**Detailed Syllabus**
**Lecture-wise Breakup**

| | | | |
|---|---|---|---|
| **Course Code** | 19M21PH217 | **Semester:** Even | **Semester:** IV **Session:** 2022-2023<br>**Month from:** January to June |
| **Course Name** | Fiber Optics | | |
| **Credits** | 3 | **Contact Hours** | 3 |

| | | |
|---|---|---|
| **Faculty (Names)** | **Coordinator** | Navneet Kumar Sharma |
| | **Teacher** | Navneet Kumar Sharma |

| **COURSE OUTCOMES** | | **COGNITIVE LEVELS** |
|---|---|---|
| **C230-6.1** | Recall optical fiber types, design and basic characteristics; Electromagnetic (modal) analysis of step index multimode fibers | Remembering (C1) |
| **C230-6.2** | Explain splices, connectors and fiber cable; Loss mechanism in optical fiber; Pulse propagation, dispersion and chirping in single mode fibers | Understanding (C2) |
| **C230-6.3** | Apply concepts of stimulated Raman scattering, stimulated Brillouin Scattering; Self phase modulation and cross phase modulation | Applying (C3) |
| **C230-6.4** | Analyze optical fiber sensors | Analyzing (C4) |

| **Module No.** | **Title of the Module** | **Topics in the Module** | **No. of Lectures for the module** |
|---|---|---|---|
| **1.** | Science of Fiber Optics | Introduction and importance of fiber optics technology, Wave propagation in Planer waveguide and cylindrical waveguides, Review of optical fiber types, design, numerical aperture and basic characteristics; Ray analysis of optical fiber, Electromagnetic (modal) analysis of step index multimode fibers, Hybrid and linearly polarized modes, Power confinement and mode cut off, Mode field diameter. | 12 |
| **2.** | Experimental Techniques | Fiber fabrication and characterization, splices, connectors and fiber cable. Loss mechanism in optical fiber. Pulse propagation, Dispersion and chirping in single mode fibers, Dispersion-compensation mechanism, Dispersion-tailored and dispersion-compensating fibers, Fiber birefringence and polarization mode dispersion, Fiber bandwidth. | 12 |
| **3.** | Nonlinear effects in optical fiber | Stimulated Raman scattering, stimulated Brillouin scattering, self phase modulation, cross phase modulation, optical solitons. | 8 |
| **4.** | Fiber based devices | Optical fiber sensors: Intensity modulated sensors, Phase modulated sensors, Spectrally modulated sensors, Optical temperature Sensor, Mach-Zehnder interferometer. Photonic crystal fibers. | 8 |
| | | **Total number of Lectures** | **40** |

**Evaluation Criteria**

| **Components** | **Maximum Marks** |
|---|---|
| T1 | 20 |
| T2 | 20 |

| | |
|---|---|
| End Semester Examination | 35 |
| TA | 25 [Attendance (05 M), Class Test, Quizzes, etc (06 M), Assignments in PBL mode (10 M), and Internal assessment (04 M)] |
| **Total** | **100** |

| **Recommended Reading material:** Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format) | |
|---|---|
| **1.** | Fundamentals of Photonics – B. E. A. Saleh and M. C. Teich, wiley, 2nd edition. |
| **2.** | Principles of Optics - M. Born and E. Wolf , Cambridge university press, 7th edition. |
| **3.** | Optical Electronics - A.Ghatak and K.Thyagarajan, Cambridge university press. |
| **4.** | Optical Fiber Communications: principles and practice – John M.Senior, Pearson Education, 3rd edition. |
| **5.** | Electronic Communications – D. Roddy and J. Coolen, Pearson Education, 4th edition. |

**Project based learning:** Each student will opt a topic and will do the theoretical study in detail. The students will submit their report. The students analyze the fiber fabrication and characterization, loss mechanisms in optical fiber, optical solitons, optical fiber sensors and photonic crystal fibers. This shall improve the skills and employability of the students in optical fiber industries.

## Detailed Syllabus

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|---|---|---|---|
| **Course Code** | 19M27PH211 | **Semester: EVEN** | **Semester:** 4th **Session: 2022-23**<br>**Month from:** Jan to June |
| **Course Name** | Dissertation | | |
| **Credits** | 10 | **Contact Hours** | 20 |
| **Faculty (Names)** | **Coordinator(s)** | Manoj Kumar | |
| | **Teacher(s) (Alphabetically)** | Anirban Pathak, Navneet Sharma, Papia Chowdhury, Sandeep Mishra | |

| **COURSE OUTCOMES** | | **COGNITIVE LEVELS** |
|---|---|---|
| **C250.1** | Review the contemporary scholarly literature, activities, and explore experimental and theoretical tools/ techniques/software/hardware for hands-on in the respective project area in various domain of theoretical and experimental condensed matter and applied optics. | Understanding (C2) |
| **C250.2** | Acquire knowledge in the selected field of study. Analyze various feasible methods/techniques of solving a problem to slot a appropriate solution methodology | Analyzing (C4) |
| **C250.3** | Employ latest techniques and software tools to accomplish the proposed objectives. Evaluate/validate obtained results based on evidence and analysis. | Evaluating (C5) |
| **C250.4** | Demonstrate the technical report writing and oral communication skills. Illustrate the significance of possible future developments in the selected field. | Create Level (C6) |

| **S.N.** | **Topics in module** |
|---|---|
| Module 1 | Identification of the dissertation problem and literature review in the related field and explore experimental and theoretical tools/ techniques/software/hardware. |
| Module 2 | Acquire knowledge and analyze various methods/techniques to be used in solving the defined problem and find a suitable methodology. |

| | |
|---|---|
| Module 3 | Utilize latest techniques/software/hardware tools to achieve the proposed objectives and obtain results. Evaluation/analysis of the obtained results and their interpretation. |
| Module 4 | Compilation of the results and report writing with ethics (plagiarism less than 10%) and presentation of the dissertation work. |

| **Evaluation Criteria** | |
|---|---|
| **Components** | **Maximum Marks** |
| Day to Day Evaluation | 40 (To be awarded by supervisor) |
| End Semester Evaluation | 50 (To be awarded by a panel of 3 examiners) |
| Special Contribution | 10 (To be awarded by a panel of 3 examiners) |
| **Total** | **100** |

**CO-PO and CO-PSO Mapping:**

| COs | PO1 | PO2 | PO3 | PSO1 |
|---|---|---|---|---|
| **C250.1** | 1 | 3 | | 3 |
| **C250.2** | 1 | 3 | | 3 |
| **C250.3** | 1 | 3 | | 3 |
| **C250.4** | | | 3 | |
| **C250** | 1 | 3 | 3 | 3 |

**Detailed Syllabus**

**Lecture-wise Breakup**

| | | | |
|---|---|---|---|
| **Course Code** | 20M22PH220 | **Semester: Even** | **Semester: 4th Session 2022-23**<br>**Month from: Jan to June** |
| **Course Name** | Optical and Quantum Computing | | |
| **Credits** | **3** | **Contact Hours** | **3** |

**Faculty (Names)** **Coordinator** Dr. Sandeep Mishra

**Teacher** Dr. Sandeep Mishra

| **COURSE OUTCOMES** | | **COGNITIVE LEVELS** |
|---|---|---|
| **CO1** | Recall basicphysics and mathematics behind computation | Remembering (C1) |
| **CO2** | Explain computation as a physical process | Understanding (C2) |
| **CO3** | Apply optical elements and laws of optics and quantum mechanics to perform computation tasks | Applying (C3) |
| **CO4** | Analyze complex problems related to optical and quantum computing using optical and quantum resources | Analyzing (C4) |

| **Module No.** | **Title of the Module** | **Topics in the Module** | **No. of Lectures for the module** |
|---|---|---|---|
| **1.** | **Introduction to computing** | History of computation, status and future prospects; Basic ideas of information theory and complexity classes; Shannon entropy;Information as a physical quantity and physical world from the perspective of information theory; bits and qubits; limitations of traditional semiconductor-based computers and different alternative strategies with specific attention to optical and quantum approaches to computation; Basic Operation of Optics for Computing and the possible architectures of optical computers | 5 |
| **2.** | **Mathematical preliminaries** | Essential linear algebra; partial transpose; partial trace; Gram-Schmidt procedure, etc.; discrete Fourier transform; Fourier transform property of lens | 5 |
| **3.** | **Optical computing** | Logical and arithmetic computation (including addition, subtraction, multiplication, averaging, vector-matrix multiplication, etc.) using photons; Digital optical computing: devices used and basic ideas and applications of polarization-encoded optical shadow-casting scheme; Optical storage and switches; SLM and its applications in optical computing | 10 |
| **4.** | **Quantum computation and** | Non-locality and entanglement: their generation, characterization and measures; linear and nonlinearoptical | 15 |

| | | | |
|---|---|---|---|
| | **quantum communication** | components used in computing; quantum gates and circuits and how to implement a quantum/classical gate using linear and nonlinear optical devices; teleportation, superdense coding, quantum algorithms;quantum cryptography; quantum error correcting codes; practical quantum computers (including quantum computers in cloud) | |
| **5.** | **Optical realizations and challenges** | Optical realization of classical and quantum computing devices, KLM approach, present challenges and future opportunities | 5 |
| | | **Total number of Lectures** | **40** |

**Evaluation Criteria**

| **Components** | **Maximum Marks** |
|---|---|
| T1 | 20 |
| T2 | 20 |
| End Semester Examination | 35 |
| TA | 25 [2 Quiz (6 M), Internal assessment (4 M), Attendance (5 M) |
| and PBL (10 M)] | |
| **Total** | **100** |

**Project Based learning:** The students will be given some minor projects to work in group of two students on different aspects of Optical and Quantum computing. The idea it to encourage the students to learn the techniques of quantum commutation for real life applications. IBM quantum experience have put some 5-qubit quantum computers on cloud and students can access them to run their quantum circuits. Such projects will help the students in development of their own circuits for practical applications. Students can also gain some experience of quantum cryptography by working on BB84 protocol set up located at quantum cryptography lab of the institute. Further, students will be encouraged to understand and develop techniques via which the current quantum technologies can be used for solving real life problems.

**Recommended Reading material:** Author(s), Title, Edition, Publisher, Year of Publication etc. ( Text books, Reference Books, Journals, Reports, Websites etc. in the IEEE format)


| | |
|---|---|
| **1.** | X Li, Z Shao, M Zhu, and J Yang, Fundamentals of Optical Computing Technology, Springer, Singapore 2018ISBN 978-981-10-3847-1 |
| **2.** | P Kok and B W Lovett, Optical Quantum Information Processing, Cambridge University Press, Cambridge, 2010 ISBN 978-0-521-51914-4 |
| **3.** | M A Karim and Abdul A S Awwal, Optical Computing an Introduction, Wiley, Singapore, 2003 |
| **4.** | A Pathak, Elements of Quantum Computation and Quantum Communication, Boca Raton, CRC Press, 2015 |
| **5.** | M A Nielsen and I Chuang, Quantum computation and quantum information, Cambridge University Press, Cambridge, 2010 |
| **6** | R P Feynman, Feynman's Lectures on Computing, CRC Press, Boca Raton, 2018 |


**CO-PO MAPPING:**

| COs | PO1 | PO2 | PO3 | PSO1 |
|---|---|---|---|---|
| CO1 | 2 | 2 | | 1 |
| CO2 | 3 | 3 | | 3 |
| CO3 | 2 | 3 | | 3 |
| CO4 | 2 | 3 | | 3 |

**3: Strongly Related 2: Moderately Related 1: Weakly related Left Blank: Not related**

## Department of Physics and Materials Science and Engineering

## AY: 2022-23 (Even Semester)

## Course Opening Report

**Programme Name: M.Sc. Physics**
**Semester: 4th**
**Course Name & Code: Optical and Quantum Computing (20M22PH220)**
**NBA code: C231-6**

**1. Course Outcomes:** At the completion of the course, students will be able to,

| S.N. | DESCRIPTION | COGNITIVE LEVEL |
|---|---|---|
| **CO1** | Recall basic physics and mathematics behind computation | Remembering (C1) |
| **CO2** | Explain computation as a physical process | Understanding (C2) |
| **CO3** | Apply optical elements and laws of optics and quantum mechanics to perform computation tasks | Applying (C3) |
| **CO4** | Analyze complex problems related to optical and quantum computing using optical and quantum resources | Analyzing (C4) |

**2. CO-PO-PSO Mapping:**

| COs | PO1 | PO2 | PO3 | PSO1 |
|---|---|---|---|---|
| C231-6.1 | 2 | 2 | | 1 |
| C231-6.2 | 3 | 3 | | 3 |
| C231-6.3 | 2 | 3 | | 3 |
| C231-6.4 | 2 | 3 | | 3 |

**3. Identified gaps in Syllabus/ Course Description (If Any):**

| Topics to be introduced | Strengthens CO | Strengthens PO, PSO | Method of Identification |
|---|---|---|---|
| None | | | |
| | | | |

**4. Modifications in Syllabus/ Course Description (If Any):**

| Details of Modification (Addition/ Removal) | Justification | Strengthens POs/PSOs |
|---|---|---|
| None | | |
| | | |

**5. Actions for Improving CO Attainments:** None

**6. Innovative Teaching and Learning Method to be used:** Assignments will be given on topic of advance development in the field of Quantum Computing and open discussion session will be held for further understanding of these topics. We will utilize Online education platform such as IBM Quantum research.

**7. Strategies for**

**Strategies for**

- **Weak Learners:**

| SNo. | Strategy | Expected Outcomes | Documents to be produced |
|---|---|---|---|
| 1 | Extra study material and questions will be given for weak learners to practice. | Weak learners will be able to develop a better understanding and perform better. | Tutorials |

- **Bright Students:**

| SNo. | Strategy | Expected Outcomes | Documents to be produced |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1. | Students will be given related research papers and will be asked to go through and present the important points of research articles. | Bright students will develop the presentation skills about research articles and project development skills. | Project/assignment report |

**8. Innovative Evaluation Strategy to be used:** Regular assessment of students throughout the semester in the form of quiz, tutorials, assignments and open discussion. We will also utilize Online evaluation plateform G-forms, Quizes.

**Signature:**

**Module Coordinator:Dr Manoj Tripathi**

**Signature:**

**Course Coordinator: Dr. Sandeep Mishra**