stars, including their classification using the Hertzsprung-Russell (HR) diagram, and explore phenomena such as white dwarfs, neutron stars, pulsars, supernovae, and stellar black hole
5. Examine the formation of the solar system, characteristics of the Sun across its different zones, and properties of interior and exterior planets, their satellites, as well as the Kuiper belt and Oort cloud.
6. Identify characteristics and conditions necessary for habitable planets, explore potential locations for life within our solar system such as Mars, Europa, Enceladus, and other icy bodies, and understand methods for detecting exoplanets.

Course Outcomes:

CO #	Course Outcomes:	POs	PSos

CO1	Describe the laws that govern the astrophysical phenomena.	1,2,3	1
CO2	Explain the nature and properties of compact astrophysical objects.	2,3	2
CO3	Elaborate astrophysical observations and measurements.	3,4	1
CO4	Discuss the principles of formation of the Planets and Comets.	1,2	1
CO5	To evaluate habitable planet conditions, detect exoplanets, and analyze bio-signatures, preparing for the search for extraterrestrial life and intelligence missions.	4,5	2
CO6	To know the life span of the universe, star and Sun	5,6	1

Course content

Unit -1 **6 hrs**

Basic Concepts of Astrophysics: Basic concepts - Astronomical Units, Light year, parallax, Astronomical Coordinates, Kepler's Laws, Optical telescopes and their characteristics, Modern Optical telescopes, Astronomical Instruments – Photometer, Photographic plates, Spectrographs, Charge Coupled Detector.

Unit-2 **6 hr**

Astrobiology History of Astrobiology, Life on earth, structure of Life – building blocks, cells, Life on earth – Conditions on early earth, evidence of life, the tree of life, life in extreme environments, the rise of multicellularity, the great oxidation event.

Unit-3 **6 hrs**

Star & Solar system Formation of star, Classification of star – HR diagram, White dwarfs, Neutron stars, Pulsars, Supernovae, Stellar Black holes, Solar system - formation of solar system, sun – characteristics & its different zones, Interior & Exterior planets – properties, satellites, Kuiper belt, Oort clouds.

Unit-4 **6 hrs**

Habitable planets & Extraterrestrial Intelligence Habitable planets – Characteristics & Conditions, Life on Mars – locations, Europa, Enceladus & Other Icy Bodies, Methods of detection of exoplanets, Bio-signature of life on exoplanet atmosphere, How to 86 look Bio-signatures, Missions to search for Bio-signatures, Contacting Extraterrestrial civilization, the search of Extraterrestrial intelligence

Books for reference:

1. BW Carroll & DA Ostlie, An Introduction to Modern Astrophysics, Latest Edition, AddisonWesley (2005).
2. Martin Harwit, Astrophysical Concepts, Latest Edition, Springer,(2014)
3. C.R. Kitchin, Astrophysical Techniques, CRC press,(2015).
4. Carroll, Bradley W., and Dale A. Ostlie. An Introduction to Modern Astrophysics. Reading, MA: Addison-Wesley Pub., 1995.
5. Kippenhahn, Rudolf, and Alfred Weigert. Stellar Structure and Evolution. New York, NY: Springer-Verlag, 1990.

6. Teerikorpi, P, The Evolving Universe and the Origin of Life, Springer publishing,2001.
7. Souza, Valeria, Segura, Antígona, Foster, Jamie, Astrobiology and Cuatro Ciénegas Basin as an Analog of Early Earth, Springer, 1990

Course Title	**General Physics Lab –III**				**Course Type**		**HC**	
Course Code	M24SP0303	**Credit**	**2**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	-	-	-				
	Tutorial	-	-	-				
	Practical	2	4	4	**Theory**	**Practical**	**CIE**	**SEE**
	Total	**2**	**4**	**4**	**48**	**-**	**50%**	**50%**

COURSE OVERVIEW:

This course immerses students in fundamental physics ideas through hands-on experiments, developing abilities in precise measurement using advanced tools such as lasers and spectrographs. They use lasers and gratings to investigate optical phenomena such as diffraction and refraction, testing theoretical rules with practical data. Bridging theory to practical applications in physics and astrophysics prepares students for research and real-world applications, while also encouraging curiosity and innovation in experimental physics.

COURSE OBJECTIVES:

The objectives of this course are to:

1. To introduce the basic concepts of physics through hands on experience and impart experimental skill to students.
2. To develop the ability to perform precise measurements of physical properties using advanced instruments and methodologies, such as laser systems and spectrographs
3. To Investigate optical phenomena such as diffraction, reflection, and refraction using lasers and gratings, enhancing understanding through practical experimentation
4. To Verify fundamental physical laws experimentally, reinforcing theoretical concepts with practical observations and measurements.
5. To bridge theoretical knowledge with practical applications in physics and astrophysics, preparing students for research and real-world applications.
6. To explore through hands-on experiments, promoting curiosity and innovation in the field of experimental physics.

COURSEOUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs

CO1	To gain a comprehensive understanding of the electronic and optical properties of materials, including charge carrier density, refractive index, and attenuation coefficients	1,2,3	1
CO2	Students will acquire skills in spectroscopic and diffraction techniques, enabling them to analyze spectral properties and verify fundamental laws such as Fresnel's and Mallu's laws.	2,3	2
CO3	To acquire proficiency in conducting laser-based experiments, including the determination of laser beam parameters and studying diffraction through apertures.	1,4	3
CO4	To interpret phase diagrams of binary mixtures, such as Pb-Sn alloys, enhancing their knowledge of material science and phase transitions.	1,5	1,2
CO5	To expertise in evaluating the performance of optical fibers by determining parameters like numerical aperture and attenuation coefficient, essential for telecommunications and sensor applications	2,3	1
CO6	To apply experimental physics principles to real-world problems, such as measuring atmospheric extinction coefficients and determining the distances of astronomical objects, thereby linking theoretical concepts with practical applications.	3,4	1,2,3

LIST OF EXPERIMENTS:

1. Hall effect experiment: Determination of Hall co-efficient and charge carrier density.
2. Determination of laser beam parameters
3. Verification of Mallu's law.
4. Experiments with lasers and reflection grating.
5. To photograph the spectra of Fe (standard) and Cu arc using CDS spectrograph and to determine the
wavelengths of Cu spectrum using Hartman formula.
6. Fresnel's law verification
7. Determination of Numerical aperture and attenuation coefficient of an optical cable.
8. Refractive index of liquids/solids using laser light.
9. Diffraction of laser light through two closely spaced circular apertures.
10. Determination of Distance of Pleids Clusters by Main sequence Fitting and Using Clea Software.
12. Determination of Atmospheric Extinction Coefficients using Clea software using Photometry data.
12. Estimation of Hubble's constant using Clea Software.
13. Study of phase diagram using Pb- Sn alloy as a binary mixture.

Course Title	**Electronics Lab (Practical)**			**Course Type**	**SC**
Course Code	**M24SPS331**	**Credit**	**4**	**Class**	

Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment weightage	
	Lecture	-	-	-				
	Tutorial	-	-	-				
	Practical	2	4	4	Theory	Practical	CIE	SEE
	Total	**2**	**4**	**4**	**-**	**48**	**50%**	**50%**

COURSE OVERVIEW:

This course covers practical applications of operational amplifiers (OP-AMPs) and modulation techniques. Students will design OP-AMP circuits for square wave generation, active integrator, differentiator, and a 4-bit DAC using R-2R ladder network. They will also implement second-order Butterworth active filters, study modulation methods including AM, DSB-SC, SSB-SC, FM, and their demodulation. Additionally, the course includes designing pre-emphasis and de-emphasis circuits, verifying the Sampling Theorem, and implementing PAM, PWM, PPM, Delta, and Adaptive Delta modulation techniques.

COURSE OBJECTIVES:

The objectives of this course are to:

1. Familiarize students with applications of 741 IC's.
2. Analyse AM and FM modulation and demodulation techniques.
3. Convert analog to a digital signal, sampling and quantization.
4. To design digital modulation techniques.
5. Familiarize the conversion of data from Analog to Digital and Digital to Analog.

COURSEOUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Design of OPAMP circuits as a comparator, differentiator, 4-bit DAC	1,2,3	1
CO2	Analyze the functioning of basic electronic circuits of AM and FM modulation and demodulation through experimentation using discrete electronic components	2,3	2
CO3	Verify sampling theorem by experiment.	1,4	3
CO4	Verify different modulation and demodulation techniques through experimentation	1,5	1,2
CO5	Draw the outputs of various angle modulation and demodulation systems.	2,3	1
CO6	Verify the outputs of ASK, FSK, PSK circuits.	3,4	1,2,3

Course Outcomes:

On successful completion of this course, the student shall be able to:

1. Analyze the functioning of basic electronic circuits of AM and FM modulation and demodulation through experimentation using discrete electronic components.
2. Verify sampling theorem by experiment.
3. Verify different modulation and demodulation techniques through experimentation.
4. Draw the outputs of various angle modulation and demodulation systems
5. Verify the outputs of ASK, FSK, PSK circuits.

List of Experiments:

Analog and Digital communication lab

1. Design and implementation of OP-AMP as a square wave generator.
2. Design and implementation of OP-AMP active integrator and differentiator.
3. Design and test the operation of 4-bit DAC using R-2R ladder network and OP-AMP MA741.
4. Design a second-order Butterworth active low pass filter and high pass filter.
5. Amplitude modulation and demodulation.
6. DSB SC modulation and demodulation.
7. SSB SC modulation and demodulation.
8. Frequency modulation and demodulation.
9. Pre Emphasis-De Emphasis circuits.
10. Verification of sampling theorem.
11. PAM generation and reconstruction.
12. PWM AND PPM: generation and reconstruction
13. Delta and Adaptive delta modulation.

<table>
<tr><td>Course Title</td><td colspan="4">Condensed Matter Physics Lab (Practical)</td><td colspan="2">Course Type</td><td colspan="2">SC</td></tr>
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<tr><td>Lecture</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Tutorial</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td>2</td><td>4</td><td>4</td></tr>
<tr><td>Total</td><td>2</td><td>4</td><td>4</td><td>-</td><td>48</td><td>50%</td><td>50%</td></tr>
</table>

COURSEOVERVIEW:
This course covers X-ray powder diffraction (XRD) for determining lattice parameters of FCC and BCC crystals, particle size, stress, and strain analysis. It includes the synthesis of metal nanoparticles,

Reitveld refinement using FullProf Suite, energy gap determination from absorption spectra, and thermoluminescence glow curve analysis. Students will also measure Curie temperatures, estimate CIE coordinates for nanophosphors, and study I-V characteristics of semiconducting materials.

COURSEOBJECTIVES:

1. XRD Analysis Skills: Develop the ability to analyze and determine lattice parameters, particle size, stress, and strain using X-ray powder diffraction (XRD) data for FCC and BCC crystals.
2. Nanoparticle Synthesis: Gain practical experience in synthesizing metal nanoparticles through the solution combustion technique.
3. Software Proficiency: Learn to perform Reitveld refinement and other advanced data analyses using FullProf Suite software.
4. Optical and Luminescence Techniques: Acquire the skills to determine energy gaps using absorption spectra and analyze thermoluminescence glow curves.
5. Magnetic and Electrical Characterization: Measure Curie temperatures, estimate CIE coordinates of nanophosphors, and study I-V characteristics of semiconducting materials.

COURSEOUTCOMES(COs):

CO#	Course Outcomes	POs	PSOs
CO1	Students will be able to accurately analyze XRD data to determine lattice parameters, particle size, stress, and strain for FCC and BCC crystals.	2,4,5	1
CO2	Students will demonstrate the ability to synthesize metal nanoparticles using the solution combustion technique.	4,5	2
CO3	Students will effectively use FullProf Suite software to perform Reitveld refinement and other complex data analyses.	3,5	1
CO4	Students will be proficient in determining energy gaps using absorption spectra and analyzing thermoluminescence glow curves.	3, 4	1,4
CO5	Students can measure Curie temperatures using the B-H curve for hard and soft ferromagnetic materials.	3, 4	1, 3
CO6	Students will be able to analyze the I-V characteristics of semiconducting materials using a Keithley source meter and estimate CIE coordinates of nanophosphor samples.	3,5	1,4

Course Content:
LIST OF EXPERIMENTS:

1. Analysing and determining the lattice parameters (h k l) values of FCC crystals by X-ray powder diffractogram data.
2. Analysing and determining the lattice parameters (h k l) values of BCC crystals by X-ray powder diffractogram data.
3. Determination of particle size, stress and strain using PXRD data.
4. Synthesis of metal nanoparticles by solution combustion technique.

5. Determination of Reitveld refinement parameter using full proof suit software.
6. Determination of energy gap by using absorption spectra.
7. Analysis and estimation of kinetic parameters of Thermoluminescence glow curves.
8. Determination of Curie temperature using B-H curve of a Ferromagnetic material (both hard and soft).
9. Estimation of CIE coordinates of nanophosphors samples.
10. Study of I-V characteristics of semiconducting material by using Kithely source meter.

Course Title	**Photonics Lab (Practical)**				**Course Type**		**SC**	
Course Code	**M24SPS333**	**Credit**	**2**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	-	-	-				
	Tutorial	-	-	-				
	Practical	2	4	4	**Theory**	**Practical**	**CIE**	**SEE**
	Total	**2**	**4**	**4**	**-**	**48**	**50%**	**50%**

COURSEOVERVIEW:
Course objectives

1. To provide knowledge about lasers and laser characteristics for the use in Industry and research
2. To explain the basic phenomena of acoustic optic and electro optics effects
3. To demonstrate different applications of Mach zender interferometer
4. To perform and understand the single mode and multimode fiber light propagation propeties under various conditions.

Course outcomes:

CO#	Course Outcomes	POs	PSOs
CO1	To get knowledge of LASER beam characteristics.	2,4,5	1
CO2	To understand and demonstrate Acousto optic efffect on laser beam	4,5	2
CO3	To illustrate non-linear optical properties and to gain knowledge of electro optic effects	3,5	1

CO4	To apply optics and physics of materials knowledge in demonstrating optoelectronic devices- solar cell	3, 4	1,4
CO5	Evaluation of multimodes of a multimode fiber by a laser.	3, 4	1, 3
CO6	Explore the applications of Mach –Zender interferometer.	3,5	1,4

Course Content:

1. Verification of Gaussian nature, divergence angle and spot size of the given laser beam
2. Mach-Zender Interferometer:
    i. Determination of wavelength of a semiconductor laser
    ii. Determination of Refractive index of given transparent glass slab
    iii. Determination of Refractive index of air medium
3. Optical Fiber Characterization
    A. Single mode Fiber Fiber Characterization
        i. Bending losses
        ii. Splice losses
    B. Single mode Fiber Characterization
4. Ultrasonic diffraction
    i. To measure the velocity of ultrasonic wave in liquid
    ii. To determine the bulk modulus of the liquid
    iii. To find the compressibility of given liquid
5. Determination of refractive index of a given medium using Brewster angle method
6. Pockels Effect (Electro-optic effect)
    i. Intensity variation as a function of applied voltage
    ii. Half wave voltage
    iii. Birefringence Vs applied voltage
7. Solar Cell Characterization
    i. To plot the I-V characteristic curve of a solar cell
    ii. To observe the relationship of current, voltage and power in a solar cell
    iii. To identify maximum power point, Short circuit current and open circuit current

Course Title	Advanced Materials and Technology (Practical)				Course Type		SC	
Course Code	M24SPS334	Credit	2		Class			
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment weightage	
	Lecture	-	-	-				
	Tutorial	-	-	-				
	Practical	2	4	4	Theory	Practical	CIE	SEE
	Total	**2**	**4**	**4**	**-**	**48**	**50%**	**50%**

COURSEOVERVIEW:

COURSEOBJECTIVES:

The objectives of this course are to:

1. To introduce the basic concepts of physics through hands on experience and impart experimental skill to students.
2. To develop the ability to perform precise measurements of physical properties using advanced instruments and methodologies.
3. To fabricate the hybrid devices for the solar cell, photo diode and memory device application.
4. To verify various application of materials such as themoluminescence, photoluminescence and photocatalytic application.

COURSEOUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Analyse the characterization of solar cells and photodiode	2,4,5	1
CO2	To illustrate super capacitor properties of materials	4,5	2
CO3	To apply and physics of materials knowledge in demonstrating memory devices devices- solar cell	3,5	1
CO4	Evaluate photoluminescence properties of various materials	3, 4	1,4

List of Experiments

1. I-V characteristics study of solar cells
2. I-V characteristics of Photodiode
3. I-V characteristics study for memory devices applications
4. Photoluminescence characterization of nanomaterials
5. Thermoluminescence characterization

6. Photocatalytic applications of nanomaterials
7. Nanomaterial synthesis for Anti-bacterial applications
8. Thin-film preparation techniques: Spin coating.
9. Supercapacitor studies different materials.

References:

1. X. Moya David and Muñoz-Rojas (Ed.), Materials for Sustainable Energy Applications Conversion, Storage, Transmission, and Consumption, 2016, Pan Stanford Publishing Pvt. Lt
2. F. Beguin and E. Frackowiak, Supercapacitors- Materials, Systems, and Applications. Wiley-VCH Verlag GmbH & Co. 2013

Course Title	**Mini Project**				**Course Type**		**HC**	
Course Code	**M24SP0304**	**Credit**	**2**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	-	-	-				
	Tutorial	-	-	-				
	Practical	2	4	4	**Theory**	**Practical**	**CIE**	**SEE**
	Total	**2**	**4**	**4**	**-**	**48**	**50%**	**50%**

COURSE OVERVIEW:
Master a specific physics area through extensive research. Develop skills in literature review, experimental design, and data analysis. apply theoretical knowledge and gain hands-on experience with advanced tools. improve scientific writing and presentation. Learn to efficiently manage and complete research projects.

COURSE OBJECTIVES:

1. **Deep Understanding**: Achieve in-depth knowledge in a specific area of physics.
2. **Research Skills**: Develop literature review, experimental design, and data analysis proficiency.
3. **Problem-Solving**: Apply theory to solve complex physics problems.
4. **Technical Proficiency**: Gain hands-on experience with advanced tools and techniques.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	**Research Competence**: Demonstrate the ability to conduct independent research and produce original findings in a specific area of physics.	2,4,5	1
CO2	**Technical Expertise**: Gain proficiency with advanced experimental techniques, computational tools, and instrumentation relevant to the research.	4,5	2
CO3	**Analytical Skills**: Develop strong analytical and critical thinking skills for evaluating scientific data and hypotheses.	3,5	1
CO4	**Scientific Communication**: Enhance the ability to effectively communicate research results through written reports, publications, and oral presentations.	3, 4	1,4
CO5	Interpret and draw conclusions from research data	3, 4	1, 3
CO6	Interpret research findings and communicate them effectively in written and oral formats	3,5	1,4

FOURTH SEMESTER

Course Title	Research Methodology				Course Type		HC	
Course Code	M24SPS401	Credit	2		Class			
Course Structure	LTP	Credit	Contact Hours	Work Load	Total Number of Classes Per Semester		Assessment weightage	
	Lecture	2	2	2				
	Tutorial	-	-	-				
	Practical	-	-	-	Theory	Practical	CIE	SEE
	Total	2	2	2	24	-	50%	50%

COURSE OVERVIEW:

This course introduces research methodologies across various fields. It covers the fundamental aspects of conducting research, including formulating a research problem, data collection and analysis, and interpreting and reporting results.

COURSE OBJECTIVES:

The objectives of this course are to:

1. To provide an understanding of the fundamental principles and types of research.
2. To equip students with the skills needed to identify and formulate research problems.
3. To teach effective methods for data collection and analysis.
4. To develop the ability to interpret research findings and communicate them effectively through written reports.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	Understand and apply fundamental principles and types of research.	1	1,4
CO2	Develop and refine research questions and hypotheses.	1	1,4
CO3	Apply appropriate data collection methods.	1	1
CO4	Recognize and address ethical issues in research.	1	1
CO5	Interpret and draw conclusions from research data	1	1
CO6	Interpret research findings and communicate them effectively in written and oral formats	1	1,4

Research Methodology

Unit-1 6 hrs

Research and Types of research: Meaning of Research, Objectives of Research, Motivation in Research, Types of research, research approach, significance of research, Research methods vs Methodology, Applied vs. Fundamental research, Quantitative vs. Qualitative research, Conceptual vs Empirical, Research Process, Criteria of good Research

Unit-2 6hrs

Formulation of research problem: Defining and formulating the research problem -Selecting the problem -Necessity of defining the problem -Importance of literature review in defining a problem, Critical literature review, Identifying gap areas from literature review, Development of working hypothesis and objectives.

Unit-3 6hrs

Data Collection and analysis: Execution of the research, Observation and Collection of data, Methods of data collection, Modeling, Statistical design of experiments- types and principles Mathematical Models of experiments- types and principles. Data processing and Analysis strategies, Hypothesis-testing.

Unit-4 6hrs

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing for funded projects, Different Steps in Writing Report funded projects, Layout of the Research Report for publications, Types of Reports, Mechanics of Writing a R esearch Report, Application of ICT in research., plagiarism, ethical considerations in research.

Reference Books:

1. Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar, SAGE Publications, 2014.
2. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by John W. Creswell and J. David Creswell, SAGE Publications, 2017
3. The Craft of Research by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams, University of Chicago Press, 2016.
4. Practical Research: Planning and Design by Paul D. Leedy and Jeanne Ellis Ormrod, Pearson, 2019
5. Formulating Research Methods for Information Systems: Volume 2 edited by Leslie P. Willcocks, Chris Sauer, and Mary C. Lacity, Springer, 2016
6. Developing Research Questions: A Guide for Social Scientists by Patrick White, Palgrave Macmillan, 2013
7. Qualitative Research: A Guide to Design and Implementation by Sharan B. Merriam and Elizabeth J. Tisdell, Jossey-Bass, 2015
8. The SAGE Handbook of Qualitative Data Collection edited by Uwe Flick, SAGE Publications, 2018

9. Research Methods: The Basics by Nicholas Walliman, Routledge, 2017
10. Writing Research Reports: A Practical Guide for Science, Engineering, and Technology Students by L. A. Smith, Springer, 2012
11. Publication Manual of the American Psychological Association by American Psychological Association, APA, 2020
12. The Chicago Guide to Writing About Numbers by Jane E. Miller, University of Chicago Press, 2015

Course Title	**Astrophysics and Cosmology**				**Course Type**		**HC**	
Course Code	**M24SP0402**	**Credit**	**4**		**Class**			
Course Structure	**LTP**	**Credit**	**Contact Hours**	**Work Load**	**Total Number of Classes Per Semester**		**Assessment weightage**	
	Lecture	4	4	4				
	Tutorial	-	-	-				
	Practical	-	-	-	**Theory**	**Practical**	**CIE**	**SEE**
	Total	**4**	**4**	**4**	**48**	**-**	**50%**	**50%**

COURSEOVERVIEW:

This course provides a comprehensive exploration of astrophysics and cosmology, covering foundational concepts such as planetary motions, celestial mechanics, and the interaction of radiation with matter. Students gain proficiency in using advanced astronomical instruments like telescopes and spectrographs, and study notable space-based observatories such as the Hubble Space Telescope. Topics also include cosmological theories, stellar evolution, galaxy dynamics, astrobiology, and the search for habitable planets and extraterrestrial intelligence. The course emphasizes analyzing astronomical data and understanding the broader implications of our universe's evolution and structure.

COURSEOBJECTIVES:

The objectives of this course are to:

1. Gain a comprehensive understanding of planetary motions, celestial mechanics, and the interaction of radiation with matter in astrophysical contexts.
2. Study prominent space observatories like the Hubble Space Telescope and Chandra X-ray Observatory, and their contributions to astronomical research and discovery.
3. Investigate cosmological theories, stellar formation processes, galaxy dynamics, and phenomena such as supernovae, black holes, and dark matter.
4. Explore the conditions necessary for life on Earth and potential habitable planets, methods for detecting exoplanets, and the search for extraterrestrial life and intelligence.
5. To Acquire proficiency in analyzing astronomical data, including measurements of astronomical quantities, properties of stars and galaxies, and the evolution of the universe's structures.

6. To Gain insights into the evolution of the universe, including its large-scale structures, redshift phenomena, and the physical conditions within astronomical objects from planets to galaxies.

COURSEOUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	To Understand fundamental astrophysical concepts, including celestial motions and planetary dynamics.	1,2,3	1
CO2	To Analyze the lifecycle of stars, from formation to endpoints such as white dwarfs, neutron stars, and black holes, utilizing theoretical models and observational data.	2,3	2
CO3	To Explain high-energy astrophysical phenomena, including radiation-matter interactions and the origins of X-rays and gamma rays in the universe.	1,4	3
CO4	To Evaluate theories in astrobiology and exoplanetary science, focusing on conditions for habitability, methods for detecting exoplanets and biosignatures, and the quest for extraterrestrial intelligence.	1,5	1,2
CO5	To develop skills in analyzing astronomical data, including measurements of astronomical quantities, stellar properties, distances, and the evolution of structures in the universe	1,2,3	1
CO6	To investigate the history of astrobiology, conditions for life on Earth and potentially habitable planets, methods for detecting exoplanets, and the search for extraterrestrial intelligence.	3,4	2

Unit-1: 12 hrs

Basic concepts of Astrophysics: Introduction to astrophysics- Various culture Influence on cosmology (Indian/Greek/Mayan Civilization), sky coordinates and motions, Earth's rotation, timekeeping (sidereal vs. synodic periods), and trigonometric parallax. Study of planetary motions through Kepler's Laws and Newtonian gravity. Examination of light and energy, including radiation across different bands. Overview of the celestial sphere, astronomical coordinate systems, and the measurement of time. Introduction to astronomical instrumentation: Interaction of Radiation with matter – Sources of high energy (UV-gamma rays) radiation in the universe - Detectors for high energy particles, X-rays, gamma rays and neutrinos – Space astronomy - such as photometers, photographic plates, spectrographs, and charge-coupled detectors (CCDs). Optical & Modern Telescopes –working &characteristics, Astronomical Instruments – Photometer, Photographic plates, Spectrographs, Charge Coupled Detector – basic principle & working. Notable space-based telescopes- Hubble Space Telescope (HST) and Chandra X-ray Observatory.

Unit-2: 12 hrs

Introduction to Cosmology: Theories of formation of solar system, sun – characteristics & its different zones, Interior & Exterior planets – properties, satellites, Kuiper belt, Oort clouds. Galaxies- Milky Way's structural components and Hubble's classification of galaxies, Examination of the Milky Way's dynamics, covering its rotation, differential rotation, Oort constant, rotation curve, dark matter, spiral arms, stars, and star clusters. Exploration of Active Galactic Nuclei (AGN) - supermassive black holes, quasars, radio galaxies, Seyfert galaxies, BL Lac Objects, and the unified model of AGNs (qualitative only). Stellar Formation and Classification – HR diagram, Main sequence evaluation, White dwarfs, Neutron stars, Pulsars, Supernovae, Stellar Black holes, Hubble's law, distances of external galaxies, dark matter, Olbers' paradox, the Big Bang, cosmic microwave background radiation, and models of the Universe (open, closed, flat) (Qualitative only).

Unit-3: 12 hrs

Astrobiology, Habitable planets &-Extraterrestrial Intelligence: Introduction, History of Astrobiology, Life on earth, structure of Life – building blocks, cells, Life on earth – Conditions on early earth, evidence of life, the tree of life, life in extreme environments, the rise of multicellularity, the great oxidation event 70 Habitable planets – Characteristics & Conditions, Life on Mars – locations, Europa, Enceladus & Other Icy Bodies, Methods of detection of exoplanets, Bio-signature of life on exoplanet atmosphere, How to look Bio-signatures, Missions to search for Bio-signatures, Contacting Extraterrestrial civilization, the search of Extraterrestrial intelligence

Unit -4: 12 hrs

Analysis of astronomical data: Qualitative description of various astronomical objects- planets to large-scale structures, and the physical conditions within these objects. Discussion of length, mass, and timescales, and the evolution of structures in the universe, including redshift. Measurement of astronomical quantities such as brightness, radiant flux, and luminosity, along with astronomical distances, stellar radii, masses of stars, and stellar temperatures.

Books for reference:

1. BW Carroll & DA Ostlie, An Introduction to Modern Astrophysics, Latest Edition,Addison-Wesley, 2004.

2. Martin Harwit, Astrophysical Concepts, Latest Edition, Springer,2014.

3. C.R. Kitchin, Astrophysical Techniques, CRC press,2016 .

4. Carroll, Bradley W., and Dale A. Ostlie. An Introduction to Modern Astrophysics. Reading, MA: Addison-Wesley Pub., 1995.

5. Kippenhahn, Rudolf, and Alfred Weigert. Stellar Structure and Evolution. New York, NY: SpringerVerlag, 1990.

6. Teerikorpi, P, The Evolving Universe and the Origin of Life, Springer publishing, ISBN 978-3-030-17921-2.

7. Souza, Valeria, Segura, Antígona, Foster, Jamie, Astrobiology and Cuatro Ciénegas Basin as an Analog of Early Earth, Springer, 2017

8. Donald Goldsmith, Hidden Worlds and the Quest for Extraterrestrial Life, Harvard University press,2013,

9. M. Longair, High Energy Astrophysics, vol. 1 and 2, Cambridge University Press,2012 10. F. Melia, High Energy Astrophysics, Princeton University Press, 2013 11. Ya B. Zeldovich and I.D. Novikov, Relativistic Astrophysics, vol. I, Stars and Relativity,2014

<table>
<tr><td>Course Title</td><td colspan="3">Major Project</td><td colspan="2">Course Type</td><td colspan="2">HC</td></tr>
<tr><td>Course Code</td><td>M24SP0403</td><td>Credit</td><td colspan="2">4</td><td colspan="2">Class</td><td></td></tr>
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<tr><td>Lecture</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Tutorial</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Theory</td><td rowspan="2">Practical</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td></tr>
<tr><td>Practical</td><td>8</td><td>16</td><td>16</td></tr>
<tr><td>Total</td><td>4</td><td>16</td><td>16</td><td>-</td><td>48</td><td>50%</td><td>50%</td></tr>
</table>

COURSE OVERVIEW:

Master a specific physics area through extensive research. Develop skills in literature review, experimental design, and data analysis. apply theoretical knowledge and gain hands-on experience with advanced tools. improve scientific writing and presentation. Learn to efficiently manage and complete research projects.

COURSE OBJECTIVES:

1. **Deep Understanding**: Achieve in-depth knowledge in a specific area of physics.
2. **Research Skills**: Develop literature review, experimental design, and data analysis proficiency.
3. **Problem-Solving**: Apply theory to solve complex physics problems.
4. **Technical Proficiency**: Gain hands-on experience with advanced tools and techniques.
5. **Scientific Communication**: Enhance scientific writing and presentation abilities.
6. **Critical Thinking**: Cultivate analytical skills through hypothesis evaluation.
7. **Project Management**: Learn to manage and complete research projects efficiently.

COURSE OUTCOMES(COs):

On successful completion of this course, the student shall be able to:

CO#	Course Outcomes	POs	PSOs
CO1	**Research Competence**: Demonstrate the ability to conduct independent research and produce original findings in a specific area of physics.	2,4,5	1
CO2	**Technical Expertise**: Gain proficiency with advanced experimental techniques, computational tools, and instrumentation relevant to the research.	4,5	2
CO3	**Analytical Skills**: Develop strong analytical and critical thinking skills for evaluating scientific data and hypotheses.	3,5	1

CO4	**Scientific Communication**: Enhance the ability to effectively communicate research results through written reports, publications, and oral presentations.	3, 4	1,4
CO5	**Project Management**: Exhibit strong project management skills, including planning, organization, and time management to complete research objectives.	3, 4	1, 3
CO6	**Career Readiness**: Prepare for careers in academia, industry, or research institutions by gaining practical experience and demonstrating professional competence in physics research.	3,5	1,4

Project:

Each student will choose the topic of research particularly from any area of soft cores studied and work under the guidance of allocated faculty member. The project shall preferably be application oriented or industry need based that could be useful to the society. In case of industry need base project the student may opt co-supervisor from the concerned industry. The student will have to make a preliminary survey of research done in broad area of his/her area of interest and decide on the topic in consultation with his/her supervisor(s). The project work floated should be completed within 16 weeks and project report has to be submitted within the stipulated date by the University/within 18 weeks whichever is earlier. The student has to meet the concerned supervisor(s) frequently to seek guidance and also to produce the progress of the work being carried out. The student should also submit progress report during 5th week and 10th week of the beginning of the semester and final draft report with findings by 15th week. After the completion of the project the student shall submit project report in the form of dissertation on a specified date by the School.

Career Development and Placement

Having a degree will open doors to the world of opportunities for you. But Employers are looking for much more than just a degree. They want graduates who stand out from the crowd and exhibit real life skills that can be applied to their organizations. Examples of such popular skills employers look for include:

1. Willingness to learn
2. Self motivation
3. Team work
4. Communication skills and application of these skills to real scenarios
5. Requirement of gathering, design and analysis, development and testing skills
6. Analytical and Technical skills
7. Computer skills
8. Internet searching skills
9. Information consolidation and presentation skills
10. Role play
11. Group discussion, and so on

REVA University therefore, has given utmost importance to develop these skills through variety of training programs and such other activities that induce the said skills among all students. A full-fledged Career Counseling and Placement division, namely Career Development Center (CDC) headed by well experienced senior Professor and Dean and supported by dynamic trainers, counselors and placement officers and other efficient supportive team does handle all aspects of Internships and placements for the students of REVA University. The prime objective of the CDC is to liaison between REVA graduating students and industries by providing a common platform where the prospective employer companies can identify suitable candidates for placement in their respective organization. The CDC organizes pre-placement training by professionals and also arranges expert talks to our students. It facilitates students to career guidance and improve their employability. In addition, CDC forms teams to perform mock interviews. It makes you to enjoy working with such teams and learn many things apart from working together in a team. It also makes you to participate in various student clubs which helps in developing team culture, variety of job skills and overall personality.

The need of the hour in the field of Physics is knowledge in the subject, but also the skill to do the job proficiently, team spirit and a flavour of innovation. This kept in focus, the CDC has designed the training process, which will commence from second semester along with the curriculum. Special coaching in personality development, career building, English proficiency, reasoning, puzzles, and communication skills to every student of REVA University is given with utmost care. The process involves continuous training and monitoring the students to develop their soft skills including interpersonal skills that will fetch them a job of repute in the area of his / her interest and march forward to make better career. The School of Applied sciences also has emphasised subject based skill training through lab practice, internship, project work, industry interaction and many such skilling techniques. The students during their day to day studies are made to practice these skill techniques as these are inbuilt in the course curriculum. Concerned teachers also continuously guide and monitor the progress of students.

The University has also established University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director to facilitate skill related training to REVA students and other unemployed students around REVA campus. The center conducts variety of skill development programs to students to suite to their career opportunities. Through this skill development centre the students shall compulsorily complete at least two skill / certification based programs before the completion of their degree. The University has collaborations with Industries, Corporate training organizations, research institutions and Government agencies like NSDC (National Skill Development Corporation) to conduct certification programs. REVA University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana.

The University has also signed MOU's with Multi-National Companies, research institutions, and universities abroad to facilitate greater opportunities of employability, students' exchange programs for higher learning and for conducting certification programs.

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