<u>**Detailed Syllabus**</u>

Lecture-wise Breakup

Course Code	19M21PH216	**Semester:** Even	**Semester: 4th Session:** 2020-2021 **Month from:** July-December
Course Name	Advanced Condensed Matter Physics-2		
Credits	03	**Contact Hours**	03
Faculty (Names)	**Coordinator**		
	Teacher		

COURSE OUTCOMES		**COGNITIVE LEVELS**
C230-5.1	Understand the Physics behind the defects in materials	Remember Level (C1)
C230-5.2	Understand the role of defects in determining properties of materials	Understand Level (C2)
C230-5.3	Develop knowledge of conception or notion involved in various theories and models studied in this course	Apply Level (C3)
C230-5.4	Applying various experimental method/tools to understand the defects in solids	Apply level (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Defects and Diffusion in solids	Introduction to Defects. Equilibrium Point defects, Vacancy Formation, Vacancy Concentration Determination, Self-Interstitial Defects, Frenkel Defects, Extrinsic Defects, Equilibrium Concentration of Defects, Thermodynamics of Defects, Interstitial Diffusion. Non-Steady State Diffusion, Self Diffusion,, Diffusion Along Defects	12
2.	Extended Defects	Dislocations, Edge Dislocations, Mixed Dislocations, unit and Partial Disclocations, Multiplications of Dislocations, Interaction of Dislocations and Point Defects: Dislocations Loops, Dislocation climb, Decoration of Dislocation, Internal Boundaries, Low angle Boundaries, Twin Boundaries, Antiphase Boundaries	12
3.	Defects Dynamics	Dislocation in FCC, HCP and BCC, Partial Dislocation, Stacking Fault, Burger Vector and its properties	8
4.	Observation of Defects in Solids	Experimental method of detecting dislocations and stacking faults, Electron Microscopy: Kinematical theory of diffract ion contrast and lattice imaging.	8
		Total number of Lectures	**40**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 [2 Quiz (7 M), Attendance (7 M) and A mini-project and class performance (6 M) and class performance (5M)]
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.	chard J. D. Tilley, "Defects in Solids", John Wiley & Sons, Inc.
2	Weertman J. and Weertman J. R. "Elementary Dislocation Theory"
3	Anderson P.M. , Hirth J.P., Lothe J., "Theory of Dislocations" 3rd Edition
4	Hirsch, P.B., "Electron Microscopy of Thin Crystals"

Detailed Syllabus
Lecture-wise Breakup

Course Code	19M21PH217	**Semester:** Even	**Semester:** IV **Session:** 2020-2021 **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**
CO1	Recall optical fiber types, design and basic characteristics; Electromagnetic (modal) analysis of step index multimode fibers	Remembering (C1)
CO2	Explain splices, connectors and fiber cable; Loss mechanism in optical fiber; Pulse propagation, dispersion and chirping in single mode fibers	Understanding (C2)
CO3	Apply concepts of stimulated Raman scattering, stimulated Brillouin Scattering; Self phase modulation and cross phase modulation	Applying (C3)
CO4	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 [2 Quiz (7 M), Attendance (7 M) and A mini-project and class performance (6 M) and class performance (5M)]
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.	An Introduction to Fiber Optics - A. K. Ghatak and K. Thyagarajan, Cambridge university Press.
2.	Fiber Optic Communication Systems - G. P. Agarwal, John Wiley Sons, 1997.
3.	Optical Fiber Communications: principles and practice – John M. Senior, Pearson Education, 3rd edition.
4.	Fiber Optics and Optoelectronics - R. P. Khare, Oxford University Press.
5.	Fundamentals of Photonics – B. E. A. Saleh and M. C. Teich, wiley, 2nd edition.

Detailed Syllabus
Lecture-wise Breakup

Course Code	20M22PH215		**Semester: Odd**		**Semester 4th Session 2020-21** **Month from: Jan to June**
Course Name	Introduction to Nanoscience				
Credits	3			**Contact Hours**	3
Faculty (Names)	**Coordinator**				
	Teacher				

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Recall basics of nanoscience and nanomaterials	Remembering (C1)
CO2	Explain various physical phenomena under the domain of nanoscience	Understanding (C2)
CO3	Apply the concept and principles to solve problems related to nanoscience	Applying (C3)
CO4	Analyze and examine the concepts of nanoscience and nanomaterials for application-oriented outcomes	Analyzing (C4)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	**Introduction to nanoscience**	Development of nanoscience and nanotechnology, naturally occurring nanomaterials, Introduction to Quantum Mechanics (with relevance to nanotechnology), Electron confinement using Schrodinger wave equation, Particle confinement in 1-D, 2-D, 3-D box, Density of states. Potential barrier and Particle tunneling; Its applications	6
2.	**Properties of nanomaterials**	Classification of nanomaterials, Bulk to Nano, Surface to volume ratio, Surface states and energy (Reactivity and fluctuations), Semiconducting nanoparticles (optical properties), Metallic nanoparticles (surface plasmons), Magnetic nanoparticles (superparamagnetism/nanomagnetism), Mechanical properties of nanomaterials, Chemical Properties of Nanomaterials (Reactivity etc.)	8
3.	Synthesis of nanomaterials	Top to Bottom approach and Vice Versa, Nucleation and Growth, Physical Methods, Mechanical Methods (Ball milling and Melt Method), Evaporative methods, CVD and Sputtering, Epitaxial Growth, Chemical Methods (Sol Gel, precipitation, Hydrothermal, Spray), Langmuir-Blodget Method	10
4.	Some special nanomaterials	Carbon nanomaterials (Fullerenes, CNT and Graphene), Nanomagnetism, Superconducting nanomaterials, Solar materials, Sensing Materials, High mobility and 2-D electron gas materials, Metal- Organic Framework, Porous Materials, Core-Shell Materials,	10
5.	**Applications of**	Energy Applications, Si-based solar cells, DSSC, Hydrogen	6

	nanomaterials	Storage, Battery and Fuel cells, Photo detector, Quantum well nanostructures for LEDs, GaN and its Applications, Environmental and Agricultural Medical, space, food and others	
Total number of Lectures			**40**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 [2 Quiz (7 M), Attendance (7 M) and A mini-project and class performance (6 M) and class performance (5M)]
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.	Nanostructures and nanomaterials: synthesis properties and application, Guozhong Cao, Imperial college press, London.
2.	Introduction to nanotechnology, Charles Poole et al J John Wiley & Sons, Singapore.
3.	Nanotechnology: Principles and Practises by Sulbha Kulkarni 3rd edition Springer

Detailed Syllabus
Lecture-wise Breakup

Course Code	20M22PH216	**Semester: Even**	**Semester** IV **Even Sem 2021** **Month: January to June**
Course Name	Design and Fabrication of Solar Cells		
Credits	3	**Contact Hours**	3
Faculty (Names)	**Coordinator(s)**	Dr. B. C. Joshi	
	Teacher(s)	Dr. B. C. Joshi,	

COURSE OUTCOMES		**COGNITIVE LEVELS**
CO1	Classify the various type of renewable and non-renewable energy resources and explain working of photovoltaic device.	Understand Level (Level 2)
CO2	Demonstrate the basic principles to design, model and fabricate photovoltaic devices.	Understand Level (Level 2)
CO3	Identify challenges and apply strategies to optimize performance of various type of solar cells	Apply Level (Level 3)
CO4	Analyze Solar PV module, mismatch parameter and rating of PV module	Analyze Level (Level 4)
CO5	Evaluate the performance of various stand-alone PV systems with battery and AC and DC load	Evaluate Level (Level 5)

Module No.	**Title of the Module**	**Topics in the Module**	**No. of Lectures for the module**
1.	Review	Energy issues, conventional energy sources, Renewable energy sources, Solar Energy	02
2.	Solar cell fundamentals	Semiconductor materials, carriers generation and recombination, p-n junction diode, p-n junction under illumination, Current-Voltage (I-V), open circuit voltage (V_{OC}), short circuit current (I_{SC}) Maximum power, current and voltage and Efficiency, Quantum Efficiency	08
3.	Solar cell Design and Technologies	Upper limits of cell parameters, loses in solar cell, solar cell design, design for high I_{sc}, V_{oc}, FF, Production of Si, Si wafer based solar cell technology, thin film solar cell technologies (CIGS, microcrystalline and polycrystalline Si solar cells, amorphous Si thin film solar cells), multijunction solar cells, Emerging solar cell technologies: organics solar cells, Dye-sensitized solar cell (DSC), GaAs solar cell	12
4.	Fabrication and characterization of solar cells	Fabrication of Si solar cells: Surface preparation, texturization, diffusion, etching, cleaning, oxide passivation, metal print, back contact print, firing/sintering, testing, Characterization: Solar Simulators and Quantum Efficiency measurement	10
5.	Solar Photovoltaic Applications	Solar Photovoltaic Modules, Series/parallel connection, mismatch, bypass diode, Effect of temperature, Balance of system- BOS (Inverters, Controllers, Wiring, Batteries), Photovoltaic system, Standalone system, Grid connected system, Hybrid system, Designing of PV system, Estimating PV system size and cost, Photovoltaic safety.	08

Total number of Lectures	**40**

Evaluation Criteria

Components	**Maximum Marks**
T1	20
T2	20
End Semester Examination	35
TA	25 [2 Quiz (7 M), Attendance (7 M) and A mini-project and class performance (6 M) and class performance (5M)]
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.	Tom Markvart and Luis Castaner, "Solar Cells: Materials, Manufacture and Operations," Elsevier, 2006
2.	Stuart R. Wenhem, Martin A. Green, M.E. Watt, "Applied Photovoltaics," Earthscan, 2007
3.	Jenny Nelson, "The Physics of Solar Cells" Imperial college press," Aatec publications, 1995.
4.	C S Solanki, "Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI, 2015
5.	Richard J. Komp "Practical Photovoltaics: Electricity from Solar Cells", Aatec Publications, 1990

Detailed Syllabus
Lecture-wise Breakup

Course Code	20M22PH220	**Semester: Even**		**Semester: 4th Session 2021-22** **Month from: Jan to June**
Course Name	Optical and Quantum Computing			
Credits	3		**Contact Hours**	3
Faculty (Names)	**Coordinator**	Anirban Pathak		
	Teacher	Anirban Pathak		

COURSE OUTCOMES		**COGNITIVE LEVELS**
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)

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**	Non-locality and entanglement: their generation, characterization and measures; linear and nonlinear optical	15

	computation and 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 (7 M), Attendance (7 M) and A mini-project and class performance (6 M) and class performance (5M)]
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.	X Li, Z Shao, M Zhu, and J Yang, Fundamentals of Optical Computing Technology, Springer, Singapore 2018 ISBN 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 A 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

Detailed Syllabus

Course Code	19M27PH211	Semester: EVEN	Semester: 4th Session: 2020-2021 Month from: Jan to June
Course Name	Dissertation		
Credits	10	**Contact Hours**	20
Faculty (Names)	**Coordinator(s)**	Manoj Kumar	
	Teacher(s) (Alphabetically)	Anirban Pathak, Ashish Bhatnagar, Dinesh Tripathi, N K Sharma, R K Dwivedi	

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 and Designing (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 Term 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**