<table>
<tr><td>Course Title</td><td colspan="2">Introduction to Quantum Materials and Devices</td><td>Course No
(to be assigned by Academic Cell)</td><td colspan="4">PHY5XXXX</td></tr>
<tr><td rowspan="2">Department/ Specialization</td><td colspan="2" rowspan="2">Physics</td><td rowspan="2">Credits</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>Offered for</td><td colspan="2">UG (higher semester)/PG/DD</td><td>Status</td><td colspan="2">Core</td><td colspan="2">Elective √</td></tr>
<tr><td>Faculty proposing the course</td><td colspan="2">Dr. Manjusha Battabyal</td><td>Type</td><td colspan="2">New √</td><td colspan="2">Revision</td></tr>
<tr><td colspan="3">Recommendation from the DAC: Recommended</td><td colspan="5">Date of DAC: 11.02.2025</td></tr>
<tr><td>External Expert(s)</td><td colspan="7">1. Prof K Sethupathi, IIT Madras; 2. Prof Pranaba K Muduli, IIT Delhi</td></tr>
<tr><td>Learning objectives</td><td colspan="7">➢ To expose the students for practical understanding on various quantum materials.
➢ The course will focus on various quantum materials, quantum devices, and quantum transport phenomena.</td></tr>
<tr><td>Learning outcomes</td><td colspan="7">➢ The students can understand quantum principles, can identify the quantum materials and analyze their properties.
➢ The students can describe the role of quantum phenomena, such as superconductivity, topological states, and quantum coherence, in the functionality of materials and devices.
➢ The students will be able to apply principles of quantum materials to design and conceptualize quantum devices for applications in computing, sensing, and energy technologies.</td></tr>
<tr><td>Contents of the course (with approximate break up of hours)</td><td colspan="7">Quantum mechanics- fundamentals, Heisenberg Uncertainty Principle, Quantization and the Concept of Spin, Wave-particle duality - the quantum harmonic oscillator, Quantum LC circuit, quantisation of electromagnetic fields (6L+1T)
Quantum Materials: Materials in low dimensional state, density of states, quantum wells and heterostructures, quantum wires, quantum dots, nanocrystals, sprintronic-materials, practical (experiment) on synthesis protocol of quantum dots (12L+4T).
Properties: Optical properties, absorption, luminescence, tunneling processes in low-dimensional semiconductors, quantum conductance, quantum memory, quantum-well lasers. superconductivity (Cooper-pairs, the Josephson effect, flux quantisation) sprintronic properties of the materials (14L+5T).
Quantum devices: Single-electron transistor (SET), calculation and fabrication methods, analyses techniques; Quantum optoelectronic devices, Quantum devices at ultra-low temperatures, candidates for quantum computers, Superconducting qubit, basics of superconducting quantum computers (10L+4T).</td></tr>
<tr><td>Text books</td><td colspan="7">1. Debdeep Jena, Quantum Physics of Semiconductor Materials and Devices (Oxford University Press, Oxford, 2022) ISBN: 9780198856856

2. J Paglione, N P Butch, E E Rodriguez, Fundamentals of Quantum Materials, (World Scientific publisher, 2021) , ISBN: 978-981-12-1936-8</td></tr>
<tr><td>Reference books</td><td colspan="7">1. David Ferry, Quantum Mechanics An Introduction for Device Physicists and Electrical Engineers, CRC Press, 2020, ISBN 9780367467272

2. Mohamed Henini, Marcelo Oliveira Rodrigues, Quantum Materials, Devices, and Applications, 2022, Elsevier Publisher, ISBN-9780128205662</td></tr>
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