KRISHNA KANTA HANDIQUI STATE OPEN UNIVERSITY (KKHSOU)

PROGRAMME PROJECT REPORT

ON

MASTER OF SCIENCE IN PHYSICS

Two Year (Four Semester) Post Graduate Programme as per UGC-CBCS Mode in Accordance with NEP-2020 to be offered from 2026-27 Academic Session

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1. PROGRAMME OVERVIEW

The Master of Science in Physics (M.Sc. in Physics) is a postgraduate programme offered by the Krishna Kanta Handique State Open University (KKHSOU) through the Open and Distance Learning (ODL) mode. The programme is designed to provide learners with advanced knowledge and skills in the field of Physics and to develop their analytical, theoretical, and experimental understanding of the discipline. The duration of the M.Sc. in Physics programme is two years, and the curriculum is divided into four semesters. The curriculum for the M.Sc. (Physics) programme has been carefully designed to align with current trends and technological developments, ensuring that learners are equipped with the necessary knowledge and competencies to meet the demands of academia, research, and industry.

The programme structure consists of Discipline Specific Core (DSC) courses and a selection of Discipline Specific Elective (DSE) courses, which provide learners with a comprehensive understanding of the subject and offer diverse learning opportunities. In addition, Ability Enhancement Courses (AEC) and Value Added Courses (VAC) are bundled and offered to learners to strengthen their interdisciplinary knowledge and skill development.

Since the University organizes its academic disciplines through a School System, multidisciplinary and interdisciplinary courses under AEC and VAC are expected to be implemented effectively with the support of faculty members from related disciplines. Furthermore, the University is registered with the Academic Bank of Credit (ABC) under the National Education Policy 2020, which allows learners to transfer academic credits and provides greater flexibility in course selection.

The Centre for Internal Quality Assurance (CIQA) of the University has organized several meetings and workshops for designing academic programmes in accordance with the guidelines of Open and Distance Learning (ODL). Based on the inputs received, the Committee on Courses (CCS), along with external subject experts from reputed universities of the region, has prepared the programme structure and detailed syllabi. The syllabus was subsequently presented before the Schools of Studies, and after receiving due recommendations, it was approved in the Meeting of the Academic Council held on 19th January, 2026

This Programme Project Report (PPR) presents the two-year postgraduate programme in M.Sc. in Physics under the Hiranya Chandra Bhuyan School of Science and Technology (HCBSST) of KKHSOU, and it reflects the outcome of the academic planning and approval process undertaken by the University.

2. PROGRAMME'S MISSION AND OBJECTIVES

2.1 Vision and Mission of KKHSOU

- To emerge as a premier institution of higher education with a focus on quality education and social responsibility.
- To provide technology-enabled, skill-based higher education.
- To equip learners with knowledge and skills to excel in their chosen fields.
- To promote "Education Beyond Barriers" through flexible ODL mode.
- To impart innovative, relevant education with emphasis on research and excellence.
- To ensure inclusive and skill-oriented education for diverse and disadvantaged learners

2.2 Mission and objectives of M.Sc. in Physics Programme

The mission of the Master of Science (Physics) programme is to provide advanced and systematic knowledge of both fundamental and applied areas of physics through a flexible and learner-centred open and distance learning framework. The programme aims to build strong theoretical and practical foundations while promoting interdisciplinary learning across core and emerging domains of physics. It seeks to develop analytical thinking, experimental competence, research aptitude, and communication skills among learners so that they can pursue higher studies and contribute effectively to scientific research, technological development, and professional careers in physics and related fields.

The objectives of the programme are as follows:

- To develop strong analytical, mathematical, and problem-solving skills for understanding and interpreting physical phenomena.
- To nurture scientific temper and critical thinking for analysing physical systems and solving complex problems in physics.
- To provide knowledge of experimental methods, measurement techniques, and laboratory practices essential for practical applications in physics.
- To introduce learners to modern and interdisciplinary areas of physics and their technological applications.
- To encourage research aptitude, innovation, and scientific inquiry through project work, seminars, and independent learning.
- To enhance scientific communication skills for effective presentation and dissemination of knowledge.
- To prepare learners for higher studies, research, teaching, and professional careers in physics and allied scientific disciplines.

- To promote lifelong learning and adaptability to emerging developments in science and technology.

3. RELEVANCE OF THE PROGRAMME WITH KKHSOU'S MISSION AND GOALS

The M.Sc. in Physics programme offered by KKHSOU through the ODL mode is closely aligned with the vision and mission of the Universit,. KKHSOU seeks to expand access to quality higher education and skill-oriented training by reaching learners who are unable to participate in conventional higher education systems. In this context, the M.Sc. Physics programme plays an important role in extending postgraduate education in the Physical sciences to a wide range of learners through a flexible and learner-centric ODL framework.

The programme reflects the University's guiding philosophy of "*Education Beyond Barriers*." It creates opportunities for learners from diverse socio-economic and geographical backgrounds to pursue advanced studies in Physics. The programme supports the University's mission of expanding access to education for remote learners, working professionals, and those who could not complete higher education earlier. It also enables learners to enhance their knowledge and professional skills through flexible learning pathways.

The curriculum of the programme has been carefully designed to equip learners with a strong conceptual understanding of both fundamental and applied areas of physics. The inclusion of Discipline Specific Core (DSC) and Discipline Specific Elective (DSE) courses ensures that learners gain exposure to diverse domains of contemporary Physics. Laboratory experiments, seminars, and project work further enhance learners' analytical abilities, experimental competence, and research orientation. These components support the University's goal of equipping learners with the knowledge and skills required to excel in their respective fields.

The programme also incorporates interdisciplinary perspectives through the inclusion of emerging areas such as Renewable energy. It further provides Ability Enhancement Courses (AEC) that strengthen learners' broader academic and professional competencies. Learners may also opt for Value Added Courses (VAC) offered by other disciplines of the University, enabling them to acquire multidisciplinary knowledge and skills in accordance with the evolving needs of higher education and the knowledge economy.

By fostering strong theoretical knowledge, analytical thinking, and experimental proficiency, the M.Sc. Physics programme contributes to the broader academic goals of KKHSOU in promoting excellence in education, research, and innovation. The programme also advances the University's commitment to inclusive, flexible, and quality higher education. It prepares learners to contribute meaningfully to scientific advancement, technological development, and societal progress.

4. NATURE OF PROSPECTIVE TARGET GROUP OF LEARNERS

The M.Sc. Physics programme offered through the ODL mode is designed for the diverse group of learners seeking advanced knowledge and professional development in physics. The prospective target groups of learners for this programme include the following categories:

1. Graduates in Science (BSc) with Physics as one of the subjects at the undergraduate level and wish to pursue postgraduate studies in Physics.
2. Learners who are unable to pursue higher education through the conventional mode due to social, financial, geographical, or other personal constraints.
3. Working professionals seeking to upgrade their qualifications, strengthen their scientific knowledge, or continue higher education through the flexible mode of Open and Distance Learning.
4. Learners aspiring to build careers in research, teaching, industry, and other professional fields related to Physics and allied sciences.
5. Lifelong learners, including women, differently-abled learners, and other individuals seeking inclusive and accessible opportunities for higher education.

Considering the growing demand for postgraduate education in Physics and the accessibility provided through the ODL mode, the programme is expected to attract learners from diverse backgrounds. The annual enrolment is projected to increase steadily, subject to the availability of study centres, institutional capacity, and prevailing regulatory guidelines.

5. APPROPRIATENESS OF PROGRAMME TO BE CONDUCTED IN OPEN AND DISTANCE LEARNING MODE TO ACQUIRE SPECIFIC SKILLS AND COMPETE

The M.Sc. Physics programme is well-suited to be offered through the Open and Distance Learning (ODL) mode as it primarily focuses on the development of conceptual understanding, analytical ability, and problem-solving skills in various areas of physics. These competencies can be effectively achieved through carefully designed, self-instructional and learner-centric Self Learning Materials (SLMs), prepared in accordance with UGC ODL quality standards.

The programme adopts a multi-modal instructional approach comprising printed SLMs, e-learning resources, recorded video lectures, assignments, and academic counselling sessions. This blended learning framework facilitates independent learning while ensuring academic support, thereby enabling learners to comprehend theoretical concepts and develop analytical and research skills.

In addition to theoretical components, the programme incorporates practical sessions, laboratory experiments, seminars, and project work to ensure the acquisition of experimental skills and scientific methodology. In accordance with the UGC ODL guidelines, the practical components of the programme will be conducted through identified Learner Support Centres that have been offering the M.Sc. in Physics programme for at least seven years, are equipped with the necessary laboratory infrastructure, and are supported by qualified academic counsellors.

6. INSTRUCTIONAL DESIGN

6.1 Curriculum design

The programme design ensures that adequate learner support services, continuous assessment mechanisms, and opportunities for interaction are provided to maintain academic standards and learning outcomes equivalent to conventional mode programmes. The integration of theory, practical training, and research-oriented activities enables the holistic development of learners. This approach is in alignment with established practices followed by recognized open universities such as Indira Gandhi National Open University, where science programmes are effectively delivered through a combination of self-learning materials, digital support, academic counselling, and supervised practical sessions.

Therefore, the ODL mode is appropriate for offering the M.Sc. Physics programme as it facilitates accessible, flexible, and quality higher education while enabling learners to acquire the required knowledge, technical skills, and research competencies necessary for higher studies and professional careers in physics and related fields. In alignment with the UGC guidelines on Indian Knowledge Systems (IKS), the curriculum includes components that integrate indigenous scientific traditions and knowledge frameworks relevant to the physical sciences. This inclusion aims to foster a holistic understanding of physics by connecting modern scientific concepts with India’s rich knowledge heritage.

The programme M.Sc. in Physics has been so designed that it meets the standards of the UGC-ODL Regulations 2020. The syllabus of the programme has been designed with the active participation of faculty members of the concerned discipline along with subject experts from reputed universities of Assam. During the process of designing the M.Sc. Physics syllabus, the following members listed in Table 1 were actively involved.

Table 1: Members Involved in Designing the M.Sc. Physics Syllabus

Sl. No.	Name	Designation	Organization
1	Prof. Anurup Gohain Barua	Professor	Gauhati University, Assam
2	Prof. Mrinal Kumar Das	Professor	Tezpur University, Assam
3	Dr. Debajyoti Barooah	Associate Professor	Cotton University, Assam
4	Dr. Ridip Dev Choudhury	Associate Professor	KKHSOU, Assam

5	Dr. Antara Mahanta Barua	Assistant Professor	KKHSOU, Assam
6	Dr. Chandra Kamal Borah	Assistant Professor (Contractual)	KKHSOU, Assam
7	Dr. Kabita Baruah	Assistant Professor (Contractual)	KKHSOU, Assam

6.2 Programme Structure

The details of the programme structure, including credit distribution, course distribution, semester-wise course and credit allocation, and marks distribution for the M.Sc. in Physics programme are presented in the ***Annexure I.*** The detailed course wise syllabus of the programme is given in ***Annexure II.***

6.3 Duration of the Programme

The minimum duration for the completion of the M.Sc. Physics programme is two years, while the maximum duration is four years, which is twice the minimum duration. This duration is in accordance with the relevant provisions of the UGC regulations for programmes offered through the ODL mode.

6.4 Credit Hours

The University follows a system of assigning 30 hours of study for each credit of a course. Accordingly, a 4 credit course requires a total of 120 hours of study. Out of the total credit hours, a minimum of 10 percent (i.e., at least 12 hours per course) is provided as academic counselling to learners at their respective Learner Support Centres. In addition, the University provides Learning Management System (LMS) support based on the four-quadrant approach, which includes self-learning materials, video lectures, self-assessment activities, and discussion support for learners.

6.5 Faculty and Other Support Staff Requirement

The faculty members of the M.Sc. in Physics programme under the Hiranya Chandra Bhuyan School of Science and Technology (HCBSST) is shown in Table 2. The M.Sc. in Physics programme incorporates Ability Enhancement Courses (AEC) and Value Addition Courses (VAC), which broaden its interdisciplinary and multidisciplinary scope. To facilitate the effective development and implementation of the programme, expertise from faculty members across different Schools of the University has been integrated into its design and delivery.

A list of course coordinators against each core course of the programme is presented in ***Annexure V.***

Table 2: Faculty Members of M.Sc. in Physics Programme

Sl. No.	Name	Designation	Qualification
1	Dr. Antara Mahanta Barua	Assistant Professor	M.Sc., M.Tech. Ph.D.
2	Dr. Chandra Kamal Borah	Assistant Professor (Contractual)	M.Sc., Ph.D.
3	Dr. Kabita Baruah	Assistant Professor (Contractual)	M.Sc., Ph.D.

6.6 Instructional Delivery Mechanisms

The Self Learning Materials (SLM) have been prepared keeping in mind the requirements of instructional design. These SLMs are prepared and finalised by the internal faculty with the help of resource persons across the state. Besides the internal faculty members, Senior/Retired Professors/Associate Professors/Assistant Professors from different Universities/Colleges are engaged as SLM writers and Content Editors. Particular attention has been given so that the basic three domains of knowledge, viz., the behavioural domain, cognitive domain, and constructive domain can be addressed. In general, the university offers printed SLMs and the same in audio-visual formats. Apart from that, plans are being made to deliver the Programme through LMS. The LMS would consist of four quadrants: video lectures, downloadable/printable reading material, self-assessment tests through tests and quizzes, and an online discussion forum for clarifying questions. The SLMs are made easy to read and understand by incorporating the following major components:

- **a.** Learning Objectives (major objectives of the Unit are stated)
- **b.** Introduction (linkage with previous Unit as may be applicable and general introduction of the content is provided)
- **c.** Check Your Progress (generally after every section CYP is provided to learners to gauge their understanding)
- **d.** Answers to Check Your Progress (CYP answers are provided at the end of the Unit)
- **e.** Activity/Activities (activities for enhancing learners' critical outlook is included in SLM)
- **f.** Let us Know (Depending on the necessity some important information related to the content is provided in a box)
- **g.** Let Us Sum Up (pin pointed summary of the Unit is given)
- **h.** Further Reading (this section has been incorporated for those learners who are interested in advance knowledge of the content)

i. Model Questions (Different types of questions have been provided in the unit).

6.7 Learner Support Services

The student support services available in the University would be extended to the learners of M.Sc. in Physics Programme. All these support services would help the learners to imbibe the required knowledge and skills; to seek avenues in employment; to go for higher studies; and to know about the subject in an in depth manner. Learner support services include the following among others.

- **KKHSOU City Campus:** The University's City Campus located at Khanapara in Guwahati functions as a major centre for learner services. The campus facilitates interaction between learners and faculty members, provides walk-in academic guidance, and supports activities related to admission, examination, and distribution of study materials. The training programmes for coordinators, counsellors, and other functionaries are organises at the campus. Online counselling for all learners of all semesters of all programmes are centrally organised from city campus.

a. **Regional Centres:** In addition to the City Campus, the University operates regional centres that coordinate academic and administrative activities in different parts of Assam. These centres assist learners in accessing support services and coordinate the functioning of study centres within their jurisdiction. Regional centres are in places such as Jorhat, Bongaigaon, Lakhimpur, and Silchar, thereby expanding the reach of the University's learner support network. The Regional Centres also conduct orientation programmes, facilitate communication between the University and the study centres, and provide assistance regarding admission, academic schedules, and examinations.

b. **Study Centres:** Study centres are the backbone of an open and distance learning institution. On behalf of the University, the study centres cater to the various requirements of learners, viz. admissions-related information, delivering Self Learning Materials, conducting counselling sessions, distributing assignments and evaluating them, conducting term-end exams, etc. The study centres throughout the state handle these affairs on behalf of the University.

c. **Pre-enrolment Counselling:** In cooperation with study centres, the University provides pre-enrolment counselling for all the programs through online and offline modes. It provides basic knowledge of the programmes, counselling sessions, etc. Moreover, programme specific pre-enrolment counselling is also organised.

d. **Learner Support Services from EMPC**

The Electronic Media Production Centre (EMPC) serves as the media and digital learning support hub for the learners. It provides support through the production and dissemination of multimedia educational content, community radio broadcasting, and other ICT-enabled academic resources, as outlined below. These initiatives aim to enhance accessibility, promote interactive learning, and strengthen the overall learner support system of the University.

- **Multimedia Learning Materials**

EMPC produces a wide range of audio-visual educational content to support various academic programmes offered by the University. These include:

- Course-based educational video lectures
- Academic lectures and expert discussions for reference
- Demonstrations and concept-based learning modules

The produced content is disseminated through the official KKHSOU YouTube channel and other digital platforms which enable learners to access supplementary learning resources beyond the printed SLMs.

- **Community Radio Services**

EMPC also supports learner engagement through the University's Community Radio Station Jnan Taranga 90.0 FM, which broadcasts educational and interactive programmes for learners as well as the wider community.

The following programmes are specifically designed to support the learners of the University:

- **Siksha Barta:** A 30-minute interactive programme broadcast every Thursday at 10:00 AM. Through this programme, learners from different locations can directly interact with faculty members and University officials to clarify their academic queries and concerns.
- **Gyan Safura:** A 30-minute programme broadcast every Monday at 10:00 AM, featuring discussions on various educational topics contributed by faculty members of the University.
- **News Bulletin:** Broadcast daily at 10:50 AM and 2:30 PM, this programme provides updates on important academic announcements and key activities of KKHSOU.
- **Academic Counselling through Radio:** A dedicated one-hour programme focusing on academic discussions based on the Self Learning Material (SLM)

units of different courses. This programme is broadcast every Monday, Wednesday, and Friday from 3:30 PM to support learners in understanding their course contents more effectively.

- **Internet Radio Facility:** The Internet Radio facility enables the broadcast of radio programmes through online platforms. Through this facility, educational and awareness programmes of the Community Radio Station Jnan Taranga 90.0 FM can be accessed globally via the platform iRadioLive.com, thereby extending the reach of the University's academic and learner support services beyond geographical boundaries.

e. **ICT-Enabled Learner Support:** ICT support is a major component of any ODL system of education. Some of the ICT-based support systems provided by the university, which can be availed by the learners of M.Sc. Physics Programme are listed below:

- **University Website:** The official website of the University (www.kkhsou.in) serves as the central digital platform for disseminating academic and administrative information. The website contains detailed information regarding programmes offered by the University, admission procedures, examination schedules, and study centre locations. A dedicated learner support section provides access to important academic resources including electronic self-learning materials, assignments, examination admit cards, mark sheets, and other essential documents. The website also provides links to important academic announcements and institutional updates. Learners of the M.Sc. Physics programme will be able to access programme-specific academic information, learning materials, and institutional resources through this online portal.
- **Learning Management System (e-Bidya):** The University has developed its own Learning Management System known as e-Bidya using the open-source MOODLE platform. This digital learning environment allows learners to access course materials and learning resources at any time. The LMS provides video lectures, tutorial materials, discussion forums, and other digital learning resources that support the teaching–learning process. Through this platform, learners can interact with teachers and fellow learners, participate in academic discussions, and access digital learning content related to their courses. The M.Sc. Physics programme will also be hosted on the e-Bidya platform so that

learners can benefit from structured online learning resources and academic interaction.

- **E-Mentoring System:** To strengthen academic support and learner engagement, the University has introduced an e-mentoring system in which groups of learners are guided by faculty mentors from the concerned discipline. Using platforms such as Telegram and WhatsApp, the system helps learners identify academic challenges, develop effective study strategies, and stay continuously engaged with the programme. It also supports them in overcoming learning difficulties. For M.Sc. Physics learners, e-mentoring may additionally provide guidance on advanced theoretical concepts, research orientation, and project work preparation.
- **Support for Differently Abled Learners:** The University promotes inclusive education and provides support to learners with special needs. It ensures access to learning resources for visually and physically challenged learners through accessible materials and audio resources. Additional academic support is offered via study centres and counselling services to facilitate effective participation in the learning process. The University is committed to creating an inclusive and equitable learning environment for all learners.
- **Handbook/SOP:** The University has brought out a Handbook for the Study Centres and a Standard Operating System (SOP) of Examination.
- **Face-to-face/Online Ticketing/Complaint System:** Learners' queries are attended in the face-to face mode and digital mode as well in a continuous way, through telephone, SMS and emails. There is a dedicated online portal through which the queries received automatically move to concerned department for solving the same. Once the problem is solved, the learner is informed by SMS and email.
- **Face to face and Walk-in Counselling:** Learners in Master of Science (Physics) will receive face-to face counselling from study centers. The University also provides face-to-face counselling/walk-in counselling to learners at the specially maintained city learner support center located at the city campus on Sundays or weekdays.
- **Online Counselling:** The University's faculty conducts online counselling sessions through different online platform like Zoom, Google Meet, Cisco

Webex and Facebook etc. in addition to regular counselling sessions in study centers. It provides direct interaction of learners with the regular faculty members of the University which creates a greater sense of inclusion and reduces feelings of isolation by offering personal care and guidance to all learners.

- **KKHSOU Mobile App:** A mobile application named "KKHSOU" has been developed to enable learners to stay connected with the University at any time. The application is available for download on the Google Play Store.
- **SMS Alert Facility:** The University has implemented an SMS alert system for learners which notify of university news, events, and learner-related information.
- **E-mail:** Learners can also write emails to any officials/faculty members of the University. For this a general email ID: info@kkhsou.in has been created. Concerns raised through email to this email address are addressed by the University's relevant officials or faculty members. Apart from that, the email and phone numbers of all faculty members are available on the website and Information Brochure. Any learners can write directly to them as well.
- **KKHSOU in Social Media:** KKHSOU has incorporated social media sites like Facebook pages, Whatsapp group, Twitter Account that enables sharing and interaction with the students' community.

7. PROCEDURE FOR ADMISSION, CURRICULUM TRANSACTION AND EVALUATION

7.1 Procedure for admission

i. **Online Admission:** Admission to M.Sc. in Physics programme would be offered by KKHSOU through online via the University website (www.kkhsou.in). A prospective learner may take admission as per his/her choice in any of the recognized study centre for the M.Sc. in Physics programme in the State of Assam. A learner is to submit all relevant documents for admission through the online admission portal. The course fee is to be paid through through online payment methods, such as credit card, debit card, net banking, or other available digital payment options. After admission is done, a unique Registration / Enrolment Number is automatically generated which will have to be used for future communications with the University. Based on his/her choice, and operational conveniences, a learner shall be assigned to a particular study centre for availing of dedicated services and counselling/tutoring facilities. Newly admitted learners will receive SLMs through the study centre, and in some cases, at their home address. e-SLMs are also available on the University website. The University has a Credit Transfer Policy which is being revised to facilitate course exemption in order to promote dual degree.

ii. **Refusal/Cancellation of Admission:** At the time of admission the candidate must submit a declaration that he/she is not pursuing more than two degree programmes under KKHSOU/any other recognised University or Institution simultaneously. If any false declaration is detected at any stage, his/her admission/mark sheets/ certificates may be cancelled by the University.

iii. **Continuous Admission:** By paying the necessary fees, a learner can obtain admission to the next semester once a particular semester is completed. Admission to the subsequent semester is not determined by the results of the previous semester. One may take admission in the next semester even without appearing in the previous semester examination. The admission period should be continuous from the date of completion of the previous semester's exams until 60 days after the start date. Incomplete exams, including back papers, will be allowed to be taken up when announcements of examination results are made. Learners are advised to regularly visit the University's website and maintain regular contact with their allotted study centres.

iv. **Pursuing Two Academic Programmes Simultaneously:** As per UGC guidelines dated April 2022 a learner can pursue two academic programmes simultaneously, one in full time physical mode and another in Open and Distance Learning (ODL)/Online mode; or up to two ODL/Online programmes.

v. **Fee Waiver for Differently Able Persons (DIVYANGJAN)**: The fee waiver will be applicable for differently able learners in all semesters of the programme where he/she has enrolled. Such learners must submit 'Form no. IV' issued by the Social Welfare Department or Disability and a copy of the Certificate issued by the Department of Empowerment of Persons with Disabilities, Ministry of Social Justice and Empowerment, Govt. of India. Forms/certificates of differently-abled learners, duly verified by the Social Welfare Department, Government of Assam, will also be considered for fee waiver for eligible learners of the M.Sc. in Physics Programme.

vi. **Financial Assistance:** The University provides free education to jail inmates and differently-abled learners. At present, it extends free education to inmates in 30 district jails across the state. However, laboratory-based programmes are currently not permitted for jail inmates.

7.2 Curriculum Transaction

Learners enrolled in the M.Sc. Physics programme are provided with various academic support services, including Self-Learning Materials (SLMs), to facilitate effective learning. These supports are listed below:

i. **Programme Guide:** There will be a programme guide that provides overall guidance for the academic activities of the M.Sc. in Physics programme. It outlines the programme structure, course details, learner support services, course assessment, and other essential information for learners.

ii. **Self-learning Materials (SLMs):** SLMs are designed to be learner friendly and easy to follow. With the support of subject experts, they are prepared using relevant and up-to-date information and knowledge.

iii. **Electronic Self Learning Materials (E-SLMs):** Apart from printed SLMs, E-SLMs are provided to the learners through the portal- http://eslm.kkhsou.in, which serves as a digital repository of study materials. Learners can access electronic learning resources for various programmes through this platform.

iv. **Induction and Counselling Sessions:** Induction sessions are organised jointly by university officials and faculty members, while counselling sessions are conducted by Study Centres, usually on Sundays. These face-to-face sessions help learners clarify their doubts regarding the courses. In addition, online counselling sessions will be arranged periodically by the University faculty for the M.Sc. Physics programme.

v. **Web-based tools:** The University also provide Web Enabled Academic Support Portal through e-Bidya, the Learning Management System of KKHSOU available at https://www.lmskkhsou.in/web/ to access the course materials and other learning resources.

7.3 Eligibility Criteria

The eligibility requirements for admission to the M.Sc. Physics programme are outlined below:

Table 3: Eligibility Criteria for Admission to the M.Sc. Physics Programme

Academic Programme	**Eligibility Criteria**
Master of Science in Physics	Graduates with B.Sc. Degree having Physics as either in the major or minor discipline in his/her UG programme from any University recognized by UGC. Or

	Science graduates after successfully completing the third year of the Four-Year Undergraduate Programme (FYUGP) having Physics as a subject in his/her UG programme from an UGC recognized university.

Thus, candidates who have completed a bachelor's degree with physics as a major subject from a recognized university may apply for admission to the M.Sc. Physics programme offered by the University.

7.4 Fees Structure

The total fee of the M.Sc. in Physics programme is Rs. **40,520/-** only (Rupees Forty Thousand Five Hundred Twenty only). The fee includes course fee, SLM fee, examination fee, Centre fee, marksheet fee, laboratory fee, practical exam fee and other fee. At present, the total fee for the programme is Rs. 9,830/- each for the first three semesters, while it is Rs. 11,030/- for the fourth semester, which includes an additional Rs. 1,200/- as project fees. The fee structure is shown in the Table 4.

Table 4: Fee Structure of M.Sc. in Physics Programme

M.Sc. in Physics								
Mode of payment of Fee: **Per Semester**								
Course Fee (Rs.)	SLM Fee (Rs.)	Exam Fee (Rs.)	Centre Fee (Rs.)	Mark Sheet Fee (Rs.)	Lab Fee (Rs.)	Practical Exam Fee (Rs.)	Other Fee (Rs.)	**Total Fee (Rs.)**
3000	1000	1000	430	100	2500	800	1000	**9830**
Total Fees for the Programme: Rs. 9830×4 = **39320 + *1200= 40,520/- only** (**Rupees Forty Thousand Five Hundred Twenty only**) ***Project Fees Rs. 1200/- is applicable in IV Semester**								

7.5 Assessment and Evaluation

The assessment and evaluation system of the M.Sc. Physics programme is designed to ensure transparency, fairness, and academic rigor in measuring learners' performance. The evaluation framework follows the guidelines of the UGC Regulations for Open and Distance Learning (2020) and the UGC Curriculum and Credit Framework. The system aims to assess the attainment of the programme learning outcomes as well as the specific course outcomes through continuous monitoring and final examinations. The University adopts a two-component evaluation system, consisting of Formative Assessment (continuous evaluation) and Summative Assessment (end-semester examination). This dual approach ensures that learners are assessed not only on their final examination performance but also on their continuous engagement with the course content and academic activities. For most courses in the M.Sc. Physics programme, learner performance will be assessed through continuous evaluation mechanisms, assignments, practical assessments, and end-semester examinations. The evaluation follows a 30:70 pattern, where 30 percent marks are assigned to formative assessment and 70 percent marks to summative assessment. This pattern applies to both theoretical and practical courses unless otherwise specified. The evaluation framework also emphasizes research orientation and analytical thinking through seminars, presentations, and project/dissertation work.

7.5.1 Structure of Course Evaluation

The M.Sc. Physics programme is organized into four semesters, and each course generally carries 100 marks. The marks distribution is as follows:

- Formative Assessment (Internal Assessment) – 30 Marks
- Summative Assessment (End Semester Examination) – 70 Marks

This evaluation structure applies to both theoretical courses and laboratory courses. Practical courses such as Physics Laboratory I, II and III will also evaluate using the same pattern, where internal assessment may include laboratory records, experimental performance, and assignments, while the summative component includes practical examination and viva-voce.

7.5.2 Formative Assessment

Formative assessment is designed to evaluate learners' progress throughout the semester. The purpose of continuous assessment is to encourage regular study, conceptual understanding, and academic participation. In the M.Sc. Physics programme, formative assessment carries 30% marks for each course and may include the following components:

- Assignments based on Self Learning Materials (SLMs)
- Short quizzes or written tests conducted by study centres
- Participation in academic interaction sessions such as Personal Contact Programmes (PCPs)
- Submission of laboratory records in practical courses
- Participation in academic seminars or extension activities

The Self Learning Materials contain 'Check Your Progress' exercises that enable learners to evaluate their understanding of the topics independently. Although these exercises are primarily for self-learning purposes, they help learners prepare for assignments and examinations. Assignments constitute a significant component of formative assessment. Learners are required to submit handwritten assignments for each course to their respective study centres within the prescribed deadlines. Feedback and suggestions are provided to help learners improve their understanding of the subject. Marks obtained through continuous evaluation are uploaded by the study centre coordinators to the University's assessment portal and contribute to the final grade of the course.

7.5.3 Summative Assessment

Summative assessment is conducted at the end of each semester to evaluate the learners' comprehensive understanding of the course content. The University conducts these examinations in pen-and-paper mode at designated examination centres or study centres. The end semester examination carries 70 marks for each course and is conducted according to the standard operating procedures prescribed by the University. Question papers are prepared and moderated by subject experts to maintain academic standards.

The University follows a standard operating procedure (SOP) for conducting examinations to maintain fairness and transparency. To ensure the integrity of the examination process, the University appoints Supervisory Officers, Examination Monitoring Officers, and examination inspection teams.

Question papers are prepared by subject experts and undergo moderation to ensure academic quality and standardization. Answer scripts are evaluated by qualified examiners, including both internal and external faculty members. After the evaluation process is completed, results are declared following verification and scrutiny. Learners have the option to apply for re-scrutiny or re-evaluation within the stipulated time if they wish to review their results.

7.5.4 Evaluation of Practical Courses

Experimental training forms an essential component of the M.Sc. in Physics programme. The laboratory courses namely Physics Laboratory I, II and III are designed to develop experimental skills, data analysis ability, and scientific reasoning. The evaluation of practical courses includes:

- Performance during laboratory experiments
- Maintenance and submission of laboratory records
- Analysis and interpretation of experimental data
- Viva-voce examination conducted during the practical examination

The practical examination forms part of the 70 marks summative assessment, while laboratory work and records contribute to the 30 marks formative assessment. Practical examinations will be conducted under the supervision of internal and external examiners to ensure objectivity and fairness.

7.5.5 Seminar Evaluation

In the second semester, learners are required to present a seminar on a selected topic related to physics. The detailed guidelines for seminar presentation and evaluation are provided in ***Annexure-III.*** The seminar is evaluated for 100 marks and carries 4 credits. The seminar evaluation would focus on:

- Understanding of the selected topic
- Clarity of presentation
- Analytical interpretation of scientific concepts
- Ability to respond to questions and discussions

This activity helps learners develop scientific communication skills and encourages them to explore contemporary developments in physics.

7.5.6 Major Project / Dissertation Evaluation

In the final semester, learners are required to undertake a major research project, which carries 200 marks and 8 credits. The project work provides an opportunity for learners to apply theoretical knowledge and research skills in a specialized area of physics. Under the supervision of a qualified faculty member or approved guide, learners will identify a research problem, conduct literature review, collect and analyse data or experimental results, and prepare a detailed research report. The detailed guidelines for Project/ Dissertation presentation and evaluation are provided in ***Annexure-IV.***

The evaluation of the project includes:

- Assessment of the written research report
- Quality and originality of the research work
- Methodology and analysis of results
- Presentation of the dissertation report
- Viva-voce examination

The project report is expected to demonstrate the learner's ability to apply scientific reasoning and research methodology to real-world problems in physics.

7.5.7 Assessment of the Programme

The University adopts the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) system for measuring academic performance. The SGPA represents the performance of a learner in a particular semester and is calculated by dividing the total grade points earned by the total credits of the courses taken in that semester. The CGPA represents the cumulative performance of the learner across all semesters of the programme. Both SGPA and CGPA are rounded off to two decimal places and are reported in the learner's academic transcript. At the end of each semester, learners receive a semester-wise grade report, and after completion of the programme, a consolidated transcript showing overall academic performance is issued.

The University follows a letter grade system for evaluating academic performance. The grading scheme is as follows:

Table 5: Grading system of KKHSOU

Letter Grade	Grade Point
O (Outstanding)	10
A+ (Excellent)	9
A (Very Good)	8
B+ (Good)	7
B (Above Average)	6
C (Average)	5
P (Pass)	4

7.5.8 Alignment with Learning Outcomes

The assessment and evaluation system of the M.Sc. Physics programme is designed to measure the attainment of programme outcomes as well as course outcomes. While preparing question papers, assignments, laboratory exercises, seminar topics, and project guidelines, due consideration is given to the intended learning objectives of the respective courses and the overall programme. This outcome-based evaluation approach ensures that the assessment process reflects the knowledge and competencies that learners are expected to acquire during the programme. It helps maintain academic quality and ensures that learners develop conceptual understanding of physical principles, analytical and problem-solving abilities, and experimental skills in laboratory work, and research aptitude through seminars and project work, which are essential for a postgraduate programme in Physics.

8. REQUIREMENT OF LABORATORY SUPPORT AND LIBRARY RESOURCES

8.1 Laboratory Support

Laboratory courses are an integral component of the M.Sc. in Physics programme. Importance has been given to the utility of the practical sessions with respect to development of problem-solving skills and industry-oriented applications. Laboratory classes will be conducted at the Study Centre and online laboratory counselling sessions are also held. For in-service learners, laboratory classes would be conducted on Sundays and holidays. The Learner Support Centres (LSCs) have been chosen for offering the M.Sc. in Physics program as per UGC Regulations for ODL and Online Programmes, 2020, [vide Part II, Clause 4 (B) (ii)]. Learner Support

Centres which have been offering the same programme in conventional mode for at least seven years have been chosen. It was also ensured that the chosen LSCs are having adequate laboratory facilities.

8.2 Library Resources

Library services for learners of KKHSOU are provided through physical facilities at recognized study centres and the Central Library located at the University's city campus. Reference books and learning materials are recommended by faculty members of the respective disciplines/schools as well as by the Self-Learning Material (SLM) contributors.

The Central Library of KKHSOU maintains a substantial collection of relevant reference books and textbooks supporting the MSc in Physics Programme. As of 26-03-2026, the library houses approximately 20,001 print books along with 8 newspapers and 7 magazines and 2 print journals. These resources are valuable not only for learners but also for faculty members, SLM writers, and content editors.

In addition to print materials, the library provides access to a wide range of electronic resources, including e-journals, online databases, and gateway portals. Programme-specific journal subscriptions are communicated to learners as they become available. The library is fully automated using an Integrated Library System (ILS) and is equipped with RFID (Radio-Frequency Identification) technology to enhance efficiency and accessibility.

Learners can access library services at their convenience through the library webpage (http://library.kkhsou.in/). They can also utilize the Digital Library (http://dlkkhsou.inflibnet.ac.in/), which serves as an online platform for collecting, preserving, and disseminating the University's academic and intellectual output to a global audience.

Beyond physical access, the library offers an Online Public Access Catalogue (OPAC) (http://opac.kkhsou.ac.in/), enabling users to browse and search the library collection remotely.

The University has implemented an Open Educational Resources (OER) Policy, which governs the development and dissemination of learning materials in both physical and digital formats. Furthermore, KKHSOU has entered into a Content Partner Agreement with the National Digital Library of India (NDLI), facilitating access to a vast repository of national and international digital resources through a single-window platform (https://ndl.iitkgp.ac.in/).

To further strengthen digital access, the University integrates resources from the Open Network for Open Science (ONOS), providing learners with access to a wide range of scholarly publications, research outputs, and open-access academic content.

Additionally, the library provides access to specialized databases such as the Economic and Political Weekly Research Foundation (EPWRF) database, which offers valuable datasets, analytical tools, and research materials particularly useful for studies in economics, social sciences, and allied disciplines. Overall, the KKHSOU library system ensures comprehensive academic support by combining traditional resources with advanced digital services, thereby catering effectively to the diverse needs of learners enrolled in MSc Physics Programme.

9. COST ESTIMATE OF THE PROGRAMME AND THE PROVISIONS

The office of the Finance Officer of KKHSOU keeps all the records of finances regarding print of SLMs, honorarium paid to the members of the Committee on Courses, honorarium paid to Content Writers, Content Editors, Language Editors, Translators, Proof Readers and also the expenditure related with organizing counsellors' workshops, meeting of the co-ordinators of the study centres etc. Moreover, the finance office also maintains records of purchase of computers, online space, books, journals etc. The accounts are maintained as per the laid down procedures of government. Regarding the cost of programme development, programme delivery, and programme maintenance, the finance office conducted an exercise based on historical costing method to arrive at indicative figures of cost. The findings are presented below in respect of the M.Sc. in Physics Programme.

9.1 Programme Development Cost

The programme development cost includes the cost of developing and printing the study materials. The SLM development cost for the postgraduate programme and the printing cost per SLM are presented below.

Table 6: SLM Development Cost for Master Degree Programme

English Medium per unit	₹ 7,600.00/-
(a) Writing	₹ 4,000.00/-
(b) Content Editing	₹ 2,000.00/-
(c) Language Editing	₹ 1,000.00/-
(d) Translation	__________
(e) DTP (Avg. 40 pages per unit @ 15/- per page)	₹ 600.00/-

Table 7: Printing Cost per SLM (for 1000 learners)

Printing (inside pages avg. 80 both side pages @690/- per page	₹ 55,200.00/-
Cover Page	₹ 5,850.00/-
Binding	₹ 2,400.00/-
Packing	₹ 5,500.00/-
Total	**₹ 68,950.00/-**

9.2 Programme Delivery Cost

The self-learning materials (SLMs) prepared for the M.Sc. in Physics program need to be delivered to various study centers located in remote areas. On average, the University delivers about 2.2 kg of study materials per learner, per semester. The cost of delivering 2.2 kg of such materials is Rs. 60 per semester. Therefore, the total program delivery cost for the M.Sc. in Physics program per learner for four semesters is Rs. 240. Accordingly, depending upon the number of learners; the cost for the MSc in Physics programme will be provisioned by the University.

9.3 Programme Maintenance Cost

The University has made financial provisions for organizing stakeholder meetings, counselling workshops, and other activities as per the academic plan and academic calendar approved by the Academic Council. These workshops and meetings will not only benefit learners of the M.Sc. in Physics programme but also learners of other programmes. The University will also bear the cost of organizing the meetings of the Syllabus Revision Committee and providing additional study materials if required to enhance programme quality. As per data from the University's finance department, the programme maintenance cost is estimated at Rs. 1,750/-. The University is committed to maintain the quality of the MSc Programme in Physics and once approved, the University will keep adequate financial provision for development, delivery, and maintenance of the programme presented as per the Programme Project Report

10. QUALITY ASSURANCE MECHANISM AND EXPECTED PROGRAMME AND COURSE LEARNING OUTCOMES

10.1 Quality Assurance Mechanism

With regard to quality assurance of all the Programmes of the University including the M.Sc. in Physics Programme, the University is involved in the following activities:

The programme design and structure is decided upon after a series of discussions and deliberations with a team of subject experts, who are eminent professors from reputed Universities. Formed with due approval from the University authority, this Committee on Courses is helped by the in house faculties of the Discipline of Physics of Hiranya Chandra Bhuyan School of Science and Technology of the University in preparing the framework of the programme.

The University has a SLM Policy which is followed in development of SLM. SLM Audit is a regular feature of the University which is conducted by CIQA. The writers of the contents for the SLMs and content editors involved, are mostly in house faculties and academics from reputed higher educational institutions maintaining the ratio laid by the UGC regulations. SLMs are distributed through a well laid down mechanism to all the learners by a mix of modes. Moreover, eSLM has been made available. Like the SLM Policy, the University has adopted University wide approaches for development of policies, Strategic Action Plan and their implementation.

CIQA takes care of the following among others to enhance the quality of the various facets of the University:

- Counsellors' workshops
- Stakeholders' meetings
- Feedback responses from the learners from various programmes
- SLM Audit

In order to keep the programme on M.Sc. in Physics updated, the programme would be revised and necessary changes would be incorporated for the benefit of the learners, based on the inputs received from the mechanism as mentioned above. Learners' and stakeholders' feedback is regularly collected and based on that, remedial measures and improvement mechanisms are worked out.

10.2 Expected Programme Outcomes

The Master of Science (M.Sc.) in Physics programme is designed to ensure that, upon successful completion, learners acquire advanced knowledge, professional competencies, and research capabilities in the discipline of Physics. In alignment with the principles of outcome-based education and the guidelines of the University Grants Commission (UGC), the expected Programme Outcomes (POs) are as follows. These outcomes are measurable and are assessed through course evaluation, laboratory performance, seminar presentations, and project/dissertation work.

PO1: Advanced Disciplinary Knowledge:

Demonstrate comprehensive and in-depth knowledge of fundamental and advanced areas of Physics which enable to understand and interpret complex physical principles and phenomena.

PO2: **Analytical and Problem-Solving Ability:**

Apply appropriate mathematical techniques and physical principles to analyse, model, and solve complex problems in theoretical and applied physics with logical rigor and precision.

PO3: Experimental and Technical Competence:

Design and conduct experiments, utilize standard laboratory instruments, analyse experimental data, and draw scientifically valid conclusions, in accordance with established laboratory practices.

PO4: Computational and Digital Proficiency:

Employ computational tools, numerical methods, and relevant software for simulation, modelling, and data analysis in diverse areas of physics.

PO5: Interdisciplinary Application and Technological Awareness:

Integrate knowledge of physics with allied and emerging areas such as electronics, semiconductor devices, photonics, astrophysics, nanoscience, and renewable energy, and demonstrate awareness of technological applications.

PO6: Research Aptitude and Scientific Inquiry:

Demonstrate the ability to identify research problems, review relevant literature, apply appropriate methodologies, and undertake independent research culminating in a dissertation or project work, with a commitment to lifelong learning and employability.

PO7: Scientific Communication and Presentation Skills:

Communicate scientific concepts, experimental findings, and research outcomes effectively in both written and oral forms, as well as in seminars, reports, and presentations.

PO8: Critical Thinking and Innovation

Exhibit critical thinking, logical reasoning, and innovative approaches in analysing scientific problems and proposing solutions.

PO9: Professional Ethics and Responsibility:

Adhere to ethical standards in scientific practice, with emphasis on integrity in data collection, analysis, reporting, and other aspects of professional conduct.

10.3 Learning Outcome based Curriculum Framework (LOCF) of MSc in Physics Programme

The M.Sc. Physics programme is developed in accordance with the Learning Outcome-Based Curriculum Framework (LOCF) as recommended by the University Grants Commission (UGC), and is aligned with the provisions of the UGC Regulations for Open and Distance Learning (ODL), 2020. The framework ensures a learner-centric, outcome-oriented, and competency-based approach to curriculum design, delivery, and assessment.

Table 8: Course Objectives and LOCF of the M.Sc. in Physics

Sem.	Course Type	Course Name	Course Objectives	Course Learning Outcomes
I	DSC	Classical Mechanics	• Understand basic concepts of classical mechanics. • Apply Lagrangian and Hamiltonian methods. • Analyse central force and rigid body motion. • Solve problems using H–J and oscillation theory. • Explain the basics of special theory of relativity.	**CO1:** Formulate systems using generalized coordinates. **CO2:** Derive Lagrange's and Hamilton's equations. **CO3:** Solve central force and rigid body problems. **CO4:** Apply canonical and H–J methods. **CO5:** Explain relativistic effects using Lorentz transformations.
I	DSC	Mathematical Physics	• Understand vector calculus and linear algebra tools. • Apply matrices, tensors, and operators in physical problems. • Solve differential equations using standard methods. • Use special functions and integral transforms. • Introduce complex analysis and group theory concepts.	**CO1:** Compute gradients, matrices, and linear operator problems. **CO2:** Apply tensors and geometry in physical systems. **CO3:** Solve differential equations using Laplace and Fourier methods. **CO4:** Use special functions and complex analysis techniques. **CO5:** Explain symmetry using group theory and representations.
I	DSC	Physics Lab I	• Gain practical understanding of mechanics, elasticity, oscillations, and electronics. • Determine important physical constants using experimental methods. • Develop skills in measurement, data analysis, and graphical interpretation. • Handle scientific instruments and basic electronic (OP-AMP) circuits. • Prepare scientific reports with proper error analysis and interpretation.	**CO1:** Explain the principles of the prescribed physics experiments. **CO2:** Determine physical constants such as the acceleration due to gravity (g), elastic constants, viscosity, resistivity, and band gap. **CO3:** Analyse experimental data and verify physical laws. **CO4:** Design and test basic transistor-based amplifier and regulator circuits. **CO5:** Evaluate experimental results with proper error analysis and documentation.
I	DSE	Introduction to Semiconductor Devices	• Get an idea of the fabrication processes of integrated circuits • Understand semiconductor fundamentals and carrier transport	**CO1:** Explain semiconductor band structure, carrier behavior, and transport phenomena **CO2:** Compare BJT, JFET, and MOSFET performance in circuits

			• Explain operation and applications of diodes, transistors, and FETs • Describe the behavior of special diodes and power semiconductor devices • Get an idea of the fabrication processes of integrated circuits.	**CO3:** Demonstrate transistor operation and biasing for amplifiers **CO4:** Analyse power devices like SCR, TRIAC, DIAC, Power MOSFET, and IGBT **CO5:** Summarize IC fabrication steps and their effect on device performance
II	DSC	Electromagnetic Theory	• Understand electrostatics using Laplace and Poisson equations. • Apply boundary value methods and image techniques. • Explain electromagnetic fields in matter. • Analyze Maxwell's equations and wave propagation. • Introduce radiation and relativistic electrodynamics.	**CO1:** solve Laplace and Poisson boundary value problems. **CO2:** Apply dielectric and magnetic material concepts. **CO3:** Derive and use Maxwell's equations in vacuum and matter. **CO4:** Analyze electromagnetic waves and radiation problems. **CO5:** Explain electrodynamics using relativistic formulation.
II	DSC	Quantum Mechanics	• Introduce the basic concepts of quantum mechanics. • Develop the mathematical formalism of quantum mechanics. • Apply the Schrödinger equation to standard problems. • Explain the postulates and physical interpretation of quantum mechanics. • Introduce approximation methods and relativistic quantum mechanics.	**CO1:** Explain the basic concepts of quantum mechanics. **CO2:** Use the mathematical formalism of quantum mechanics. **CO3**: Apply the Schrödinger equation to standard problems. **CO4:** Analyse angular momentum, spin, and measurement in quantum systems. **CO5:** Apply approximation methods and outline relativistic quantum mechanics.
II	DSC	Physics Lab II	• Understand basic concepts of modern physics, electricity, and electronics through experiments. • Apply experimental methods to determine physical constants. • Analyse electrical, magnetic, and electronic circuits. • Develop skill in using CRO, LCR, and function generators. • Interpret experimental data and verify physical laws.	**CO1:** Determine important physical constants. **CO2:** Verify laws related to modern physics and electromagnetism. **CO3:** Analyze RC, LCR circuits and resonance. **CO4:** Demonstrate basic analog communication experiments. **CO5:** Test and interpret electronic signals and circuits.
II	DSE	Fundamentals of	• Describe analog and digital communication principles,	**CO1:** Classify signals, analyze noise, and explain analog and digital modulation.

		Communication System	including signals, noise, and modulation. • Recognize AM, FM, PM, and digital modulation techniques and their detection methods. • Explain receivers, mobile, satellite, and optical communication system architectures. • Discuss data communication, multiplexing, and multiple access techniques. • Explore emerging technologies like IoT, WSNs, and smart communication systems.	**CO2:** Design and evaluate AM, FM, PM, ASK, FSK, PSK, QPSK, and QAM schemes. **CO3:** Analyze the operation of receivers, mobile, satellite, and optical communication systems. **CO4:** Analyze data transmission, multiplexing, and multiple access techniques for efficient communication. **CO5:** Evaluate modern applications like IoT, WSNs, and smart systems.
III	DSE	Condensed Matter Physics	• Understand the crystal structure, bonding, and defects in solid materials. • Explain diffraction, lattice vibrations, and thermal behaviour of solids. • Apply free electron and band theories to interpret electronic properties of materials. • Analyze semiconducting, dielectric, magnetic, properties of solids. • Explain the basic properties of nanomaterials and common experimental techniques.	**CO1:** Explain crystal structures, bonding, defects, and diffusion mechanisms in solids. **CO2:** Illustrate the principles of X-ray diffraction, phonons, and thermal properties of solids. **CO3:** Apply free electron and band theories to interpret the electrical properties of materials. **CO4:** Analyse semiconducting, dielectric, magnetic, and superconducting materials. **CO5:** Identify and understand nanomaterials and basic experimental techniques in condensed matter physics
III	DSC	Fundamentals of Analog and Digital Electronics	• Understand the principles, characteristics, and applications of operational amplifiers • Study data converters and waveform generation techniques. • Describe the combinational and sequential logic circuits including registers, counters. • Explain the principles of feedback and oscillation and their role in circuit design. • Comprehend special function ICs and semiconductor memories.	**CO1:** Determine the performance characteristics and limitations of operational amplifiers **CO2:** Apply DACs, ADCs, and waveform generator ICs in signal processing systems. **CO3:** Analyse Boolean identities and Karnaugh maps to minimize logic expressions and use logic families. **CO4:** Design combinational logic circuits, registers and counters to solve electronic problems **CO5:** Demonstrate the operation and applications of semiconductor memories.

III	DSC	Physics Lab III	• Understand basic principles of materials and electronic devices. • Perform experiments using standard instruments. • Apply theory to practical measurements. • Analyze experimental data. • Evaluate device and material behaviour.	**CO1:** Conduct experiments on materials and electronic circuits. **CO2:** Measure physical and electronic parameters accurately. **CO3:** Analyze experimental results and graphs. **CO4:** Interpret material properties and device characteristics. **CO5:** Prepare proper laboratory records and reports.
III	DSE	Introduction to Astrophysics	• Introduce basic concepts and historical development of astrophysics. • Understand gravitation, planetary motion, and orbital dynamics. • Learn methods of astronomical distance measurement and magnitude system. • Study astronomical instruments and multi-wavelength observations. Apply radiation laws, spectroscopy, and Doppler/redshift in astrophysics. • Understand star formation, galaxies, and fundamentals of cosmology	**CO1:** Explain the scope, evolution, and historical development of astrophysics. **CO2:** Apply Kepler's and Newton's laws to analyse the motion and orbits of celestial bodies. **CO3:** Estimate and interpret astronomical distances, magnitudes, and observational data using standard methods. **CO4:** Describe and apply the principles of telescopes, detectors, blackbody radiation, spectra, and Doppler/redshift in astronomical observations. **CO5:** Explain and analyse star formation, stellar properties (H–R diagram), galaxies, and basic cosmological concepts.
III	DSE	Fundamentals of Laser and Photonics	• Understand the fundamental nature of light and basic principles of photonics and lasers. • Explain light–matter interaction and the physical basis of laser action. • Describe the construction and working of basic laser systems and optical fibers. • Identify major types of lasers and fundamental photonic devices. • Recognize important applications of lasers and photonics in science and technology.	**CO1:** Explain the basic concepts of light, photons, and optical radiation. **CO2:** Analyze the principle of laser action and working of common lasers. **CO3:** Apply fundamental principles of optics and photonics to optical fibers and devices. **CO4:** Differentiate between different laser systems, fibers, and photonic components. **CO5:** Evaluate the suitability of lasers and photonic systems for basic scientific and technological applications.

IV	DSC	Atomic and Molecular Physics	• Understand atomic quantum states and spectroscopic notation. • Explain atomic spectra and fine/hyperfine structures • Analyze spectral splitting in external fields Interpret X-ray spectra and related principles • Learn fundamentals of molecular spectroscopy and Franck–Condon principle.	**CO1:** Explain atomic energy levels and spectra using quantum numbers and term symbols. **CO2:** Interpret H, He and alkali spectra using coupling and exchange interaction. **CO3:** Predict spectral splitting in electric and magnetic fields (Stark, Zeeman, Paschen–Back). **CO4:** Analyse X-ray emission and absorption spectra using Moseley's law and screening. **CO5:** Classify and interpret molecular rotational, vibrational, Raman and electronic spectra using Franck–Condon principle.
IV	DSC	Nuclear and Particle Physics	• Understand nuclear structure, forces and models of the nucleus. • Explain radioactive decay, nuclear reactions, fission and fusion processes. • Apply theoretical concepts to analyse interaction of radiation with matter and detection methods. • Analyse particle accelerators, detectors and experimental nuclear techniques. • Introduce the basics of particle physics, quark model and fundamental interactions.	**CO1:** Describe nuclear structure, properties and models. **CO2:** Explain radioactive decay, nuclear reactions, fission and fusion. **CO3:** Apply radiation–matter interaction principles and detector concepts. **CO4:** Analyze particle accelerators and experimental nuclear techniques. **CO5:** Identify elementary particles, quark model and fundamental interactions.
IV	DSC	Statistical Mechanics	• Understand basic principles of statistical mechanics • Explain microstates, macrostates and ensembles • Apply classical and quantum statistics to physical systems • Analyse thermodynamic quantities using partition functions • elate statistical concepts to real physical phenomena	**CO1:** Define key concepts of statistical mechanics **CO2:** Describe classical and quantum distribution laws **CO3:** Compute basic thermodynamic properties **CO4:** Distinguish between Bose, Fermi and classical systems **CO5:** Interpret phase transitions, fluctuations and transport processes
IV	DSE	Experimental Techniques	• Understand measurement and error analysis. • Explain signal detection and noise reduction. • Describe vacuum and characterization techniques.	**CO1:** Analyse data using statistical methods. **CO2:** Evaluate signal quality using SNR.

			• Apply nuclear and resonance methods. • Use Python and software for data analysis	**CO3:** Interpret results from XRD, microscopy, and spectroscopy. **CO4:** Differentiate detectors and accelerator techniques. **CO5:** Develop simple Python programs for numerical analysis
IV	DSE	Physics of Nanomaterials	• Understand basic concepts of nanoscience and nanotechnology 23 • Explain quantum confinement and size effects. • Describe different types of nanomaterials and carbon nanostructures. • Explain characterization and nanofabrication techniques. • Apply simulation and software tools in nanotechnology studies	**CO1:** Classify nanomaterials based on structure and dimension. **CO2:** Analyse size-dependent and quantum effects in nanomaterials. **CO3:** Interpret XRD, TEM, STM, AFM, and optical spectroscopy results. **CO4:** Evaluate preparation methods and properties of fullerenes and CNTs. **CO5:** Perform simulation and surface analysis using SCAPS, Gwyddion, and VESTA.
	DSE	High Energy Physics	• List fundamental particles and interactions. • Explain symmetry principles and conservation laws. • Apply the quark model to classify hadrons. • Analyse experimental results and evaluate the Standard Model and cosmological evidence. • Develop basic data analysis methods for particle physics data.	**CO1:** Describe fundamental particles and interactions. **CO2:** Explain symmetry and conservation laws. **CO3:** Apply the quark model. **CO4:** Analyze experimental results. **CO5:** Interpret the Standard Model and apply basic data analysis methods in cosmology

10.4 Course Outcome-Programme Outcome (CO-PO) Mapping

In accordance with the principles of Outcome-Based Education (OBE), the Course Outcomes (COs) of each course in the M.Sc. Physics programme are systematically mapped with the Programme Outcomes (POs). This mapping ensures that the learning objectives of individual courses contribute effectively to the attainment of the overall programme outcomes.

The CO-PO mapping matrix presented below indicates the degree of correlation between course outcomes and programme outcomes using a three-point scale, where 3 represents high correlation, 2 represents moderate correlation, and 1 represents low correlation. This structured alignment facilitates continuous evaluation, quality assurance, and attainment analysis of programme objectives.

Table 9: Mapping of Courses with Programme Outcomes of MSc. Physics Programme

Sem	Course Type	Course Title		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
I	DSC1	Classical Mechanics	**CO1**	3	3	–	1	–	2	–	2	–
			CO2	3	3	–	2	–	2	–	2	–
			CO3	3	3	1	–	–	2	–	3	–
			CO4	3	3	–	2	–	3	–	3	–
			CO5	3	2	–	1	2	2	1	2	–
	DSC2	Mathematical Physics	**CO1**	3	3	–	2	–	2	–	2	–
			CO2	3	3	–	2	2	2	–	3	–
			CO3	3	3	–	3	–	2	–	3	–
			CO4	3	3	–	3	2	2	–	3	–
			CO5	3	2	–	2	3	2	1	2	–
	DSC3	Physics Lab-I	**CO1**	2	2	3	–	–	2	1	2	2
			CO2	2	2	3	1	–	2	–	2	2
			CO3	2	3	3	2	–	3	1	3	2
			CO4	2	2	3	2	2	2	–	2	2
			CO5	2	2	3	2	–	3	2	2	3
	DSE1	Introduction to Semiconductor Devices	**CO1**	3	2	–	2	3	2	–	2	–
			CO2	3	3	–	2	3	2	–	3	–
			CO3	3	3	1	2	3	2	–	3	–
			CO4	3	3	–	2	3	3	–	3	–
			CO5	3	2	–	2	3	2	1	2	–
II	DSC4	Electromagnetic Theory	**CO1**	3	3	–	2	–	2	–	3	–
			CO2	3	3	–	2	2	2	–	3	–
			CO3	3	3	–	2	–	2	–	3	–
			CO4	3	3	–	2	2	3	–	3	–
			CO5	3	2	–	2	2	2	1	2	–
	DSC5	Quantum Mechanics	**CO1**	3	2	–	1	–	2	–	2	–
			CO2	3	3	–	2	–	2	–	3	–
			CO3	3	3	–	2	–	2	–	3	–
			CO4	3	3	–	2	–	3	–	3	–
			CO5	3	2	–	2	2	3	1	2	–
	DSC6	Physics Lab II	**CO1**	2	2	3	–	–	2	–	2	2
			CO2	2	2	3	–	–	2	–	2	2
			CO3	2	3	3	2	–	3	–	3	2
			CO4	2	2	3	2	2	2	–	2	2
			CO5	2	2	3	2	–	3	2	2	3
	DSE2	Fundamentals of Communication System	**CO1**	3	3	–	3	3	2	–	3	–
			CO2	3	3	–	3	3	2	–	3	–
			CO3	3	3	–	2	3	2	–	3	–
			CO4	3	3	–	3	3	2	–	3	–
			CO5	3	2	–	3	3	2	1	2	–
III	DSC7	Condense Matter Physics	**CO1**	3	3	–	1	3	2	–	3	–
			CO2	3	3	–	1	3	2	–	3	–
			CO3	3	3	–	2	3	2	–	3	–

			CO4	3	3	–	2	3	2	–	3	–
			CO5	3	2	–	2	3	2	–	2	–
	DSC8	Fundamentals of Analog and Digital Electronics	**CO1**	3	3	–	3	2	2	–	3	–
			CO2	3	3	–	3	3	2	–	3	–
			CO3	3	3	–	2	2	2	–	3	–
			CO4	3	3	–	3	3	2	–	3	–
			CO5	3	2	–	2	3	2	–	2	–
	DSC9	Physics Lab III	**CO1**	–	–	3	1	–	2	–	2	2
			CO2	–	–	3	1	–	2	–	2	2
			CO3	–	–	3	2	–	3	–	3	2
			CO4	–	–	3	2	–	2	–	2	2
			CO5	–	–	3	2	–	3	–	2	3
	DSE3 (Optional 1)	Introduction to Astrophysics	**CO1**	3	2	–	–	2	2	–	2	–
			CO2	3	3	–	–	2	2	–	3	–
			CO3	3	3	–	–	2	2	–	3	–
			CO4	3	3	–	1	3	2	–	3	–
			CO5	3	3	–	1	3	2	–	3	–
	DSE3 (Optional 2)	Fundamentals of Laser and Photonics	**CO1**	3	2	–	2	2	2	–	2	–
			CO2	3	3	–	2	2	2	–	3	–
			CO3	3	3	–	3	3	2	–	3	–
			CO4	3	3	–	2	3	2	–	3	–
			CO5	3	2	–	2	3	2	1	2	–
IV	DSC10	Atomic & Molecular Physics	**CO1**	3	3	–	–	–	2	–	3	–
			CO2	3	3	–	–	–	2	–	3	–
			CO3	3	3	–	–	–	2	–	3	–
			CO4	3	3	–	1	–	2	–	3	–
			CO5	3	3	–	–	–	2	–	3	–
	DSC11	Nuclear & Particle Physics	**CO1**	3	3	–	–	2	2	–	3	–
			CO2	3	3	–	–	2	2	–	3	–
			CO3	3	3	–	1	2	2	–	3	–
			CO4	3	3	–	1	3	2	–	3	–
			CO5	3	3	–	–	3	2	–	3	–
	DSC12	Statistical Mechanics	**CO1**	3	2	–	1	–	2	–	2	–
			CO2	3	3	–	1	–	2	–	3	–
			CO3	3	3	–	2	–	2	–	3	–
			CO4	3	3	–	1	–	2	–	3	–
			CO5	3	3	–	1	–	2	–	3	–
	DSE4 (Optional 1)	Experimental Techniques	**CO1**	–	2	3	2	–	3	–	2	2
			CO2	–	2	3	2	–	2	–	2	2
			CO3	–	2	3	2	–	2	–	2	2
			CO4	–	2	3	2	–	2	–	2	2
			CO5	–	2	2	3	–	3	–	2	2
	DSE4 (Optional 2)	Physics of Nano Materials	**CO1**	3	2	–	2	3	2	–	2	–
			CO2	3	3	–	2	3	2	–	3	–
			CO3	3	3	–	3	3	2	–	3	–
			CO4	3	3	–	2	3	2	–	3	–
			CO5	3	2	–	3	3	3	–	2	–
			CO1	3	2	–	–	2	2	–	2	–

	DSE4 (Optional 3)	High Energy Physics	**CO2**	3	3	–	–	2	2	–	3	–
			CO3	3	3	–	–	3	2	–	3	–
			CO4	3	3	–	1	3	2	–	3	–
			CO5	3	3	–	–	3	3	–	3	–

ANNEXURE I

STRUCTURE OF M.SC. IN PHYSICS PROGRAMME

Credit Distribution for Master of Science in Physics

Sl. No.	Nature of Courses	Total no. of Courses	Credit	Total Credits
1	DSC (Discipline Specific Core)	12	4	48
2	DSE (Discipline Specific Elective)	04	4	16
3	AEC (Ability Enhancement Course)	02	4	8
4	VAC (Value Added Course)	02	2	4
5	Seminar	01	4	4
6	Project/Dissertation	01	8	8
	Total	**22**		**88**

Course Distribution for Master of Science in Physics

Semester	DSC	DSE	AEC	VAC	Dissertation/ Seminar	Semester wise credits
I	DSC 1 DSC 2 DSC 3	DSE 1	AEC 1	VAC 1		22
II	DSC 4 DSC 5 DSC 6	DSE 2	-	VAC 2	Seminar	22
III	DSC 7 DSC 8 DSC 9	DSE 3	AEC 2	-		20
IV	DSC 10 DSC 11 DSC 12	DSE 4			Project/Dissertation	24
Total Credit	**48**	**16**	**8**	**4**	**12**	**88**

Semester-wise Course and Credit Distribution

Semester	DSC (12 Courses, Credit 4 each)	DSE (4 Courses, Credit 4 each)	AEC (2 Courses, Credit 4 each)	VAC (2 Courses, Credit 2 each)	Dissertation/ Seminar (Seminar: 4 Credits, Project: 8 Credits)	Total Credits
I	Classical Mechanics Mathematical Physics Physics Lab-I	Introduction to Semiconductor Devices	AEC 1 (Renewable Energy Or Other options available under the AEC basket in Annexure VI)	VAC 1 (One course from the VAC basket in Annexure VI)	-	**22**
II	Electromagnetic Theory Quantum Mechanics Physics Lab-II	Fundamentals of Communication System	-	VAC 2 (One course from the VAC basket in Annexure VI)	Seminar	**22**
III	Condensed Matter Physics Fundamentals of Analog and Digital Electronics Physics Lab-III	Introduction to Astrophysics Or Fundamentals of Laser and Photonics	AEC 2 (Cyber security)*	-		**20**
IV	Atomic and Molecular Physics Nuclear and Particle Physics Statistical Mechanics	Experimental Techniques Or Physics of Nanomaterials Or High Energy Physics		-	Project/ Dissertation	**24**
Total Credit	**48**	**16**	**8**	**4**	**12**	**88**

* Compulsory for all

Marks Distribution of Courses for Master of Science in Physics

Semester	Course Name	Whether DSC/DSE/AEC /VAC	Marks	Credit
I	Classical Mechanics	DSC	100 (30F+70S)	4
	Mathematical Physics	DSC	100 (30F+70S)	4
	Physics Lab-I	DSC	100 (30F+70S)	4
	Introduction to Semiconductor Devices	DSE	100 (30F+70S)	4
	Renewable Energy or other options from the basket	AEC	100 (30F+70S)	4
	VAC 1	VAC	100 (30F+70S)	2
II	Electromagnetic Theory	DSC	100 (30F+70S)	4
	Quantum Mechanics	DSC	100 (30F+70S)	4
	Physics Lab-II	DSC	100 (30F+70S)	4
	Fundamentals of Communication System	DSE	100 (30F+70S)	4
	VAC 2	VAC	100 (30F+70S)	2
	Seminar		100	4
III	Condensed Matter Physics	DSC	100 (30F+70S)	4
	Fundamentals of Analog and Digital Electronics	DSC	100 (30F+70S)	4
	Physics Lab-III	DSC	100 (30F+70S)	4
	Introduction to Astrophysics Or Fundamentals of Laser and Photonics	DSE	100 (30F+70S) or 100 (30F+70S)	4 or 4
	Cyber Security	AEC	100 (30F+70S)	4
IV	Atomic & Molecular Physics	DSC	100 (30F+70S)	4
	Nuclear and Particle Physics	DSC	100 (30F+70S)	4
	Statistical Mechanics	DSC	100 (30F+70S)	4
	Experimental Techniques Or Physics of Nanomaterials Or High Energy Physics	DSE	100 (30F+50S+20P) or 100 (30F+50S+20P) or 100 (30F+70S)	3+1=4 or 3+1=4 or 4
	Major Project		200	8
	Total		**2300**	**88**

N.B.: F = Formative Assessment (i.e., Internal Assessment); S = Summative Assessment (i.e., End Semester Examination); P=Practical; 1 credit = 30 hours of learning; 4 credits=30 × 4=120 hours of learning.

ANNEXURE-II

DETAILED COURSE-WISE SYLLABUS OF M.SC. IN PHYSICS PROGRAMME

Semester I: Classical Mechanics

Course Type	DSC
Course Credit	4
Course Code	PGPHY S1-01(DSC)
Total Marks	100 (30% Formative, 70% Summative)

Course Objectives:

The course will enable the learners to:

● Understand basic concepts of classical mechanics.

● Apply Lagrangian and Hamiltonian methods.

● Analyse central force and rigid body motion.

● Solve problems using H–J and oscillation theory.

● Explain the basics of special theory of relativity.

Course Outcomes:

After completing this course, the learner will be able to:

● Formulate systems using generalized coordinates.

● Derive Lagrange's and Hamilton's equations

● Solve central force and rigid body problems.

● Apply canonical and H-J methods.

● Explain relativistic effects using Lorentz transformations.

Unit 1: Introductory Ideas of Mechanics

Coordinate systems; Degrees of freedom; Constraint; Generalized co-ordinates.

Unit 2: Dynamical Equilibrium

Principle of virtual work; D'Alembert's principle.

Unit 3: Lagrangian Dynamics-I

Lagrange's equation of motion; Application of Lagrange's equation.

Unit 4: Lagrangian Dynamics-II

Variational Principle; Derivation of Lagrange's equation of motion; Newton's equation of motion from Lagrange's equation.

Unit 5: Hamiltonian Dynamics

Hamiltonian and canonical equations; Hamiltonian equations in different coordinate system: Cartesian, Polar, cylindrical, and Spherical; Application of Hamilton's equation.

Unit 6: Canonical Transformation

Canonical transformation; Legendre's transformation; Generating Functions; Condition for canonical transformation.

Unit 7: Brackets and Liouville's Theorem

Poisson's Brackets; Lagrange's Brackets; Relation between Lagrange and Poisson Brackets; Angular momentum and Poisson Brackets; Liouville's Theorem.

Unit 8: Hamilton-Jacobi Theory

The Hamilton-Jacobi equation; Hamilton's-Jacobi method: Solution of Harmonic oscillator problem, Kepler's problem; Hamilton Characteristic Function.

Unit 9: Two-Body Central Force Problem

Central Force and Motion in a Plane; Reduction of two body problem into equivalent one body problem; Equations of motion under central force and first integral; Numerical problems; Differential equation for an orbit; Inverse square law of force.

Unit 10: Small Oscillations

Potential energy and Equilibrium; Types of Equilibrium: stable, unstable, and neutral; General theory of small oscillations; Two coupled Oscillators: Solution of differential equations, Normal co-ordinates, Normal modes of frequencies.

Unit 11: Dynamics of a Rigid Body-I

Introduction; Degrees of freedom of a rigid body; Generalized coordinates of a rigid body; Body and space reference systems.

Unit 12: Rigid Body Dynamics-II

Euler's equations: Euler angles, Components of Angular velocity; Principal axes and Principal moments of Inertia; Rotational kinetic energy of a rigid body.

Unit 13: Special theory of Relativity

Galilean Transformation; Principle of relativity and speed of light; Postulates of special theory of relativity; Lorentz Transformation and its consequences.

Unit 14: Four Dimensional Formulation

Minkowski space; Four vectors and examples.

Suggested Readings:

● Taylor, J. R. (2005). Classical mechanics. University Science Books.

● Kleppner, D., & Kolenkow, R. J. (2014). An introduction to mechanics (2nd ed.).

Cambridge University Press.
● Goldstein, H., Poole, C. P., & Safko, J. L. (2002). Classical mechanics (3rd ed.). Addison-Wesley.
● Goldstein, H. (2011). Classical mechanics (3rd ed.). Pearson Education India.
● Morin, D. J. (2008). Introduction to classical mechanics: With problems and solutions. Cambridge University Press.
● Kibble, T. W. B., & Berkshire, F. H. (2004). Classical mechanics (5th ed.). Imperial College Press.
● Upadhyaya, J. C. (2016). Classical mechanics. Himalaya Publishing House.
● Rana, N. C., & Joag, P. S. (2001). Classical mechanics. Tata McGraw-Hill

Semester I: Mathematical Physics

Course Type	**DSC**
Course Credit	**4**
Course Code	**PGPHY S1-02(DSC)**
Total Marks	**100 (30% Formative, 70% Summative)**

Course Objectives

The course will enable the learners to:

● Understand vector calculus and linear algebra tools.

● Apply matrices, tensors, and operators in physical problems.

● Solve differential equations using standard methods.

● Use special functions and integral transforms.

● Introduce complex analysis and group theory concepts.

Course Outcomes

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

● Compute gradients, matrices, and linear operator problems.

● Apply tensors and geometry in physical systems.

● Solve differential equations using Laplace and Fourier methods.

● Use special functions and complex analysis techniques.

● Explain symmetry using group theory and representations.

Unit 1: Review of vector calculus

Vector operators: Overview of Vector operators, Gradient of Scalar function, Divergence of a vector field, Curl of a vector field, Important vector identities, Physical meaning of operators; Numerical exercises

Unit 2: Linear Vector Spaces

N-dimensional vector space; Basis and Dimensions: Orthogonal and Orthonormal basis; Inner product; Hilbert space; Gram–Schmidt Orthonormalisation; Outer product; Applications.

Unit 3: Linear Operators

Linear operators; Algebra of operators; Matrix representation of linear operators; Eigenvalue problems (introductory).

Unit 4: Matrices

Special Matrices: Symmetric, Antisymmetric, Orthogonal, Hermitian, Anti-Hermitian, Unitary; Eigenvalues and Eigenvectors; Cayley–Hamilton Theorem; Diagonalization.

Unit 5: Tensor Analysis

Basics of Tensors; Covariant and Contravariant Tensors; Line Element; Metric Tensor; Associated Tensors.

Unit 6: Tensor Calculus and Geometry

Christoffel Symbols; Covariant Derivative; Geodesics; Riemann-Christoffel Curvature Tensor; Bianchi Identities.

Unit 7: Differential Equations

Order and Degree; First and Second Order Linear Differential Equations.

Unit 8: Special Functions

Types of Polynomials: Legendre, Bessel, Hermite and Laguerre Polynomials; Rodrigues Formula; Generating Functions; Orthogonality; Bessel Functions and Applications.

Unit 9: Laplace Transform

Laplace Transform of Elementary Functions: Properties, Shifting and Scaling; Derivatives and Integrals of Laplace Transform; Convolution Theorem; Inverse Laplace Transformation; Solution of Differential Equations.

Unit 10: Fourier Integrals

Preliminaries of Special Functions: Gamma, Error, Bessel Functions; Fourier Integral Representations; Proof of the Fourier Integral Theorem.

Unit 11: Fourier Transform

Fourier Transformation and Properties; Fourier Transform of Derivatives; Shift Theorem, Change of Scale; Modulation Theorem; Convolution Theorem; Parseval's Identity.

Unit 12: Complex Analysis-I

Complex Functions; Cauchy–Riemann Equations; Analytic and Harmonic Functions

Unit 13: Complex Analysis-II

Complex Integration, Cauchy Theorem and Integral Formula; Taylor and Laurent Series; Poles; Residues.

Unit 14: Group Theory

Basics Of Group Theory: Definition, Examples; Discrete Groups: Cyclic, Dihedral, Permutation Groups; Subgroups; Lagrange Theorem; Cosets And Conjugacy Classes; Introduction to Group Representations; Rotational Groups: SO(2), SO(3), U(1), SU(2).

Suggested Readings:

● Dass, H. K., & Verma, R. (2013). Mathematical physics. S. Chand.

● Boas, M. L. (2006). Mathematical methods in the physical sciences (3rd ed.). John Wiley & Sons.

● Arfken, G. B., Weber, H. J., & Harris, F. E. (2013). Mathematical methods for physicists (7th ed.). Elsevier Academic Press.

● Mathews, J., & Walker, R. L. (1970). Mathematical methods of physics (2nd ed.). Benjamin.

● Riley, K. F., Hobson, M. P., & Bence, S. J. (2006). Mathematical methods for physics and engineering (3rd ed.). Cambridge University Press.

Semester I: Physics Lab I

Course Type	**DSC**
Course Credit	**4**
Course Code	**PGPHY S1-03(DSC)**
Total Marks	**100 (30% Formative, 70% Summative)**

Course Objectives:

The course will enable the learners to:

● Gain practical understanding of mechanics, elasticity, oscillations, and electronics.

● Determine important physical constants using experimental methods.

● Develop skills in measurement, data analysis, and graphical interpretation.

● Handle scientific instruments and basic electronic (OP-AMP) circuits.

● Prepare scientific reports with proper error analysis and interpretation

Course Outcomes:

After completing this course, the learner will be able to:

● Explain the principles of the prescribed physics experiments.

● Determine physical constants such as the acceleration due to gravity (g), elastic constants, viscosity, resistivity, and band gap.

● Analyse experimental data and verify physical laws.

● Design and test basic transistor-based amplifier and regulator circuits.

● Evaluate experimental results with proper error analysis and documentation.

List of Experiments:

1. To measure the resistivity of a semiconductor and determine its band gap using the four-probe method.
2. To study V–I characteristics of PN junction diode and determine cut-in voltage and dynamic resistance.
3. To design a voltage regulator circuit and study the characteristics of a Zener diode.
4. To study input and output characteristics of BJT (CE mode) and determine current gain.
5. To design of Class an amplifier using transistor.
6. To study characteristics of FET / MOSFET and determine trans conductance.
7. To design and study a single-stage RC coupled amplifier and determine voltage gain and bandwidth.
8. To determine the wavelength of a given laser source using (a) Young's double slit experiment and (b) Single Slit diffraction method.
9. To study the input and output characteristics of a transistor in CE (Common Emitter), CB (Common Base) and CC (Common collector) configuration.
10. To determine the Stefan's Boltzmann constant using ballistic galvanometer/incandescent lamp.
11. To determine the modulus of rigidity of a wire using Maxwell's needle
12. To determination the wavelength of monochromatic light using Fresnel biprism.
13. To calibrate a given temperature sensor (Thermistor)

Suggested Readings:

1. Prakash, I., & Ramakrishna. (2011). A textbook of practical physics (11th ed.).

2. Chattopadhyay, D., Rakshit, P. C., & Saha, B. (2002). An advanced course in practical physics (6th rev. ed.).
3. Squires, G. L. (2015). Practical physics (4th ed.).
4. Panigrahi, S., & Mallick, B. (2015). Engineering practical physics (1st ed.).
5. Malvino, A. P., & Bates, D. (n.d.). Basic electronics: A text lab manual.
6. Arora, C. L., & Sanon, G. (2007+). B.Sc. practical physics (various eds.).
7. Pal, J. C. (c. 2010). The theory of errors in physical measurements.

Semester I: Introduction to Semiconductor Devices

Course Type	**DSE**
Course Credit	**4**
Course Code	**PGPHY S1-01(DSE)**
Total Marks	**100 (30% Formative, 70% Summative)**

Course Objectives:

The course will enable the learners to:

- Get an idea of the fabrication processes of integrated circuits
- Understand semiconductor fundamentals and carrier transport
- Explain operation and applications of diodes, transistors, and FETs
- Describe the behavior of special diodes and power semiconductor devices
- Get an idea of the fabrication processes of integrated circuits.

Course Outcomes:

After completing this course, the learner will be able to:

- Explain semiconductor band structure, carrier behavior, and transport phenomena
- Compare BJT, JFET, and MOSFET performance in circuits
- Demonstrate transistor operation and biasing for amplifiers
- Analyse power devices like SCR, TRIAC, DIAC, Power MOSFET, and IGBT
- Summarize IC fabrication steps and their effect on device performance.

Unit 1: Semiconductor Basics

Bonding forces and Energy bands: Conductor, Insulator, Semiconductors; Semiconductor Types: Direct and Indirect semiconductors, Electrons and Holes, Intrinsic and Extrinsic

Semiconductors; Charge Transport and Mobility in Semiconductors: Conductivity and Mobility, Drift and Resistance, Effects of temperature and doping on mobility, Hall Effect.

Unit 2: P-N Junction Diode

Overview of the PN Junction; Forward and Reverse biased junctions; I-V characteristics of the diode; Reverse bias breakdown: Zener breakdown, Avalanche breakdown.

Unit 3: Diode Applications

Power supply; Filter circuits and Voltage Regulation; Zener diode; Switching Applications: Clipping and clamping circuits.

Unit 4: Thermistors

Introduction to Thermistor; Principle of operation; Types of Thermistors; Characteristics and Applications.

Unit 5: Optoelectronic Devices

Photodiodes: Current and Voltage in an Illuminated Junction; Solar Cells; Photo detectors; Light Emitting Diode: Light Emitting materials; Laser Diodes.

Unit 6: Bipolar Junction Transistor

Introduction to Bipolar Junction transistor: Types of Transistor, Configuration, Operation Modes; Working of Transistor: PNP transistor, NPN transistor; Transistor Characteristics.

Unit 7: Transistor Applications

Application of BJT: BJT as an Amplifier, BJT as a Switch; Introduction to ICs, Oscillator Basics.

Unit 8: Transistor Biasing

Transistor biasing and stabilization: Need for biasing, DC load line, operating point, Bias stability; Two port Network: Hybrid model, h parameters; Thevenin's and Norton's theorems.

Unit 9: Field Effect Transistor- Part I

Introduction to FET: Comparison between BJT and FET, Advantages and applications of FETs; Classification of FETs: Construction of n-channel and p-channel JFET; Principle of operation: Drain characteristics, Transfer characteristics; JFET parameters: Transconductance (gm), Drain resistance (rd), Amplification factor (μ).

Unit 10: Field Effect Transistor- Part II

Introduction to MOSFET; Classification of MOSFETs: Depletion-type MOSFET, Enhancement-type MOSFET; Operation of Depletion type MOSFET; Operation of Enhancement type MOSFET; Characteristics of MOSFET: Threshold voltage, Body effect.

Unit 11: Microwave Diodes

Metal Semiconductor and Heterojunctions: Schottky barrier diode, Ohmic contact; Tunnel diodes; Varactor Diode; PIN diode; Gunn diode; IMPATT diode.

Unit 12: Power Semiconductor Devices

Thyristors: Construction, Characteristics, Applications; TRIAC and DIAC: Construction, Characteristics, Applications; Power MOSFET and IGBT: Construction, characteristics, Applications.

Unit 13: Fabrication of P-N Junctions- Part I

Wafer Preparation and Doping Techniques; Thermal oxidation; Diffusion process; Rapid Thermal Processing (RTP); Ion implantation.

Unit 14: Fabrication of P-N Junctions- Part II

Thin Film Deposition and Patterning Processes; Chemical Vapour Deposition (CVD); Photolithography; Etching techniques; Metallization.

Suggested Readings:

1. Sharma, S. (2019). Electronic principles (4th ed., reprint 2024). S. K. Kataria & Sons.
2. Pierret, R. F. (1996). Semiconductor device fundamentals. Prentice-Hall.
3. Salivahanan, S., Suresh Kumar, N., & Vallavaraj, A. (2017). Electronic devices and circuits (4th ed.). McGraw-Hill Education.
4. Sze, S. M. & Lee, M. K. (2021). Semiconductor physics and devices (3rd ed.). Wiley India.
5. Gupta, S. C. (2012). Optoelectronics and fiber optic communication (2nd ed.). Prentice Hall of India.
6. Streetman, B. G. & Banerjee, S. (2015). Solid state electronic devices (7th ed.). Pearson Education.

Semester II: Electromagnetic Theory

Course Type	DSC
Course Credit	4
Course Code	PGPHY S2-04(DSC)
Total Marks	100 (30% Formative, 70% Summative)

Course Objectives

The course will enable the learners to:

● Understand electrostatics using Laplace and Poisson equations.

● Apply boundary value methods and image techniques.

● Explain electromagnetic fields in matter.

● Analyze Maxwell's equations and wave propagation.

● Introduce radiation and relativistic electrodynamics

Course Outcomes

After completing this course, the learner will be able to:

● Solve Laplace and Poisson boundary value problems.

● Apply dielectric and magnetic material concepts.

● Derive and use Maxwell's equations in vacuum and matter.

● Analyze electromagnetic waves and radiation problems.

● Explain electrodynamics using relativistic formulation.

Unit 1: Laplace's Equation – I

Laplace's Equation: Laplace,s equations in One, Two and Three Dimensions; Solutions of Laplace's equation in Cartesian Coordinates.

Unit 2: Laplace's Equation – II

Solutions In Curvilinear Coordinates: Cylindrical and Spherical Coordinates.

Unit 3: Poisson's Equation

Poisson's Equation; Physical Interpretation; Boundary Conditions; Uniqueness Theorem; Simple Problems.

Unit 4: Electrical Images in Electrostatics

Electrostatic Images; Induced Surface Charge; Force And Energy; Point Charge Near Conducting Plane and Sphere.

Unit 5: Dielectrics and Polarization

Polarization in Dielectrics; Induced Dipoles; Polar Molecules; Bound Charges and Its Physical Interpretation.

Unit 6: Electric Fields in Matter

Gauss's Law in Dielectrics: Boundary Conditions; Linear Dielectrics: Electric Susceptibility, Permittivity, Dielectric Constant; Field inside Dielectric Media.

Unit 7: Magnetostatics

Magnetization; Bound Currents; Magnetic Field inside Matter; Magnetostatics Boundary

Conditions.

Unit 8: Magnetic Materials

Magnetization of matter; Diamagnetism; Para magnetism; Ferromagnetism; Torque and Force on Magnetic Dipoles**.**

Unit 9: Maxwell's Equations – I

Electrodynamics before Maxwell; Maxwell's Modification of Ampère's Law; Maxwell's Equations in Vacuum**.**

Unit 10: Maxwell's Equations – II

Maxwell's Equations in Matter: Conducting Media; Boundary Conditions of Maxwell's Equations; Continuity Equation; Poynting Theorem; Maxwell Stress Tensor.

Unit 11: Electromagnetic Waves

Wave Propagation; Waveguides and Coaxial Transmission Lines.

Unit 12: Electromagnetic Potentials and Transformations

Electromagnetic Potentials: Scalar and Vector Potentials, Maxwell's Equations in Scalar and Vector Potentials; Transformations: Gauge Transformations; Coulomb and Lorentz Gauges; Retarded Potentials; Jefimenko's Equations.

Unit 13: Radiation from Moving Charges

Liénard–Wiechert Potentials; Fields of Moving Charges; Radiation from Accelerated Charges.

Unit 14: Relativistic Electrodynamics

Special Theory of Relativity; Lorentz Transformations; Electromagnetic Field Tensor; Magnetism as a Relativistic Effect.

Suggested Readings:

1. Griffiths, D. J. (1999). Introduction to electrodynamics. Prentice Hall.
2. Laud, B. B. (1988). Electromagnetics. Wiley Eastern Limited.
3. Tewari, K. K. (2007). Electricity and magnetism. S. Chand and Company.
4. Purcell, E. M., & Morin, D. J. (2013). Electricity and magnetism (3rd ed.). Cambridge University Press.
5. Jackson, J. D. (1998). Classical electrodynamics (3rd ed.). Wiley.
6. Aruldhas, G. (2004). Electromagnetic fields and waves. Prentice Hall of India (PHI Learning).

Semester II: Quantum Mechanics

Course Type	DSC
Course Credit	4
Course Code	PGPHY S2-05(DSC)
Total Marks	100 (30% Formative, 70% Summative)

Course Objectives

The course will enable the learners to:

- Introduce the basic concepts of quantum mechanics.
- Develop the mathematical formalism of quantum mechanics.
- Apply the Schrödinger equation to standard problems.
- Explain the postulates and physical interpretation of quantum mechanics.
- Introduce approximation methods and relativistic quantum mechanics.

Course Outcomes:

After completing this course, the learner will be able to:

- Explain the basic concepts of quantum mechanics.
- Use the mathematical formalism of quantum mechanics.
- Apply the Schrödinger equation to standard problems.
- Analyse angular momentum, spin, and measurement in quantum systems.
- Apply approximation methods and outline relativistic quantum mechanics.

Unit 1: Wave-Particle Duality

Wave Aspect of Particles: De Broglie's Hypothesis, Davison–Germer Experiment; Particles Vs Waves: Concept of Wave Function, Classical and Quantum View.

Unit 2: Uncertainty and Wave Packets

Principle of Linear Superposition; Heisenberg's Uncertainty Principle and Implications; Probabilistic Interpretation; Wave Packets: Localised Wave Packet, Motion of Wave Packets, Group Velocity, Phase Velocity.

Unit 3: Mathematical Formalism of Quantum Mechanics – I

The Hilbert Space; Square Integrable Wave Functions; Dirac Notations.

Unit 4: Mathematical Formalism of Quantum Mechanics – II

Operators; Commutator Algebra; Uncertainty between Two Operators; Eigenvalues and

Eigenvectors; Matrix Representation: Dirac Notation and Operators; Basic Concept of Wave Mechanics and Matrix Mechanics.

Unit 5: Postulates of Quantum Mechanics

Basic Comparison between Quantum Mechanics and Classical Mechanics; Basic Postulates of Quantum Mechanics; The State of A System: Probability Density, Superposition Principle; Observables And Operators; Measurement In Quantum Mechanics, Expectation Values

Unit 6: Schrödinger Wave Equation – I

Wave Equation of Free Particle; Time-Dependent Schrödinger Equation.

Unit 7: Schrödinger Wave Equation – II

Time-Independent Schrödinger Equation; Stationary States and Eigenvalue Problem.

Unit 8: Application of Schrödinger Equation

Application of SWE in Infinite Square Well Potential; Finite Square Well Potential; Harmonic Oscillator.

Unit 9: Angular Momentum

Orbital Angular Momentum; General Formalism Of Angular Momentum: Operators, Commutation Relations, Eigenvalues And Eigen Functions; Spin Angular Momentum: Pauli Spin Matrices And Their Properties; Matrix Representation Of Spin Operators.

Unit 10: Identical Particles

Exchange Symmetry of Wave Functions; Pauli Exclusion Principle; Symmetry Character of Particles; Slater Determinant.

Unit 11: Perturbation Theory – I

Basic Concept; First-Order Energy Correction; Second-Order Energy Correction; Time-Independent Perturbation Theory and Applications.

Unit 12: Perturbation Theory – II

Time-Dependent Perturbation Theory; Fermi's Golden Rule; Selection Rules.

Unit 13: Variational Principle

Introduction; Statement of Variational Principle; Basic Concept of Variational Method; Conditions for Trial Wave Function; Accuracy and Physical Interpretation; Simple Applications.

Unit 14: Relativistic Quantum Mechanics

Relativistic Vs Non-Relativistic Quantum Mechanics; Klein–Gordon Equation; Dirac Equation.

Suggested Readings:

● Zettili, N. (2001). Quantum mechanics: Concepts and applications. John Wiley & Sons.

● Griffiths, D. J., & Schroeter, D. F. (2018). Introduction to quantum mechanics (3rd ed.). Cambridge University Press / Pearson Education.

● Sakurai, J. J., & Napolitano, J. (2017). Modern quantum mechanics (2nd ed.). Pearson Education / Addison-Wesley.

● Gasiorowicz, S. (2003). Quantum physics (3rd ed.). Wiley.

● Schiff, L. I. (1968). Quantum mechanics (3rd ed.). McGraw-Hill.

● Mathews, P. M., & Venkatesan, K. (2014). A textbook of quantum mechanics (2nd ed.). McGraw-Hill Education India.

● Ghatak, A., & Lokanathan, S. (2004). Quantum mechanics: Theory and applications (5th ed.). Macmillan India.

● Beiser, A. (2003). Concepts of modern physics (6th ed.). McGraw-Hill.

Semester II: Physics Lab II

Course Type	**DSC**
Course Credit	**4**
Course Code	**PGPHY S2-06(DSC)**
Total Marks	**100 (30% Formative, 70% Summative)**

Course Objectives

The course will enable the learners to:

● Understand basic concepts of modern physics, electricity, and electronics through experiments

● Apply experimental methods to determine physical constants.

● Analyse electrical, magnetic, and electronic circuits.

● Develop skill in using CRO, LCR, and function generators.

● Interpret experimental data and verify physical laws

Course Outcomes

After completing this course, the learner will be able to:

● Determine important physical constants.

● Verify laws related to modern physics and electromagnetism.

● Analyze RC, LCR circuits and resonance.

● Demonstrate basic analog communication experiments.

● Test and interpret electronic signals and circuits.

List of Experiments:

1. To determine Planck's constant using LED / photoelectric effect experiment.
2. To study the photoelectric effect and verify Einstein's photoelectric equation.
3. To determine the Stefan–Boltzmann constant using a tungsten filament lamp.
4. To plot the B–H curve of a ferromagnetic material and determine hysteresis loss.
5. To determine the frequency of AC mains using a sonometer / LCR circuit.
6. To study resonance in LCR circuit and determine Q-factor.
7. Study of Amplitude Modulation (AM) using function generator and diode detector.
8. Envelope Detector (AM Demodulation) using diode, RC circuit.
9. Study of Modulation Index of AM using CRO.
10. Study of Sampling Theorem (PAM) using IC / function generator.
11. Study of Frequency Response of RC Low Pass / High Pass Filter.
12. Study of bandwidth using CRO.
13. Study of clipping and clamping circuits.

Suggested Readings:

1. Chattopadhyay, D., & Rakshit, P. C. (2005). An advanced course in practical physics. New Central Book Agency.

2. Suri, R. P., & Chandra, R. (1990). Experiments in electronics. S. Chand & Comp

Semester II: Fundamentals of Communication System

Course Type	DSE
Course Credit	4
Course Code	PGPHY S2-02(DSE)
Total Marks	100 (30% Formative, 70% Summative)

Course Objectives:

The course will enable the learners to:

● Describe analog and digital communication principles, including signals, noise, and modulation.

● Recognize AM, FM, PM, and digital modulation techniques and their detection methods.

● Explain receivers, mobile, satellite, and optical communication system architectures.

● Discuss data communication, multiplexing, and multiple access techniques.

● Explore emerging technologies like IoT, WSNs, and smart communication systems.

Course Outcomes:

After completing this course, the learner will be able to:

● Classify signals, analyze noise, and explain analog and digital modulation.

● Design and evaluate AM, FM, PM, ASK, FSK, PSK, QPSK, and QAM schemes.

● Analyze the operation of receivers, mobile, satellite, and optical communication systems.

● Analyze data transmission, multiplexing, and multiple access techniques for efficient communication.

● Evaluate modern applications like IoT, WSNs, and smart systems.

Unit 1: Overview of Communication Systems

Classification of Signals; Elements of Communication System; Noise and Bandwidth in Communication Systems: Internal and external noise, Thermal noise, Signal-to-noise ratio (SNR), Bandwidth and Frequency Spectrum; Modulation: Need for Modulation, Types of Modulation.

Unit 2: Amplitude modulation (AM)

Introduction to Amplitude Modulation: Types of AM; Mathematical Representation of AM; Frequency Spectrum of AM Signals; Generation of AM: Square-law Modulator; Demodulation of AM.

Unit 3: Frequency Modulation (FM)

Introduction to Frequency Modulation; Equation and Bandwidth; Frequency Modulation and Demodulation Techniques; Pre-emphasis & De-emphasis in FM.

Unit 4: Phase Modulation (PM)

Introduction to Phase Modulation; Equation and Bandwidth; Phase Modulation and Demodulation Techniques: Comparison of AM, FM, and PM.

Unit 5: AM and FM Receiver

AM Receivers: Superheterodyne AM receiver; AM Detection: Envelope detector, Diode detector; FM Receivers: Principle of operation, Block diagram and functions of each block.

Unit 6: Introduction to Digital Communication

Digital Signal Representation; Elements of Digital Communication System; Sampling Theorem;

Pulse Modulation Techniques: PAM, PWM, and PPM.

Unit 7: Amplitude Shift Keying (ASK) and Frequency Shift Keying (FSK)

Basic concept of ASK; Generation and Detection of ASK signals: Coherent detection, Non-coherent detection; Basic concept of FSK; Generation and Detection of FSK signals.

Unit 8: Phase Shift Keying (PSK)

Introduction to PSK; Generation and Detection of PSK signals; QPSK and QAM; Comparison of various digital modulation techniques.

Unit 9: Introduction to Mobile Communication

Generations of Mobile Communication (1G to 5G); Cellular Networks; Mobile Signal Propagation; Challenges and Future Trends in Mobile Communication.

Unit 10: Introduction to Satellite Communication

Geostationary satellites; Satellite orbits: Antenna look angles, Satellite frequency allocations; Satellite system link models: up link, down link, cross link, transponders; Satellite system Architecture and parameters.

Unit 11: Overview of Optical Fiber Communication

Light as Carrier for Optical Communication; Optical Fiber Types and Characteristics; Fiber Optic Communication System: Components, Signal Propagation in Optical Fibers; Optical Modulation Techniques, Advantage disadvantages and applications.

Unit 12: Data Communication and Transmission Media

Data Communication Concepts; Data Transmission Modes; Serial and Parallel Transmission; Guided Transmission Media: Twisted Pair, Coaxial Cable, Optical Fiber; Unguided Transmission Media: Radio Waves, Microwaves, Infrared.

Unit 13: Multiplexing and Multiple Access Techniques

Multiplexing Concepts; Frequency Division Multiplexing (FDM); Time Division Multiplexing (TDM); Code Division Multiplexing (CDM); Multiple Access Techniques in Wireless Communication.

Unit 14: Advanced Communication Applications

Introduction to Modern Communication Applications; Internet of Things (IoT); Wireless Sensor Networks; Smart Communication Systems.

Suggested Readings:

1. Kennedy, G., & Davis, B. (1992). Electronic communication systems (4th ed.). Tata McGraw-Hill, New Delhi.

2. Haykin, S. (2001). Communication systems (4th ed.). John Wiley & Sons.

3. Lathi, B. P. (2009). Modern digital and analog communication systems (4th ed.). Oxford University Press.

4. Lee, W. C. Y. (1995). Mobile cellular communications (2nd ed.). McGraw-Hill / PHI Learning, India.
5. Roddy, D. (2006). Satellite communications (4th ed.). Tata McGraw-Hill.
6. Senior, J. M. (2009). Optical fiber communications (3rd ed.). Pearson Education.

Semester III: Condensed Matter Physics

Course Type	DSC
Course Credit	4
Course Code	PGPHY S3-07(DSC)
Total Marks	100 (30% Formative, 70% Summative)

Course Objectives

The course will enable the learners to

- Understand crystal structures, bonding, defects, and thermal properties of solids.
- Explain diffraction, lattice vibrations, and phonon dynamics in solids.
- Apply free electron and band theories to study solids and semiconductors.
- Analyze dielectric, magnetic, and superconducting properties of materials.
- Explore nanomaterials, experimental techniques, and Indian metallurgical practices

Course Outcomes

After completing this course, the learner will be able to

- Explain crystal structures, bonding, defects, and thermal properties of solids.
- Analyze diffraction, phonons, and lattice dynamics in solids.
- Apply band theory to interpret the behaviour of metals and semiconductors.
- Evaluate dielectric, magnetic, and superconducting properties of materials.
- Understand nanomaterials, experimental techniques, and Indian metallurgy.

Unit 1: Crystal Structure

Bravais lattices; Closed packed structures: SC, BCC, FCC, HCP; Crystal structures of NaCl and ZnS; Crystal structures of Diamond and Graphite; Miller indices; Interplanar spacing.

Unit 2: Atomic Bonding in Solids

Forces between atoms; Types of bonding in solids: ionic, covalent, metallic, hydrogen bonding and van der Waals bonding; Potential energy curves.

Unit 3: Crystal Imperfections and Diffusion

Point defects: Schottky, Frenkel, Vacancy, Interstitial defects; Line defects: Edge, Screw dislocations; Burgers vector; Diffusion in solids: Fick's laws of diffusion.

Unit 4: Diffraction of X-rays by Crystals

X-ray scattering and diffraction; Bragg's law; Laue equations; Atomic scattering factor; Geometrical structure factor; Reciprocal lattice: Concept and construction; Ewald's construction and its relation to Bragg's law.

Unit 5: Lattice Vibrations and Phonons

Concept of phonons; Dynamics of a linear monatomic chain; Dispersion relation and Brillouin zones; Dynamics of a diatomic linear chain; Normal processes and Umklapp processes; Phonon density of states.

Unit 6: Thermal Properties of Solids

Specific heat of solids; Dulong–Petit law; Einstein model: Principle, Limitations; Debye theory of specific heat; Thermal expansion and thermal conductivity of solids.

Unit 7: Free Electron Theory of Metals

Free electron gas model; Electrical conductivity and Ohm's law; Wiedemann–Franz law; Sommerfeld quantum free electron theory; Fermi–Dirac Statistics: Fermi–Dirac distribution function, Fermi energy, Fermi temperature, Fermi surface; Thermal and electrical conductivity of metals.

Unit 8: Band Theory of Solids

Bloch theorem; Kronig–Penney model; Origin of energy bands; Brillouin zones; Effective mass of electrons; Band theory: Conductor, Semiconductor, Insulator.

Unit 9: Semiconductor Physics

Fermi Level of Semiconductor; Density of States; Effective Mass; Carrier Generation and Recombination; Continuity Equation; Diffusion Length and Einstein Relation; Built-in Electric Field; Optical Properties of Semiconductors.

Unit 10: Dielectric Properties of Materials

Electric dipole moment; Polarization mechanisms: Electronic, Ionic, Orientational, Space charge polarization; Local electric field; Clausius–Mossotti relation; Dielectric constant and polarizability; Piezoelectricity, Pyroelectricity and Ferroelectricity.

Unit 11: Magnetic Properties of Materials

Classification of magnetic materials; Diamagnetism: Langevin theory; Paramagnetism: quantum theory; Ferromagnetism: Weiss molecular field theory, Exchange interaction;

Domain theory; Curie and Néel temperatures; Introduction to Anti ferromagnetism and ferrimagnetism.

Unit 12: Superconductivity

Phenomenology of superconductivity; Meissner effect; Types of superconductors: Type I, Type II; Isotope effect; London equations; BCS theory; Flux quantization; Josephson effects.

Unit 13: Nanomaterials and Low-Dimensional Systems

Introduction to nanoscience and nanotechnology; Quantum confinement; Low-dimensional systems: quantum wells, quantum wires and quantum dots; Size-dependent properties of nanomaterials; Applications of nanomaterials.

Unit 14: Experimental Techniques in Condensed Matter Physics

Crystal growth methods: Top down, Bottom up; Thin film deposition techniques: PVD, CVD, MBE, PLD; Indian Metallurgy: Wootz Steel and Zinc Extraction; Materials Processing and Heat Treatment Characterization techniques: XRD, SEM, TEM, AFM, Raman Spectroscopy (basic principles).

Suggested References:

1. Kittel, C. (2005). Introduction to solid state physics (8th ed.). Wiley India.
2. Wahab, M. A. (2011). Solid state physics: Structure and properties of materials (2nd ed.). Narosa Publishing House.
3. Singh, J. (2014). Solid state physics: Fundamentals and applications. Wiley India.
4. Dekker, A. J. (2000). Solid state physics. Macmillan India.
5. Ibach, H., & Lüth, H. (2009). Solid-state physics: An introduction to principles of materials science (4th ed.). Springer.

Semester-III: Fundamentals of Analog and Digital Electronics

Course Type	**DSC**
Course Credit	**4**
Course Code	**PGPHY S3-08(DSC)**
Total Marks	**100 (30% Formative, 70% Summative)**

Course Objectives

The course will enable the learners to

- Understand the principles, characteristics, and applications of operational amplifiers
- Study data converters and waveform generation techniques.
- Describe the combinational and sequential logic circuits including registers, counters.
- Explain the principles of feedback and oscillation and their role in circuit design.
- Comprehend special function ICs and semiconductor memories.

Course Outcomes:

After completing this course, the learner will be able to-

- Determine the performance characteristics and limitations of operational amplifiers
- Apply DACs, ADCs, and waveform generator ICs in signal processing systems.
- Analyse Boolean identities and Karnaugh maps to minimize logic expressions and use logic families.
- Design combinational logic circuits, registers and counters to solve electronic problems
- Demonstrate the operation and applications of semiconductor memories.

Unit 1: Fundamentals of Operational Amplifier

Differential amplifier and Common Mode Rejection Ratio (CMRR); Basic Concepts of Operational Amplifier: Op-amp symbol, terminals, packages and specifications; Block Diagram Representation of op-amp: Ideal op-amp and practical op-amp; Open-loop and closed-loop configurations; Concept of Virtual Short and Virtual ground.

Unit 2: OPAMP Performance Characteristics

DC and AC performance characteristics; Frequency compensation and noise considerations; Slew rate; Input offset voltage and input offset current.

Unit 3: OPAMP Applications

Basic op-amp circuits: Inverting and Non-inverting voltage amplifiers; Voltage Follower; Addition; Subtraction; Integration; Differentiation; Analog computation; Logarithmic amplifier

Unit 4: Data Conversion Devices-I

Digital-to-Analog Conversion: Need for Digital-to-Analog Conversion, Basic principle of DAC operation, Applications of DACs; Weighted Resistor DAC; R-2R Ladder;

Unit 5: Data Conversion Devices-II

Analog-to-Digital conversion: ADC specifications, ADC circuits; Ramp; Type of ADC: Successive Approximation ADC, Dual Slope ADC, Flash Type ADC, Monolithic ADC; Applications of ADC.

Unit 6: Waveform Generator ICs

Signal generator: Sine wave, triangular, sawtooth; Multivibrators using op-amps; ICL8038 function generator: Block diagram and working; Voltage regulators: Fixed and adjustable (IC 723), Switching regulators.

Unit 7: Timer ICs

IC 555 Timer: Block diagram and pin configuration; Monostable operation; Astable operation; Bistable operation; Applications of 555 Timer.

Unit 8: Feedback and Oscillator Circuit

Feedback Circuits: Concept of feedback, Feedback connection types; Effects of feedback; Feedback Amplifier; Oscillator Circuits: Principle of oscillation and Barkhausen criterion; Phase Shift Oscillator.

Unit 9: Boolean Algebra and Logic Families

Overview of Boolean identities; Minimizing Boolean Expressions; Boolean Simplification using Karnaugh map (upto 4 variables); Introduction to Logic Family: Logic Gates.

Unit 10: Combinational Logic Circuits

Adders and Subtractors: Half-adder, Full-adder, Half-subtractor, Full-subtractor; Multiplexers and Demultiplexers; Encoders and Decoders.

Unit 11: Sequential Logic Circuits

Overview Sequential Circuits; Introduction to Flip Flop; Types of Flip Flop: RS, JK, D and T Flip Flops.

Unit 12: Registers

Basic Concepts of Registers; Types of Register: Serial and Parallel Register, Shift Register; Applications of Registers.

Unit 13: Counters

Basic Concepts of Counters; Asynchronous counter and design; Synchronous counter and design; Applications of Counters.

Unit 14: Semiconductor Memories

Classification of semiconductor memories; Sequential memories: Static and Dynamic Shift Registers; Read-only memories: ROM, PROM, EPROM; Read–write memories: Static RAM and Dynamic RAM; Programmable Logic Array (PLA): Basic architecture and operation; Charge Coupled Device (CCD): Principle and applications.

Suggested References:

1. Gayakwad, R. A. (2018). Op amps and linear integrated circuits (4th ed.). Pearson

Education.
2. Salivahanan, S., Suresh Kumar, N., & Vallavaraj, A. (2011). Electronic devices and circuits. McGraw Hill Education.
3. Malvino, A. P., & Bates, D. J. (2021). Electronic principles (9th ed.). McGraw Hill Education.
4. Boylestad, R. L., & Nashelsky, L. (2012). Electronic devices and circuit theory (11th ed.). Pearson Education.
5. Jain, R. P. (2011). Digital electronics. Tata McGraw Hill Education.
6. Leach, D. P., Malvino, A. P., & Saha, G. (2011). Digital principles and applications (7th ed.). Tata McGraw Hill Education.

Semester III: Physics Lab III

Course Type:	**DSC**
Course Credit:	**4**
Course Code	**PGPHY S3-09(DSC)**
Total Marks:	**100 (30% Formative, 70% Summative)**

Course Objectives

The course will enable the learners to:

- Understand basic principles of materials and electronic devices.
- Perform experiments using standard instruments.
- Apply theory to practical measurements.
- Analyze experimental data.
- Evaluate device and material behaviour.

Course Outcomes

After completing this course, the learner will be able to:

- Conduct experiments on materials and electronic circuits.
- Measure physical and electronic parameters accurately.
- Analyze experimental results and graphs.
- Interpret material properties and device characteristics.
- Prepare proper laboratory records and reports.

List of Experiments

1. To study the Hall effect and determine Hall coefficient, carrier concentration and mobility.

2. To study the temperature dependence of electrical resistivity of a semiconductor.

3. To determine the magnetic susceptibility of a given material using Quincke's / Gouy's method.

4. To determine the dielectric constant of a given material at different frequencies.

5. To study ferroelectric hysteresis loop using CRO.

6. To study thermoelectric effect and determine Seebeck coefficient of a material.

7. To study photoconductivity of a given semiconductor material.

8. To design and study a Wien bridge / RC phase shift oscillator.

9. To study operational amplifier (741) as inverting, non-inverting and summing amplifier.

10. To design and study active filters (low pass / high pass) using op-amp.

11. To design and study a Schmitt Trigger circuit and observe its hysteresis characteristics.

12. To study digital logic gates and verify truth tables using ICs.

13. To design and study counters and shift registers using ICs.

Suggested References

1. Arora, C. L., & Sethi, B. L. (2013). B.Sc. practical physics (Vol. 1 & 2). S. Chand & Company.
2. Gupta, S. L., & Kumar, H. (2014). Practical physics (15th ed.). Pragati Prakashan.
3. Khandelwal, D. P. (2015). A laboratory manual of physics for undergraduate classes. Vani
4. Prakashan.
5. Navas, K. A. (2016). Electronics lab manual. PHI Learning.
6. Suresh, R., & Arumugam, S. (2012). Practical physics. S. Chand Publishing.
7. Singh, R. R., & Singh, R. (2011). Advanced practical physics. Kalyani Publishers.

Semester III: Introduction to Astrophysics

Course Type	**DSE**
Course Credit	**4**
Course Code	**PGPHY S3-03(DSE)**
Total Marks	**100 (30% Formative, 70% Summative)**

Course Objectives

The course will enable the learners to-

- Understand the basic concepts and historical development of astrophysics.
- Apply the principles of gravitation and orbital dynamics to celestial systems.
- Learn astronomical measurement methods and observational techniques.
- Study radiation, spectroscopy, stellar evolution, galaxies, and cosmology.
- Explore Indian contributions to astronomy and observational practices

Course Outcomes

After completing this course, the learner will be able to:

- Explain the development and scope of astrophysics in modern and Indian astronomy.
- Apply physical laws to analyze the motion of celestial bodies.
- Interpret astrophysical observations using radiation and spectroscopic principles.
- Describe the formation and evolution of stars, galaxies, and the universe.
- Analyze the scientific contributions of Indian astronomy in celestial studies.

Unit 1: Fundamentals of Astrophysics

Nature of science and astronomy; The Universe—Beginning and Conclusion; Ancient astronomy; Astronomy and Astrology; Birth of Modern Astronomy; Indian astronomical traditions: Vedanga Jyotisha, Nakshatra system**;** Classical Indian astronomical texts: Surya Siddhanta, Aryabhata's Cntribution.

Unit 2: Orbits and Galaxies

Laws of Planetary Motion: Newton's law of gravitation; Orbits in the Solar System; Motions of Satellites and Spacecraft; Indian planetary models**.**

Unit 3: Measurement of Astronomical Distances

Astronomical unit: Parsec, Light year, Stellar parallax; Standard candles; Distance ladder.

Unit 4: Astronomical Magnitudes

Apparent and Absolute magnitude; Flux and luminosity; Pogson's scale; Color indices.

Unit 5: Astronomical Instrumentations

Refracting and reflecting telescopes; Resolving power and magnification; Radio telescopes; Detectors: Photomultipliers and CCDs.

Unit 6: Electromagnetic Radiation in Astronomy

Electromagnetic spectrum; Atmospheric windows; Multi-wavelength astronomy; Space-based observations.

Unit 7: Blackbody Radiation

Concept of blackbody; Planck's radiation law; Wien's displacement law; Stefan–Boltzmann law; Applications to stars.

Unit 8: Spectra of Astronomical Objects

Continuous, Emission, and Absorption spectra; Kirchhoff's laws in Astronomy; Fraunhofer lines; Stellar spectral classification.

Unit 9: Doppler Effect and Redshift

Doppler shift in astronomy; Radial velocity measurement; Cosmological redshift; Applications in binaries and galaxies.

Unit 10: Formation of Stars

Stellar Formation and Evolution; Energy production in stars and synthesis of elements; Molecular clouds; Jeans criterion; Protostar formation.

Unit 11: Stellar Structure

Identifications of bright celestial bodies; Celestial sphere and Celestial coordinates; Stellar Parameters: Stellar Distances, Stellar Magnitude, Stellar Luminosity; H-R diagram; Nakshatra System in Indian Astronomy: **T**raditional Indian celestial mapping, Nakshatra and Rashi systems**.**

Unit 12: Galaxies

Classification of galaxies; Normal and active galaxies; Structure of Milky Way; Interstellar matter in galaxies; Galaxy clusters.

Unit 13: Introduction to Cosmology

Expansion of the universe; Hubble's law; Big Bang theory; Cosmic Microwave Background; Dark matter and dark energy (introductory); Cyclic universe in Indian cosmology: Sṛṣṭi–Pralaya, Yuga, and Kalpa.

Unit 14: Indian Observational Astronomy and Calendrical Science

Ancient Indian observational astronomy: Vedic observations, celestial motions, Jantar Mantar instruments, Panchanga, Eclipse prediction; Solar–Lunar Motions and Celestial Events in Indian Astronomy; Contributions of Indian Astronomers: Contribution of Sawai Jai Singh II, Sankar Varman and Chandrasekhara Samanta.

Suggested References:

1. Carroll, B. W., & Ostlie, D. A. (2007). An introduction to modern astrophysics (2nd ed.). Pearson / Addison-Wesley.

2. Basu, B. (1998). An introduction to astrophysics. Prentice-Hall of India.
3. Duorah, H., & Duorah, K. (2001). Introduction to astrophysics. Kalyani Publishers.
4. Shukla, K. S. (1985). Contributions to the History of Indian Astronomy.
5. Kak, S. (1994). The Astronomical Code of the Rigveda.
6. Burgess, E. (Trans.). Surya Siddhanta: A Textbook of Hindu Astronomy. Yale University Press.
7. Translation and studies on Vedanga Jyotisha (Lagadha) for Vedic astronomy and calendrical science.
8. Varahamihira. Pañcasiddhāntikā (translated editions).

Semester-III: Fundamentals of Laser and Photonics

Course Type	DSE
Course Credit	4
Course Code	PGPHY S3-04(DSE)
Total Marks	100 (30% Formative, 70% Summative)

Course Objectives

After completing this course, the learner will be able to:

- Understand the fundamental nature of light and basic principles of photonics and lasers.
- Explain light–matter interaction and the physical basis of laser action.
- Describe the construction and working of basic laser systems and optical fibers.
- Identify major types of lasers and fundamental photonic devices.
- Recognize important applications of lasers and photonics in science and technology.

Course Outcomes

After completing this course, the learner will be able to-

- Explain the basic concepts of light, photons, and optical radiation.
- Analyse the principle of laser action and working of common lasers.
- Apply fundamental principles of optics and photonics to optical fibers and devices.
- Differentiate between different laser systems, fibers, and photonic components.
- Evaluate the suitability of lasers and photonic systems for basic scientific and technologicalapplications.

Unit 1: Nature of Light and Electromagnetic Spectrum

Dual nature of radiation: wave and particle picture; electromagnetic spectrum: radio waves to gamma rays; coherence and incoherence; monochromaticity; directionality; comparison of ordinary light and laser light.

Unit 2: Basic Concepts of Photonics

Photon concept: energy and momentum of photon; interaction of light with matter: absorption, emission and scattering; classical and quantum view of radiation; intensity and phase of light waves.

Unit 3: Wave Optics Foundation for Photonics

Interference: Young's double slit experiment; coherence: coherence length and coherence time; diffraction: single slit diffraction; polarization: linear, circular and elliptical polarization.

Unit 4: Light–Matter Interaction

Atomic energy levels: discrete energy states; radiative and non-radiative transitions; absorption and emission of radiation; spontaneous and stimulated emission; Einstein coefficients: physical significance.

Unit 5: Optical Amplification and Population Inversion

Concept of optical gain; Threshold condition for population inversion; Two, Three and Four level Systems; Pumping mechanisms: optical pumping and electrical pumping; Basic principle of laser action.

Unit 6: Basic Components of a Laser System

Active medium: solid, liquid and gas media; pumping source; optical resonator: plane and spherical mirrors; role of resonant cavity in laser oscillation.

Unit 7: Fundamental Laser Characteristics

Directionality; Coherence: Temporal and Spatial coherence; Monochromaticity; Intensity of laser beam; Comparison of laser and conventional light sources.

Unit 8: Solid State Lasers

Ruby laser: Construction and Working principle; Nd:YAG laser: Construction, Working principle and Characteristics; Merits and limitations; Basic applications of solid-state lasers.

Unit 9: Gas Lasers

He–Ne laser: construction and working principle, Characteristics, Applications; CO_2 laser: Construction and working principle, Characteristics, Applications; Comparison of solid-state and gas lasers.

Unit 10: Semiconductor Lasers

PN junction and heterojunction concept; Laser diode: Construction and working principle, Characteristics; Advantages and limitations; Applications in communication and devices.

Unit 11: Optical Fibers – Basic Concepts

Principle of total internal reflection; Structure of optical fiber: Core and cladding; Numerical aperture and acceptance angle; Types of fibers: step index and graded index fibers.

Unit 12: Light Propagation in Optical Fibers

Modes in optical fibers: single mode and multimode fibers; Attenuation: absorption and scattering losses; Dispersion: material, waveguide and modal dispersion; Concept of bandwidth.

Unit 13: Fundamental Photonic Devices

Photodetectors: photodiode, PIN diode and avalanche photodiode; light emitting diode (LED): working principle; Solar cell: basic principle and characteristics.

Unit 14: Basic Applications of Lasers and Photonics

Applications in medicine: surgery and diagnostics; applications in industry: cutting and welding; applications in communication; applications in scientific research and daily life.

Suggested Readings

1. Saleh, B. E. A., & Teich, M. C. (2019). Fundamentals of photonics (3rd ed.). Wiley India.
2. Ghatak, A., & Thyagarajan, K. (1998). Optical electronics. Cambridge University Press India.
3. Ghatak, A., & Thyagarajan, K. (2017). Introduction to fiber optics. Cambridge University Press India.
4. Svelto, O. (2010). Principles of lasers (5th ed.). Springer India.
5. O’Shea, D. C., & Dowling, J. P. (2004). Laser fundamentals. Cambridge University Press India.
6. Kumar, A., & Singh, J. (2015). Lasers: Principles, types and applications. PHI Learning, New Delhi.

Semester-IV: Atomic and Molecular Physics

Course Type	**DSC**
Course Credit	**4**
Course Code	**PGPHY S4-10 (DSC)**
Total Marks	**100 (30% Formative, 70% Summative)**

Course Objectives

The course will enable the learners to:

● Understand atomic quantum states and spectroscopic notation

● Explain atomic spectra and fine/hyperfine structures

● Analyze spectral splitting in external fields

● Interpret X-ray spectra and related principles

● Learn fundamentals of molecular spectroscopy and Franck–Condon principle.

Course Outcomes

After completing this course, the learner will be able to:

● Explain atomic energy levels and spectra using quantum numbers and term symbols.

● Interpret H, He and alkali spectra using coupling and exchange interaction.

● Predict spectral splitting in electric and magnetic fields (Stark, Zeeman, Paschen–Back).

● Analyse X-ray emission and absorption spectra using Moseley's law and screening.

● Classify and interpret molecular rotational, vibrational, Raman and electronic spectra using Franck–Condon principle.

Unit 1: Quantum state of an electron in an atom

Quantum numbers for one and for multi-electron system; Gyromagnetic ratio, Bohr Magneton, Larmor frequency, Space Quantization; Vector Model of atom; spectroscopy terms and their notation; Stern-Gerlach experiment.

Unit 2 Hydrogen spectra

Variation in Rydberg Constant due to finite nuclear mass; Hyperfine structure; Isotopic sheet; Width of the spectrum lines; Hydrogen Fine Structure.

Unit 3: Helium Atom and its Spectra

Exchange force; Spectrum of Helium; Quantum –Mechanical Explanation of the splitting of the terms of He atom.

Unit 4: Spectroscopic Terms: L-S and j-j couplings

Spectroscopic terms and notation; L-S coupling and j-j coupling; Lende- Interval Rule; Normal and inverted multiplex; Determination of spectral terms for L-S and j-j Coupling.

Unit 5: Spectra of Alkali elements

Broad Features of Alkali Spectra; Sodium Spectra; Intensity ratio.

Unit 6: Zeeman Effect and Paschen Back Effect

Normal and Anomalous Zeeman Effects; Experimental Set-up for studying Zeeman Effect;

Explanation of Normal and Anomalous Zeeman Effect; Paschen-Back Effect; Transition from weak to strong field; examples of Zeeman Effect.

Unit 7: Stark Effect

Stark Effect in Hydrogen: Its main features; Weak-field Stark effect in Hydrogen; Strong field Stark effect in Hydrogen.

Unit 8: X-ray Spectra

X-ray line spectra; Kossel's explanation of characteristic X-ray spectra; Moseley's law; Fine structure in X-ray emission spectra; Screening and Spin-Relativity Doublets; X-ray absorption spectra; Structure of X-ray absorption edges; Optical Spectra; Auger Effect.

Unit 9: Molecular Spectra

Born-Oppenheimer Approximation; Types of molecular spectra: Electronic spectra, Vibrational-Rotational spectra, Pure Rotational spectra; Types of molecular energy states and associated spectra; Types of non-electronic bands: Vibrational-Rotational bands, Pure rotational Bands.

Unit 10: Pure Rotational Spectra

Salient features of rotational spectra; Molecular requirement of rotational spectra; Molecule as a rigid rotator: explanation of rotational spectra; Non-rigid rotator; Isotope effect on rotational spectrum.

Unit 11: Vibrational Rotational Spectra

Salient features of Vibrational-Rotational spectra; Molecule as a Harmonic oscillator; Molecule as Anharmonic oscillator.

Unit 12: Raman Spectra

Nature of Raman Spectra; Experimental arrangements for Raman spectra; Classical and Quantum theory of Raman effect; Raman spectra and Molecular structure; Infra-red spectra versus Raman spectra.

Unit 13: Electronic Spectra

Salient features of Molecular electronic spectra; Formation of electronic spectra; Vibrational (gross) structure of electronic band-system in emission; Electronic band spectra in absorption.

Unit 14: Franck-Condon Principle

Difference between Electronic bands and Vibrational Rotational bands; Observed intensity distribution (vibration) in band systems: Franck-Condon Principle; Quantum- mechanical formulation of Franck-Condon principle.

Suggested References:

1. Kumar, R. (2008). Atomic and molecular spectra: Laser. Kedar Nath Ram Nath, Meerut.
2. Bernath, P. F. (2020). Spectra of atoms and molecules (4th ed.). Oxford University Press.
3. Banwell, C. N., & McCash, E. M. (1994). Fundamentals of molecular spectroscopy (4th ed.). McGraw-Hill.
4. Hollas, J. M. (2004). Modern spectroscopy (4th ed.). John Wiley & Sons.
5. Svanberg, S. (1991). Atomic and molecular spectroscopy: Basic aspects and practical applications. Springer-Verlag.

Semester IV: Nuclear and Particle Physics

Course Type	**DSC**
Course Credit	**4**
Course Code	**PGPHY S4-11(DSC)**
Total Marks	**100 (30% Formative, 70% Summative)**

Course Objectives

The course will enable the learners to:

● Understand nuclear structure, forces and models of the nucleus.

● Explain radioactive decay, nuclear reactions, fission and fusion processes.Apply theoretical concepts to analyse interaction of radiation with matter and detection methods.

● Analyse particle accelerators, detectors and experimental nuclear techniques.

● Introduce the basics of particle physics, quark model and fundamental interactions.

Course outcomes

After completing this course, the learner will be able to:

● Describe nuclear structure, properties and models.

● Explain radioactive decay, nuclear reactions, fission and fusion.

● Apply radiation–matter interaction principles and detector concepts.

● Analyze particle accelerators and experimental nuclear techniques.

● Identify elementary particles, quark model and fundamental interactions.

Unit 1: Nuclear Composition and Size

Classification of nucleus; Nuclear properties: charge, mass, nuclear radius, nuclear density, nuclear spin, parity, nuclear magnetic dipole moment, electric quadrupole moment; Empirical relations for nuclear radius.

Unit 2: Binding Energy and Liquid Drop Model

Binding energy and mass defect; Semi-empirical mass formula; Liquid drop model: assumptions, successes and limitations; Beta stability line; Mirror nuclei and isobars.

Unit 3: Nuclear Shell Model

Shell model: assumptions and experimental evidence; Magic numbers; Nuclear potentials; Spin–orbit coupling; Nuclear energy levels; Parity and spin of nuclear states; Schmidt lines.

Unit 4: Nuclear Forces and Nuclear Models

Introduction to Nuclear Forces: Properties of nuclear forces; Exchange forces; Yukawa theory; Collective model of nucleus: rotational and vibrational states (introductory); Comparison of nuclear models.

Unit 5: Radioactivity and Nuclear Decay

Law of radioactive decay; Decay constant, half-life and mean life; Alpha decay: theory and Geiger–Nuttall law; Beta decay: Fermi theory (qualitative), neutrino hypothesis; Gamma decay and internal conversion.

Unit 6: Interaction of Nuclear Radiation with Matter

Energy loss of charged particles: Bohr formula and Bethe–Bloch formula; Range and stopping power; Interaction of gamma rays with matter: photoelectric effect, Compton scattering and pair production; Neutron interaction with matter (qualitative).

Unit 7: Nuclear Reactions

Introduction to Nuclear Reactions: Types of nuclear reactions; Conservation laws; Q-value equation; Threshold energy; Nuclear reaction cross-section; Compound nucleus theory (Bohr hypothesis); Direct and compound nuclear reactions.

Unit 8: Fission and Fusion Reactions

Nuclear fission: basic theory, induced fission, chain reaction, fission of U-235; Nuclear reactors: basic principle, criticality, moderator and control rods; Nuclear fusion: Basic principle, stellar fusion, fusion reactors and thermonuclear reactions.

Unit 9: Particle Accelerators

Principle of particle acceleration; Linear accelerator (LINAC); Cyclotron and its limitations; Betatron; Synchrotron; Basic idea of modern high-energy accelerators.

Unit 10: Radiation Detectors and Instrumentation

Gas-filled detectors: ionization chamber, proportional counter, Geiger–Müller counter; Scintillation detectors; Semiconductor detectors (basic idea); Counting statistics and dead time.

Unit 11: Elementary Particles and Their Classification

Classification of elementary particles; Leptons, mesons and baryons; Hadrons and their properties; Quantum numbers; Symmetries and conservation laws; Introduction to antiparticles.

Unit 12: Quark Model and Hadron Structure

Quark model of hadrons; Baryon and meson structure; Color quantum number; Hadron classification using SU(3) (qualitative); Evidence for quarks.

Unit 13: Fundamental Interactions

Four fundamental interactions: strong, electromagnetic, weak and gravitational; Exchange particles; Basic idea of Feynman diagrams; Weak interaction and neutrinos (introductory).

Unit 14: Cosmic Rays and Applications of Nuclear Physics

Primary and secondary cosmic rays; Extensive air showers; Detection of cosmic rays; Applications of nuclear physics: Medicine, Industry, Agriculture, Power generation.

Suggested References:

1. Tayal, D. C. (2011). Nuclear physics (5th ed.). Himalaya Publishing House.
2. Roy, R. R., & Nigam, B. P. (2001). Nuclear physics: Theory and experiment. Wiley Eastern.
3. Ghoshal, S. N. (2004). Nuclear physics. S. Chand & Company.
4. Krane, K. S. (2008). Introductory nuclear physics. Wiley India.
5. Dunlap, R. A. (2004). An introduction to the physics of nuclei and particles. Thomson Brooks

Semester IV: Statistical Mechanics

Course Type	**DSC**
Course Credit	**4**
Course Code	**PGPHY S4-12(DSC)**
Total Marks	**100(30% Formative, 70% Summative)**

Course Objectives

The course will enable the learners to:

● Understand basic principles of statistical mechanics

- Explain microstates, macrostates and ensembles
- Apply classical and quantum statistics to physical systems
- Analyse thermodynamic quantities using partition functions
- Relate statistical concepts to real physical phenomena

Course Outcomes

After completing this course, the learner will be able to:

- Define key concepts of statistical mechanics
- Describe classical and quantum distribution laws
- Compute basic thermodynamic properties
- Distinguish between Bose, Fermi and classical systems
- Interpret phase transitions, fluctuations and transport processes

Unit 1: Need for Statistical Mechanics

Limitations of classical thermodynamics, Need for statistical method, Microscopic and Macroscopic description, Relation between mechanics and thermodynamics

Unit 2: Microstates, Microstates and Phase Space

Microstate and Macrostate: Definition, Examples, Phase space: Phase points, trajectories; Liouville theorem: statement, significance

Unit 3: Basic Postulates and Thermodynamic Probability

Basic postulates of statistical mechanics; Equal a priori probability; Thermodynamic probability: definition, calculation, Qualitative relation: Probability and Entropy.

Unit 4: Statistical Ensembles

Concept of ensemble; Microcanonical ensemble: isolated systems; canonical ensemble: systems in thermal equilibrium; Grand canonical ensemble: Systems with energy and particle exchange; Physical significance of ensembles

Unit 5: Maxwell–Boltzmann Statistics

Classical statistics: assumptions and validity, Maxwell–Boltzmann distribution law, limitations of classical statistics.

Unit 6: Speed Distribution and Kinetic Theory

Molecular speed distribution: derivation and properties, mean speed, most probable speed, rms speed; Applications to ideal gas; Law of equipartition of energy

Unit 7: Specific Heat of Gases

Degrees of freedom; Equipartition theorem; Specific heat; Monoatomic and Diatomic gases;

Limitations of classical theory.

Unit 8: Canonical Ensemble and Partition Function

Canonical ensemble: Micocanonical, Canonical, Grand Canonical; Probability distribution, Partition function: Definition and Physical significance

Unit 9: Thermodynamics from Partition Function

Internal energy, Helmholtz free energy, entropy and pressure, energy fluctuations, simple examples of partition function

Unit 10: Grand Canonical Ensemble

Grand canonical ensemble: concept and applications, grand partition function, chemical potential, particle number fluctuations

Unit 11: Quantum Statistics – Introduction

Need for quantum statistics, Bose–Einstein statistics: basic ideas, Fermi–Dirac statistics: basic ideas, comparison with Maxwellwell–Boltzmann statistics

Unit 12: Bose Statistics and Applications

Bose–Einstein distribution, Bose–Einstein condensation, photon gas, black-body radiation, Planck's radiation law, Debye theory of specific heat

Unit 13: Fermi Statistics and Electron Theory

Fermi–Dirac distribution, Fermi energy, degenerate electron gas, electron theory of metals, heat capacity of electrons

Unit 14: Interacting Systems, Fluctuations and Nonequilibrium Processes

Real gases and interactions, virial expansion: basic idea, Ising model: simple idea, thermodynamic fluctuations, Brownian motion and random walk, diffusion, viscosity and heat conduction, entropy and irreversibility

Suggested References

1. Huang, K. (2024). Statistical Mechanics (2nd Indian Adaptation). Wiley-India.
2. Pathria, R. K., & Beale, P. D. (2011). Statistical Mechanics (3rd ed.). Academic Press.
3. Reif, F. (1965). Fundamentals of Statistical and Thermal Physics. McGraw-Hill.
4. Mandl, F. (1988). Statistical Physics (2nd ed.). Wiley.
5. Srivastava, R. K., & Ashok, J. (2005). Statistical Mechanics. Prentice-Hall of India.

Semester IV: Experimental Techniques

Course Type	DSE
Course Credit	4
Course Code	PGPHY S4-05 (DSE)
Total Marks	100 (30% Formative, 50% Summative, 20% Practical)

Course Objectives

The course will enable the learners to:

- Understand measurement, error analysis, and signal processing techniques.
- Learn vacuum, microscopy, and material characterization methods.
- Apply spectroscopic, resonance, and nuclear experimental techniques.
- Develop computational skills for data analysis and numerical methods.
- Explore Indian contributions to spectroscopy and material studies.

Course Outcome

- After completing this course, the learner will be able to:
- Analyze experimental data using statistical and computational methods.
- Apply characterization and spectroscopic techniques in experiments.
- Interpret structural and microscopic properties of materials.
- Explain resonance, nuclear, and particle detection techniques.
- Assess Indian contributions to spectroscopy and material analysis.

Unit 1: Data Analysis and Basic Measurement

Statistical analysis of errors; Accuracy and Precision; Propagation of Errors: Gaussian distribution, least square fitting, regression, Correlation.

Unit 2: Signal Detection and Noise Reduction

Extraction of signals from noise; Signal-to-noise ratio (SNR); Lock-in amplifiers; Signal averaging techniques.

Unit 3: Vacuum Gauges and Pumps

Vacuum Techniques**:** Basic concepts of vacuum; Pressure measurement: Pirani gauge, Penning gauge, Ionization gauge; Vacuum pumps: Rotary pump, Diffusion pump, Turbo-molecular pumps.

Unit 4: Structural and Microscopic Characterization

X-ray Diffraction (XRD): Powder diffraction, Laue method; Bragg's Law in reciprocal lattice space, Determination of lattice parameters, Scherrer Formula: Determination of crystallite size, Idea of Integral Breadth method and determination of lattice strain.

Unit 5: Electron Microscopy

Principles and Applications of Scanning Electron Microscope (SEM); Transmission Electron Microscope (TEM); Scanning Probe Microscopes (STM/AFM); Electron Diffraction: Transmission Electron Diffraction (TED), Selected Area Electron Diffraction (SAED).

Unit 6: Spectroscopic Techniques

UV-Visible and FTIR (Fourier Transform Infrared) spectroscopy; Photoluminescence: Fluorescence and Phosphorescence; Indian contribution to spectroscopy: Raman Spectroscopy, Light scattering studies; Spectroscopy in Indian Materials and Heritage Analysis.

Unit 7: Laser Techniques

Laser characteristics; Types of LASER; Laser-induced breakdown spectroscopy.

Unit 8: Resonance Techniques

Electron Spin Resonance (ESR); Nuclear Magnetic Resonance (NMR); Mossbauer Spectroscopy.

Unit 9: Surface and Compositional Analysis

Surface Analysis: X-ray Photoelectron Spectroscopy (XPS); Compositional analysis: Energy Dispersive X-ray Analysis (EDAX/EDX), Auger Electron Spectroscopy (AES)

Unit 10: Nuclear and Particle Physics Techniques

Radiation Detection: Gas-filled detectors (GM counter, proportional counter), Scintillation detectors (NaI(Tl)), Semiconductor detectors (HPGe); Particle Accelerators: Pelletron, Synchrotron, and Colliding beam machines, Positron Annihilation Lifetime Spectroscopy (PALS)

Unit 11: Computational Techniques

Data Handling: Programming in Python for simulation, error handling, curve fitting (least-squares), interpolation; Numerical differentiation/integration.

PRACTICAL PART OF PGPHY S4-05 (DSE)

1. To analyse repeated Voltage Measurements of a Resistive Circuit at Constant Current and Verify Gaussian (Normal) Distribution of Experimental Data Using R Software or Microsoft Excel.
2. To amplify a weak AC signal using a simple op-amp amplifier and study signal-to-noise ratio (SNR) and noise reduction using CRO/DSO measurements.
3. To measure the variation of junction capacitance with reverse bias voltage of a PN junction diode using the RC transient (DC step) method and determine the built-in potential.
4. To determine the unknown current corresponding to a given intermediate voltage using linear interpolation technique in Python.
5. To calculate the area under a voltage–current (V–I) curve using the Trapezoidal Rule in Python.

Suggested References:

For Theory part:

- Taylor, J. R. (1997). An introduction to error analysis: The study of uncertainties in physical measurements. University Science Books.
- Bevington, P. R., & Robinson, D. K. (2003). Data reduction and error analysis for the physical sciences. McGraw-Hill.
- Press, W. H., Teukolsky, S. A., Vetterling, W. T., & Flannery, B. P. (2007). Numerical recipes: The art of scientific computing (3rd ed.). Cambridge University Press.
- Cullity, B. D., & Stock, S. R. (2001). Elements of X-ray diffraction (3rd ed.). Prentice Hall.
- Srinivasan, S. R. (2007). Introduction to materials characterization. New Age International.
- Ghosal, S. N. (2011). Nuclear physics. S. Chand & Company

For Practical part:

- R Core Team. (2026). R: A language and environment for statistical computing. https://www.r-project.org/
- _Amakant, A. G. (2013). Operational amplifiers and linear integrated circuits: Laboratory

manual. PHI Learning.

• Saha, G. (2011). Laboratory manual for introductory electronics experiments. Narosa Publishing House.

• Gezerlis, A. (2020). Numerical methods in physics with Python. Cambridge University Press.

• Kong, Q., Siauw, T., & Bayen, A. (2020). Python programming and numerical methods: A guide for engineers and scientists. Academic Press.

Semester IV: Physics of Nanomaterials

Course Type	**DSE**
Course Credit	**4**
Course Code	**PGPHY S4-06 (DSE)**
Total Marks	**100 (30% Formative, 50% Summative, 20% Practical)**

Course Objectives

The course will enable the learners to:

- Understand basic concepts of nanoscience and nanotechnology
- Explain quantum confinement and size effects.
- Describe different types of nanomaterials and carbon nanostructures.
- Explain characterization and nanofabrication techniques.
- Apply simulation and software tools in nanotechnology studies.

Course Outcomes

After completing this course, the learner will be able to:

- Classify nanomaterials based on structure and dimension.
- Analyse size-dependent and quantum effects in nanomaterials.
- Interpret XRD, TEM, STM, AFM, and optical spectroscopy results.
- Evaluate preparation methods and properties of fullerenes and CNTs.
- Perform simulation and surface analysis using SCAPS, Gwyddion, and VESTA.

Unit 1: Introduction to Nanoscience

Development of nanoscale science; Definition of nanoscience and nanotechnology; Length scales: micro to Nano regime; Importance and scope of nanoscale science; Key discoveries and milestones.

Unit 2: Basic Principles of Nanoscience and Technology

Surface-to-volume ratio; Size-dependent properties; Quantum size effects; Nanoscale behaviour.

Unit 3: Types of Nanomaterials and Synthesis methodologies

Classification of nanomaterials; 0D, 1D, 2D and 3D nanostructures; Metallic nanaomaterials; Semiconductor nanomaterials; Oxide nanomaterials; Qualitative idea of nanomaterial synthesis: Ball Milling, Epitaxial techniques; Template synthesis of nanostructures

Unit 4: Quantum Confinement

Quantum Confinement: 0D, 1D, 2D, 3D; Bulk to Nano transition: Band structures; Density of states; Weak and strong confinement regimes.

Unit 5: Carbon-Based Nanomaterials

Carbon nanostructures overview; Graphene; Fullerenes; CNTs; Nanofibers; Properties and importance of carbon nanomaterials, Applications of Graphene and CNT based materials in present day world.

Unit 6: Fullerenes-Preparation, Structure and Properties

Introduction to fullerenes; Preparation methods; Structure and bonding; Electrical, Optical and mechanical properties.

Unit 7: Carbon Nanotubes (CNTs) - Preparation, Structure and Properties

CNT classification: SWCNT, MWCNT; Methods of preparation: Structure, Chirality; Applications of CNTs.

Unit 8: Nanofabrication

Nanofabrication: Lithographic and non-lithographic techniques; Optical lithography; E-beam lithography; Focused ion beam lithography; X-ray lithography; Etching techniques; Nano patterning.

Unit 9: Structural and Surface Characterization Techniques

Structural Techniques: X-ray Diffraction (XRD), Small Angle X-ray Scattering (SAXS), Dynamic Light Scattering (DLS), Scanning Electron Microscope (SEM); Surface/Imaging Techniques: Transmission Electron Microscope (TEM), Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM).

Unit 10: Optical Characterization Techniques

UV–Visible absorption spectroscopy; Photoluminescence (PL); Raman spectroscopy and its importance in nanomaterials.

Unit 11: Future Trends in Nanotechnology

Emerging nanotechnologies; Future research directions; Ethical, safety and sustainability issues.

PRACTICAL PART OF PGPHY S4-06 (DSE)

1. To familiarize with ORIGIN Graphics and Analysis Software for analysis of absorption and photoluminescence spectra and X-ray diffraction pattern (Demo).
2. To study the effect of band gap on the performance of a nanomaterial-based solar cell using SCAPS-1D solar cell simulation software.
3. To determine the surface morphology of a nanomaterial thin film using Gwyddion software.
4. To generate and visualize the crystal structure of Zinc Oxide (ZnO) and simulate its X-ray diffraction (XRD) pattern using VESTA software.
5. To synthesize CdS nanostructures by the chemical co-precipitation method and record UV-Vis absorption spectra. Examine possible quantum confinement effects.

Suggested references:

For Theory part:

1. Poole, C. P., Jr., & Owens, F. J. (2003). Introduction to nanotechnology. Wiley-Interscience.
2. Kulkarni, S. K. (2007). Nanotechnology: Principles and practices. Capital Publishing Company.
3. Harris, P. J. F. (2009). Carbon nanotube science: Synthesis, properties and applications (2nd ed.). Cambridge University Press.
4. Cullity, B. D., & Stock, S. R. (2001). Elements of X-ray diffraction (3rd ed.). Prentice Hall.
5. Williams, D. B., & Carter, C. B. (2009). Transmission electron microscopy: A textbook for materials science (2nd ed.). Springer.

For Practical part:

6. Güntherodt, H.-J., & Wiesendanger, R. (Eds.). (1992). Scanning tunneling microscopy I & II. Springer.
7. Bhushan, B. (Ed.). (2010). Springer handbook of nanotechnology (3rd ed.). Springer

8. Crystallography Open Database. (2026). Crystallography Open Database. https://www.crystallography.net/cod/
9. Gwyddion Developers. (2026). Gwyddion software. https://gwyddion.net/
10. ImageJ Developers. (2006). ImageJ software. https://imagej.net/ij/download.html
11. SCAPS Developers, University of Ghent. (2026). SCAPS-1D simulation software. https://scaps.elis.ugent.be/
12. SEM Image Open Database. (2024). SEM image open database. Zenodo. https://zenodo.org/records/15510590
13. Van der Walt, S., et al. (2026). VESTA (Visualization for Electronic and Structural Analysis) software. https://jp-minerals.org/vesta/en/download.html

Semester IV: High Energy Physics

Course Type	DSE
Course Credit	4
Course Code	PGPHY S4-07(DSE)
Total Marks	100 (30% Formative, 70% Summative)

Course Objectives

The course will enable the learners to:

- List fundamental particles and interactions.
- Explain symmetry principles and conservation laws.
- Apply the quark model to classify hadrons.
- Analyse experimental results and evaluate the Standard Model and cosmological evidence.
- Develop basic data analysis methods for particle physics data.

Course Outcomes

After completing this course, the learner will be able to:

- Describe fundamental particles and interactions.
- Explain symmetry and conservation laws.
- Apply the quark model.
- Analyze experimental results.
- Interpret the Standard Model and apply basic data analysis methods in cosmology

Unit 1: Elementary Particles

Elementary particles; Classification and properties

Unit 2: Fundamental Interactions

Fundamental interactions: Strengths and ranges; Natural units

Unit 3: Symmetry and Conservation Rules

Symmetry in fundamental interaction; Conservation rules in fundamental interaction

Unit 4: Quark Model

Need for quark model; Quark flavours: up; down; strange; charm; bottom; top; Quantum numbers of quarks: electric charge; baryon number; strangeness; charm; bottomless; topness; Structure of hadrons: mesons (quark–antiquark); baryons (three–quark states); Colour charge;

Unit 5: Discovery of Fundamental Particles

Discovery of fundamental particles: Electron; Positron; Proton; Neutron; Muon; Tau

Unit 6: Cosmic Rays

Cosmic Rays: Sources; Flux; Properties Cosmic Rays, Extensive air showers; Status of cosmic ray experiments

Unit 7: Standard Model

Introduction to the Standard Model; Need for the Standard Model; Structure of the Standard Model; Electroweak Unification; Higgs Mechanism in the Standard Model; Achievements of the Standard Model; Limitations of the Standard Model

Unit 8: Beyond Standard Model

Developments beyond the Standard Model; Grand Unified Theories (GUT); Supersymmetry (SUSY); Extra Dimensions.

Unit 9: Collider and Accelerator Experiments

Collider & amp; Accelerator experiments: Principle; Particle detection; Working; HERA; LHC; Overview and discovery of Higgs boson

Unit 10: Neutrinos-I

Neutrinos: Postulation and discovery; Different sources of neutrinos

Unit 11: Neutrinos - II

Neutrinos: Solar neutrino anomalies; Atmospheric neutrino anomalies; Neutrino oscillations and neutrino mass; Overview of neutrino experiments

Unit 12: Early Universe

Big Bang theory; Steady state theory; Cosmic Microwave Background Radiation; Decoupling of matter and radiation; Inflation.

Unit 13: Dark Matter & amp; Dark Energy

Dark Matter: Introduction, Evidences; Direct and indirect detection; Dark Energy.

Unit 14: Data Analysis

Introduction to data analysis techniques for particle physics.

Suggested References:

1. Griffiths, D. (1987). Introduction to elementary particles. John Wiley & Sons.
2. Tayal, D. C. (2021). Nuclear physics. Himalaya Publishing House.
3. Halzen, F., & Martin, A. D. (2008). Quarks and leptons: An introductory course in modern particle physics. John Wiley & Sons.
4. Perkins, D. H. (2000). Introduction to high energy physics. Cambridge University Press.
5. Dey, T. (2011). Particle physics: A primer. Levant Books.
6. Sakurai, J. J. (2016). Invariance principles and elementary particles. Princeton University Press.
7. Lyons, L. (1989). Statistics for nuclear and particle physicists. Cambridge University Press.

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ANNEXURE III

GUIDELINES FOR SEMINAR PAPER PRESENTATION

M.Sc. PHYSICS PROGRAMME (KKHSOU)

1. INTRODUCTION

As part of the academic requirements of the Master of Science (M.Sc.) in Physics programme of Krishna Kanta Handiqui State Open University (KKHSOU), learners are required to prepare and present a seminar paper during the second semester. This component is designed to provide learners with an opportunity to engage with topics beyond the prescribed Self Learning Materials (SLMs) and to explore advanced and emerging areas in physics. It facilitates independent academic inquiry, promotes critical engagement with scientific literature, and encourages the systematic organization and communication of scientific ideas. The seminar also serves as a preparatory platform for higher studies and research by encouraging analytical thinking, conceptual clarity, and familiarity with contemporary developments in the discipline.

2. OBJECTIVES OF THE SEMINAR

The seminar component is designed to achieve the following objectives:

1. To develop the ability to undertake independent study and critically review scientific literature in physics.
2. To enhance scientific writing and oral presentation skills in a structured and coherent manner.
3. To strengthen conceptual understanding of advanced topics in theoretical and applied physics.
4. To promote analytical thinking and problem-solving abilities in scientific contexts.
5. To familiarize learners with recent developments, research trends, and interdisciplinary applications in physics.
6. To prepare learners for higher studies and research-oriented activities in physics and related fields.

3. SELECTION OF SEMINAR TOPIC

Learners may select a seminar topic from any relevant area of physics, preferably related to the courses offered in the M.Sc. Physics programme and any other related to interdisciplinary areas of Physics. Possible areas include.

- Classical Mechanics
- Quantum Mechanics
- Electrodynamics
- Statistical Mechanics
- Solid State Physics
- Nuclear and Particle Physics
- Electronics and Semiconductor Physics
- Astrophysics and Cosmology
- Nanoscience and Materials Science
- Computational Physics
- Renewable Energy Physics
- Medical Physics
- Space Science and Satellite Technology

The topic should be finalized in consultation with the Academic Counsellor or faculty member of the Study Centre.

4. STRUCTURE OF THE SEMINAR PAPER

The seminar paper should be written in a clear and systematic manner and should normally consist of the following sections:

4.1 INTRODUCTION

The introduction should present the central idea of the seminar topic and explain its relevance in physics. The learner should

- introduce the chosen seminar topic in a precise and understandable manner, providing sufficient background for the reader.
- explain the importance and relevance of the topic within the field of physics, highlighting its theoretical, practical, or research significance.
- clearly state the objectives of the seminar paper, indicating the purpose, scope, and focus of the study.
- provide a brief outline of the structure of the paper, giving an overview of the main sections to guide the reader through the discussion.

4.2 BACKGROUND / LITERATURE REVIE

This section should provide the scientific background of the topic. The learner should include

- Historical development of the concept
- Contributions of important scientists
- Fundamental theories related to the topic
- Status of research or applications

This section helps the audience understand the scientific context of the topic.

4.3 ANALYSIS / DISCUSSION

This section forms the main body of the seminar paper. The learner should

- Discuss the main theoretical concepts and principles.
- Present relevant equations and mathematical formulations where necessary.
- Include diagrams, graphs, or experimental illustrations.
- Explain the physical significance of the results or concepts.

The discussion should demonstrate the learner's conceptual understanding and analytical ability.

4.4 CONCLUSION

The conclusion should summarize the key ideas discussed in the seminar paper. The learner should:

- Restate the main objective of the study
- Summarize the major points of the discussion
- Highlight the significance of the topic in physics
- Mention possible future developments or applications, if relevant

5. FORMAT OF THE SEMINAR REPORT

The seminar report should be prepared in a clear and systematic manner following standard academic writing practices. It should be typed on A4 size paper using an appropriate font and spacing for readability. The length of the report should normally be between 8 and 12 pages, including figures, tables, and references.

All diagrams, figures, and tables should be properly labelled and numbered, and page numbers should be included throughout the document.

6. REFERENCING STYLE

All sources used in preparing the seminar paper must be properly acknowledged to ensure academic integrity. Learners should follow a standard referencing style while listing books, journal articles, and other sources. References should be presented in a consistent format at the end of the seminar report. For example,

- **Book**: Goldstein, H. (2002). *Classical Mechanics*. Pearson Education, New Delhi.
- **Journal Article**: Einstein, A. (1905). "On the Electrodynamics of Moving Bodies", *Annalen der Physik*, 17, 891–921.

7. SEMINAR PRESENTATION

Each learner is required to present the seminar before an academic panel or audience as part of the programme requirements. The presentation may be conducted at the Study Centre, University Headquarters, or through online mode, as notified by the University. The duration of the presentation is generally 10–15 minutes.

- The learner should present the topic in a clear, structured, and coherent manner.
- The objectives and key ideas of the seminar should be communicated effectively.
- The presentation should demonstrate conceptual understanding and logical organization of the subject.
- Important findings, interpretations, or applications should be highlighted.
- The learner may use suitable presentation aids such as slides, charts, or board work to enhance clarity.
- The presentation should conclude with a summary of the key points.
- All references must be clearly highlighted in the presentation.

8. EVALUATION CRITERIA

The seminar component shall be evaluated based on the following criteria:

Components	**Marks**
Quality of Seminar Paper	15
Understanding of the Topic	15
Technical Accuracy & Depth of Content	15
Clarity of Presentation	10
Use of Diagrams / Equations	10
Response to Questions (viva)	10
Originality / Analytical Thinking	15
Communication Skills	10
Total	**100**

9. GENERAL INSTRUCTIONS FOR LEARNERS

- Learners shall retain a copy of the seminar paper duly signed by the Study Centre Coordinator, along with a Certificate of Seminar Presentation issued by the Study Centre.

These documents should be preserved for record and may be required by the University for verification at any stage.

- Learners may be required to present their seminar at the University Headquarters, Study Centre, or any other designated venue, either in face-to-face mode or through online platforms, as notified by the University.
- The seminar report should be prepared using a computer and printed on standard A4 size paper. Appropriate margins and page numbering should be maintained throughout the document. Printing on both sides of the paper may be adopted.
- The venue for the seminar presentation should be properly organized, and necessary arrangements, including display of a suitable seminar title or banner, should be ensured by the Study Centre.
- The Study Centre is expected to maintain a record of the seminar presentation, preferably through video recording. Learners are also advised to retain a copy of their presentation recording (if available) until the declaration of final semester results, as the University may require it for verification purposes.

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ANNEXURE IV

GUIDELINES FOR PROJECT/DISSERTATION

MSC IN PHYSICS PROGRAMME (KKHSOU)

SECTION I

1. INTRODUCTION

The Project/Dissertation component of the M.Sc. in Physics programme is a vital academic exercise aimed at integrating theoretical knowledge with practical application. It enables learners to apply concepts from core and elective physics courses to investigate real-world or theoretical problems. This course carries significant academic weight (8 credits) and involves approximately 240 hours of dedicated study and research work. Students are expected to approach this work with seriousness and commitment for three primary reasons. First, it provides an opportunity to explore and analyse scientifically relevant problems using established physical principles. Second, due to its high credit value, it plays a crucial role in determining overall academic performance. Third, and most importantly, it helps in developing essential research skills such as problem formulation, analytical thinking, data interpretation, and scientific writing, which are indispensable for higher studies and research careers.

The project may focus on theoretical, computational, or experimental aspects of physics, depending on the learner's interest and available resources. Students are encouraged to design a structured research proposal by drawing upon the methodologies learned in research-oriented courses and by utilising analytical tools such as mathematical techniques, computational methods, and data analysis. The aim is to apply acquired knowledge to address meaningful scientific questions or phenomena.

It must be emphasised that the Project/Dissertation work should be original, authentic, and should meaningfully contribute to the advancement of the subject. Any form of plagiarism, lack of originality, or mere reproduction of existing materials from other sources is strictly unacceptable. If the submitted work is found to be non-authentic or not aligned with academic standards, the University reserves the full authority to reject the Project/Dissertation without providing any justification, and such cases will be awarded zero marks. Furthermore, the work must be carried out individually; group submissions are strictly prohibited. In instances where significant similarity is detected between the work of two or more learners, all such submissions will be rejected, and zero marks will be assigned to each concerned candidate.

Overall, the Project/Dissertation serves as a bridge between academic learning and research practice, preparing students for advanced scientific inquiry and professional engagement in the field of physics.

Presentation Guidelines: The Project/Dissertation Report must strictly adhere to the prescribed presentation format as outlined in Section II of the official guidelines. In addition, learners are advised to follow the recommendations and practical tips provided in Section III to enhance the overall quality and effectiveness of their work.

Citation and Referencing Standards: As the Project/Dissertation constitutes a formal research activity, it is essential to maintain a standard citation and referencing practice. The University requires the use of APA 7th edition style, as prescribed by the American Psychological Association (APA). Proper acknowledgement of all sources through consistent citation is mandatory to ensure academic integrity.

Role and responsibilities of Project/ Dissertation Guide: The role of the Project/Dissertation Guide is crucial in ensuring the successful completion of the work. The guide should possess adequate expertise in the relevant area of Physics and will assist in framing the research problem, planning the methodology, determining data requirements (where applicable), and guiding analysis and interpretation. Students are required to consult their guide at multiple stages—during the initial design of the study, throughout the execution phase, and at the time of drafting and final editing of the report. The draft version must be reviewed by the guide before final submission.

Eligibility of the Project/Dissertation Guide

- Faculty members of Universities or Degree Colleges, Course Coordinators, Academic Consultants, or Counsellors with relevant teaching experience in Physics or allied areas.
- Professionals holding a master's degree in physics or related disciplines with a minimum of five years of relevant experience.
- In case the learner sought guidance from a teacher or professional who is not part of your study centre's counselling faculty, their biodata must first be approved by the concerned Course Coordinator. The biodata should clearly indicate academic qualifications, teaching or professional experience, area of specialization, research contributions, and prior experience in supervising project work.

General Instructions for the learners

- Learners must keep a complete copy of the final Project/Dissertation Report with all original signatures for future academic, research, or professional use. The University may request submission of this copy at any time.
- Learners may be required to present their Project/Dissertation at the University headquarters or any designated centre, either in offline or online mode, as decided by the University.
- The final report must be computer-typed and printed on standard A4 size paper, preferably on both sides.
- Margins should be maintained at approximately 1.2 inches on the left and right, and 1 inch on the top and bottom. Proper page numbering must be followed throughout the report, with preliminary pages such as the Title, Acknowledgement, and Contents numbered using Roman

numerals (i, ii, iii, etc.), and the main body of the text numbered using Arabic numerals (1, 2, 3, …).

- Annexures, if included, should be placed at the end of the report and numbered using Roman numerals.
- Maintaining proper formatting, ensuring academic integrity, and maintaining regular consultation with the guide are essential for preparing a high-quality MSc Physics Project/Dissertation Report.

Section II:
Project/Dissertation Performa (M.Sc. in Physics Programme)

Cover Page:

The bound copy of the Project/Dissertation Report should include a properly designed cover page. **The hard cover must be navy blue in colour.** The cover page should clearly display the following details:

- The title of the Project/Dissertation, written concisely in capital letters. If required, an appropriate sub-title may be added for further clarity.
- The learners name along with enrolment number, examination roll number, and year of examination.
- The name and designation of the faculty member, Course Coordinator, or Academic Consultant who supervised the work.
- The name and designation of the external guide or professional (if applicable) associated with any organization who provided guidance for the project.

PROJECT REPORT/DISSERTATION

ON

…………*Topic Name*………………

SUBMITTED TO

KRISHNA KANTA HANDIQUI STAE OPEN UNVERSITY

IN

PARTIAL FULLFILLMENT OF THE

M.Sc. IN PHYSICS
(YEAR)

By

Name : …………………………………………
Enrollment No…………………………………….
Study Centre Code:

Under the Guidance

of

Name of Internal Guide / External Guide
Designation

KRISHNA KANTA HANDIQUI STATE OPEN UNIVERSITY
Guwahati, Assam

Certificate of Guide/Supervisor

<u>**Certificate of the Guide/ Supervisor**</u>

Mentor / Guide Name:

Designation:

This is to certify that the project report entitled "_______________" has been prepared by Ms./Mr. ____________ bearing enrolment number______________ under my supervision and guidance, for
the partial fulfilment of MSc in Physics of Krishna Kanta Handiqui State Open University.
His/her field work is satisfactory.

Date: Signature of Guide

Certificate of the Study Centre Coordinator/ Academic consultant of Study Centre

Certificate of the Study Centre Coordinator/ Academic consultant of Study Centre

Coordinator/ Academic consultant Name:
Designation:

This is to certify that the project report entitled "____________" has been prepared by Ms./Mr. __________ under the guidance of Dr./ Sri/Mr./Ms._____________, for the partial fulfilment of MSc in Physics programme of Krishna Kanta Handiqui State Open University. His/her field work is satisfactory.
.
Date: Signature

Acknowledgement: The learner should include an acknowledgement section expressing gratitude for the support and assistance received during the Project/Dissertation work. This may include guidance from the Supervisor, help from teachers, access provided by libraries, and support from any organizations, sources, or individuals. The learner may also acknowledge the encouragement and assistance of family members, friends, or others. The acknowledgement must conclude with the learner's signature along with their enrolment number.

Self-Declaration by the Learner: The learner must make the following declaration:

Self-Declaration by the learner I do hereby declare that this project work entitled " _________" submitted by me for the partial fulfilment of the requirement for the award of MSc in Physics programme of Krishna Kanta Handiqui State Open University is a product of my own research work. The report embodies the finding based on my study and observation and has not been submitted earlier for the award of any degree or diploma to any Institute or University. Name: Signature of the Learner: Enrolment Number: Date:

Table of Contents (Index)

The Table of Contents (also referred to as the Index) should clearly list the titles of all chapters along with their corresponding page numbers. It must also include major subdivisions, appendices, and annexures. In addition, the starting page numbers of the preliminary sections such as the Preface (if any), Bibliography, Appendices, and Annexures should be properly indicated for easy reference.

Main Report Structure

The main body of the Project/Dissertation Report should strictly follow the chapter framework proposed in the approved synopsis. A typical and recommended sequence is outlined below:

Chapter I: Introduction of the Problem

This chapter should present a clear background of the research problem and define the specific issue being investigated. It should elaborate on the significance of the problem in the context of Physics, along with the objectives and scope of the study. The expected contribution and potential impact of the work should also be highlighted. If applicable (especially in experimental or applied work), a brief description of the laboratory, institution, or organization where the work was carried out may be included.

Chapter II: Theoretical Perspective / Review of Literature

This chapter should provide a comprehensive overview of the theoretical concepts, principles, and existing literature related to the topic of study. It should reflect the current status of research in the relevant area of Physics and summarize key findings from previous studies. This discussion should establish the need for the present work and justify the approach adopted in the study.

Chapter III: Methodology, Scope, and Limitations

This chapter should describe in detail the methodology adopted to carry out the study. Depending on the nature of the work (theoretical, computational, or experimental), it should include aspects such as model formulation, experimental setup, data collection procedures, simulation techniques, or analytical methods used. Sources of data (primary/secondary, if applicable) and techniques of data processing and analysis must be clearly explained. The scope of the study and any limitations encountered during the work should also be explicitly stated.

Chapter IV, V, VI, …: Analysis, Results, and Discussion (Main Body)

These chapters form the core of the report and should present the results obtained along with their analysis and interpretation. The research problem must be addressed in a clear and logical manner, supported by appropriate data, graphs, tables, or theoretical arguments. The discussion should focus on key findings, distinguishing between major results and less significant observations. Chapters should be organized systematically, maintaining a balanced length and avoiding unnecessary details in the main text. Extensive data or supplementary material may be placed in the appendices. Emphasis should be given to clarity, coherence, and scientific reasoning to ensure the effectiveness of the report.

Appendices and Annexures

- **Appendices:**
  Appendices should be labeled alphabetically (e.g., Appendix A, Appendix B, etc.) and should contain detailed data, calculations, derivations, computer codes, or additional material used in the study. These are not part of the main chapters but should be referred to wherever necessary in the discussion. Appendices should be placed after the final chapter (usually after summary and conclusions).
- **Annexures:**
  Annexures should be numbered numerically (e.g., Annexure I, Annexure II, etc.) and include supporting documents or supplementary information that are relevant to the study but not directly part of the primary data or analysis. These are included for reference and clarity.

References

References should be provided either at the bottom of the respective pages (as footnotes) or at the end of each chapter. Alternatively, all references may be compiled at the end of the report immediately after the appendices and annexures. Proper and consistent citation must be maintained throughout the document following APA 7th edition guidelines.

Bibliography

The bibliography should include a comprehensive list of all published sources consulted during the Project/Dissertation work. This typically covers all materials cited in the text as well as additional relevant readings. The entries should be arranged systematically following APA 7th edition style, usually in alphabetical order. If required, the list may be categorized separately for books, research articles, and other sources.

SECTION III

A Guide to Organising the Contents of Project Report / Dissertation

1. Title of the Study

The title should be a single, clear, and concise statement that reflects the core focus of the study. It should accurately indicate the key variables or concepts involved, especially in the context of Physics (theoretical, experimental, or computational). The title must be brief yet informative, enabling the reader to immediately understand the relevance of the work. Avoid informal or journalistic expressions and refrain from using unnecessary phrases such as "a study of…" or "an experiment to find…". The title should represent the content precisely without redundancy, as it forms the first point of engagement for the reader.

2. Abstract of the Study

The abstract should present a concise summary of the entire Project/Dissertation in a single paragraph, ideally not exceeding 150 words. It should briefly state the objective of the study, the methodology or approach adopted, the key findings, and the main conclusions. Detailed statistical data or technical descriptions should be avoided in this section. Since the abstract is often the only part initially read, it must provide a clear and comprehensive overview that enables the reader to decide the relevance of the work. It is advisable to write the abstract after completing the full report, possibly starting with a longer draft and then refining it into a concise version.

3. Introduction to the Study

The introduction should begin by clearly establishing and justifying the research problem undertaken in the field of Physics. After reading this section, the reader should be able to understand the subject of the study as well as the rationale behind it. At the same time, the introduction should explain the purpose of the work in a manner that is accessible even to a non-specialist. Typically, it should start with a general framework of the topic and gradually move towards the specific objectives and reasoning of the study.

An effective introduction should follow a logical sequence:

- **Identification of the research problem:** Clearly describe the topic or issue to be investigated and justify its scientific importance, relevance, or applicability in Physics.
- **Review of previous work:** Present a brief account of earlier theoretical, experimental, or computational studies related to the topic. Where appropriate, indicate the contributions of existing models, theories, or findings.
- **Justification of the present study:** Critically examine the limitations or gaps in previous work. These may arise due to methodological constraints, need for refinement or extension of existing theories, lack of experimental verification, or the necessity to compare or validate different approaches. This discussion should logically lead to the need for the present investigation and indicate how the current study attempts to resolve unresolved issues or improve existing understanding.
- **Statement of objectives and expectations:** Clearly state the objectives, research questions, or hypotheses of the study, explaining what is expected based on theoretical background or earlier findings. In case of exploratory work, where outcomes are not precisely known, the intended aims and possible outcomes should be briefly indicated.

The concluding part of the introduction is particularly important, as it connects the theoretical background with the main body of the study. A well-structured introduction not only provides clarity of purpose but also facilitates effective analysis, discussion, and interpretation of the results.

4. Methodology of Research

The methodology section should clearly describe the procedures and techniques adopted to carry out the study. Rather than being presented as a single block, this section should preferably be organised into appropriate subsections. It should explain, in a systematic manner, the steps followed in conducting the research and, where applicable, the process of data collection, experimentation, or computation. The description must be sufficiently detailed to enable the reader to understand and, if required, reproduce the study.

Depending on the nature of the work in Physics, this section may include theoretical formulation, experimental design and setup, instrumentation used, computational methods, simulation techniques, and data analysis procedures. The use of relevant research tools and techniques should be clearly stated. It is also desirable to include a brief review of methodologies adopted in earlier studies to justify the approach chosen for the present work. This section may typically include:

- Description of research design and overall approach
- Experimental setup, instruments, or computational techniques used
- Methods of data collection and processing (where applicable)

- Reference to and justification based on methodologies used in previous studies

Clarity, precision, and logical organisation are essential in this section to ensure scientific validity, transparency, and reproducibility of the work.

5. Chapterisation of the Study

The main body of the Project/Dissertation should be systematically organized according to the approved chapter plan. The arrangement of chapters should ensure a logical progression of ideas, maintaining continuity and coherence throughout the discussion. Each chapter should contribute meaningfully to the overall theme of the study.

6. Findings and Discussion

The presentation of results should begin with a clear description of how the data or outcomes of the study were processed and analysed. This involves explaining the procedure followed to obtain the results from raw observations, measurements, simulations, or calculations. Where applicable, the method of aggregation or computation should be specified. Any criteria used for excluding certain data points or observations must be clearly justified and stated.

Where appropriate, results should be summarized using suitable statistical or analytical measures to provide a clear and concise overview. In experimental or computational studies, this may include quantities such as mean values, standard deviations, error estimates, or other relevant parameters. Such information may be presented within the text or through well-organized tables, especially when dealing with multiple variables or conditions. Graphical representations are often more effective than tables or textual descriptions for illustrating trends, relationships, or complex patterns in the data.

All tables and figures must be properly numbered and accompanied by descriptive captions indicating the variables, conditions, and units of measurement. Axes in graphs should be clearly labeled, and every table or figure included must be appropriately referred to and discussed within the main text so that the reader understands its relevance.

Direct reproduction of raw outputs from software or computational tools should be avoided. Instead, only the relevant and meaningful results should be presented in a clear, concise, and non-repetitive manner. Consistency in terminology and notation between the methodology and results sections should be maintained to enhance clarity.

In many cases, descriptive analysis may be supplemented with appropriate statistical or analytical tests to support the interpretation of results. Wherever such methods are used, it should be clear how they have been applied and on what data. Relevant parameters and indicators should be reported as required to ensure accuracy and completeness of the analysis. Overall, the results and discussion should be presented logically, with emphasis on clarity, relevance, and scientific interpretation, ensuring that the findings effectively address the objectives of the study.

7. Conclusion and Future Scope

The conclusion should provide a clear and concise summary of the major findings of the study and emphasise their significance within the field of Physics. It should present the key inferences drawn from the results, linking them directly to the objectives of the investigation. In addition, this section should briefly discuss any limitations encountered during the study, along with possible improvements or extensions that could enhance the work. Suggestions for future research directions in the related area may also be included to indicate the scope for further investigation. Overall, a well-structured conclusion brings logical closure to the study while clearly highlighting its academic and scientific contribution.

Section IV

Certain Areas of Research for Your Project/Dissertation

The faculty has outlined broad themes as potential areas of research, and an indicative list is provided below to guide learners in selecting a suitable topic for their project or dissertation. These topics are meant only for reference; learners are free to choose any relevant area within Physics based on their interest, available resources, and guidance from their supervisor.

1. Applications of Quantum Mechanics in Simple Physical Systems
2. Numerical Solutions of Schrödinger Equation for Model Potentials
3. Study of Electromagnetic Wave Propagation in Different Media
4. Analysis of Electrical and Magnetic Properties of Materials
5. Performance modeling of different semiconductor materials (Si, GaAs, CdTe) in solar cells
6. Effect of temperature and irradiance on the I-V and P-V characteristics of Si and thin-film solar cells
7. Design and simulation of a solar-powered DC-DC converter using power semiconductor devices (MOSFET/diodes)
8. Investigation of Optical Properties using Interference, Diffraction, or Polarization
9. Study of Laser Principles and Applications
10. Computational Modelling in Physics using Programming Techniques
11. Study of Thermodynamic Systems and Statistical Behaviour of Particles
12. Analysis of Heat Transfer Mechanisms in Physical Systems
13. Solar-energy-harvesting system interfaced with a low-power RF communication module
14. Design and performance study of a simple digital communication link using ASK/FSK/PSK
15. Noise and channel-capacity analysis of baseband and bandpass communication channels
16. Design and performance study of a solar-powered wireless sensor node using semiconductor electronics
17. Solar-energy-harvesting system interfaced with Zigbee/LoRa using low-power RF semiconductor devices
18. Study of Nuclear Radiation and its Detection Techniques

19. Environmental Physics: Radiation, Pollution, and Energy Resources
20. Study of Solid-State Physics: Crystal Structure and Band Theory
21. Electrical Conductivity and Magnetic Behaviour of Materials
22. Study of Nanomaterials and their Physical Properties
23. Simulation and Modelling of Physical Systems using MATLAB/Python
24. Astrophysics: Study of Stellar Structure and Evolution
25. Experimental Verification of Physical Laws using Laboratory Techniques
26. Applications of Physics in Medical Science (Medical Physics)
27. Study of Computational Physics Methods and Simulations
28. Study of Fluid Dynamics and its Applications
29. Physics of Climate and Atmospheric Phenomena
30. Study of Superconductivity and its Applications

These suggested areas are intended to guide learners in identifying relevant and feasible topics for their Project/Dissertation. The final selection should ensure originality, scientific relevance, and suitability within the scope of the M.Sc. Physics programme.

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ANNEXURE V

LIST OF ASSIGNED FACULTY (COURSE-WISE) IN M.SC. IN PHYSICS PROGRAMME

Semester	Type of Courses	Title of Courses	Faculty/Course Coordinator	Discipline
I	DSC	Classical Mechanics	Dr. Kabita Baruah	Physics
	DSC	Mathematical Physics	Dr. Kabita Baruah	Physics
	DSC	Physics Lab-I	Dr. Kabita Baruah	Physics
	DSE	Introduction to Semiconductor Devices	Dr. Antara Mahanta Barua	Electronics
	AEC	Renewable Energy	Dr. Antara Mahanta Barua	Electronics
II	DSC	Electromagnetic Theory	Dr. Chandra Kamal Borah	Physics
	DSC	Quantum Mechanics	Dr. Chandra Kamal Borah	Physics
	DSC	Physics Lab-II	Dr. Antara Mahanta Barua	Electronics
	DSE	Fundamentals of Communication System	Dr. Antara Mahanta Barua	Electronics
	-	Seminar	Dr. Antara Mahanta Barua Dr. Kabita Baruah Dr. Chandra Kamal Borah	Electronics Physics Physics
III	DSC	Condensed Matter Physics	Dr. Chandra Kamal Borah	Physics
	DSC	Fundamentals of Analog and Digital Electronics	Dr. Antara Mahanta Barua	Electronics
	DSC	Physics Lab-III	Dr. Chandra Kamal Borah	Physics
	DSE	Introduction to Astrophysics	Dr. Kabita Baruah	Physics
	DSE	Fundamentals of Laser and Photonics	Dr. Kabita Baruah	Physics
IV	DSC	Atomic and Molecular Physics	Dr. Kabita Baruah	Physics
	DSC	Nuclear and Particle Physics	Dr. Chandra Kamal Borah	Physics
	DSC	Statistical Mechanics	Dr. Chandra Kamal Borah	Physics
	DSE	Experimental Techniques	Dr. Antara Mahanta Barua	Electronics
	DSE	Physics of Nanomaterials	Dr. Chandra Kamal Borah	Physics
	DSE	High Energy Physics	Dr. Kabita Baruah	Physics
	-	Major Project	Dr. Antara Mahanta Barua Dr. Kabita Baruah Dr. Chandra Kamal Borah	Electronics Physics Physics

ANNEXURE VI

COMMON BASKET OF ABILITY ENHANCEMENT COURSES (AECS) AND VALUE ADDED COURSES (VACS) FOR PG PROGRAMMES

Semester	Course Type	Course title
I	**AEC** (any one course)	Renewable Energy
		Social entrepreneurship and project management
		English for Media Studies
	VAC (any one course)	English communication skills
		Essentials of Indian Constitution
		Indian traditional Knowledge System (ভাৰতীয় পৰম্পৰাগত জ্ঞান কোষ)
		Introduction to Ethics
		Traditional media
II	**VAC** (any one course)	Advertising strategy
		Life skills
III	**AEC**	Cyber security

SEMESTER-I

SYLLABUS OF ABILITY ENHANCEMENT COURSES (AEC)

COURSE TITLE: RENEWABLE ENERGY

CREDIT:4; TOTAL MARKS:100

COURSE OBJECTIVES:

The main objectives of the course are-

- to provide the fundamental concepts and types of renewable energy sources.
- to analyse the technical and economic aspects of various renewable sources
- to explore energy storage methods and grid integration techniques for renewable energy.
- to evaluate the environmental impacts and sustainability of renewable energy technologies.
- to give an idea about policies, incentives, and challenges in renewable energy adoption globally.

COURSE OUTCOMES:

The learners will be able to-

- Summarize the fundamental characteristics of various renewable energy sources and the technologies employed for their effective utilization.
- Demonstrate the technologies for energy conversion using different renewable energy resources.
- Analyze the advantages and limitations of various renewable energy sources.
- Interprete global and Indian government policies and programs aimed at promoting the adoption and expansion of renewable energy capacity.

UNIT 1: CONVENTIONAL SOURCES OF ENERGY

Overview of Conventional Energy Sources; Types of Conventional Sources: Fossil Fuels, (Limitations, Formation, and Extraction of Conventional Energy Sources), Nuclear Energy; Global and National (India-Focused) Distribution of Reserves; Strategic Importance of Conventional Energy Resources; Uses and Applications: Environmental Impacts.

UNIT 2: RENEWABLE SOURCES OF ENERGY

Introduction of Renewable Energy; Need of Renewable Energy: Energy Scenario: Global and Indian Context; Classification of Energy Sources: Renewable Vs Non-Renewable; Energy Security and Sustainability.

UNIT 3: SOLAR ENERGY

Introduction to Solar Energy: Importance, Solar Radiation and Measurement; Solar Radiation Geometry; Solar Thermal System, Classification of Solar Thermal Collectors: Non-Concentrating and Concentrating Collectors; Flat Plate Collector; Concept of Solar Thermal for Power Generation and Process Heating; Solar Thermal Application- Solar Distillation, Solar Cooker, Solar Cooling, Solar Green Houses.

UNIT 4: SOLAR PHOTOVOLTAIC SYSTEM

Introduction to Photovoltaic (PV): Characteristics; Different Solar Cell Technologies; PV System Components; PV Models: Equivalent Circuits; PV System Applications: Off-Grid and Grid-Connected PV Systems; Rooftop PV System; Operation and Maintenance of Solar Power Plants; Sun Tracking Systems.

UNIT 5: WIND ENERGY

Introduction to Wind Energy; Characteristics of Wind and Wind Power (Betz limit for maximum power coefficient); Wind Turbines: Types, Components; Aerodynamics of Wind Turbine: Aerofoil, Lift and Drag Characteristics; Grid Integration of Wind Turbines: Power Electronic Interfaces, Grid Interconnection Topologies; Challenges of Wind Energy Technology.

UNIT 6: HYDRO ENERGY

Hydropower Resources; Fundamental of Hydro Energy Estimation; Components of A Hydropower System: Dams and Reservoirs, Intake Structures and Penstocks; Hydropower Technologies: Small, Medium, and Large Hydro Systems, Pumped Storage and Micro-Hydro; Hydro Turbines: Pumped Hydro Energy; Environmental Impact of Hydropower Applications.

UNIT 7: BIOENERGY

Introduction to Bioenergy: Biomass and Biofuels; Potential of Bioenergy; Sources of Bioenergy; Bioenergy Fuels: Characteristics and Applications; Environmental and Economic Aspect of Bioenergy.

UNIT 8: OCEAN ENERGY

Ocean Energy Potential; Wave Energy Devices; Ocean Thermal Energy Conversion (OTEC) and Applications; Introduction to Osmotic Power.

UNIT 9: TIDAL ENERGY

Energy from Wave; Wave Energy Devices; Introduction to Tidal Energy; Tide Energy Technologies.

UNIT 10: GEOTHERMAL ENERGY

Geothermal Resources; Potential of Geothermal energy; Geothermal Technologies and Applications.

UNIT 11: ENERGY STORAGE DEVICES AND HYBRID RENEWABLE ENERGY SOURCES

Battery: Types, Specifications, Charging and Discharging Characteristics; Definition and classifications of hybrid systems: Standalone, Grid-tied, Microgrid-based Hybrids; Role of Storage in Hybridization, Hybrid systems for EV charging.

UNIT 12: ENERGY ECONOMICS AND AUDITING

Economics of Energy Savings Schemes: Costs, Interest, Depreciation; Investment in Energy Saving Projects: Rate of Return, Payback, Discounted Cash Flow Methods; Case Studies: Energy Production and Conversion, Energy Audit of Electrical, Mechanical, and Thermal Equipment, Energy Audit of Residential Sector, Industrial Sector, and Commercial Sectors; Lifecycle Assessment of Energy Systems; Socio-Economic Aspects of Energy Transition.

UNIT 13: RENEWABLE ENERGY POLICIES

National and International Renewable Energy Policies; Policy Implementation for Rural Electrification, Smart Cities etc. KUSUM, PM Surya Ghar: Muft Bijli Yojana, Green Energy Corridors (GEC).

UNIT 14: RENEWABLE ENERGY AND ENVIRONMENT

Environmental Effects of Energy Production and Utilization; Energy and Climate Change: Greenhouse Gas Emissions and Global Warming; Climate Change Mitigation and Adaptation; International Agreements and Policies on Climate Change; International Protocols; Carbon Pricing and Emission Trading Systems.

UNIT 15: FUTURE TRENDS

Role of AI/ML in Hybrid Renewable Optimization; Brief Idea of Smart Charging Systems: V2V, V2G, V2X Systems.

References:

- Tiwari, G. N., & Ghosal, M. K. (n.d.). *Renewable energy resources*. Narosa Publishing House.
- Rai, G. D. (n.d.). *Non-conventional energy sources*. Khanna Publishers.
- Solanki, C. S. (n.d.). *Solar photovoltaics: Fundamentals, technologies and applications*. PHI Learning.
- Twidell, J., & Weir, T. (n.d.). *Renewable energy sources*. CRC Press.
- Sukhatme, S. P. (n.d.). *Solar energy*. Tata McGraw Hill.
- Ramesh, R., & Kumar, S. (n.d.). *Renewable energy technologies*. Narosa Publishing House.
- Agarwal, M. P. (n.d.). *Solar energy*. S. Chand and Co. Ltd.
- Mittal, K. M. (n.d.). *Non-conventional energy systems*. A. H. Wheeler Publishing Co. Ltd.
- Jayakumar, P. (2009). *Solar energy: Resource assessment handbook*.
- Oxford & IBH Publishing Co. (n.d.). *Biomass energy*.

COURSE TITLE: SOCIAL ENTREPRENEURSHIP AND PROJECT MANAGEMENT

UNIT 1: ENTREPRENEURSHIP

Concept of Entrepreneur; Characteristics of Entrepreneur; Concept of Entrepreneurship; Role of Entrepreneurs in Economic Growth; Emergence of Entrepreneurial Class; Entrepreneurial Leadership and Motivation

UNIT 2: THEORIES OF ENTREPRENEURSHIP

Economic Theory; Sociological Theory; Dynamic Entrepreneurship Innovation Theory; Leibenstein's X- efficiency Theory; Theory of Profit

UNIT 3: SOCIAL ENTREPRENEURSHIP

Meaning and concept of Social Entrepreneurship; Importance of Innovation in the Social Development Sector; Entrepreneurship Development Programme-Meaning and Importance; Institutions providing EntrepreneurshipDevelopment Programmes in India; Banking and Microfinance

UNIT 4: SOCIAL ENTREPRENEURSHIP IN NORTHEAST INDIA

Social Sector Perspectives and Interventions of Social Entrepreneurs; Role of Entrepreneurship Development Programmes in Context of North-East Region; Local Economy and Training Indigenous Entrepreneurs

UNIT 5: SOCIAL ENTREPRENEURSHIP AND LIVELIHOODS

Social Entreprenuershp in India, Social Entreprenuership and Livelihood, Sustainable Livelihood Strategies, Challenges of Growth, Joint Venture

UNIT 6: PROJECT MANAGEMENT AND SOCIAL ENTREPRENEURSHIP

Meaning of Project and Project Management; Emergence of Entrepreneurship; Importance of Project Management for Social Entrepreneurs; Social Entrepreneurship Models

UNIT 7: PROJECT LIFE CYCLE

Meaning of Project Life Cycle; Importance of Project Life Cycle; Phases of Project Life Cycle; Life Cycle Curve

UNIT 8: PROJECT ASSESSMENT

Project Identification and Formulation; Market and Demand Analysis; Technical Analysis; Economic and Financial Analysis; Social Cost Benefit Analysis; Formulation of Detailed Project Report; Project Monitoring and Reporting; Project Completion and Evaluation; Project Review and Termination

UNIT 9: STAKEHOLDER AND RESOURCE PLANNING IN PROJECT MANAGEMENT

Project Stakeholder Management; Identifying Project Stakeholders; Organisational Culture and Project Management; Project Planning; Planning of Physical Resources; Planning of Human Resources; Planning of Financial Resources

UNIT 10: NETWORKING

Meaning and Components of Network; CPM (Critical Path Method); PERT (Programme Evaluation and Review Technique); Basic Difference Between PERT and CPM; Importance of Network in Project Management

COURSE TITLE: ENGLISH FOR MEDIA STUDIES

UNIT 1: INTERVIEWING AND NOTE TAKING

Definition of Interview, preparing for interview, conducting the interview, text of interview, language for audio-visual interview, note taking

UNIT 2: EDITORIAL WRITING

Defining Editorial, Introduction to the editorial page, writing the editorial, rules for Editorial writing, writing the Feature, Writing the Article, writing the middle, Letters to the Editor

UNIT 3: ART OF COLUMN WRITING

Types of columns, distinguishing characteristics of an op-ed, steps to be followed while writing a column

UNIT 4: ELEMENTS OF GOOD WRITING

Characteristics- precision, clarity in writing, use of simple sentences, grammar and punctuation, avoiding clichés, pacing, use of transitions

UNIT 5: PREPARING COPY

Copy editing- use of quotes, paraphrases, attribution, writing the lead, grammatical mistakes- confusion in the use of 'who' and 'whom', possessive pronouns, use of active voice, copy reading symbols

UNIT 6: MASTERING THE LANGUAGE OF EDITING

Importance on vocabulary, sentence construction, participles, pronouns, verbs, nouns, foreign words, prepositions, paragraphs, selection of right words

UNIT 7: REVIEW WRITING

Book review- fiction, adverse criticism, non-fiction, the collection, poetry, drama, Steps to be followed while doing a book review, drama review, Film review

UNIT 8: COMPOSITION

Column writing, science write-up, review writing

UNIT 9: HEADLINE WRITING

Meaning of headline, Types of headline, Functions of a headline, Factors to be kept in mind while writing headlines, Headline writing skills- use of verbs, use of Articles and Voices, Use of Decks, The Five Ws, use of Short Synonyms, Abbreviations, Punctuation, Line Balance, Guidelines for Headline Writing

UNIT 10: WRITING FOR ADVERTISING COPY

Introduction, Key concepts in Advertising, Copywriting, Radio copy, Television copy

UNIT 11: WRITING AND REWRITING FOR PUBLIC RELATIONS 188-200

Preparing news releases- Announcement releases, Backgrounders, Position Papers, Tip Sheets, Rewriting News Releases, Writing newsletter stories

UNIT 12: GRAMMAR AND USAGE

Sequence of Tenses, Voice, Narration, Punctuation, Vocabulary

UNIT 13: COMMON ERRORS IN THE USE OF ENGLISH LANGUAGE

Errors of Concord, Errors of Construction, Errors of Order, Errors of Prepositions, Errors of Conjunctions

UNIT 14: REPORTING PUBLIC SPEECH

Reporting public speeches- background information, covering the speech, using a prepared text, writing the speech story for print

UNIT 15: STYLE AND THE STYLEBOOK

Need of a stylebook, -consistency, preference and tradition, Guidelines of different stylebooks, Mechanical rules

SYLLABUS OF VALUE ADDED COURSES (VAC)

COURSE TITLE: ENGLISH COMMUNICATION SKILLS

UNIT 1: WHAT IS COMMUNICATION

Defining Communication, Significance and Process of Communication, Communication Network, Communication Media or Methods, Barriers to Communication, Effective Communication.

UNIT 2: COMMUNICATION SKILLS

What is Communication? Types of Communication, Written Communication, Spoken Communication, Non-Verbal Communication, Essentials of Written Communication, Essentials of Oral Communication.

UNIT 3: ISSUES ON ORAL COMMUNICATION I

Skills Involved in Oral Communication, Listening and Speaking Skills, Reading and Writing Skills, The Process of Speech, Non-verbal Communication.

UNIT 4: ISSUES ON ORAL COMMUNICATION II

Conversation as a speech event, Turn-Taking, The Language of Conversation, Phrasal Verbs.

UNIT 5: TELEPHONE SKILLS

Understanding Telephone Communication, Handling Calls, Making Requests, Request to Do Things, Giving Instructions.

UNIT 6: INTERVIEW SKILLS

The Art of Interviewing, Examples of Interviews—Job Interviews, Media Interviews.

UNIT 7: PUBLIC SPEAKING

The art of Public Speaking, Techniques of Persuasive Speech, Techniques of Informative Speech.

UNIT 8: DIALOGUES IN CONTEXTS

Importance of Dialogues in Social Interactions, Some Dialogues of Contexts-At the Post Office, At the Doctor's, buying a Shirt, At the Market, In the Library, At the Railway Station, At the Tea Stall, An Interview, At the Book Seller's, At the Garage, Hiring a Taxi, At the Restaurant, At the Bank, At the Hotel.

COURSE TITLE: ESSENTIALS OF INDIAN CONSTITUTION

UNIT 1: MAKING OF THE INDIAN CONSTITUTION

Formation of the Constituent Assembly, Drafting Committee, Adoption of the Constitution of India

UNIT 2: PHILOSOPHY AND IDEALS OF THE INDIAN CONSTITUTION

Philosophy and Ideals of the Indian Constitution: The Preamble of the Constitution of India; Sources of the Indian Constitution

UNIT 3: FEATURES OF THE INDIAN CONSTITUTION

Salient Features of the Indian Constitution

UNIT 4: FUNDAMENTAL RIGHTS AND FUNDAMENTAL DUTIES OF INDIAN CITIZENS

Meaning of Fundamental Rights: Features of Fundamental Rights, Types of Fundamental Rights, Restrictions on Fundamental Rights

UNIT 5: DIRECTIVE PRINCIPLES OF STATE POLICY

Meaning, Nature and Classification of Directive Principles of State Policy

UNIT 6: GOVERNMENT AT THE UNION AND STATE LEVELS

Government at the Union level: The President of India, The Vice-President of India, The Union Council of Ministers, The Prime Minister; Government at the State level: The Governor, The State Council of Ministers and the Chief Minister

UNIT 7: THE PARLIAMENT OF INDIA AND THE STATE LEGISLATURE

Composition of the Parliament of India: The President, The Rajya Sabha, The Lok Sabha; Powers and Functions of the Parliament; Relation between the two Houses of the Parliament; Legislative Procedure: Procedure for a Money Bill; The State Legislature : The Legislative Assembly or Vidhan Sabha, The Legislative Council or Vidhan Parishad

UNIT 8: JUDICIARY IN INDIA: SUPREME COURT AND HIGH COURTS JUDICIAL REVIEW AND JUDICIAL ACTIVISM

The Supreme Court; The High Court: Subordinate Courts; Judicial Review, Judicial Activism and Independence of the Judiciary in India: Judicial Review, Judicial Activism, Independence of the Judiciary in India.

COURSE TITLE: INDIAN TRADITIONAL KNOWLEDGE SYSTEM
(ভাৰতীয় পৰম্পৰাগত জ্ঞান কোষ)

অধ্যায় ১: যোগদৰ্শনৰ পৰিচয়

দৰ্শনৰসংজ্ঞা, দাৰ্শনিক পৰিভাষাত যোগৰ মূল্যায়ন, যোগৰ সংজ্ঞা আৰু অৰ্থবিচাৰ, যোগৰ উৎপত্তি, যোগসাহিত্য, যোগপণ্ডিতসকল, যোগৰ শ্ৰেণীবিভাজন, যোগ দৰ্শনৰ মূল সিদ্ধান্তসমূহ, যোগৰ লক্ষ্য আৰু উদ্দেশ্য

অধ্যায় ২: আয়ুৰ্বেদ আৰু বাস্তুশাস্ত্ৰ

আয়ুৰ্বেদ বা চিকিৎসাশাস্ত্ৰ, আয়ুৰ্বেদ শাস্ত্ৰৰ উদ্দেশ্য আৰু ভাগ, আয়ুৰ্বেদ শাস্ত্ৰৰ উৎস, বিভিন্ন আয়ুৰ্বেদ শাস্ত্ৰৰ উল্লেখ, বাস্তুশাস্ত্ৰ পৰিচয়, বাস্তুশাস্ত্ৰৰ উৎস, বিভিন্ন বাস্তুশাস্ত্ৰৰ উল্লেখ, শব্দাৰ্থ তালিকা

অধ্যায় ৩: বেদান্ত দৰ্শনৰ পৰিচয়

বেদান্তৰ উৎপত্তি আৰু ক্ৰমবিকাশ, অদ্বৈত বেদান্ত দৰ্শনৰ বিভিন্ন বিষয়বস্তুৰ চমু আভাস, জ্ঞানতত্ত্ব, ব্ৰহ্মতত্ত্ব, জগততত্ত্ব, মায়াতত্ত্ব, ঈশ্বৰতত্ত্ব, জীৱতত্ত্ব, মোক্ষতত্ত্ব

অধ্যায় ৪: অলংকাৰ শাস্ত্ৰৰ সম্প্ৰদায়সমূহ

কাব্যশাস্ত্ৰৰ আৰম্ভণি আৰু বিকাশ, অলংকাৰ শাস্ত্ৰৰ বিভিন্নসম্প্ৰদায়

অধ্যায় ৫: কৌটিল্যৰ অৰ্থশাস্ত্ৰঃ পৰিচয়

অৰ্থশাস্ত্ৰৰ ৰচয়িতা, অৰ্থশাস্ত্ৰৰ বিষয়বস্তু, অৰ্থশাস্ত্ৰৰ নামকৰণৰ তাৎপৰ্য, ভাৰতীয় পৰম্পৰাত অৰ্থশাস্ত্ৰৰ গুৰুত্ব

অধ্যায় ৬: চৰকসংহিতাঃসাধাৰণ আলোচনা

আয়ুৰ্বেদঃ আয়ুৰ্বেদৰ অৱতৰণ, চৰক সংহিতাৰ পৰম্পৰা, চৰক সংহিতাৰ অধ্যায়বিভাগ, চৰক সংহিতাৰ অধ্যায়সমূহৰ নামকৰণ, চৰক সংহিতা টীকাকাৰ

অধ্যায় ৭: অসমত ৰচিত হোৱা সংস্কৃতকাব্য

ধৰ্মশাস্ত্ৰ অথবা স্মৃতিশাস্ত্ৰঃ তন্ত্ৰসাহিত্য, পুৰাণসাহিত্য, নাটক, ব্যাকৰণ, কাব্যঃ শ্ৰীকৃষ্ণলীলামৃত্ম্, সতীজয়মতী, শ্লোকমালা, পতাকান্নায়, প্ৰকামকামৰূপম্, অবিনাশি, কবিকৌতূহলম্, প্ৰশস্তিমূলককাব্য, ব্যঞ্জনাপ্ৰপঞ্চসমীক্ষা, অনূদিতকাব্য

COURSE TITLE: INTRODUCTION TO ETHICS

UNIT 1: NATURE AND SCOPE OF ETHICS

Definition of Ethics, Nature of Ethics, Scope of Ethics

UNIT 2: THE CONCEPT OF MORALITY

Definition of Morality, the Nature of Morality, Different Moral

Concepts, Moral Theory,

UNIT 3: FACT AND VALUE

What is fact, what is value, Classification of values, Distinction between fact and value

UNIT4: MORAL CONCEPTS:

Good, Right, Duty, Virtue.

UNIT 5: FREEDOM AND DETERMINISM

Determinism: Its Meaning, Arguments in Support of Determinism, What is Freedom or Free Will, Arguments In Support of Free Will, Brief Note On Predestination, Fatalism and Scientific Determinis, The Case Of Freedom and Determinism,

UNIT 6: PURUSARTHA

Learning Objectives, Introduction, Artha, Kama Dharma, Moks. a, Four Basic Sciences,

UNIT 7: THEORIES OF PUNISHMENT

Notion of Crime and Punishment, Theories of Punishment, Deterrent Theory, Reformative Theory, Retributive Theory, Capital Punishment.

COURSE TITLE: TRADITIONAL MEDIA

UNIT 1: TRADITIONAL FOLK MEDIA

Traditional folk media – an introduction, Nature of traditional folk media, Communication through traditional folk media, Traditional media as part of socio-cultural and ritual communication

Unit 2: FEATURES OF TRADITIONAL FOLK MEDIA

Traditional media as a mass medium, Features and characteristics of traditional media –its advantages and disadvantages, Storytelling as the core of traditional media

Unit 3: TRADITIONAL MEDIA IN INDIA

History and growth of traditional media in India- a brief overview of some of the traditional folk media forms of India, Applications of traditional media for development purposes

Unit 4: TECHNOLOGICAL IMPLICATIONS ON TRADITIONAL FOLK MEDIA

Impact of electronic media on traditional media, Mass communication media vis-à-vis folk culture, success stories of the use of traditional media as a catalyst of social change and development

Unit 5: TRADITIONAL MEDIA FOR DEVELOPMENT COMMUNICATION

Development communication and traditional mediadevelopment communication, traditional media as development media

Unit 6: TRADITIONAL FOLK MEDIA AND INDIAN CULTURE

Features of folk tradition- role of traditional media, Media for communicating social ethos- traditional media and social ethos, modern mass media and social ethos, Folk media as a platform for disseminating information about Indian culture

Unit 7: RELEVANCE OF TRADITONAL FOLK MEDIA

Traditional folk forms in rural India – Folk Theatre, Folksongs, Narrative forms, Religious discourse, puppet show, Impact on rural development, uses in different fields

SEMESTER-II

SYLLABUS OF VALUE ADDED COURSES (VAC)

COURSE TITLE: ADVERTISING STRATEGY

UNIT 1: ADVERTISING- BASIC CONCEPTS

Concepts of advertising, objectives and scope of advertising, social and ethical implications of advertising, types of advertising, advertising as an industry

UNIT 2: IMC AND ADVERTISING

IMC; advertising as a communication process; communication models; AIDA model and its purpose; the changing marketing environment

UNIT 3: DEVELOPING EFFECTIVE PROMOTION

Identifying the target audience, determining the promotional objectives, designing the promotion and selecting the channel, push vs. pull strategy, establishing the promotional budget and implementing promotional strategy

UNIT4: MANAGING ADVERTISING I

Developing and managing advertising program, Setting advertising objectives, DAGMAR, Deciding on advertising budget.

UNIT 5: MANAGING ADVERTISING II

Developing the advertising message, role of music and humor in advertising, factors considered while developing the advertising copy, creativity in advertising,

UNIT 6: MEDIA STRATEGIES

Media planning and objectives, deciding on media, different types of media and their advantages and disadvantages, choosing among major media types, media schedule decisions, space and time buying

UNIT 7: EVALUATING ADVERTISING EFFECTIVENESS

Deciding on reach, frequency and impact; Copy testing, advertising recognition and recall tests, Issues in assessing impact of advertising, measuring the performance of an advertising agency

COURSE TITLE: LIFE SKILLS

UNIT 1: LISTENING AND SPEAKING

Effective Listening and Speaking, Listening and Comprehension, Probing Questions and Their Importance in Listening and Speaking, Barriers to Effective Listening, Pronunciation and Its Importance, Enunciation and Its Importance, Vocabulary and Its Role in Effective Listening and Speaking, Fluency and Its Importance in Speaking and Common Errors in Listening and Speaking

UNIT 2: READING, WRITING AND DIFFERNT MODES OF WRITING

Steps in the Process of Reading,Meaning of Writing,Techniques of Effective Writing, Different Modes of Writing and Common Uses of Writing

UNIT 3: DIGITAL LITERACY AND SOCIAL MEDIA, DIGITAL ETHICS AND CYBER SECURITY

Microsoft Office Suite Proficiency, Virtual Communication Platforms, Cybersecurity Awareness, Digital Ethics and Etiquette

UNIT 4: NONVERBAL COMMUNICATION

Meaning of Verbal and Nonverbal Communication, Functions of Nonverbal Communication, Purposes of Using Nonverbal Communication, Types of Nonverbal Communication, Examples of Different Nonverbal Communications, Advantages and Disadvantages of Nonverbal Communication, Importance of Nonverbal Communication

UNIT 5: GROUP DISCUSSION SKILLS AND INTERVIEW SKILLS

Meaning of Group Discussion and Interview, Objectives of Group Discussion, Types of Group Discussion, Importance of Group Discussion,Way to Conduct a Group Discussion, Process of Group Discussion, Essential Skills for Group Discussion, Interview, Interview Skill

UNIT 6: EXPLORING CAREER OPPORTUNITIES AND RÉSUMÉ SKILLS

Knowing Yourself while Looking for a Job, Need for the Right Job or Employment, Career Information: Sources and Availability of Career Opportunities, What is a Résumé? Components of a Good Résumé, Difference between a Résumé, CV and Biodata

UNIT 7: COGNITIVE AND NON-COGNITIVE SKILLS, PRESENTATION SKILLS AND LISTENING SKILLS

Meaning of Skills, Meaning of Cognitive and Non-Cognitive Skills, Meaning of Presentation Skills, Meaning of Listening Skills

UNIT 8: TRUST AND COLLABORATION, BRAINSTORMING, SOCIAL AND CULTURAL ETIQUETTES AND INTERNAL COMMUNICATION

Meaning of Teamwork and Collaboration, Trust and Collaboration, Brainstorming, Social and Cultural Etiquettes

UNIT 9: LEADERSHIPSKILLS, INNOVATIVE LEADERSHIP AND DESIGN THINKING

Leadership: Meaning and Importance, Characteristics and Theories of Leadership, Leadership styles, Basic Leadership Skills, Innovative Leadership , Concept of Emotional and Social intelligence, Leaders in the Era of Globalisation, Design Thinking

UNIT 10: MANAGERIAL SKILLS

Basic Managerial Skills, Managing Conflict, Types of Conflict and their Management, Resolving Conflict Through Negotiation, Self-Management Skills, Understanding Self-Concept, Self-management, Managing Personal Finance.

UNIT 11: ENTREPRENEURSHIP SKILLS, ETHICS AND INTEGRITY

Basics of Entrepreneurship, Classification and Types of Entrepreneurships, Traits and Competencies of Entrepreneur, creating Business Plan, Ethics and Conduct, Importance of Ethics, Personal and Professional Moral Codes of Conduct.

UNIT 12: LOVE AND COMPASSION; TRUTH AND NONVIOLENCE

Love and Compassion, Truth and Nonviolence, Gandhian Nonviolence.

UNIT 13: PEACE, SERVICE, RENUNCIATION

Peace and Indian Schools of Thoughts, Peace and Human values, Peace and Conflict, Service and Renunciation, Altruistic and Egoistic Actions, Non-attached Actions and Niskama Karma, Pravritti and Nivritti, Niskama Karma and Renunciation.

UNIT 14: CONSTITUTIONAL VALUES, JUSTICE AND HUMAN RIGHTS, RIGHTEOUSNESS

Righteousness, Dharma and Propriety, Justice, Liberty, Equality, Human Dignity and Fraternity, Fundamental Rights of Indian Citizens, Fundamental Duties of Indian Citizen.

SEMESTER-III

SYLLABUS OF ABILITY ENHANCEMENT COURSES (AEC)

COURSE TITLE: CYBER SECURITY

UNIT 1: CYBER SECURITY: NAVIGATING CYBERSPACE

Cyber security increasing threat landscape, Cyber security terminologies Cyberspace, attack,attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism.

UNIT 2: CYBERSECURITY: NATIONAL INFRASTRUCTURE

Protection of end user machine, Critical IT and National Critical Infrastructure, Cyber warfare, Case Studies.

UNIT 3: CYBER CRIMES 1

Cybercrimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logicbombs, DoS, DDoS, APTs, virus, Trojans, ransomware, data breach.

UNIT 4: CYBER CRIMES 2

Online scams and fraudsemail scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/ credit card fraud, Online payment fraud.

UNIT 5: CYBER CRIMES 3

Cyberbullying, website defacement, Cyber-squatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking.

UNIT 6: SOCIAL MEDIA SCAMS & FRAUDS

Social Media Scams & Frauds- impersonation, identity theft, job scams, misinformation, fake News cybercrime against persons - cyber grooming, child pornography, cyber stalking.

UNIT 7: SOCIAL ENGINEERING ATTACKS

Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies.

UNIT 8: CYBER CRIME AND LEGAL LANDSCAPE 1

Cybercrime and legal landscape around the world, IT Act, 2000 and its amendments. Limitations of IT Act, 2000.

UNIT 9: CYBER CRIME AND LEGAL LANDSCAPE 2

Cybercrime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and Social media.

UNIT 10: CYBER LAWS AND CASE STUDIES

Cyber Laws of other countries, Case Studies.

UNIT 11: DATA PRIVACY AND DATA SECURITY 1

Defining data, meta-data, big data, non-personal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges.

UNIT 12: DATA PRIVACY AND DATA SECURITY 2

Data protection regulations of other countries- General Data Protection Regulations(GDPR),2016 Personal Information Protection and Electronic Documents Act (PIPEDA)., Social media- data privacy and security issues.

UNIT 13: CYBER SECURITY MANAGEMENT 249-276

Cyber security Plan- cyber security policy, cyber crises management plan, Business continuity, Risk assessment.

UNIT 14: CYBER SECURITY COMPLIANCE AND GOVERNANCE

Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy.

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