

**10** YEARS  
OF UNIVERSITY  
RECOGNITION  
**20** YEARS OF  
ACADEMIC  
EXCELLENCE



**REVA**  
UNIVERSITY  
Bengaluru, India

# School of Applied Sciences M.Sc. PHYSICS

## HANDBOOK-2020-2022

Rukmini Knowledge Park  
Kattigenahalli, Yelahanka, Bengaluru – 560064

[www.reva.edu.in](http://www.reva.edu.in)

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Kattigenahalli, Yelahanka, Bengaluru – 560064



**REVA**  
UNIVERSITY

Bengaluru, India

**SCHOOL OF APPLIED SCIENCES**

**M.Sc., (Physics) Program**

**Hand Book**

**2020-22**

Rukmini Knowledge Park,  
Kattigenahalli, Yelahanka, Bangalore-560064  
Phone No: +91-080-66226622, Fax: 080-28478539

**Rukmini Educational**  
Charitable Trust

[www.reva.edu.in](http://www.reva.edu.in)

## 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 team-work 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 - a large number of 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.M.Dhanamjaya**  
Vice Chancellor, REVA University

## Director Message

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, Tunneling Electron microscope and other advanced technologies which help the people to visualize the unexplored world. 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 Material science/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 Material Science, 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 MSc 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 MSc 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.

The curriculum caters to and has relevance to local regional, national, global developmental needs.

Maximum number of curses are integrated with cross cutting issues with relevant to professional ethics, gender, human values, environment and sustainability.

**Dr. Beena G**

Director

School of Applied Sciences

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## **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 Divya Sree 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 27<sup>th</sup> 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 Kempegowda 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 programme 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 Sensor 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, Nano 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.

The 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 recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana. 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, Oklahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC<sup>2</sup>, 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 Ratna Prof. 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 Shubha Vidyaya, - 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.

## **Vision**

REVA University aspires to become an innovative university by developing excellent human resources with leadership qualities, ethical and moral values, research culture and innovative skills through higher education of global standards

## **Mission**

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centres
- 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

## **About 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 achieve excellence in studies and research through pedagogy and support interface between industry and academia

## Members of Board of Studies

### Board of Studies in Physics (PG)

Sl. No.	Name of Members	Designation
1.	<b>Dr. D V Sunitha</b> Associate Professor & Coordinator, Asst. Director School of Physical Sciences (Physics ) REVA University	Chairperson
2.	<b>Prof. Chandrabhas Narayana</b> , FRSC FNAScFASc Dean R&D Chemistry and Physics of Materials Unit Jawaharlal Nehru Centre for Advanced Scientific Research, Jakkur P.O., Bangalore 560064 INDIA	External Member
3.	<b>Dr. Manohar Rao</b> Principal Product specialist PerkinElmer India Pvt Ltd, No. 33, Swayam Prabhe North Park Road, Kumara Park East, Bangalore 560001	External Member
4.	<b>Dr. K.M. Eshwarappa</b> Associate Professor, Davangere University, Davangere, Karnataka Ph: +91-9036830242 E-mail: km.eshwarappa@gmail.com	External Member
5.	<b>Dr. Madeshkumar</b> Professor Ph: +91-9341271290 E-mail: madeshkumar@reva.edu.in	Internal Member
6.	<b>Dr. Jaydev Pattar</b> Associate Professor Ph: +91-9341271290 Email: jaydevpattar@rev.edu.in	Internal Member
7.	<b>Dr. P Anjaneyulu</b> Associate Professor Ph: +91-9989036960 E-mail: p.ajaneyulu@reva.edu.in	Internal Member
8.	<b>Dr. K Upendra kumar</b> Associate Professor Ph: +91-8374589647 E-mail: upendrakumar.k@reva.edu.in	Internal Member
9.	<b>Dr. K. Munirathnam</b> Assistant professor Ph: 9035286246 E-mail: <a href="mailto:munirathnam.k@reva.edu.in">munirathnam.k@reva.edu.in</a>	Internal Member
10.	<b>Mr. Rahul Patel</b> Ph: +91-99937262525 E-mail: roopampatel@gmail.com	Student representative

## 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 competitiveworld with greater confidence in becoming proud citizens of mother India.



## M. Sc. (Physics) Program

### Programme 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 programme 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 programme 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 programme deals with courses in classical mechanics, quantum mechanics, material science, semiconductors, electrodynamics and related areas.

### **Programme Educational Objectives (PEOs)**

The aim of the programme 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 Programme Educational objectives are to prepare the students to:**

PEO1	Pursue higher education through continuous learning with effective communication skills
PEO2	have successful professional careers in academia, industry and government
PEO3	Start own enterprise and provide solutions to scientific research problems
PEO4	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 programme, a student will be able to:

PO1	<b>Domain knowledge:</b> Apply the knowledge of physics and fundamentals for the solution of complex problems in day to day life.
PO2	<b>Problem analysis:</b> Identify, formulate, research literature, and analyze problems to arrive at substantiated conclusions using principles of physical sciences.
PO3	<b>Design/development of solutions:</b> 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.
PO4	<b>Conduct investigations of complex problems:</b> Use research-based knowledge, for analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	<b>Modern tool usage:</b> Apply appropriate techniques, resources, and IT tools including prediction and modeling to complex activities with an understanding of the limitations.
PO6	<b>Environmental and society:</b> 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.
PO7	<b>Environment and sustainability:</b> Understand the impact of the solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	<b>Ethics:</b> Apply ethical principles and commit to ethics, and responsibilities and norms of the professional practice
PO9	<b>Individual and team work:</b> Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.
PO10	<b>Communication:</b> 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.
PO11	<b>Life-long learning:</b> 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)**

PSO1	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.
PSO2	Identify , compare and and synthesis of materials of the materials best suited for futuristic scientific applications
PSO3	Explore the knoweledge of basic concepts of atomic, molecular, nuclear physics to analyse the spectra obtanied from various bodies.
PSO4	Demonstrate the knowledge of fundamentals of electronic devices and photonics

**REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Postgraduate Degree programs- 2020**  
(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 the “**REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Post Graduate Degree Programs- 2020**”.

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

**2. The Programs:**

The following programs and all Graduate Degree programs to be instituted and introduced in REVA University in coming years shall follow these regulations.

**M.Sc in:** Physics, Biotechnology, Biochemistry, Chemistry, Mathematics

**3. Definitions:**

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

(i) L= Lecture (ii) T= Tutorial (iii) P=Practice; where:

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

**T** stands for **Tutorial** session consisting participatory discussion / selfstudy/ 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 that equip students to acquire the much required skill component.

**4. Courses of study and Credits**

**4.1.** The study of various subjects in M. Sc., degree program are grouped under various courses. Each of these course carries credits which are based on the number of hours of teaching and learning.

**4.1.1.** In terms of credits, every **one hour session of L amounts to 1 credit per Semester.**

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** over a period of one Semester of 16 weeks for teaching-learning process.

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

**4.1.3. A course shall have either or all the four components.** That means a course may have only lecture component, or only practical component or combination of any two or all the three components.

**4.1.4. The concerned BoS will assign Credit Pattern for every course based on the requirement. However, generally, courses can be assigned with 1-4 Credits depending on the size of the course.**

**4.1.5. Different Courses of Study are labelled and defined as follows:**

**Core Course:**

A course which should compulsorily be studied by a candidate as a core-requirement is termed as a Core course. The CORE courses of Study are of THREE types, viz – (i) Hard Core Course, and (ii) Soft Core Course.

**a. Hard Core Course (HC):**

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.

**b. Soft Core Course (SC):**

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.

**c. Open Elective Course:**

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**.

**d. Project Work / Dissertation:**

Project work / Dissertation work is a special course involving application of knowledge in solving / analysing /exploring a real life situation / difficult problem. A project work carrying **FOUR or SIX** credits is called **Minor Project work / Dissertation**. A project work of **EIGHT, TEN, TWELVE or SIXTEEN** credits is called **Major Project work / Dissertation**. **A Project work may be a hard core or a Soft Core as decided by the BoS / concerned.**

**5. Eligibility for Admission:**

Bachelors Degree of three years with Biotechnology or any Life Science subject as one of the cognate / major / optional subjects with 45% (40% in case of candidates belonging to SC/ST) of marks in aggregate from any recognized University / Institution or any other qualification recognized as equivalent thereto.

## 6. Scheme, Duration and Medium of Instructions:

6.1. M.Sc., degree program is of 4 semesters - 2 years duration. A candidate can avail a maximum of 6 semesters (3 years) including blank semesters, if any to successfully complete M. Sc. degree. Whenever a candidate opts for blank semester, he/she has to study the prevailing courses offered by the School when he/she resumes his/her studies.

6.2. The medium of instruction shall be English.

## 7. Credits and Credit Distribution

7.1. A candidate has to earn 96 credits for successful completion of Two Year Postgraduate degree with a distribution of credits for different courses as given in Table - 1 given below:

**Table 1: Credits and Credit Distribution for Two Year Post Graduate degree programs**

Course Type	Credits for Two Year (4 Semesters) Post Graduate Degree Programs
Hard Core Course	A minimum of 60 but not exceeding 70
Soft Core Course	A minimum of 14 but not exceeding 30
Open Elective	A minimum of 04
RULO	A minimum of 2 but not exceeding 8
<b>Total</b>	<b>96</b>

7.2. 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 **Hard Core (HC) or Soft Core (SC) or Open Elective (OE)**.

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

However, following shall be the RULO (REVA Unique Learning Offerings) courses with credits mentioned against them, common to all branches of study. However the BOS of respective program/ discipline shall decide about the total credits for RULO courses.

RULO Courses		
Sl. No.	Course Title	Number of Credits
1	Sports, Yoga, Music, Dance, Theatre	2
2	MOOC / Swayam/ Coursera/Internship /Soft Skill Training	6
	<b>Total</b>	<b>8</b>

- 7.4. The concerned BOS shall specify the desired Program Objectives, Program Educational Objectives, Program Specific Outcomes and Course Outcomes while preparing the curriculum of a particular program.
- 7.5. A candidate can enrol for a maximum of 30 credits and a minimum of 20 credits per Semester. However he / she may not successfully earn a maximum of 30 credits per semester. This maximum of 30 credits does not include the credits of courses carried forward by a candidate.
- 7.6. Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to IV semester and complete successfully 96 credits in 4 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.

## **8. Add-on Proficiency Certification / Diploma:**

### **8.1 Add- on Proficiency Certification:**

To acquire Add on Proficiency Certification a candidate can opt to complete a minimum of 4 extra credits either in the same discipline /subject or in different discipline / subject in excess to 96 credits for the Two Year Post Graduate degree programs.

### **8.2 Add on Proficiency Diploma:**

To acquire Add on Proficiency Diploma, a candidate can opt to complete a minimum of 18 extra credits either in the same discipline /subject or in different discipline / subject in excess to 96 credits for the Two Year Post Graduate degree programs.

The Add on Proficiency Certification / Diploma so issued to the candidate contains the courses studied and grades earned.

## **9. Assessment and Evaluation**

a) Each course is assessed for a total weight of 100%. Out of the total 100% weight; 50% weight is for Continuous Internal Assessment (CIA or IA) and the remaining 50% for the Semester End Examination (SEE). This applicable for theory, laboratory, workshop, studio and any such courses

b) Out of 50% weight earmarked for Internal Assessment (IA)- 15% for test-1, 15% for test-2 and 20% for Assignments and this is applicable for theory based courses

c) The tests and assignments are conducted as per the semester academic calendar provided by the University

**The details as given in the table**

<b>Component</b>	<b>Description</b>	<b>Conduction</b>	<b>Weight Percentage</b>
C1	Test-1: IA1	6 <sup>th</sup> week from the starting date of semester	15
	Test-2: IA2	12 <sup>th</sup> week from the starting date of semester	15
C2	1 Assignment/Seminar	7 <sup>th</sup> week	10
	2 Assignment/Seminar	13 <sup>th</sup> week	10
C3	SEE including practical	between 17 <sup>th</sup> Week-20 <sup>th</sup> Week	50
<b>Results to be Announced</b>			<b>By the end of 21<sup>st</sup> Week</b>

Note: IA or CIA includes C<sub>1</sub> and C<sub>2</sub>

Each test must be conducted for a duration of 60 minutes, setting the test question paper for a maximum of 30 marks. The final examination must be conducted for a duration of 3 hours and the question paper must be set for a maximum of 100 marks.

Students are required to complete courses like technical skills, placement related courses, Open electives and any such value addition or specialized courses through online platforms like SWAYAM/NPTEL/Any other reputed online education aggregator. Students are required to choose the courses on the advice of their course coordinator/Director and required to submit the course completion certificate along with percentage of marks/grade scored in the assessment conducted by the online education aggregator. If the online education aggregator has issued a certificate along with the grade or marks scored to students, such courses will be considered for SGPA calculations, in case the aggregator has issued only a certificate and not marks scored, then such courses will be graded through an examination by concerned School, in case, if grading is not possible, students will be given a pass grade and award the credit and the credits will not be considered for SGPA calculations. The Online/MOOCs courses will not have continuous internal assessment component

Such of those students who would like to discontinue with the open elective course that they have already registered for earning required credits can do so, however, they need to complete the required credits by choosing an alternative open elective course.



### **Setting question paper and evaluation of answer scripts:**

- i. For SEE, three sets of question papers shall be set for each theory course out of which two sets will be by the internal examiners and one set will be by an external examiner. In subsequent years by carrying forward the unused question papers, an overall three sets of question papers should be managed and depending on the consumption of question papers either internal or external examiner be called for setting the question paper to maintain an overall tally of 3 papers with the conditioned mentioned earlier. The internal examiner who sets the question paper should have been course tutor
- ii. The Chairman of BoE shall get the question papers set by internal and external examiners.
- iii. The Board of Examiners shall scrutinize and approve the question papers and scheme of valuation. It is the responsibility of the BoE to see that all questions contained in the question paper are within the prescribed syllabus of the concerned course.
- iv. There shall be single valuation for all theory papers by internal examiners. However, there shall be moderation by the external examiner who has the subject background. In case no external examiner with subject background is available, a senior faculty member within the discipline shall be appointed as moderator.
- v. The SEE examination for Practical work / Field work / Project work/Internship will be conducted jointly by internal and external examiners as detailed below: However, the BoE on its discretion can also permit two internal examiners.
- vi. If a course is fully of (L=0):T:(P=0) type or a course is partly P type i.e, (L=3): (T=0) (P=1), then the examination for SEE component will be as decided by the BoS concerned.

### **10. Evaluation of Practical's and Minor Project / Major Project / Dissertation**

**10.3.1.** A practical examination shall be assessed on the basis of:

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

**10.3.2.** In case a course is fully of P type (L=0:T=0:P=4), the performance of a candidate shall be assessed for a maximum of 100 marks as explained below:

- a) Continuous Internal assessment (CIA) = 50 marks
- b) Semester end practical examination (SEE) = 50 marks

The 25 marks for continuous assessment shall further be allocated as under (IA or CIA):

i	Conduction of regular practical throughout the semester	20 marks
ii	Maintenance of lab records /industry reports/SDP reports	15 marks
iii	Laboratory test and viva	15 marks
	Total	50 marks

The 50 marks meant for Semester End Examination, shall be allocated as under:

i	Conduction 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

**10.3.3.** The SEE for Practical work will be conducted jointly by internal and external examiners. However, if external examiner does not turn up, then both the examiners will be internal examiners.

**10.3.4.** In case a course is partly P type i.e, (L=3): (T=0) (P=1), then the examination for SEE component will be as decided by the BoS concerned.

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

**10.4.** 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:

1	First Dissertation presentation describing the problem definition	Should be done a semester before the project semester	Weightage: 0%
2	Dissertation Progress presentation-1	7 <sup>th</sup> week from the start date of project semester	Weightage: 25%
3	Dissertation progress presentation-2	14 <sup>th</sup> Week from the start date of project semester	Weightage -25%
4	Final project Viva and Dissertation Submission	17 <sup>th</sup> -20 <sup>th</sup> Week of project Semester	Weightage: 30% for Dissertation Weightage : 20% for Final Viva Voce

### 11. Provision for Appeal

If a candidate is not satisfied with the evaluation of C1,C2 components, he/she can approach the grievance cell with the written submission together with all facts, the assignments, test papers etc, which were evaluated. He/she can do so before the commencement of 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 taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the grievance cell is final.

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

- The Registrar (Evaluation) - 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.

## **12. Eligibility to Appear Semester End Examination (SEE)**

**12.1.** 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 course(s), as provided in the succeeding sections, shall be eligible to appear for SEE examination.

### **12.2. Requirements to Pass a Course**

Students are required to score a total minimum of 40% (Continuous Internal assessment and SEE) in each course offered by the University/ Department for a pass (other than online courses) with a minimum of 20 (40% of 50) marks in final examination

## **13. Requirements to Pass the Semester**

To pass the semester, a candidate has to secure minimum of 40% marks in each subject / course of the study prescribed in that semester.

### **13.1 Provision to Carry Forward the Failed Subjects / Courses:**

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

### **13.2. Provision to Withdraw Course:**

A candidate can withdraw any course within ten days from the date of notification of final results. Whenever a candidate withdraws a course, he/she has to register for the same course in case it is hard core course, the same course or an alternate course if it is Soft Core Course or Open Elective Course. A DROPPED course is automatically considered as a course withdrawn.

### **13.3. Re-Registration and Re-Admission:**

a) 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 end semester examination (C3) and he / she shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

b) 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 he / she shall seek re-admission to such dropped semester.

#### **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.

a) 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 (C4) examination and such student shall seek re-admission as provided in 7.8.4.

b) Teachers offering the courses will place the above details in the School Board meeting during the last week of the semester, before the commencement of C3, and subsequently a notification pertaining to the above will be brought out by the Director of the School before the commencement of C3 examination. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

#### **15. Absence during Mid Semester Examination:**

In case a student has been absent from a mid-semester (C1,C2) examination due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Head of the School, for make-up examination. The Head 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 test for such candidate(s) well in advance before the C3 examination of that respective semester. Under no circumstances C1,C2 test shall be held after C3 examination.

#### **16. Grade Card and Grade Point**

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

(SGPA).

**16.2. Final Grade Card:** Upon successful completion of M.Sc., Degree a Final Grade card consisting of grades of all courses successfully completed by the candidate will be issued by the Registrar (Evaluation).

**16.3. 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 > 90	9	v*9	A+
70 > 80	8	v*8	A
60 > 70	7	v*7	B+
55 > 60	6	v*6	B
50 > 55	5.5	V*5.5	C +
40 > 50	5	v*5	P
0-40	0	v*0	F
ABSENT			AB

O - Outstanding; A-Excellent; B-Very Good; C-Good; D-Fair; E-Satisfactory; F - Fail

Here, P is the percentage of marks ( $P=[C1+C2+C3]$ ) secured by a candidate in a course which is **rounded to nearest integer**. V is the credit value of course. G is the grade and GP is the grade point.

### 16.3.1. 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) =  $\sum(Ci \times Gi) / \sum Ci$**  where Ci is the number of credits of the i<sup>th</sup> course and Gi is the grade point scored by the student in the i<sup>th</sup> course.

### Illustration for Computation of SGPA and CGPA

#### Illustration 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	3	B+	7	3X7=21
Course 4	3	O	10	3X10=30
Course 5	3	P	5	3X5=15
Course 6	3	B	6	3X6=18
Course 7	2	O	10	2X10=20
Course 8	2	A	8	2X8=16
	24			188

Thus, **SGPA =  $188 \div 24 = 7.83$**

#### Illustration 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	3	A+	9	3X9=27
Course 4	3	B+	7	3X7=21
Course 5	3	B	6	3X6=18
Course 6	3	P	5	3X5=15
Course 7	2	B+	7	2X7=21
Course 8	2	O	10	2X10=20
	24			175

Thus, **SGPA =  $175 \div 24 = 7.29$**

#### Illustration No.3

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade point)
Course 1	4	O	10	4 x 10 = 40
Course 2	4	A+	9	4 x 9 = 36
Course 3	3	B+	7	3 x 7 = 21
Course 4	3	B	6	3 x 6 = 18
Course 5	3	A+	9	3 x 9 = 27
Course 6	3	B+	7	3 x 7 = 21
Course 7	2	A+	9	2 x 9 = 18
Course 8	2	A+	9	2 x 9 = 18
	24			199

Thus, **SGPA =  $199 \div 24 = 8.29$**

### Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (96) for Two year Post Graduate degree program is calculated taking into account all the courses undergone by a student over all the semesters of a program i. e.,

$$CGPA = \frac{\sum(C_i \times S_i)}{\sum C_i}$$

Where  $S_i$  is the SGPA of the  $i$ th semester and  $C_i$  is the total number of credits in that semester.

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

#### Illustration: No.1

CGPA after Final Semester

Semester (ith)	No. of Credits (Ci)	SGPA (Si)	Credits x SGPA (Ci X Si)
1	24	6.83	24 x 6.83 = 163.92
2	24	7.71	24 x 7.71 = 185.04
3	24	8.68	24 x 8.68 = 208.32
4	24	9.20	24 x 9.20 = 220.80
Cumulative	96		778.08

$$\text{Thus, CGPA} = \frac{24 \times 6.83 + 24 \times 7.71 + 24 \times 8.68 + 24 \times 9.20}{96} = 8.11$$

96

### 16.3.2. CONVERSION OF GRADES INTO PERCENTAGE:

*Conversion formula for the conversion of CGPA into Percentage is:*

$$\text{Percentage of marks scored} = \text{CGPA Earned} \times 10$$

$$\text{Illustration: CGPA Earned } 8.10 \times 10 = 81.0$$

### 16.3.3. 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	P	Pass	Satisfactory



**Overall percentage=10\*CGPA**

**17. Challenge Valuation**

- a. A student who desires to apply for challenge valuation shall obtain a photo copy of the answer script by paying the prescribed fee within 10 days after the announcement of the results. He / She can challenge the grade awarded to him/her by surrendering the grade card and by submitting an application along with the prescribed fee to the Registrar (Evaluation) within 10 days after the announcement of the results. This challenge valuation is only for SEE. The answer scripts for which challenge valuation is sought for shall be evaluated by the external examiner who has not involved in the first evaluation. The higher of two marks from first valuation and challenge valuation shall be the final.
- b. With regard to any specific case of ambiguity and unsolved problem, the decision of the Vice-Chancellor shall be final.

### Mapping of PEOs with Respect to POs

	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10	PO 11
PEO1	3	1	1	1	1		3	1			3
PEO2	3	3	2			1			3		
PEO3	3		3	3	2		2			1	
PEO4	3		1		1	1			1	3	2

### Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

Course Code	PO S/COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P O 7	PO 8	PO 9	P O 10	PO 11	PS O1	PS O2	PS O3	PS O4
M20PH1010 Mathematical Physics	1	3	3		1	1	1			2	3	2	3			
	2	3	3		1	1	1			2	3	2	3			
	3	3	3		1	1	1			2	3	2	3			
	4	3	3		1	1	1			2	3	2	3			
M20PH1020 Classical Mechanics	1	3	3	1	2	2			1			2	3			
	2	3	2	2	2	2			1				3			
	3	3	3	2	3	2	1	1	1			2	3			
	4	3	2	1	1	1			1			2	3			
M20PH103 Electronic devices	1	3	3		1	1	1			2		1				3
	2	3	3	2	1	2						2				3
	3	3	3	2						2		2				3
	4	3	3	2	1	2						2				3
M20PH1040 Quantum Mechanics I	1	3	3	3	1	1	1			2		3	3			
	2	3	3	3							2	3	3			
	3	3	3							2		3	3			
	4	3	3								2	3	3			
M20PH1050 Solid state physics	1	3	2	2	2	2	1	1	1			1		3		
	2	3	2	2	2	2	1	1	1			1		3		
	3	3	2	2	2	2	1	1	1			1		3		
	4	3	2	3	3	3	1	1	1			1		3		
M20PH2010 Quantum Mechanics II	1	3	3	3	1	1	1				2	3	3			
	2	3	3	3	1	1	1			2		3	3			
	3	3	3		1	1	1				2	3	3			
	4	3	3		1	1	1			2		3	3			
M20PH2020 Statistical Mechanics	1	3	3	1	3	2						2	3			
	2	3	3	1	2	1						1	3			
	3	2	3	2	3	3						2	3			
	4	3	2	1	2	2						2	3			
M20PH2030 Electrodynamics	1	3	2		1	1	1			2	1	1	3			
	2	3	2		1	1	1			2	1	1	3			
	3	3	2		1	1	1			2	1	1	3			
	4	3	2		1	1	1			2	1	1	3			
M20PH2040	1	3	2	1	2	2			1			2			3	

<b>Atomic and Molecular Physics</b>	2	3	2	2	2	2			1					3	
	3	3	3	3	3	3	1	1	1			2		3	
	4	2	2	1	1	1			1			2		3	
<b>M20PH2051 Electronics-I :Digital electronics</b>	1	3	3	3		1	1	1		2		1			3
	2	3	3	3	1	2						2			3
	3	3	3	3								2			3
	4	3	3	3	1	2						2			3
<b>M20PH2052 Condensed Matter Physics - I</b>	1	3	2	1	2	2			1	1		2		3	
	2	3	3	3	3	3	1	1	1	1		2		3	
	3	3	2	2	2	2			1	1				3	
	4	2	2	1	1	1			1	1		2		3	
<b>M20PH2053 Photonics-I</b>	1	3	3		1	1	1								3
	2	3	2	2	2	2			1						3
	3	3	2	1	2	2	1		1						3
	4	3	2	2	2	2			1						3
<b>M20PH3010 Astrophysics</b>	1	3	3	2	1	3	1	1			2	1	3		
	2	3	3	1	3	3						3	3		
	3	3	3	1			1				2		3		
	4	3	3	1				1				1	3		
<b>M20PH3020 Nano- science and Nanotechnology</b>	1	1	2	2	2	2	1	1	1			1		3	
	2	1	2	2	2	2	1	1	1			1		3	
	3	1	2	2	2	2	1	1	1			1		3	
	4	1	2	3	3	3	1	1	1			1			
															3
<b>M20PH3030 Nuclear and Particle physics</b>	1	3	3	2	3	2	1					2		3	
	2	3	3	2	3	2		1	1			2		3	
	3	3	3	1	3	3						2		3	
	4	3	3	1	2	2		1						3	
<b>M20PH3041 Electronics – II: Digital Electronics</b>	1	2	3							2		1			3
	2	2	3	2	1	2						2			3
	3	2	3	2								2			3
	4	2	3	2	1	2						2			3

**M Sc (Physics) Program  
Scheme of Instructions  
(Effective from Academic Year 2019-20)**

**SEMESTER-I**

Sl. No.	Course Code	Title of the Course	Course Type	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1	M20PH1010	Mathematical Physics	HC	3	1	0	4	5
2	M20PH1020	Classical Mechanics	HC	3	1	0	4	5
3	M20PH1030	Electronic devices	HC	3	1	0	4	5
4	M20PH1040	Quantum Mechanics I	HC	3	1	0	4	5
5	M20PH1050	Solid state physics	HC	3	1	0	4	5
<b>Practical Courses</b>								
6	M20PH1060	General Physics lab - I	HC	0	0	3	3	5
7	M20PH1070	Electronics lab	HC	0	0	3	3	5
<b>Total Credits</b>				<b>15</b>	<b>5</b>	<b>6</b>	<b>26</b>	<b>35</b>

**SEMESTER-II**

Sl. No.	Course Code	Title of the Course	Course Type	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1	M20PH2010	Quantum Mechanics II	HC	3	1	0	4	5
2	M20PH2020	Statistical Mechanics	HC	3	1	0	4	5
3	M20PH2030	Electrodynamics	HC	3	1	0	4	5
4	M20PH2040	Atomic and Molecular Physics	HC	3	1	0	4	5
5	M20PH2051	Electronics - I :Digital electronics	SC <sup>#</sup>	2	1	0	3	4
6	M20PH2052	Condensed Matter Physics - I	SC <sup>#</sup>					
7	M20PH2053	Photonics-I	SC <sup>#</sup>					
8	M20PH2060	Music, Dance, sports, Theater, Yoga	RULO	0	0	2	2	3
9	M20PH2070	Skill development Programme	RULO	0	0	2	2	3
<b>Practical Courses</b>								
10	M20PH2080	General Physics lab - II	HC	0	0	3	3	5
11	M20PH2090	Atomic and Molecular Physics Lab	HC	0	0	3	3	5
<b>Total Credits</b>				<b>14</b>	<b>5</b>	<b>10</b>	<b>29</b>	<b>40</b>

**Note: #Soft Core (SC):** Student shall opt for one SC of his/her choice which will be continued in higher semesters also.

### SEMESTER-III

Sl. No.	Course Code	Title of the Course	Course Type	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1	M20PH3010	Astrophysics	HC	2	1	0	3	4
2	M20PH3020	Nano-science and Nanotechnology	HC	2	1	0	3	4
3	M20PH3030	Nuclear and Particle physics	HC	2	1	0	3	4
4	M20PH3041	Electronics – II: Digital Electronics and Communication Systems	SC <sup>#</sup>	3	1	0	4	5
5	M20PH3042	Condensed Matter Physics – II	SC <sup>#</sup>					
6	M20PH3043	Photonics-II	SC <sup>#</sup>					
7	M20PH3051	Electronics – III: Linear integrated circuits	SC <sup>#</sup>	3	1	0	4	5
8	M20PH3052	Condensed Matter Physics - III	SC <sup>#</sup>					
9	M20PH3053	Photonics-III	SC <sup>#</sup>					
10	M20PH3060	Astrobiology and Extraterrestrial Life	OE <sup>#</sup>	3	1	0	4	5
<b>Practical Courses</b>								
11	M20PH3070	General Physics lab - III	HC	0	0	3	3	5
12	M20PH3081	Electronics Lab	SC <sup>#</sup>	0	0	3	3	5
13	M20PH3082	Condensed Matter Physics Lab						
14	M20PH3083	Photonics Lab						
<b>Total Credits</b>				<b>15</b>	<b>6</b>	<b>6</b>	<b>27</b>	<b>37</b>

**Note: i) #OE is Open Elective Course** offered for students of other Schools; the students of MSc –Physics shall take any ONE of the OE course offered by other Schools.

**ii) \*Soft Core (SC):** Students shall have to continue the Soft Core opted during the Second Semester

### SEMESTER-IV

Sl. No.	Course Code	Title of the Course	Course Type	Credit Pattern & Credit Value				Contact Hours
				L	T	P	Total	
1	M20PH4010	Research methodology	HC	2	0	0	2	2
2	M20PH4020	Major Project	HC	0	0	8	8	16
3	M20PH4030	MOOC/SWAYAM	RULO	0	0	4	4	-

	/Internship*						
<b>Total Credits</b>			<b>0</b>	<b>0</b>	<b>14</b>	<b>14</b>	<b>20</b>
<b>Total Credits of I to IV Semesters</b>			<b>44</b>	<b>16</b>	<b>36</b>	<b>96</b>	<b>132</b>

**Note:** \* The students shall undergo Internship during summer vacation and mid-term vacation soon after Second and Third Semester exams are completed and present the report on the Internship undergone during the Fourth Semester for evaluation.

#### Semester-wise Summary of Credit Distribution

Semesters	No. of Credits	No. of Hours
First Semester	26	35
Second Semester	29	40
Third Semester	27	37
Fourth Semester	14	20
<b>Total Credits</b>	<b>96</b>	<b>132</b>

#### Distribution of Credits Based on Type of Courses

Semester	HC	SC	OE	RULO	TOTAL
<b>I</b>	26	-	-	-	26
<b>II</b>	22	3	-	4	29
<b>III</b>	12	11	4	-	27
<b>IV</b>	10	-	-	4	14
<b>Total</b>	<b>70</b>	<b>14</b>	<b>4</b>	<b>8</b>	<b>96</b>

HC=Hard Core; SC=Soft Core; OE=Open Elective;  
RULO=REVA Unique Learning Offerings

#### Distribution of Credits Based on L: T: P

Semester	L	T	P	Total	Total Hours
<b>I</b>	19	5	6	26	35
<b>II</b>	10	5	8	25	40
<b>III</b>	15	6	6	27	37
<b>IV</b>	0	0	14	18	20
<b>Total</b>	<b>44</b>	<b>16</b>	<b>36</b>	<b>96</b>	<b>132</b>

## Detailed Syllabus

(Effective from Academic Year 2020-21)

### FIRST SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH1010	MATHEMATICAL PHYSICS	HC	3	1	0	4	5

#### Course Objectives:

To make the students understand the basics of mathematical functions necessary for formulating physical systems and phenomena observed in day to day life.

#### Course Outcomes:

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

1. Apply the mathematical skills to solve quantitative problems in the study of physics.
2. Solve the problems related to vectors and matrices for various applications.
3. The student shall be able to apply coordinate transforms to solve the physical problems expressed in tensors.
4. Apply the knowledge of Fourier transforms, Laplace transforms and mathematical special function in solving the problems in physics.

#### Course Content:

##### Unit-1:

12 hrs

##### Vectors & Tensors:

Review of Vector analysis, Gradient, Divergence and Curl operations, Gauss' and Stokes' theorem and its 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 tensors, 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, Gram-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, 4<sup>th</sup> 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).
7. Tensor Analysis — Theory & Applications. Sokolnikoff LS, 211: Edition, John Wiley Sons (1964).
8. Mathematical Methods in the Physical Sciences, Mary L. Boas, 2nd Edition, John Wiley & Sons (1983).
9. Matrices and Tensors in Physics, A.W. Joshi, 4<sup>th</sup> Edition, New Age International Publishers (1995).



Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20PH1020	CLASSICAL MECHANICS	HC	3	1	0	4	5

**Course Objectives:**

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:**

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

1. Apply the Lagrangian methods to analyze and explain the problems in classical Mechanics
2. Analyse the Central force problems to explain the Classification of orbits, Kepler's laws in planetary motion.
3. Apply the concept of Hamilton's equations to derive the expression for different principles in classical mechanics
4. Solve problems related to the mechanics of rigid bodies, the precession of rotation of earth and Rutherford's scattering, and Communicate scientific information of classical mechanics.

**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 (Variational 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 coordinates. Cyclic coordinates, Canonical Transformations, examples of Canonical transformations, Generating functions (Four basic types), 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.

**Special Theory of relativity:** Galilean Transformation, Principle of relativity and speed of light, Lorentz Transformations and its consequences.

**References Books:**

1. Classical Mechanics, J.C Upadhyaya, Himalaya Publishing house.(2005)
2. Classical mechanics, H. Goldstein, C. Poole, J. saflco. 3<sup>rd</sup> 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, 4<sup>th</sup> edition, Pergamon Press (1985).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH1030	ELECTRONIC DEVICES	HC	3	1	0	4	5

### Course Objectives:

1. To understand the basic working of Semiconducting devices and Linear Integrated Circuits.
2. To give an emphasis to the student to know the various semiconductor devices and its working.
3. To give clear understanding of various fabrication techniques of semiconducting devices.
4. To introduce the basic building blocks of linear integrated circuits.

### Course Outcomes:

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

1. Analyse the BJT circuits, operation and its characteristics.
2. Design a DC bias circuitry of BJT, UJT and SCR.
3. Construct an OPAMP circuit for different applications and develop the prototypes of electronic devices
4. Solve real time examples of BJT, UJT, SCR and OPAMP, and able to describe various opto-electronic devices

### 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 and AC load line, Transistor as an amplifier-Single stage and multistage amplifier, frequency response, Push-pull amplifier, Astable multi-vibrator using transistors, Voltage regulator 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 Uni-junction 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, phase shift oscillator.

**Unit 4:**

**12 hrs**

**Optoelectronic devices:** Photoresistor (LDR)–dark resistance, Principle and working of a photodiode, Principle and working of Light emitting diode, factors affecting the efficiency of LED, Phototransistor- structure and working, Semiconductor laser- basic structure and working. LED, Plasma Display, Liquid Crystal Displays, Numeric Displays.

**Reference Books:**

1. Basic Electronics and Linear Circuits, NN Bhargava, DC Kulashreshtha and SC Gupta, Tata Mc Graw Hill
2. Electronic Devices and Circuits: An Introduction, Allen Mottershead, Prentice Hall of India
3. Semiconductor Optoelectronic Devices, Pallab Bhattacharya, Pearson education, Asia.
4. Electronic Principles, A P Malvino, (Sixth Edition, 1999), Tata McGraw Hill, New Delhi.
5. A Text Book of Basic Electronics, RS Sedha, S Chand & Company Ltd.
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.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20PH1040	QUANTUM MECHANICS – I	HC	3	1	0	4	5

**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:

1. Understand the mathematical representations and analysis used in quantum mechanics.
2. Postulate the basics of quantum mechanics.
3. Apply Schrodinger wave equation for one dimensional problem like, particle in a box, harmonic oscillator etc and three dimensional problems in quantum mechanics.
4. Solve numerical based on angular momentum and spin operators and analyze the result obtained in Stern-Gerlach experiment.

**Course Content:**

**Unit – 1**

**12 hrs**

**Introduction:** Dual nature of matter and waves, Double-slit experiment for photons and electrons as an illustration. Fundamental Postulates of Quantum Mechanics, Review of Linear vector spaces in Dirac Bra-Ket notation, Position and momentum representations, Wave functions, Superposition principle, probability densities, probability current, Expectation values, Commutators, Eigen values and eigenvectors of a complete set of mutually commuting operators, Waves, wave packets, phase velocity and group velocity, Canonically conjugate variables, General uncertainty principle, Hamiltonian, Time-dependent and independent Schrodinger's wave equation, Ehrenfest's Theorem, Continuity equation.

**Unit - 2****12 hrs**

**Exactly solvable problems in one-dimension:** free particle (Unbound state-continuous spectrum), particle in a box (bound state-Discrete spectrum)- potential barrier and wells, Tunneling, Transmission and Reflection co-efficient, Ramsauer -Townsend effect, Alpha decay, Infinite square well potentials: symmetric and asymmetric wells, finite square well potentials: scattering and bound state solutions, simple Harmonic Oscillator: wave function and operator approach.

**Unit – 3****12 hrs**

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

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

**Unit - 4:****12 hrs**

**Exactly solvable problems in three dimensions:** separation of Schrodinger equation in Cartesian coordinates, Simple harmonic oscillator in 3-dimensions, Free particle in 3-d box – Effects of the exclusion principle on non-interacting fermions in a box, central potential, Schrodinger equation in Spherical coordinates-separation of variables  $r, \Phi, \Theta$ . The hydrogen atom – radial equation; energy spectrum; degeneracy of the spectrum; radial wave functions and probability density  $P(r)$  for finding the electron at a distance from the center; evaluation of expectation values of  $r^n$ .

**Reference Books:**

1. N. Zettili, Quantum Mechanics: Concepts and Applications, 2<sup>nd</sup> edition, John Wiley (2009)
2. A Ghatak and S Lokanathan, Quantum Mechanics, Theory and Applications, Macmillan (2004).
3. Stephen Gasiorowicz, Quantum Physics, 3<sup>rd</sup> edition, John Wiley (2003).
4. E. Merzbacher, Quantum Mechanics. 3<sup>rd</sup> edition, John Wiley(1994).
5. V.K. Thankappan, Quantum Mechanics, Wiley Eastern (1985).
6. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, TMH(1977).

7. B.Brandsden, C.Joachain, Quantum Mechanics, 2nd ed, Pearson/Prentice Hall, (2000).
8. R.L.Liboff, Introduction to Quantum Mechanics, Pearson Education(2003).
9. J.S.Townsend, A Modern Approach to Quantum Mechanics, 2nd ed, McGraw Hill.
10. C.Cohen-Tannoudji, B.Diu, F.Laloe, Quantum Mechanics (2 vol. set), Wiley Interscience (1996).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH1050	Solid state Physics	HC	3	1	0	4	5

### Course Objectives:

1. To introduce the basic principles underlying the behavior of materials.
2. To provide scientific foundation for understanding the relations among material 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 levels of structure from atoms through defects in crystals to larger scale morphology of practical materials.

### Course Outcomes:

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

1. Distinguish the relationship between a material's microstructure and its properties.
2. Analyze the properties of defects can affect the strength of a material.
3. Compare the elastic and plastic behavior of materials.
4. Analyze the phase diagrams to synthesize different phases of materials.

### Course Content:

#### Unit - 1:

**12 hrs**

#### Structural properties

Classification of solids: crystalline, non-crystalline, nanophase solids, liquids. Crystalline solids: Periodic arrays of atoms: lattice translation vectors, basis and the crystal structure primitive lattice cell, fundamental types of lattices two-dimensional lattice types three-dimensional lattice types, index system for crystal planes, simple crystal structures (hexagonal close-packed diamond and cubic zinc sulfide structure). Bragg's law in direct and reciprocal lattice, Diffraction of waves by crystals: X-rays, neutrons, electrons. brillouin zones, brillouin zones

reciprocal lattice to sc, bcc, fcc lattice fourier analysis of the basis, structure factor of the bcc and fcc lattice, atomic form factor, quasicrystals.

## **Unit - 2: Lattice dynamics**

**12 hrs**

vibrations of crystals with monatomic basis, first brillouin zone, group velocity, long wavelength limit, derivation of force constants from experiment, two atoms per primitive basis, quantization of elastic waves, viscoelastic behavior, Fracture of materials – ductile and brittle fracture – ductile brittle transition

Phonons and phonon momentum, inelastic scattering by phonons, phonon heat capacity, Planck distribution, normal mode enumeration density of states in one dimension and three dimensions, Debye model for density of states, Debye  $T^3$  law, an harmonic crystal interactions, thermal resistivity of phonon gas, Phase diagrams- the phase rule and it's applications to binary alloy systems- isomorphous, eutectic and peritectic - the lever rule, Heat treatment processes- annealing, hardening and tempering

## **Unit - 3:**

**12 hrs**

### **Electrical and optical properties**

Electron motion in a periodic potential, Kronig penny model, band theory of solids: nearly free electron and tight binding models; metals, semiconductors and insulators; conductivity, mobility, Energy levels in one dimension, effect of temperature on the Fermi-Dirac distribution, free electron gas in three dimensions, heavy fermions, Effective mass and concept of holes. Fermi surface, Fermi energy, experimental electrical resistivity of metals, Semiconductors: Carrier concentrations in intrinsic and extrinsic semiconductors, Electronic interband transitions, Excitons, Frenkel excitons.

## **Unit - 4:**

**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, Antiferromagnetism, Susceptibility below and above Neel's temperature.

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



**Reference Books:**

1. Elements of material science and engineering, Lawrence H. Van Vlack Addison Wesley (1975).
2. Material science and engineering, V. Raghavan, Prentice Hall (1993)
3. Nature of chemical Bond, L Pauling, Oxford and IBH (1960)
4. An introduction to crystallography, F.C. Phillips, Longman (1970)
5. Crystallography applied to solid state physics, Verma and srivastava New age international (2005)
6. Introduction to solid Solid state physics, C. kittel, Wiley Eastern (1993)
7. The structure and properties of Materials vol I- IV- Rose, Shepard and wulff (1987)
8. Introduction to solids, L. V Azaroff, Mc Graw Hill (1977)
9. Foundation of material science and engineering, William F. Smith, Mc Graw Hill international Editions (1988)
10. Solid state Physics Source Book- Sybil P Parker (Ed), Mc Graw Hill (1987).
11. Solid state phase transformations, V. Raghavan, Prentice hall (1991).
12. Material science and engineering, William D. Callister, Jr. Callister John Wiley & Sons, Inc (1997)

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH1060	GENERAL PHYSICS LAB - I (PRACTICAL)	HC	0	0	3	3	5

**Course Objectives:**

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 concepts in modern optics.
4. To allow the student to understand the fundamentals of instruments involved.

**Course Outcomes:**

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

1. Verify various laws of physics related to optics.
2. Determine the physical parameters through experiments.
3. Analyze the concepts of physics through experiments.

**Course Content:****LIST OF EXPERIMENTS:**

1. Verification of law of intermediate metals
2. Study the thermo emf and hence to determine inversion temperature.
3. Measurement of resistivity of a semiconductor by Four probe method at different temperature and determination of energy gap.
4. Design and study of the frequency response of CE transistor amplifier.
5. Determination of Stefan's constant and Verification of Stefan's fourth power law by electrical method.
6. Determination of Energy band gap of two different semiconductors.
7. Determination of solar constant.
8. Thermal Conductivity of a rod by Forbe's method.
9. Determination of temperature sensitivity of a thermocouple and its Calibration.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH1070	ELECTRONICS LAB (PRACTICAL)	HC	0	0	3	3	5

**Course Objectives:**

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

1. Analyze the characteristics of MOSFET and SCR.
2. Verify the outputs of astable, monostable and VCO circuits using ICs.
3. Design and construct the Single Stage BJT and FET Amplifier circuits.
5. Design voltage regulator using Zener diode and regulated power supply using IC.

**Course Content:****List of Experiments:**

1. Experiment on UJT and its applications.
2. Astable, monostable and bistable multivibrator using IC 555 timer.
3. Voltage controlled oscillator using IC741 and 555.
4. Zener diode characteristics and voltage regulation.
5. Study of FET characteristics and its applications in amplifier.
6. Study of MOSFET characteristics and its applications as amplifier.
7. Characteristics and applications of SCR.
8. Monostable multivibrator using IC 74127.
9. Design of regulated power supply.
10. Solving Boolean expressions.

**SECOND SEMESTER**

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH2010	QUANTUM MECHANICS –II	HC	3	1	0	4	5

**Course Objective:**

1. To familiarize students with the advanced quantum mechanical concepts for better understanding of behavior of sub-atomic particles.

**Course Outcomes:**

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

1. Understand Symmetry in quantum mechanics.
2. Apply approximation methods for quantum mechanical problems.
3. Understand the radiation and matter interaction
4. Understand the concepts of relativistic quantum mechanics.

**Course Content:****Unit1: Symmetry in quantum mechanics****12 hrs**

Symmetry transformation, Spatial translation -conservation of linear momentum, translation in time- Conservation of energy, Rotation in space- conservation of angular momentum, discrete

symmetries: parity and time reversal, Permutation symmetry: symmetric and anti-symmetric wave functions for two identical particles, Slater determinant and Pauli exclusion principle, Excited states of helium atom: ortho and para helium atom.

**Unit 2:**

**12 hrs**

**Approximation methods:**

**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. **Time dependent perturbation theory:** time dependent perturbation series-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, identical particles scattering.

**Scattering:** scattering cross-section, scattering amplitude, partial waves, scattering by a spherically symmetric potential- partial wave analysis, optical theorem, scattering by perfectly rigid sphere potential, scattering cross section-Born approximation-integral method, Validity of Born approximation.

**Unit – 4: Relativistic quantum mechanics**

**12 hrs**

Klein-Gordon 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, Non relativistic limit of Dirac equation for a free particle moving in a central potential, spin-orbit energy. Dirac particle under the influence of a uniform external magnetic field – magnetic moment for the Dirac particle

**Reference Books:**

1. Quantum mechanics, B.H. Bransden and Joachain, 2<sup>nd</sup> Edition Pearson Education (2004).
2. Quantum mechanics: concepts and applications, Nouredine Zettili, 2<sup>nd</sup> Edition, Wiley (2018)
3. Introduction to Quantum mechanics, David J. Griffiths, 2<sup>nd</sup> Edition, Pearson Education (2005).
4. Modern Quantum mechanics, J.J. Sakurai, Pearson Education, (2000).
5. Quantum mechanics, V.K Thankappan, 2<sup>nd</sup> Edition 2004. Pri
6. Quantum Mechanics, E. Merzbacher, 3<sup>rd</sup> edition, John Wiley (1994).
7. Quantum mechanics, Stephen Gasiorowicz, John Wiley (2003).
8. Principles of Quantum mechanics, R. Shankar, 2<sup>nd</sup> Edition, Prentice Hall, 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 Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH2020	STATISTICAL MECHANICS	HC	3	1	0	4	5

**Course Objectives:**

1. To make students understand the basics of Thermodynamics and Statistical systems.
2. To make students understand the various laws of thermodynamic.
3. To acquire the knowledge of various statistical distributions.
4. To comprehend the concepts of enthalpy, phase transitions and thermodynamic functions.

**Course Outcomes:**

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

1. Solve day-to-day life selected problems using thermodynamics laws.
2. Analyze various distribution laws.
3. Apply the concepts to test distribution laws.
4. Apply the distribution laws to solve physical problems.

**Course Content:**

**Unit – 1:****12 hrs****Thermodynamics**

Thermodynamic laws, Isothermal process, Adiabatic process, Isochoric process, Isobaric process, Relation between thermodynamic laws, Examples & Numerical problems of thermodynamics process in day to day life: Thermodynamic description of phase transitions, Surface effects in condensation. Phase equilibria; Equilibrium conditions; Classification of phase transitions; phase diagrams; Clausius-Clapeyron equation, applications, Van der Waals equation of state. Thermoelectric phenomenon, Peltier effect, Seebeck effect, Thomson effect, numerical problems.

**Unit-2****12 hrs****Classical statistical mechanics:**

The postulate of equal a priori probability; The Liouville theorem; Statistical Ensembles & examples - microcanonical ensemble, canonical ensemble, 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 a 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., Statistical 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.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH2030	Electrodynamics	HC	2	1	0	3	4

### Course Objective:

1. To introduce students the principles and applications of Electrostatics, Magneto-statics, Electrodynamics and Electromagnetic waves.

### Course Outcomes:

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

1. Apply reasoning skills to model and solve problems related to electrostatics
2. Formulate problems within magnetostatics and stationary current distributions and solve.
3. Demonstrate the understanding of Faraday's laws, Maxwell's equations and Poynting's theorem, and physics concepts in Electrodynamics.
5. Analysis and communicate scientific information of wave guides, electromagnetic radiation by using concepts of electrostatics, magneto statics and Maxwell's equations.

### Course Content:

#### Unit -1:

12 hrs

**Electrostatics:** Divergence and curl of electrostatic field, Applications of Gauss law, electrostatic potential, Poisson and Laplace equations, Boundary conditions, uniqueness theorems, electrostatic potential energy, Electrical energy of a localized charge distribution, Electrical energy of a continuous charge distribution, monopole and dipole terms, electric field of a dipole, multipole expansion of the potential, dipole-dipole interaction, Electrostatic fields in matter: polarization, internal field equations, electrostatic energy in dielectric media

#### Unit - 2:

12 hrs

**Magnetostatics:** Current density, Biot-savart law, the Magnetic Field of a Steady Current, the divergence and curl of Magnetic field  $\mathbf{B}$ , Ampere's law, magnetic vector potential, Boundary

Conditions, multipole expansion of vector potential, magnetic moment, Magnetic fields in matter: Magnetization, Torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits, the field of a magnetized object, Magnetic Susceptibility and Permeability, magnetic scalar potential, Energy in the magnetic field.

**Plasma Physics:** Plasma behavior in magnetic field, plasma as a conducting fluid-magneto hydrodynamics, magnetic confinement-Pinch effect.

**Unit -3:** **12 hrs**

**Electrodynamics:** Faraday law of induction, the Induced Electric Field, Maxwell's equations, displacement current, Maxwell equations in matter, the Continuity Equations, Poynting's theorem, conservation of momentum and energy for a system of charged particles

**Electromagnetic Waves:** The Wave equation for E and B, Energy and Momentum in Electromagnetic Waves, Plane waves in non-conducting and conducting medium, skin depth, Linear and circular polarizations, Reflection and refraction of plane waves at normal incident, total internal reflection, and reflection from a surface of a metal, Frensel's law

**Unit 4:** **12 hrs**

**Wave guides:** Wave guide equations, TE Waves in a Rectangular Wave Guide, The Coaxial Transmission Line

**Electromagnetic radiation:** Retarded Potentials, Radiation from an oscillating dipole, linear antenna, Lenard-Wiechert potentials, potentials for a charge in uniform motion, power radiated by an accelerated charge at low velocities, Larmor's formula, radiation from a charged particle with collinear velocity and acceleration, Bremsstrahlung radiation, radiation from a charged particle moving in a circular orbit, cyclotron and synchrotron radiation.

**Reference Books:**

1. Classical Electrodynamics: J.D.Jackson , Wiley Eastern Ltd., Bangalore (1978)
2. Introduction to Electrodynamics: D.J.Griffiths, Prentice Hall of India, Ltd., New Delhi (1995).
3. Electro magnetics: B.B. Laud. Wiley Eastern Ltd., Bangalore (1987)
4. Classical Electromagnetic Radiation: J.B. Marion, Academic press, NewYork (1968).
5. Classical Electrodynamics; S P Puri, Tata McGraw –Hill Publishing Company Ltd., New Delhi, (1990).



Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH2040	ATOMIC AND MOLECULAR PHYSICS	HC	3	1	0	4	5

**Course Objectives:**

1. To develop a basic understanding of physics of atoms and molecules: definitions, units, laws and rules.
2. to gain an ability of basic problems analyzing and solving in physics of atoms and molecules
3. to realize a role and practical application of physics of atoms and molecules in the modern world

**Course Outcomes:**

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

1. Analyze the concepts of atomic models, spectra of one and two valance electron atoms and the behaviour of atoms in external applied electric and magnetic field.
2. Differentiate rotational, vibrational, electronic and Raman spectra of molecules.
3. Describe electron spin and their spectroscopic applications.
4. Formulate and solve the problems related to different spectroscopic systems.

**Course Content:**

**Unit – 1:**

**12 hrs**

**Atomic Physics:** Brief review of early atomic models of Bohr and Sommerfeld. Bohr's calculation of radius, energy and spectral lines. Sommerfeld explanation for spectral lines splitting. Failures of Bohr and Sommerfeld models. One electron atom: Quantum states, Atomic orbitals, Radial and probability density wave functions and spectrum of hydrogen, Rydberg Atoms (brief treatment), Relativistic corrections to spectra of alkali atoms, Spectroscopic terms and notation Spin-orbit interaction and fine structure in alkali spectra. Lamb shift in hydrogen (qualitative Discussion only).

**Unit – 2:**

**12 hrs**

**Two electron atom:** Identical particles and the total wave function representation, Ortho and Para states and role of Pauli principle, level schemes of two electron atoms. Perturbations in the spectra of one and two electron atoms: Zeeman effect, Paschen- Back effect, Stark effect

in hydrogen spectra. Hyperfine interactions and 21cm line of hydrogen. Many electron atoms: Central field approximation. LS and JJ coupling schemes, multiplet splitting and Lande interval rule.

**Unit – 3:**

**12 hrs**

**Molecular Spectroscopy-1:** Microwave spectroscopy, Brief treatment of chemical bonds: covalent, ionic, vander Waal's interactions. The Born-Oppenheimer approximation (qualitative treatment), diatomic molecule as a rigid rotator, rotational spectra of rigid and non-rigid rotator, intensities of rotational lines, Microwave spectroscopy- principle and technique Types of rotors: Eigen values of Linear, Symmetric top, Asymmetric top and Spherical top molecules. Infrared Spectroscopy, Diatomic molecule as a simple harmonic oscillator, anharmonicity, Morse potential curves, vibrating rotator: energy levels and vibration spectra, PQR branches in rovibronic spectra, experimental technique and IR spectrometer

**Unit – 4:**

**12 hrs**

**Molecular Spectroscopy-2:** Raman spectroscopy: Theory of Raman effect, experimental techniques, rotational Raman spectra of diatomic and linear polyatomic molecules. Comparison of infrared and Raman spectra. Electronic spectroscopy of Molecules: Electronic spectra of diatomic molecules: vibrational structure, rotational structure in electronic spectra, intensity of vibrational lines in electronic spectra, Frank-Condon principle, dissociation and pre-dissociation, fluorescence and phosphorescence. Introduction to electron spin resonance and nuclear magnetic resonance spectra

**Reference Books:**

1. Introduction to Atomic spectra- H.E.White.
2. Fundamentals of molecular spectroscopy, C B Banwell.
3. Spectroscopy Vol I, II & III, Walkere and Straughen.
4. Physics of atoms and molecules, Bransden and Joachain, (2nd Edition) Pearson Education, 2004.
5. Fundamentals of Molecular Spectroscopy, Banwell and Mccash, Tata McGraw Hill, 1998.
6. Modern Spectroscopy, J.M. Hollas, John Wiley, 1998.
7. Molecular Quantum Mechanics, P.W. Atkins and R.S. Friedman. Third Edition, Oxford Press(Indian Edition), 2004.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20PH2051	ELECTRONICS-I (DIGITAL ELECTRONICS)	SC	2	1	0	3	4

**Course Objectives:**

1. To understand number systems and codes and their application to digital circuits.
2. To gain knowledge of Boolean algebra, Karnaugh maps and its application to the design and characterization of digital circuits.
3. To design and analyze a given combinational or sequential circuit using Boolean Algebra as a tool to simplify and design logic circuits.
4. To design various the logic design of programmable devices, including PLDs and synchronous & Asynchronous counters and Universal Shift Registers.

**Course Outcomes:**

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

1. Translate from one number system to its equivalent other number system and perform its arithmetic operations.
2. Explain TTL and CMOS construction, working, characteristics and applications and the use of implementation of logic circuits.
3. Draw the logic circuits by simplifying Boolean expressions using theorems, laws and K-map.
4. Analyse the operation of Combinational and Sequential logic circuits and DAC, ADC, types, specifications and applications.

**Course content:**

**Unit 1:**

**12hrs**

**Number Systems and Logic families:** Decimal, Binary, octal, and hexa-decimal number systems, binary arithmetic. Number base conversion, 1 and 2 complements Complement Codes: Excess-3 code, Gray code, examples. Basic gates: AND, OR, NOT, NAND, NOR, X-OR GATE, INHIBIT CIRCUIT, Universal gates NAND and NOR, TTL and CMOS Logic families and comparison.

**Unit 2:****12hrs**

**Boolean operations and expressions:** Introduction, Logic Operators, Simplification of logic expressions, Boolean laws; Postulates theorems and properties–Product of Sums (POS) and Sum of Products(SOP) – Karnaugh Map method – Two, three, four, five variable K-maps examples, Converting Boolean expressions to Logic and Vice versa, NAND and NOR implementation– Don't-Care conditions –examples.

**Unit 3:****12 hrs**

**Combinational and Sequential circuits:** Half and full Adder, implementation of full adder using half adders– Half and full Subtractor – Binary parallel adder – BCD adder, block diagram and working– Magnitude comparator (1 and 2 bit)– Encoders octal to binary encoder & Decoders BCD to 7- segment display– Multiplexers–De-multiplexer.

**Sequential circuits:** Comparison of Combinational and Sequential circuits, Latches, Flip-flops, SR, JK- Flip-flop, JK Master-Slave, D, T flip-flops, timing diagrams, counters, synchronous Decade counter and asynchronous counters, registers, shift registers, timing sequences.

**Unit 4:****12hrs**

**A/D and D/A conversion circuits:** Introduction, Digital to Analog Converters, Weighted Resistor DAC, R-2R Ladder DAC, advantages, disadvantages and applications. A/D converters, Counter type A/D converter, Successive Approximation Method, advantages, disadvantages and Applications, specifications.

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

**Reference Books:**

1. John F. Wakerly, "Digital Design" 4 thedition, 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", 6<sup>th</sup> edition, TMH, 2006.
5. Thomas L. Floyd, " Digital Fundamentals", 10<sup>th</sup> Edition, Pearson Education Inc, 2011
6. Donald D, Givone, "Digital Principles and Design", TMH, 2003.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH2052	CONDENSED MATTER PHYSICS - I	SC	2	1	0	3	4

**Course objectives:**

1. The atomic structure of a material depends on the method of synthesis and on various parameters involved in the technique.
2. This course will introduce the fundamental concepts of reciprocal lattice and to understand the diffraction principle and use of X-rays.
3. To know about lattice representation and reciprocal lattices.
4. To determine and analyze the crystal structure using x-ray diffraction.
5. To understand the optical and luminescence properties of ionic crystals.

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

1. Illustrate reciprocal lattice and its construction.
2. Understand the theoretical framework like indexing and interpretation of Moving film methods.
3. Characterize the crystal structures of materials using different X-ray analysis methods
4. Analyze the optical Properties and luminescence mechanisms in ionic crystals.

**Unit -1:**

**12 hrs**

**Real and Reciprocal lattice:** Introduction to Graphical construction, primitive vectors, Physical interpretation of the reciprocal space interpretation of Bragg's law using reciprocal lattice concept, general spacing formula, transformation equations and their importance.

**The Laue method and Rotating crystal methods:** Reciprocal lattice construction, instrumentation, flat plate cameras, front reflection region, back reflection region, appearance of photographs. Rotating crystal methods: Reciprocal lattice construction, instrumentation, cylindrical camera, mounting and adjustment of crystal, interpretation of photographs, unit cell determination, indexing procedure. Numerical problems

**Unit -2:**

**12 hrs**

Moving film methods: Weissenberg method, Influence, The precession method, reciprocal lattice construction for zero level and higher levels, indexing procedure, interpretation of

different photographs. Single crystal diffractometer: parfocussing and goniometry, intensity measurements. Applications of moving film methods. Numerical problems.

**Unit - 3:**

**12 hrs**

**Powder method:** X-ray powder photographic methods, instrumentation, diffraction geometry, measurement of Bragg angles and interplanar spacings, index of powder patterns, analytical and graphical methods, 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, interpretation of powder photographs of unknown crystal system, powder diffractometer and applications. Numerical problems

**Unit-4**

**12 hrs**

**Optical properties of materials:** Optical phonon model in an ionic crystal; Interaction of electromagnetic waves with optical modes, polarization, Dispersion curves of transverse optical (TO) phonon and optical photon in a diatomic ionic crystal, LST relation; Metal-insulator transition. UV-VIS, IR, FTIR and Raman spectroscopy. Luminescence, photoconductivity. Color centers in ionic crystals- Types of Color centers- methods of production-mechanism - Characteristic absorption bands, Properties of Color centers- Applications.

**Reference Books:**

1. The Laue Method, Elsevier Science & Technology (Firm) Academic Press, 1974.
2. Elements of X-ray Crystallography, L.V. Azaroff: McGraw Hill, New York, 1968.
3. An introduction to Crystallography, Michael M Wooffen: Cambridge University Press, 1997
4. Crystal growth Processes and methods, Santhana Raghavan and Ramaswamy: KRU Publications, Kumbakonam.
5. Crystallography for solid state physics, Verma and Srivastava: New age international Ltd. 1997.
6. Solid State Physics, Charles Kittel: Wiley Eastern, 1984.
7. X-ray crystallography, M.J.Burger: John Wiley, New York, 1952.
8. Crystalline Solids, Duncan M and C. Mike: Nelson, London, 1973.
9. The powder method in X-ray cryst. L.V. Azaroff and M.J.Burger: McGraw Hi11s, 1958.
10. Luminescence of Solids, D. R. Vij, Plenum Press, 1998.
11. Optical Properties of Materials and Their Applications, Jai Singh: John Wiley & Sons, 2020

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH2053	<b>PHOTONICS -1: LASERS AND MODERN OPTICS</b>	SC	2	1	0	3	4

**Course Objectives:**

1. To illustrate the Laser systems, principles and its applications.
2. To explain the basic principles of Laser induced Nonlinear optical phenomenon.
3. To understand modern optics tools and applications.

**Course Outcomes:**

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

1. Understand the principle and mechanism underlying in different LASER systems.
2. Describe the LASER induced nonlinear optical phenomenon in materials.
3. Apply Laser beam interference and Fourier analysis in holography and optical signals respectively.
4. Demonstrate Optical fibres and its wave guiding mechanism.

**Unit -1: Basic principles of lasers**

**12 hrs**

Spontaneous and stimulated emission – Coherence - Population inversion- Einstein coefficients – Pumping schemes – Threshold condition for laser oscillation – Losses and Q-factor –Principles and working mechanisms of Ruby, Nd:YAG, Ar ion, CO<sub>2</sub> and semiconducting lasers – Applications.

**Unit-2 : Non-linear Optics Basic Principles**

**12 hrs**

Origin of optical nonlinearity - Harmonic generation – Second harmonic generation – Phase matching condition – Third harmonic generation – Optical mixing – Parametric generation of light – Parametric light oscillator – Frequency upconversion – Self focusing of light – Phase conjugate optics-Guided wave optics - Nonlinear optical materials.

**Unit-3: 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 DiracDelta function – Optical applications – linear systems- The convolution integral – convolution theorem- Spectra and correlation – Parseval’s formula –

Auto correlation and cross-correlation – Apodization – Array theorem – Fourier methods in diffraction - Fraunhouffer diffraction of single slit, double slit and transmission grating using Fourier method.

**Unit-4: Fiber Optics**

**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 – Fiber optic cables – Attenuation – Signal distortion on optical wave guides- Erbium doped fiber amplifiers – Solitons in optical fibers - Block diagram of fiber optic communication system - Applications of optical fibers in communication and medicine.

**Text and Reference Books**

1. Introduction to Electrodynamics, D.J. Griffiths, 4 th Edition, Prentice-Hall of India, ND, 2013.
2. Electromagnetics, B.B. Laud, 3rd Edition, New Age International Publishers Ltd, N D, 2011.
3. Fundamentals of Electromagnetic theory, 2nd Edition, S.K. Dash and S.R. Khuntia, ND, 2011.
4. Modern Optics by G.R. Fowels, 1989.
5. Laser and their Applications, M.J. Beesly, Taylor and Francis, 1976
6. Lasers and Non-Linear Optics, B.B. Laud, 3rd Edition, New Age International Publishers Ltd,
7. Optics, E. Hecht, Addison Wiley, 1974. 9. Optical Fiber Communications, Gerel Keiser, McGraw Hill Book, 2000

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH2060	<b>YOGA / SPORTS / MUSIC / DANCE/ THEATRE</b>	RULO	0	0	2	2	3

**Note:** Music, Dance, and Theater courses are offered by the School of Performing Arts, whereas the Sports and Yoga courses are offered by the Department of Physical Education. The students have to choose any **ONE** of these courses.

**A. YOGA FOR HEALTH**

**Course Objectives:**

Following are the Course Objectives.

1. To prepare the students for the integration of their physical, mental and spiritual faculties;



2. To enable the students to maintain good health;
3. To practice mental hygiene and to attain higher level of consciousness;
4. To possess emotional stability, self control and concentration; and
5. To inculcate among students self discipline, moral and ethical values.

**Course Outcomes:**

On completion of the course learners will be able to:

1. Practice yoga for strength, flexibility, and relaxation.
2. Learn techniques for increasing concentration and decreasing anxiety
3. Become self disciplined and self-controlled
4. Improve physical fitness and perform better in studies
5. Gain self confidence to face the challenges in the society with commitment to serve the society

**Course Contents**

**Unit-I:**

Yoga: Introduction, Tips from Sage Patanjali's Yoga Sutras

Surya Namaskara:- 10 counts,12 counts,16 counts

**Unit-II:**

Asanas: Sitting- Vajrasana, Dandasana, Padmasana, Matsyasana, ArdhaMatsyendrasana, Suptavajrasana, Paschimottasana, Bakasana, Simhasana, Shirasasana.

Asanas: Standing- Tadasana, Trikonasana, Parshwakonasana, Veerabhadrasana, Parivrttatrikonasana.

**Unit-III:**

Asanas: Prone Position- Bhujangasana, Dhanurasana, Shalabhasana.

Asanas: Supine Position- Sarvangasana, Sethubandhasarvangasana, Halasana, Karnapeedasana.

Mudras- Dhyana mudra, Chinmaya mudra, Namaste mudra, Nasika mudra

**Unit-IV:**

Pranayams:- Ujjayi, NadiShodhana, Anuloma – Viloma, Basthrika, Bhramari, Sheethali Dhyana & its types, Competition format, Rules and their interpretations

**A. SPORTS (VOLLEYBALL)**

**Course Objectives:**

1. To learn the rules, fundamental skills, and strategies of volleyball.
2. To develop skills in passing, setting, serving, spiking, and blocking.
3. To learn basic offensive and defensive patterns of play.
4. To develop a positive attitude towards volleyball as a lifetime sport and to improve physical fitness through participation in volleyball.

**Course Outcomes:**

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with volleyball.
2. Apply these skills while playing volleyball and exhibit improved performance
3. Improve physical fitness and practice positive personal and lifestyle.
4. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

**Course Contents:**

**Unit-I**

Introduction about Volleyball

Players Stance, Receiving and passing

The Volley (Overhead pass), The Dig (Underhand pass), Service Reception

**Unit-II**

Service- Under Arm Service, Tennis Service, Side Arm Spin Service, Round Arm Service, High spin service, Asian serve / American serve (floating)

Setting the ball- Set for attack, Back set, Jump set

**Unit-III**

Smash/Spike- Straight smash, Body turn smash, Wrist outward smash, Wrist inward smash,

Block- Single block, Double block, Three-man block,

Rolls- Overhead pass & back rolling, One hand underhand pass with side rolling, Forward dive

**Unit-IV**

Attack Combination, Defense Systems, Libero play,

Court marking, Rules and their interpretations and Duties of officials

**B. SPORTS (BASKETBALL)**

**Course Objectives:**

1. To learn the rules, fundamental skills, and strategies of Basketball

2. To develop technical skills in passing, in ball handling, individual offense, individual defense, rebounding, screen, team offense, team defense and fast break.
3. To learn basic offensive and defensive strategies of play.
4. To develop a positive attitude towards Basketball as a lifetime sport and to improve physical fitness through participation in Basketball.
5. To develop positive understanding and appreciation of the basketball game.

### **Course Outcomes:**

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with basketball.
2. Apply these skills while playing basketball and exhibit improved performance
3. Improve physical fitness and practice positive personal and lifestyle.
4. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

### **Course Contents:**

#### **Unit-I**

- Basketball: Introduction
- Grip; Player stance- Triple threat stance and Ball handling exercises
- Passing (Two hand/one hand)- Chest pass, Bounce Pass, Over head pass, Underhand pass, Hook Pass, Behind the back pass, Baseball pass, Side arm pass and passing in running.
- Receiving-Two Hand receiving, One hand receiving, Receiving in stationary position, Receiving while jumping, Receiving while running.

#### **Unit-II**

- Dribbling- How to start dribble, How to stop dribble, High / Low dribble with variations
- Shooting- Layup shot and its variations, One hand set shot, One hand jump shot, Free throw, Hook shot, Tip-in shot.
- Stopping- Stride/Scoot, Pivoting and Faking /Feinting footwork.

#### **Unit-III**

- Rebounding- Defensive rebound, Offensive rebound, Box out, Rebound Organization.
- Individual Defensive- Guarding the man with the ball and without the ball.
- Offensive drills, Fast break drills, Team Defense/Offense, Team Tactics

#### **Unit-IV**

- Court marking, Rules and their interpretations

## **C. SPORTS (FOOTBALL)**

### **Course Objectives:**

1. To learn the rules, fundamental skills, and strategies of football.
2. To develop skills in passing, receiving, controlling the ball, dribbling, shielding, shooting, tackling, beating a defender and heading in football.
3. To learn basic offensive and defensive patterns of play
4. To use different parts of the body in utilizing the above skills while playing football
5. To develop a positive attitude towards football as a lifetime sport and to improve physical fitness through participation in football.

### **Course Outcomes:**

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with football.
2. Apply these skills while playing football and exhibit improved performance
3. Use the knowledge and understanding to perform, refine and adapt the above skills and related skills with precision, accuracy, fluency and clarity in any situation.
4. Improve physical fitness and practice positive personal and lifestyle.
5. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

### **Course Content:**

#### **Unit-I**

##### **Football: Introduction**

Kicks- Inside kick, Instep kick, Outer instep kick, Lofted kick, Chipping, Volley, Half Volley

Trapping- Trapping rolling the ball, Trapping bouncing ball with sole

#### **Unit-II**

- Dribbling- With instep and outer instep of the foot.
- Heading- From standing, running and jumping.
- Feinting- With the lower limb and upper part of the body.

#### **Unit-III**

- Tackling- Simple tackling, Slide tackling.
- Throw-in- Standing and Sliding
- Goal Keeping- Collection of balls, Ball clearance, throwing and deflecting.

## **Unit-IV**

- Ground marking, Rules and their interpretations

### **D. SPORTS (TRACK AND FIELD )**

#### **Course Objectives:**

1. To teach students the skilled techniques in sprints, relay running, hurdles, long jump, high jump, and shot put and practice them.
2. To develop competence among students in demonstrating all the techniques covered in the course.
3. To make students understand some of the scientific and empirical principles and their rationale underlying the development of skilled performance.
4. To inculcate among students the habit of team work and cooperative learning and develop competence in detecting / correcting technique errors.
5. To develop a positive attitude towards sports in general and athletics in particular and to improve physical fitness through participation in various athletic games / sports activities.

#### **Course Outcomes:**

On completion of the course learners will be able to:

1. Display competencies in executing basic techniques and skills associated with select track and field events.
2. Develop basic skills and techniques to improve one's running posture and take-off position for different jumps.
3. Learn regular practice of select track and field events and improve physical fitness
4. Appreciate track and field events by applying sports science knowledge to explain the execution of the events.

#### **Course Content:**

### **Unit-I**

Athletics: Introduction

Track Events - Steeple Chase, Race Walking, Middle and Long distance races

Race walking - Technique, Faults and Officiating.

Middle and Long distance races – Technique and Training

## **Unit-II**

Jumping Events - High Jump and Triple Jump: Basic Skills and techniques

High Jump - Straddle Roll & Flop Technique, Approach, Take-off, Technique in the air, Clearance over the bar & Landing

Triple Jump – Hop, Step and Jump Technique, Approach, Take-off & Landing

## **Unit-III**

Throwing Events - Discus Throw and Hammer Throw: Basic Skills and techniques

Discus Throw -Standing and Rotatory techniques, Grip, Stance, Rotation Technique, Power stance, Release and Reverse (Follow through)

Hammer Throw - Grip, Swings, Rotation foot work, Release and Follow through

## **Unit-IV**

Rules, Officiating and Marking - Ground / Sector Marking, Interpretation of Rules.

## **Reference Books**

### **(Athletics Part-I and Athletics Part-II)**

1. Arthur E. Ellison (ed) (1994). Athletic Training and Sports Medicine.
2. Ballisteros, J.M. (1998). Hurdles Basic Coaching Manual, IAAF.
3. Bosen K.O. (1993). Teaching Athletics Skills and Technique.
4. Bosen K.O. (1990). Study Material on Hurdles for the Regular Course Students.
5. Doherty K. (1995). Track and Field Omni book.
6. Martin, David E. Peter N. Coe (1991). Training Distance Runner.
7. Howard S. (1981). Science of Track and Field Athletics.
8. Briggs Graeme (1987). "Track and field coaching Manual", Australian Track and Field Coaches Association. Rothmans Foundation National Sports Division.
9. Carr, Gerry (1999). "Fundamentals of Track and Field. Track Athletics 1 Title G.V. 1060 5.e. 368.
10. I.A.A.F. Level-II (2001). Text Book on Jumping Event.
11. Jarver, Jesse (1987). "The Jumps", Track and Field Coaching Manual Australia.

## **F. DRAMATICS**

**Pre-requisites:** Students with background in Theatre Arts/ Keen interest in Dramatics.

### **Course Objectives:**

1. To imbibe the acting skills.

2. To understand the broader applications of theatre studies in allied arts forms.
3. To be able to use body language for better communication.
4. Students shall also be able to understand voice modulation and Navarasas.

**Course Outcomes:**

On successful completion of this course, students should be able to:

1. Freely express improvisation in non-verbal communication.
2. Shall hone good acting skills and be able to emote better.
3. Be able to put up a theatre act and play a key role.
4. Be able to differentiate good acting and understand the importance of good lyrics, stage crafting, music, dance, costume and lighting.

**Course Content:**

**UNIT – 1**

**Working on Body:**

Body and its analysis. Understanding physical abilities ( Anga, Pratyanga and Upanga). Challenges of the body. Using body as metaphor and language. The class's bodies as a collective, an ensemble, a collaborative team.

**UNIT – 2**

**Sound and Movement:**

Awareness of creating sound patterns, voice modulations, rhythm in speech and dialogues. Understanding the rhythm and patterns of movements like walking, framing, shaping, primitive and animal movements.

**UNIT – 3**

**Characterization and Improvisation:**

Observation of people around. Getting into the role and living it. Developing a character from establishment (pace and rhythm). Improvisation techniques of body and mind.

**UNIT – 4**

**Group work and Production:**

Develop a theme, concept or a play and include all the theatre skills, stage craft, costuming and put up an act. Choosing theme and characters.

**Reference Books:**

1. All about Theatre – Off stage – Chris Hogget.

2. Rangadalli Anataranga – K V Subbanna
3. The Indian Theatre – Hemendranath Das Gupta.
4. A Practical handbook for an Actor – MilisaBruder, eeMilchel Cohn, Madeleine Oliek et al, Zigler Publisher.

### **G. INDIAN CLASSICAL DANCE FORMS (Bharathanatyam, Kuchipudi ,Mohiniyattam)**

**Prerequisites: Background of classical dance training or any other dance forms.**

**Note: Non-classical dancers can also join.**

#### **Course Objectives:**

1. To develop an understanding about the Indian classical dance forms and its universal application.
2. To be able to understand the fine nuances of Classical dance.
3. To understand the importance of health through Indian classical dance, strengthen the body capacity.
4. To understand mythology and its characters in Indian classical dance form through lessons of Abhinaya.

#### **Course Outcomes:**

1. To be able to identify and appreciate the classical dance forms.
2. To be able to execute basics of Adavus with finesse.
3. To be able to express through abhinaya.
4. To be able to perform to perform the fundamentals in the chosen dance form.

#### **Course Content:**

##### **Unit 1**

An introduction to Indian classical dance forms: Bharatanatyam, Kuchipudi, Mohiniyattam.

##### **Unit 2**

Learning of Fundamentals: Exercises and Adavus- I (Bharathanatyam, Kuchipudi, Mohiniyattam).

##### **Unit 3**

Adavus –II (Bharathanatyam ,Kuchipudi, Mohiniyattam)

##### **Unit 4**

Learn a basic composition in the chosen dance form.



**Reference Books:**

1. Indian classical dance forms –U S Krishna Rao,U K Chandrabhaga Devi
2. Classical Dances –SonalMansingh, AvinashParischa
3. Kuchipudi – Sunil Kothari
4. Bharatanatyam An in depth study- Saroja vydyanathan
5. Mohiniyattam – Bharathi Shivaji

**H. PERCUSSION INSTRUMENT (TABLA AND MRIDANGAM)**

**Pre-requisites:** Students with background in Percussion instruments and knowledge of Rhythm/ Keen interest in studying Mridagam / Tabala.

**Course Objectives:**

1. To understand the Rhythmology.
2. To understand the importance of Laya, Taala.
3. To be able to understand the fine finger techniques of playing the instrument.

**Course Outcomes:**

On successful completion of this course, students should be able to:

1. To be able to set instrument to Sruthi.
2. To be able to play the fundamentals on instrument.
3. To be able to learn and perform a particular taala.

**Course Content:****UNIT 1**

Introduction to Musical Instruments, Percussion Instruments

Mridangam and its History

**UNIT 2**

Introduction to Tala System, Definitions of 5 jaathis and their recitation

Adi Talam and its various forms, Definitions and recitation of different gathis

**UNIT 3**

TisraJaathi, Khanda Jaathi, Misrajaathi, SankeernaJaathi

**UNIT 4**

Learning of JathiFormation, Basicjathis, Jathis for Dance forms

Some Basic Definitions of Korvai, Teermanam etc.,

**Reference Books:**

1. Mridangam- An Indian Classical Percussion Drum – Shreejyanthi Gopal
2. Theory and practice of Tabala – SadanandNaimpally.
3. Theory and practice of Mridangam – Dharmala Rama Murthy
4. The Art of the Indian Tabala – SrdjanBeronja.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH2070	SKILL DEVELOPMENT	RULO	0	0	2	2	3

**Note:** The students will have to undergo Skill Development course being conducted by Training and Placement cell of the University.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH2080	GENERAL PHYSICS LAB - II (PRACTICAL)	HC	0	0	3	3	5

**Course Objectives:**

1. To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate engineering and technical equipments.
2. Design of circuits using new technology and latest components and to develop practical applications of engineering materials and use of principle in the right way to implement the modern technology.

**Course Outcomes:**

On Successful completion of this course, students shall be able to:

1. Infer the result of related experiments.
2. Employ the different tools and techniques to get the data/readings related to the experiments.

3. Explore the fundamental physics behind many scientific discoveries through hands on experience.

**List of Experiments:**

1. Determination of wave length and difference in wavelengths of D<sub>1</sub> and D<sub>2</sub> lines using Michelson interferometer.
2. Active low pass and high pass filter using op-amp.
3. Determination of Fermi Energy of given conductor/semiconductor.
4. Determination of end point energy of half value methods or absorption energy by GM counter
5. Determination of Ferroelectric phase transition and verification Curie Weis law.
6. Measurement of thickness of thin wire using Laser source.
7. Determination of size of the particles using laser by diffraction halos method.
8. Determination of velocity of ultrasonic waves in liquid.
9. Determination of Rydbergconstant using hydrogen spectrum.
10. Verification of photoelectric equation and determination photonic work function and Planck's constant.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH2090	ATOMIC AND MOLECULAR PHYSICS (PRACTICAL)	HC	0	0	3	3	5

**Course Objectives:**

1. To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate engineering and technical equipments.
2. Design of circuits using new technology and latest components and to develop practical applications of engineering materials and use of principle in the right way to implement the modern technology.

**Course Outcomes:**

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

1. Verify the spectroscopic phenomenon of physics through experimentation.
2. Infer results of the experiments connected with interaction of electric and magnetic fields with atoms and molecules.
3. Distinguish the band, line and Raman spectrum through the experimentation.

**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  $^{15}\text{N}_2$  molecule by studying Rotational Raman Spectrum.
7. Determination of absorption Co-efficient of solution.
8. Recording the absorption spectra of FTO (Fluorine doped Tin Oxide) & ITO (Indium doped Tin oxide) using UV-Visible absorption spectroscopy.
9. Identifying the stretching and bending vibrational modes in FTIR spectrum.

**THIRD SEMESTER**

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3010	Astrophysics	HC	2	1	0	4	4

**Course objectives:**

1. To make students learn fundamental concepts in astrophysics that will equip them to better understand new scientific discoveries made in the coming years and decades
2. To learn about the origin and evolution of life and the search for life beyond the Earth.
3. To acquire knowledge of techniques and methods used to gain new knowledge in physics and astronomy
4. To understand astrophysics as the way to describe our real physical world

## Course outcomes

1. To explain the basic concepts of astrophysics.
2. To describe the features of objects in solar system.
3. Demonstrate an understanding of life of origin on earth and exoplanet.
4. Knowledge of the environmental conditions that might allow a planet to be habitable

## Syllabus

### Unit-1: Basic concepts of Astrophysics

12 hrs

Sky coordinates and motions, earth rotation, timekeeping (sidereal vs synodic period), Trigonometric Parallax, Planetary motions - Kepler's Laws – Gravity, Light & Energy –Optical & Modern Telescopes –working & characteristics, Astronomical Instruments – Photometer, Photographic plates, Spectrographs, Charge Coupled Detector – basic principle & working.

### Unit-2: Formation of star & solar system

12 hrs

Formation star, Classifications of star – HR diagram, Main sequence evaluation, White dwarfs, Neutron stars, Pulsars, Supernovae, Stellar Black holes, Theories of formation of solar system, sun – characteristics & its different zones, Interior & Exterior planets – properties, satellites, Kuiper belt, Oort clouds.

### Unit-3: High energy Astrophysics

12 hrs

Radiation-matter interaction – Sources of high energy (UV-gamma rays) radiation in the universe - Detectors for high energy particles, X-rays, gamma rays and neutrinos – Spaceastronomy - Elements of General Relativity - compact stars – magneto spheric processes around neutron stars (pulsars and magnetars) – interacting binaries – Roche potential and accretion – Shkura-Sunyaev thin disk model – Gamma Ray Bursts.

### Unit4: Astrobiology, Habitable planets &-Extraterrestrial Intelligence

12 hrs

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  
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

**Books for reference:**

1. BW Carroll & DA Ostlie, An Introduction to Modern Astrophysics, Latest Edition, Addison-Wesley.
2. Martin Harwit, Astrophysical Concepts, Latest Edition, Springer.
3. C.R. Kitchin, Astrophysical Techniques, CRC press.
4. Carroll, Bradley W., and Dale A. Ostlie. An Introduction to Modern Astrophysics. Reading, MA: Addison-Wesley Pub., 1995. ISBN: 9780201547306.
5. Kippenhahn, Rudolf, and Alfred Weigert. Stellar Structure and Evolution. New York, NY: Springer-Verlag, 1990. ISBN: 9780387502113.
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, ISBN 978-3-030-46086-0.
8. Donald Goldsmith, Hidden Worlds and the Quest for Extraterrestrial Life, Harvard University press, ISBN 9780674976900.
9. M. Longair, High Energy Astrophysics, vol. 1 and 2, Cambridge University Press
10. F. Melia, High Energy Astrophysics, Princeton University Press
11. Ya B. Zeldovich and I.D. Novikov, Relativistic Astrophysics, vol. I, Stars and Relativity, Physics Today 25, 3, 63 (1972); <https://doi.org/10.1063/1.3070777>

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3020	NANOSCIENCE AND TECHNOLOGY	HC	2	1	0	3	4

**Course Objectives:**

1. To understand the fundamental concepts behind nanoscience and nanotechnology.
2. To familiarize with various processing techniques available for synthesis of nanostructure materials.
3. To acquire the knowledge of various nanomaterial characterization methods.
4. To get familiarized with the various analytical techniques.

5. To understand the properties of nanomaterials.

### **Course Outcomes:**

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

1. Analyze the fundamental principles of nanotechnology and apply to different applications
2. Apply physics concepts to the nano-scale and non-continuum domain.
3. Demonstrate state-of-the-art nano-fabrication methods to prepare nano particles
4. Evaluate processing conditions to functional nanomaterials for current constraints, such as regulatory, ethical, political, social and economical, encountered when solving problems in living systems.

### **Course Content:**

#### **Unit– 1:**

**12 hrs**

**NANOSCALE SYSTEMS:** 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, Top down and Bottom up approach.

#### **Unit - 2:**

**12 hrs**

**QUANTUM DOTS:** 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:** Gas phase condensation – Vacuum deposition - Physical vapor deposition (PVD) - chemical vapor deposition (CVD) – laser ablation- Sol-Gel- Ball milling –Electro deposition- electroless deposition – spray pyrolysis – plasma based synthesis process (PSP) - hydrothermal synthesis.

**NANOTECHNOLOGY APPLICATIONS:** Applications of nanoparticles, 2-D materials, nanotubes and nanowires for nanodevice fabrication; Single electron transistors, coulomb blockade effects in ultra small metallic tunnel junctions - nanoparticles based solar cells and quantum dots based white LEDs; CNT based transistors; principle of dip pen lithography. Application in drug delivery and 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, 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.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3030	NUCLEAR AND PARTICLE PHYSICS	HC	2	1	0	3	4

**Course Objectives:**

1. To study the general properties of nucleus.
2. To study the nuclear forces and nuclear reactions.
3. To introduce the concept of elementary particles.

**Course Outcomes:**

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

1. Explain various types of nuclear of reactions



2. Construct nuclear and semi-conductor detectors
3. Apply various models to study nuclear decay
4. Apply basic laws of particle physics and macroscopic physics phenomena in determination of particle properties and properties of processes in the subatomic world

**Course Content:**

**Unit-1**

**General properties and concept of nuclei:** **12 hrs**

Nuclear Mass & Binding energy, Nuclear forces - Characteristics of nuclear forces, short range, saturation, charge independence and exchange characteristics,

**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, Bremsstrahlung, Interaction of directly ionizing radiation (gamma) - photo electric, Compton, and pair production processes. Gamma ray attenuation- attenuation coefficients, absorber, mass thickness, cross sections

**Nuclear reactions:** cross section for a nuclear reaction, Differential cross section, Q-value of reaction, threshold energy, Direct and compound nuclear mechanisms, Bohr's independence hypothesis and experimental verification.

**Unit-2**

**12 hrs**

**Nuclear fission:** energy released in fission, neutron cycle in a thermal reactor and four factor formula.

**Nuclear detectors:** scintillation detectors- NaI(Tl), plastic scintillation- scintillation spectrometer.

**Semiconductor detectors:** Surface barrier detectors, Li ion drift detectors, relation between applied voltage and the depletion region in junction detectors, counter telescopes, particle identification, and position sensitive detector.

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

**Unit-3**

**12 hrs**

**Nuclear models**

Liquid drop model - Semiempirical mass formula, stability of nuclei against beta decay, mass parabola

Fermi gas model - Kinetic energy for the ground state, asymmetry energy, Potential depth.

Shell model - evidence for magic numbers, prediction of energy levels in an infinite squarewell potential, spin orbit interaction, prediction of ground state spin parity and magnetic moment of odd nuclei, Schmidt limit.

### **Nuclear decay**

Beta decay - Fermi's theory of beta decay, curie plots and ft values, selection rules.

Gamma decay - Multi polarity of gamma rays, selection rules, internal conversion (qualitative only).

### **Unit-4**

**12 hrs**

**Elementary particle physics:** types of interactions between elementary particles, hadrons and leptons, detection of neutrinos.

**Symmetries and conservation laws:** conservation of energy, momentum, angular momentum, charge and isospin, parity symmetry, violation of parity in weak interactions, lepton number conservation, lepton family and three generations of neutrinos. Conjugation symmetry, CP violation in weak interactions

Strange particles, conservation of strangeness in strong interactions, Baryon number conservation, Gell-Mann Nishijima formula, eight fold way (qualitative only), Quark model, quark content of baryons and mesons, color degree of freedom, standard model (qualitative only).

### **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 Wiley and Sons, 1987.
4. The Atomic Nucleus 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: 3<sup>rd</sup> edition, John Wiley 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 Wiley 1984.
10. Nuclear Interactions, S.de Benedetti: John Wiley, New York, 1964.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3041	ELECTRONICS - II (ELECTRONIC COMMUNICATIONS SYSTEMS)	SC	2	1	0	4	4

**Course Objectives:**

1. To understand the fundamental concepts of communication systems.
2. To understand and compare different analog modulation schemes.
3. To understand and compare different digital modulation schemes.
4. To understand the design tradeoffs and performance of communications systems.

**Course Outcomes:**

At the end of the course the students shall be able to

1. **Analyze** the working of amplitude and frequency modulated communication systems.
2. **Analyze** various modulation schemes in digital communication system
3. **Distinguish** between Analog and Digital Communication system and analyze various sampling methods and its reconstruction.
4. **Construct** various channel coding and decoding schemes such as Hadamard code, Hamming code, Cyclic Codes, Convolution coding

**Unit 1: AM Transmitters and Receivers:**

**12 hrs**

Introduction to communication, need for modulation, Generation of AM, modulation index, bandwidth of AM, Power calculations of AM wave, low level and high level modulation, comparison of levels, AM transmitter block diagram, DSBSC modulators, Balanced modulator and Ring modulator, AM Receiver: Tuned radio frequency (TRF) receiver. Super heterodyne receiver, RF section and characteristics, mixers, frequency changing and tracking, IF rejection and IF amplifiers. Detection and automatic gain control (AGC), AM receiver characteristics.

**Unit 2: FM Transmitters and Receivers FM Transmitters:**

**12 hrs**

Basic requirements and generation of FM, modulation index, FM Modulation methods narrow and wideband FM.: Direct methods, Variable capacitor Modulator, Varactor Diode Modulator, FET or 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.

### **Digital communication systems**

#### **Unit 3: Analog to Digital Conversion**

**12 hrs**

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: Information Coding and Decoding:**

**12 hrs**

Block diagram of information system, measure of information, entropy, Source coding: instantaneous code, Shannon's encoding algorithm Shannon-Fano encoding, Huffman minimum redundancy code, code efficiency, Error control coding, Block coding-decoding, Hamming code, Binary cyclic codes, properties of cyclic codes, generator and parity polynomial, encoder and syndrome calculation circuit.

#### **References:**

1. Principles of Communication Systems – H Taub & D. Schilling, Gautam Sahe. TMH, 2007 3rd Edition.
2. Principles of Communication Systems - Simon Haykin. John Wiley, 2<sup>nd</sup> Edition,
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. Communication Systems by Simon Haykins John Wiley & Sons, 4th Edition.
7. Electronic Communications – Dennis Roddy and John Coolean , 4th Edition , PEA, 2004
8. Communication Systems – B.P. Lathi, BS Publication, 2004.
9. Electronics & Communication System – George Kennedy and Bernard Davis, TMH 2004.

10. Electronic Communication Systems – Modulation and Transmission - Robert J. Schoenbeck, 2nd Edition, PHI.
11. Analog and Digital Communications – Simon Haykin, John Wiley, 2005.
12. Analog and Digital Communication – K. Sam Shanmugam, Willey ,2005
13. Electronics Communication Systems-Fundamentals through Advanced-Wayne Tomasi, 5th Edition, 2009, PHI.
14. Lathi “Modern Digital and Analog Communication Systems,” Oxford University Press.
15. B. Sklar, “Digital Communications: Fundamentals and Applications,” Pearson Education.
16. S. Haykin, “Digital Communication,” John Willey.
17. R.P. Singh and S.D. Sapre, “Communication Systems: Analog and Digital,” Tata McGraw-Hill.
18. T. Schilling, “Principles of Communication Systems,” TMH.
19. A.B. Carlson, “Communication Systems,” TMH.
20. G. Kennedy, “Electronic Communication Systems,” TMH.
21. Digital Communications - John G. Proakis .Masoudsalehi – 5th Edition, McGraw-Hill, 2008.
22. Digital Communication - Simon Haykin, Jon Wiley, 2005.
23. Digital Communications - Ian A. Glover, Peter M. Grant, Edition, Pearson Edu., 2008.
24. Communication Systems-B.P. Lathi, BS Publication, 2006.
25. Principles of communication systems - Herbert Taub. Donald L Schiling, Goutam Sana, 3rd Edition,Mc.Graw-Hill, 2008.
26. Digital and Analog Communicator Systems - Sam Shanmugam, John Wiley, 2005.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3042	CONDENSED MATTER PHYSICS –II	SC	2	1	0	3	4

**Course Objectives:**

The course is to understand the basic knowledge on magnetic, dielectric and electric properties of material, types of magnetic and dielectric materials and their applications.

**Course Outcomes:**

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

1. Differentiate types of magnetic materials.
2. Analyze ESR and EPR spectral data.
3. Understand classical and quantum theory of dielectrics.
4. Classify ferroelectric crystals.

**Course Content:**

**Unit -1:**

**12 hrs**

**Disordered systems:** Point defects-shallow impurity states in semiconductors-Localized lattice vibrational states in solids-Vacancies, interstitials in ionic crystals- Introduction- Short range order- Long range order- Ordered lattice- 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-2**

**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 electronmicroscopy, 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 - 3:**

**12 hrs**

**Dielectrics and Ferroelectrics**

**Dielectrics:** 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- general applications of dielectric materials. Ferroelectrics, antiferroelectric Materials, Piezoelectric, pyroelectric and ferroelectric

materials,- transducer and applications. Ferro electricity in KDP and barium titanate- order— disorder and displacement theories. Thermodynamics of ferroelectric phase transitions.

**Unit - 4:**

**12 hrs**

**Magnetic Materials and Magnetic Resonance:** Neutron diffraction in magnetic structure analysis. Distinguish between hard and soft magnetic materials- application. **Magnetic Resonance:** Elements of theory of nuclear magnetic resonance (NMR)-rate of energy absorption- spin lattice and spin-spin relaxation- Bloch equations, Principles of ESR, NOR and Mossbauer techniques- applications in typical areas.

**2.5 Suggested Text Books and References**

**Reference Books:**

1. The Physical Principles of Magnetism : A. H. Morrish, John Wiley & sons, New York (1965)
2. Physics of Ferromagnetism :SoshinChikazumi, SushinChikazumi and C. D. Graham, Clarendon Press (1997)
3. Magnetism and Magnetic Materials : J.M.D Coey, Cambridge University Press, UK (2010)
4. Introduction To Magnetic Resonance Spectroscopy ESR, NMR, NQR : D. N. Sathyanarayana, I.K. International Publishing House Pvt. Limited (2009)
5. Solid State Physics : A. J. Dekker, Macmillan India Ltd., Bangalore (1981)
6. Introduction to Solid State Physics : 5th Edn C. Kittel, Wiley Eastern Ltd., Bangalore (1976)
7. Elementary Solid State Physics : M. A. Omar, Addison-Wesley Pvt. Ltd., New Delhi (2000)
8. Introduction to Magnetic Resonance: A. Carrington and A. D. Mclachlan, Harper & Row, New York, (1967).
9. Elements of Solid State Physics (2nd Ed): J.P. Srivastava, PHI Learning Pvt. Ltd., New Delhi (2009).
10. Solid State Chemistry and its Applications : A. R. West, University of Aberdeen, Wiley India Pvt Ltd (2003)

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3043	PHOTONICS II	SC	2	1	0	3	4

**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:**

1. To get knowledge of principle, mechanism and applications of LASERS
2. To understand and demonstrate LASER -matter interaction and effects
3. To illustrate non-linear optical properties and to gain knowledge of electro, acousto and magneto-optic effects
4. To apply optics and physics of materials knowledge in demonstrating optoelectronic devices

**Unit 1: LASER systems and Applications**

**12 hrs**

General description, Laser structure, Single mode laser theory, Excitation mechanism and working of: CO<sub>2</sub>, Nitrogen, Argon ion, Excimer, X-ray, Free-electron, Dye, Nd:YAG, Alexanderite and Ti:sapphire lasers, Diode pumped solid state laser, Optical parametric oscillator (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, Laser induced fusion in reactor, Laser cooling and trapping.

**Unit 2: Properties of LASER radiation**

**12 hrs**

Introduction, Laser line width, Line broadening Mechanisms-Natural broadening, collision broadening, and Doppler broadening. Laser frequency stabilization, Beam divergence, Beamcoherence, Brightness, Focusing properties of laser radiation, Laser cavity modes: Fabry Perot cavity modes, longitudinal and transverse modes.



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 3- Nonlinear Optics and Modulation of light**

**12 hrs**

Nonlinear Optical Interactions - Polarization response of materials to light - Harmonic generation- Phase matching – bistability - self focusing - Third-Order Nonlinear Susceptibility- Self-Phase Modulation- Optical Solitons - Four-Wave Mixing - Kerr effect - Multiphoton processes- Stimulated Brillouin and Raman scattering.

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 analyser, Magneto-optic effect, Faraday rotator as an optical isolator. Advantages of optical modulation.

**Unit 4: Opto electronic devices**

**12 hrs**

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. CCD, Solar cells.

**Reference and Text books :**

1. Lasers, principles and applications, J. Wilson and J.F.B. Hawkes, prentice, Hall of India, New Delhi, 1996
2. Laser fundamentals, W.T. Silfvast, Foundation books, New Delhi, 1999.
3. Semiconductor optoelectronics devices, P. Battacharya, Prentice – Hall of India, New Delhi, 1995.
4. Nonlinear Optics , Robert Boyd, Academic press, 2003.
5. Optical Electronics,A. K. Ghatak and K. Thyagarajan, Cambridge University Press, (1991).
6. Optoelectronics: An introduction, J. Wilson and J.F.B. Hawkes prentice, Hall of India, New Delhi, 1996
7. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics. John Wiley & Sons, 1991.
8. Integrated Photonics: Fundamentals, G. Lifante. John Wiley & Sons, 2003.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3051	ELECTRONICS - III (LINEAR INTEGRATED CIRCUITS)	SC	3	1	0	4	5

### Course Objectives:

1. To analyze and design various applications using Op-amp.
2. To design and construct waveform generation circuits.
3. To design timer, analog and digital circuits using op-amps.
4. To design combinational logic circuits using digital ICs.

### Course Outcomes:

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

1. Analyze linear applications of op-amp circuits such as integrator, differentiator log and antilog networks
2. Differentiate between an ideal and practical characteristic of op-amp
3. Explain the frequency response of an op-amp compensator network.
4. Analyze the basic function of comparators and convertors using OPAMP.

### Course Content:

#### Unit - 1:

**12 hrs**

#### OPERATIONAL AMPLIFIER

General feedback structure, Properties of negative feedback, The Four Basic Feedback configurations, Voltage series (noninverting) feedback amplifier, Voltage shunt (inverting) feedback amplifier, one op-amp differential amplifier. Summing, scaling and averaging amplifier (inverting, noninverting, differential configuration), logarithmic and antilogarithmic amplifiers, integrator and differentiator, V to I converter, instrumentation amplifier. Numerical.

#### Unit – 2:

**12 hrs**

#### THE PRACTICAL OP-AMP (741):

Input offset voltage and offset voltage compensation network design (for open loop, closed loop and differential amplifiers), input bias current, input offset current. total output offset voltage. Supply voltage rejection ration (SVRR), common mode rejection ratio (CMRR), Thermal drift, Noise.

**Unit - 3:****12 hrs****FREQUENCY RESPONSE OF AN OP-AMP:**

Frequency response, compensating networks; dominant pole and pole zero compensation. Frequency response of internally compensated OP-AMP & non-compensated OP-AMP, open loop voltage gain as a function of frequency. closed loop frequency response, circuit stability, slew rate; causes of slew rates and its effects in application.

**Unit – 4:****12 hrs****COMPARATORS & CONVERTERS:**

Basic comparator(inverting and non-inverting); characteristics and limitations, zero crossing detector, Schmitttrigger, clippers& clampers(positive and negative), small signal half wave & full wave rectifiers, sample and hold circuit.555 Timer and its applications: Monostable and a stable Multivibrators.

**Reference Books:**

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.Roy Chaudhary (New age).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3052	CONDENSED MATTER PHYSICS - III	SC	3	1	0	4	5

**Course Objectives:** This course provides the knowledge about the processing, characterization and testing of Polymers, ceramics and glass materials.

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

1. Synthesize the polymers, ceramics and glasses.
2. Explain the applications of composite material related to polymers, ceramics and glasses
3. Analyze the Properties, defects and inabilities of composite materials
4. Analyse and examine the data obtained from Mechanical testing instruments, metallurgical and electron microscopes and NDT

**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 blowmoulding), and structure of glasses .Types of glasses- borates silicate, oxide, metallic and semiconducting glasses; tempered glass and chemically strengthened glass.

**Unit 3:****12 hrs**

**Composite Materials:** General Introduction, matrix Materials- 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, dispersion strengthened. Particle reinforced, fiber and laminate reinforced composites with fabrication, interface, properties and applications Concrete-concrete making materials, structure, composition..Portland cement concrete, Reinforced Concrete, pressed concrete properties and applications

**Unit 4: Testing of Materials****12 hrs**

Mechanical Testing –Tensile strength By Universal Testing Machine. Hardness- Brinell, Vicker and Rockwell machines, impact testing by Charpy methods, Fatigue and 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. Textbook of Polymer Science. Fred. W. Billmeyer John Wiley & Sons, Inc. (1984)
2. Polymer Science, V.R. Gowariker, N. V. Vistrwanathan, Jayadev Shreedhar, Wiley Eastern (1937)
3. Electronic properties of Materials- Rolf E. Hummel, Springer Verlag, Springer Verlag (1985)
4. Foundations of Materials Science and Engineering- William F. Smith, McGraw Hill international Editions, (1988)
5. Elements of Materials Science and Engineering. Lawrence H. Van Vlack, Addison Wesley (1975)
6. Introduction to Ceramics- W D Kingery, H K Bower and U R Uhlman, John Wiley (1960)
7. Ultrasonic B. Carlin , Mc. Graw Hill (1950).
8. Principles of Neutron Radiography- N D Tyufyakav and A S Shtan, Amerind Publishers (1979)
9. Applied X-rays- George L Clark, Mc. Graw Hill, (1955)
10. Testing of Metallic Materials—AVK Suryanarayan , Prentice Hall India, (1990)
11. Physical Metallurgy Part I, R W Cahn and P Haasen (Ed), North.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3053	PHOTONICS-III	SC	3	1	0	4	5

**Course objectives:**

1. To provide knowledge about optical fibers 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:**

1. To get knowledge of components used in fiber optic communication and applications
2. To understand and demonstrate usage of different tools integrated optoelectronic devices

3. To demonstrate signal processing
4. To Explain the modelling and properties of photonic crystals

#### **UNIT - I: Fibre Optic Components and Sensors**

**12 hrs**

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 –Fiber opticrotation sensors. Optical biosensors: Fluorescence and energy transfer sensing, molecular beacons and optical geometries of bio-sensing, Bio-imaging, Bio sensing.

#### **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 Bistability, 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.

#### **Text and Reference 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.
7. Nanophotonics, P.N.Prasad, Wiley Interscience, 2003.
8. Biophotonics, P.N.Prasad, Wiley Publications, 2004.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3060	Astrobiology and Extraterrestrial Life	OE	3	1	0	4	5

**Course Objectives:**

1. To study the astrophysical universe, ranging from solar system objects through stars, to galaxies and the structure of the universe as a whole.
2. To understand the principles and methods of modern astrophysics.

**Course Outcomes:**

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

1. Describe the laws that govern the astrophysical phenomena.
2. Explain the nature and properties of compact astrophysical objects.
3. Elaborate astrophysical observations and measurements.
4. Discuss the principles of formation of the Planets and Comets.

**Unit -1**

**12 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**

**12 hrs**

**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**

**12 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**

**12 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 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, Addison-Wesley.
2. Martin Harwit, Astrophysical Concepts, Latest Edition, Springer.
3. C.R. Kitchin, Astrophysical Techniques, CRC press.
3. Carroll, Bradley W., and Dale A. Ostlie. An Introduction to Modern Astrophysics. Reading, MA: Addison-Wesley Pub., 1995. ISBN: 9780201547306.
4. Kippenhahn, Rudolf, and Alfred Weigert. Stellar Structure and Evolution. New York, NY: Springer-Verlag, 1990. ISBN: 9780387502113.
5. Teerikorpi, P, The Evolving Universe and the Origin of Life, Springer publishing, ISBN 978-3-030-17921-2.
6. Souza, Valeria, Segura, Antígona, Foster, Jamie, Astrobiology and Cuatro Ciénegas Basin as an Analog of Early Earth, Springer, ISBN 978-3-030-46086-0.
7. Donald Goldsmith, Hidden Worlds and the Quest for Extraterrestrial Life, Harvard University press, ISBN 9780674976900.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3070	GENERAL PHYSICS LAB –III (PRACTICAL)	HC	0	0	3	3	5

**Course Objectives:**

1. To introduce the basic concepts of physics through hands on experience and impart experimental skill to students



**Course Outcomes:**

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

1. Conduct the experiments related to different Physics laws and theories.
2. Employ the different tools and techniques to get the data/readings related to the experiments.
- a. Verify the fundamental physics behind many scientific discoveries through hands on experimentation.

**Course Content:****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 in an optical cable.
8. Laser light attenuation in an optical cable.
9. Refractive index of liquids/solids using laser light.
10. Diffraction of laser light through two closely spaced circular apertures.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3081	ELECTRONICS LAB (PRACITICAL)	SC	0	0	3	3	5

**Course Objectives:**

The study of this course aims to:

1. Provide a strong foundation on Linear Circuits.
2. Familiarize students with applications of various IC's.

3. Have a broad coverage in the field that is relevant for engineers to design linear circuits using Op-amps.
4. Familiarize the conversion of data from Analog to Digital and Digital to Analog.

**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.

**Course Content:**

**List of Experiments:**

**Analog and Digital communication lab**

1. Design Schmitt trigger and test the circuit for the given values of UTP and LTP using OP-AMP MA741.
2. OP-AMP as square wave generator.
3. Schmitt trigger.
4. Voltage regulator
5. OP-AMP as active integrator and differentiator.
6. Design and test the operation of 4 Bit DAC using R-2R ladder network and OP-AMP MA741.
7. Design a second order Butterworth active low pass filter and high pass filter.
8. Amplitude modulation and demodulation.
9. DSB SC modulation and demodulation.
10. SSB SC modulation and demodulation.
11. Frequency modulation and demodulation.
12. Pre Emphasis-De Emphasis circuits.
13. Verification of sampling theorem.
14. PAM generation and reconstruction.
15. PWM AND PPM: generation and reconstruction

16. Delta and Adaptive delta modulation.
17. TDM of two band limited signals.
18. ASK generation and detection.
19. FSK generation and detection.
20. PSK generation and detection.
21. Line coding and decoding.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3082	CONDENSED MATTER PHYSICS LAB (PRACTCAL)	SC	0	0	3	3	5

**Course Objectives:**

1. To make the student familiarize with the basics of materials.
2. To enable the student to explore the concepts involved in the X-ray diffraction.
3. To make the student understand the basic concepts in absorption and Infrared spectroscopy.
4. To allow the student to understand the fundamentals of Hysteresis.

**Course Outcomes:**

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

1. Identify the phase and phase purity of the crystal.
2. Determine particle size, stress and strain using PXRD.
3. Analyse of Thermoluminescence glow curve using ORIGIN software.
4. Determine of Curie temperature using B-H curve of a Ferromagnetic material (both hard and soft).
1. Calibrate of electromagnet and magnetic susceptibility determination of magnetic salts ( $\text{MnSO}_4$ ,  $\text{MnCl}_2$ ) by Quincke's method.
5. Study I-V characteristics of any given materials.

**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 Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH3083	Photonics LAB (PRACTICAL)	SC	0	0	3	3	5

**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 techniques of light modulation
4. To analyse and apply the knowledge of optoelectronic devices in research

**Course outcomes:**

1. To get knowledge of principle, mechanism and applications of LASERS
2. To understand and demonstrate LASER -matter interaction and effects
3. To illustrate non-linear optical properties and to gain knowledge of electro, acousto and magneto-optic effects
4. To apply optics and physics of materials knowledge in demonstrating optoelectronic devices

**Course Content:**

1. Verification of Gaussian nature of the given laser beam
2. Evaluation of divergence angle of the laser beam
3. Determined the beam divergence and spot size of a given laser
4. Determination of wavelength of a He-Ne laser beam using Mach-Zender Interferometer
5. Measurement of refractive index of the air using Mach-Zender Interferometer
6. Measurement of refractive index of the transparent materials using Mach-Zender Interferometer
7. Characteristics study of semiconductor diode Laser
  - (i) Study the characteristics of the diode current versus optical output powers
  - (ii) Study the characteristics of the temperature dependence of the threshold current for laser emission
8. Construct the Diffraction Grating by using Holography technique
9. Measurement of propagation loss using optical power meter.
10. Study the Electro-Optic effect in  $\text{LiNbO}_3$  Crystal and calculate the half-wave voltage

## FOURTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH4010	Research methodology	HC	2	0	0	2	2

### Course Objectives:

1. To gain familiarity with a research phenomenon or to achieve new insights into it
2. To portray accurately the research methods
3. To determine the research problem for literature reviews

### Course Outcomes:

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

1. Understand the various methods of research
2. Find the research problem from literature reviews
3. Analysis the data by mathematical models
4. Interpret the collection of data

#### Unit-1 Research and Types of research:

6 hrs

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 Formulation of research problem

6 hrs

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.

#### Unit-3 Data Collection and analysis:

6hrs

Execution of the research, Observation and Collection of data, Methods of data collection, Modeling, Mathematical Models for research, Data processing and Analysis strategies, Hypothesis-testing, Generalization-and-Interpretation

#### Unit-4 Interpretation and Report Writing:

6 hrs

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, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Report

**Reference Books:**

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Publications. 2 volumes.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH4020	MAJOR PROJECT	HC	0	0	8	8	16

**Course Objective:**

To carry out the research under the guidance of supervisor and in the process learn the techniques of research.

**Course Outcomes:**

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

1. Familiarize with literature search
2. Conduct the experiments related to research and formulate computational techniques
3. Interpret the scientific data.
4. Write report and defend the research findings.

**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 5<sup>th</sup> week and 10<sup>th</sup> week of the beginning of the semester and final draft report with findings by 15<sup>th</sup> 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.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./Wk.
M20PH4020	MOOC/SWAYAM/ INTERNSHIP	RULO	0	0	4	4	4

**Note: Students shall choose to take up any online course of four credits as guided by the school or shall have to undergo internship of four weeks duration, the details of which are provided here under.**

**MOOC/ SWAYAM:**

Globally, MOOC (Massive Open Online Course) platforms are gaining much popularity. Considering the popularity and relevance of MOOCs, Government of India has also launched an indigenous platform, SWAYAM. SWAYAM (Study Webs of Active Learning for Young Aspiring Minds) is basically an integrated MOOCs platform for distance education that is aimed at offering all the courses from school level (Class IX) to post-graduation level. The platform has been developed collaboratively by MHRD (Ministry of Human Resource Development) and AICTE (All India Council for Technical Education) with the help of Microsoft and is capable of hosting 2,000 courses.

A student shall register and successfully complete any of the courses available on SWAYAM. Student shall inform the MOOC/SWAYAM coordinator of the school about the course to which he/she has enrolled. The minimum duration of the course shall be not less than 40 hours and of 4 credits. The student should submit the certificate issued by the SWAYAM to the MOOC/SWAYAM coordinator of the school, the grades obtained in the course shall be forwarded to concerned authority of the University.



**Internship:** Minimum of four weeks duration internship should be carried out by the student either in industry or in an R&D organization, including educational institutes with excellent research culture. In case, if a student is unable to secure internship either in industry or in an R&D organization, a project may be carried out within the university. The student is expected to submit a formal report at the end of the internship programme. The student shall be awarded the marks for internship based on the (a) presentation and (b) comprehensive viva by the panel of examiners constituted 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.

### LIST OF FACULTY MEMBERS

Sl. No	Name of the Teacher	Designation	Contact No.	E-mail
1	Dr. D. V. Sunitha	Assoc. Prof.& Asst. Director	7760884884	<a href="mailto:sunithadv@reva.edu.in">sunithadv@reva.edu.in</a>
2	Mrs. Bharathi Devi	Assoc. Prof.	9886189024	<a href="mailto:bharathidevi@reva.edu.in">bharathidevi@reva.edu.in</a>
3	Dr. Madesh Kumar	Professor	9341271290	<a href="mailto:madeshkumar@reva.edu.in">madeshkumar@reva.edu.in</a>
4	Dr. JayadevPattar	Assoc. Prof.	9620305750	<a href="mailto:jayadevpattar@reva.edu.in">jayadevpattar@reva.edu.in</a>
5	Dr.P.Anjaneyulu	Assoc. Prof.	9741965325	<a href="mailto:p.njaneyulu@reva.edu.in">p.njaneyulu@reva.edu.in</a>
6	Dr.Upendra Kumar K	Assoc. Prof.	8374589647	<a href="mailto:upendrakumar.k@reva.edu.in">upendrakumar.k@reva.edu.in</a>
7	Dr. MahipalRanot	Assoc. Prof.	9380608015	<a href="mailto:mahipalranot@reva.edu.in">mahipalranot@reva.edu.in</a>
8	Mrs.Usha.S K	Assist. Prof.	9481033638	<a href="mailto:ushask@reva.edu.in">ushask@reva.edu.in</a>
9	Dr. Prakash Babu	Assist. Prof.	9916322600	<a href="mailto:prakashbabu.d@reva.edu.in">prakashbabu.d@reva.edu.in</a>
10	Mr. G Ranjith Kumar	Assist. Prof.	9449441201	<a href="mailto:ranjithk@reva.edu.in">ranjithk@reva.edu.in</a>
11	Dr. K Munirathnam	Assist. Prof.	9035286246	<a href="mailto:munirathnam.k@reva.edu.in">munirathnam.k@reva.edu.in</a>
12	Mr.Deepak.K	Assist. Prof.	8892926677	<a href="mailto:deepak@reva.edu.in">deepak@reva.edu.in</a>
13	Dr.Hareesh K	Assist. Prof.	9986996834	<a href="mailto:hareesh.k@reva.edu.in">hareesh.k@reva.edu.in</a>
14	Dr. Pramodini S	Assist. Prof.	9886979247	<a href="mailto:pramodini.s@reva.edu.in">pramodini.s@reva.edu.in</a>
15	Dr.Anupama A V	Assist. Prof.	9008115308	<a href="mailto:anupama.av@reva.edu.in">anupama.av@reva.edu.in</a>