ISLAMIC UNIVERSITY OF SEICENCE & TECHNOLOGY
AWANTIPORA, KASHMIR

DEPARTMENT OF PHYSICS

Ph. D

Coursework Syllabus

(Approved in BORS Meetings held on 24-08-2021 & 06-11-2023)

Department of Physics

Islamic University of Science and Technology

Overview of the Course Scheme for Ph. D Programme

As per the university ordinance and new guidelines, the research scholars who are provisionally registered under the Ph. D programme will have to undergo a pre-Ph. D coursework. The pre-Ph. D coursework shall have three components. Every student admitted to the PhD programme (Physics) will have to pass a 'coursework' with minimum 14 credits. The candidate can submit his/her thesis only after passing the course work.

Component one (Core Courses)

This component will comprise of two courses of 08 credits which are general to a Ph. D programme in Physics and every research scholar will have to opt for these courses mandatorily. It will have following courses:

1. Research and Publication Ethics
2. Research Methodology
3. Advanced Physics

Component Two (Research Centric)

The course is based on review of the literature on the particular research topic assigned to the research student to envisage the recent developments in the available literature.

Component three (Discipline Centric Elective Courses)

This component will comprise of a basket of courses belonging to different research fields offered by the Department of Physics. Each course will be of 4 credits and out of the available basket of courses students will have to opt for at least one course that will be mandatory for completion of the Ph. D course work.

Semester	Course Code	Course Title	Course Type	Maximum Marks			Credit Distribution			Credits
				Internal*	Final	Total	L	T	P	
Core	RPE900C	Research and Publication Ethics	Core	25	25	50	2	0	0	2
	PHY901C	Research Methodology	Core	50	50	100	3	1	0	4
	PHY902C	Advanced Physics	Core	25	25	50	2	0	0	2
Research Centric	PHY903C	Seminar on recent Developments in the area of Research	Core	Write up-50, Presentation-30, Viva-voce-20						02
Discipline Centric Elective	PHY904E	Advanced Nuclear Physics	Elective	50	50	100	3	1	0	4
	PHY905E	Advanced Solid-State Physics and Electronics	Elective	50	50	100	3	1	0	4
	PHY906E	Astrophysics	Elective	50	50	100	3	1	0	4
	PHY907E	Advanced Fourier Optics	Elective	50	50	100	3	1	0	4
	PHY908E	Quantum Computation and Information	Elective	50	50	100	3	1	0	4
Total Credits										**14**

*(Midterm 30 marks +Assignment/Attendance/Presentation 20 marks)

Common Course for all disciplines
Course Title: Research and Publication Ethics

Course Code: RPE900C
Credits: 2
Marks: 50

UNIT-I

Part A: Philosophy and Ethics

1. Introduction to philosophy: definition, nature and scope, concept, branches.
2. Ethics: definition, moral philosophy, nature of moral judgments and relations.

Part B: Scientific Conduct

1. Ethics with respect to science and research.
2. Intellectual honesty and research integrity.
3. Scientific misconducts: falsification, fabrication, and plagiarism.
4. Redundant publications: duplicate and overlapping publications, salami slicing.
5. Selective reporting and misrepresentation of data.

UNIT 2: **Publication Ethics**

1. Publication ethics: definition, introduction and importance.
2. Best practices/standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest.
4. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types.
5. Violation of publication ethics, authorship and contributor ship.
6. Identification of publication misconduct, complaints and appeals.
7. Predatory publishers and journals.

UNIT 3

Part A: Open Access Publishing

1. Open access publications and initiatives.
2. SHERPA/RoMEO online resources to check publisher copyright and self-archiving policies.
3. Software tool to identify predatory publications developed by SPPU.
4. Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.

Part B: Publication Misconduct

Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad Use of plagiarism software like Turnitin, Urkund and other open source software tools.

UNIT 4:

Part A: Databases
Indexing databases, Citation databases: Web of Science, Scopus, etc.

Part B:
Research Metrics
Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics.

Books Recommended:

1. Bird,A. (2006) Philosophy of Science, Routledge.
2. Maclntyre, Alasdair (1967) A short story of Ethics, London.
3. P.Chaddah, (2018) Ethics in competitive Research , Do not get scooped; do not get plagiarized, ISBN: 978-9387480865.
4. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2009) on being a scientist: guide to Responsible conduct in research: Third Edition, National Academies Press.
5. Resnik, D.B(2011) What is ethics in research and why it is important , National Institute of Environmental Health Sciences , 1-10, retrieved from, http://niehs.nih.gov/research/resources/bioethics/whatis/index.cfm.
6. Beall, J (2012). Predatory publishers are corrupting open access, Nature, (489 (7415), 179-179, http://doi.org/10.1038/489179a.
7. Indian National Science Academy (INSA) Ethics in Science and Education, research and government (2019) ISBN: 978-81939482-1-7 http://www.insaindia.res.in/pdf/Ethics_Books.pdf.

Core (C) Courses
Course Title: Research Methodology

Course Code: PHY901C
Credits: 4
Marks: 100

Unit – I: Research Methodology
Introduction to research: Types and identification of research problem, formulation of a problem, Data collection: data analysis, interpretation of results.
Literature survey, abstract surveys. Formulation of research problem and its methodology. Art of research paper and thesis writing.

Unit – II: Numerical methods and Computer Skills
Monte Carlo Simulation, Error analysis, Least Square Fitting of linear and non-linear functions, numerical solutions of the first and second order differential equations; Euler's method and Runge-Kutta methods, Integration of a given function using trapezoidal, Sympson, Gauss quadrature rules. Open Source softwares/ codes, Linux operating system, GNU, Latex etc.

UNIT III: Fortran Programming 90/95
Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration, Operators and Expressions, Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program. Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DOWHILE, Implied and Nested DO Loops).

UNIT IV: Fortran Programming Applications
Numerical solution of Ordinary Differential equations: Taylor series method, Euler's method, Runge – Kutta Methods, Boundary value and Eigen value problems: Shooting method, finite difference method, solving Eigen value problems, Polynomial method, Power Method, Solution of Partial Differential Equations: Laplace equation, Poisson equation, Heat equation, Schrodinger's equation.

Books Recommended:

1. Research Methodology: Methods and Techniques: C R Kothari, Gaurav Garg, 4th Edition, New Age International Publishers.
2. A Modern Approach to Programming in FORTRAN: R. S. Salaria. Edition 4th, Khanna Book Publishing Company.
3. A student's guide to Data and Error Analysis: Herman J. C. Berendsen. Cambridge University Press (2012).
4. Essentials of Monte Carlo Simulation, Statistical Models for Simulation: Nick T. Thomopoulos, Springer Publications.
5. Introductory methods of Numerical Analysis, S. S Sastry, Edition 5th, PHILearning Private Limited.
6. Fortran 90/95 for scientists and engineers: Stephen J. Chapman McGraw Hill, 1998.
7. Numerical Methods, E Balagurusamy Mc Graw Hill. Education (1999).
8. Numerical Recipes in Fortran, W H Press, S. A Teukolsky, Edition 2nd Cambridge University Press.

Course Title: Advanced Physics

Course Code: PHY902C
Credits: 2
Marks: 50

Unit I

Partial Differential Equations, Classes and Characteristics, First-order, Separable variables. Bessel functions of First kind, Orthogonality, Neuman Functions, Hankel Functions, Modified Bessel Functions, Spherical Bessel Function; Legendre Functions, Orthogonality, Associated Legendre Function, Spherical Harmonics, Hermite Functions; Laguerre Functions.

Green's Functions in One Dimension: Green's function for regular S-L problems via Eigen function expansion, Dirac delta function and the Green's function, Generalized Green's identity, Green's function for non S-A BVPs, Existence of a zero Eigen value – modified Green's function.

Descriptive analysis: Measure of central tendency, Dispersion, Graphical representation; Normal probability curve: Meaning, characteristics, applications; Inferential Statistics: Parametric and non-parametric testing, correlation, Regression; Non parametric statistics: Chi Square test.

Unit II

Review of Special theory of Relativity and Relativistic Electrodynamics.

Scattering theory: Introduction, Lippmann-Schwinger equation and its applications, scattering cross-section for Coulomb and Yukawa potentials.

Relativistic Quantum Mechanics: Klein Gordon equation, Dirac equation in covariant form and its solution, concept of Dirac spinors.

Quantum Information: Quantum coherence and entanglement, coherent and collective phenomenon in quantum transport.

Books Recommended:

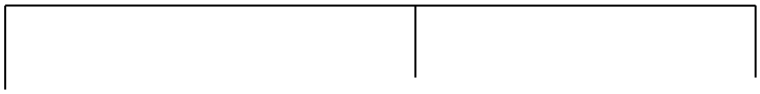
1. Mathematical Methods for Physicists, G. B. Arfken and H. J. Weber, Acad. Press, 7th ed.
2. Mathematical Methods for Students of Physics and Related Fields, Sadri Hassani, Springer, 2nd ed.
3. Advanced Engineering Mathematics, E. Kreyszig, John Wiley, 10th ed. • Mathematical Physics, M. L. Boas, John Wiley, 3rd ed.,
4. Principles of Quantum Mechanics: R. Shankar, Springer, Second Edition.
5. Relativistic Quantum Mechanics: W. Greiner, Reprint 2000.
6. Optical Coherence and Quantum Optics: L. Mandel and E. Wolf, Cambridge University Press, New York, 1995.
7. Nonlinear Optics R.W. Boyd, Academic Press, New York, 2008.

Course Title: Seminar on Recent Developments in the Area of Research

Course Code: PHY903C
Credits: 2
Marks: 100

Review of published literature: Preparation of a comprehensive and critical review of the already published literature in his/her proposed field of study in same may be submitted to a refereed/reputed journal as notified by UGC. The candidate will be evaluated on the basis of a comprehensive report to be submitted and a seminar to be delivered at the end of the semester.

100 Marks



Write-up-50 Presentation-30 Viva-20

Discipline Centric Elective (E) Courses

Course Title: Advanced Nuclear Physics

Course Code: PHY904E
Credits: 4
Marks: 100

Unit I
Review of the Deuteron Problem, Harmonic Oscillator in various coordinate systems, Deformation and Spherical Harmonics: parametrization of the nuclear surface, Types of the multipole deformations, Quadrupole deformation, Shell model of nucleus and the LS coupling.

Unit I
Nilsson model of nucleus: Introduction, the potential, qualitative treatment, exact treatment, Symmetries: General Remarks, Translation, Rotation, Isospin, Parity, Time reversal. Group theory in nuclear physics, Lie groups and Lie algebras, Group chains.

Unit III
Second Quantisation: General formalism, Motivation, Second quantisation for bosons, second quantisation for fermions, Representation of operators (one and two particle), evaluation of matrix elements, Particle-hole picture, Density functional theory in nuclear physics.

Unit IV
Microscopic models: The nucleon-nucleon interaction, general properties, functional form, interactions from nucleon-nucleon scattering, effective interactions, The Hartree-Fock approximation, the variational principle, Slater determinant approximation, The Hartree-Fock equations, Applications, Hartree-Fock-Bogolyubov theory and it's application in nuclear physics (Triaxial Projected Shell Model).
Pairing, Motivation, The seniority model, The quasi-spin model, The BCS model.

Books Recommended:

1. Nuclear Models: Greiner and Maruhan, Springer Publications (Reprint 2010).
2. Theory of Nuclear Structure, M. K. Pal, East-West Press, First Edition.
3. The Nuclear Many-Body Problem: Ring and Schuck, Springer Publications, First Edition.
4. Nuclear structure from a simple perspective: R. F. Casten, Oxford University Press, Second Edition.
5. Concepts of Nuclear Physics: B. L. Cohen, Tata Mcgraw Hill, First Edition.

Course Title: Advanced Solid-State Physics and Electronics

Course Code: PHY905E
Credits: 4
Marks: 100

UNIT-I: Solid State Physics

Quantum theory and the origin of electronic structure, electronic ground state: bonding and characteristic structures, Basic equations for interacting electrons and nuclei, Coulomb interaction in condensed matter, independent - electron approximations. Periodic solids and electron bands: Structures of crystals, The reciprocal lattice and Brillouin zone, Excitations and the Bloch theorem, Point symmetries, Integration over the Brillouin zone and special points, Density of states. Uniform electron gas and simple metals: Non-interacting and Hartree-Fock approximations, Phonons and displacive transitions, lattice dynamics from electronic structure theory. Frozen phonons, magnons, Green's function formulation, Dielectric response functions, Electron-phonon interaction and superconductivity.

Nanophysics: Quantum Confinement, Electronic structure of 1D and 0D systems: Energy sub bands, Coluomb interactions and lattice couplings, charge states, Electrical transport in 1D and 0D systems: Coluomb oscillations, spin and Mott insulators.

UNIT-II: Device Technology and Processing

Direct and Indirect bands in semiconductor, Deep Impurity states in semiconductors, Carrier Trapping, and recombination/generation in semiconductors. Inter-subband Impurity Absorption.
Solar cell materials (single crystalline, amorphous, and thin films) – surface acoustic wave and sonar transducer materials and applications - introduction to nanophase materials and their properties.
Oxidation: Oxidation process, Modelling of oxidation, Diffusion of dopants: Constant source diffusion: Junction formation, Ion implantation of dopants: Ion generation, Parameters of ion implantation, Ion range distribution. Homogeneous nucleation and heterogeneous nucleation.

Unit III: Electrical and Magnetic Properties of Materials

Electrical Properties: Conductivity—Quantum Mechanical Considerations, Experimental Results and Their Interpretation- Pure Metals, Alloys, Ordering. Thermoelectric Phenomena, Dielectric Properties, Ferroelectricity, Piezoelectricity.
Magnetic Properties: Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Langevin Theory of Diamagnetism, Langevin Theory of (Electron Orbit) Paramagnetism, Molecular Field Theory, Magnetic Recording and Magnetic Memories.

Unit IV: Optical and Thermal Properties of Materials

Optical Properties: Fluorescence and Phosphorescence, Energy Transfer and Charge Injection, Absorption of Light by Interband and Intraband Transitions, Optical Spectra of Materials, Dispersion, Light-Emitting Diodes (LED).

Thermal Properties: Thermal Conductivity, Heat Capacity: Quantum Mechanical Considerations—The Phonon, Electronic Contribution to the Heat Capacity, Thermal Conduction in Metals and Alloys—Classical Approach, Thermal Conduction in Metals and Alloys—Quantum Mechanical Considerations, Thermal Conduction in Dielectric Materials. Thermal Expansion.

Books Recommended:

1. Electronic Structure Basic Theory and Practical Methods, Richard M. Martin, Cambridge University Press.
2. Introduction to Solid State Physics: VIII Edn., C. Kittel" John-Wiley and Sons.
3. Solid State Physics: Aschroft and Mermin, Holt, Rinehart and Winston. Methods of Metallurgical experiment: B. Linchevsky, Mir Publishers, Moscow.
4. X-ray Diffraction: S.K. Chatterjee, Prentice-Hall of India Pvt. Ltd.
5. Elements of X-ray diffraction: B. D. Cullity, Addison Wesley Publication.
6. Fundamentals of Solid-State Engineering: Second Edn., Manijeh Razeghi, Springer (India) Private Ltd.
7. Semiconductor Devices: SimaDimitrijev, Oxford University Press.
8. Introduction to Semiconductor Materials and Devices: M. S. Tyagi, wiley publications.

Course Title: Astrophysics

Course Code: PHY906E
Credits: 4
Marks: 100

Course Objectives

To familiarize and expose students to various fields of advanced astronomy and astrophysics, with particular emphasis on high-energy astrophysics. This course provides an in-depth understanding of extreme radiative processes undergoing in the astrophysical systems. This also includes to help students to use the advanced computational and mathematical techniques required to study the various astrophysical systems like accretion disks around compact objects.

Course Outcomes

On completion of this course, student will be able to understand:

- Various mathematical and computational techniques used to study different astrophysical systems.
- The high energy radiative processes responsible for the emission of radiation in X-rays/γ-rays in the universe.
- Evolution and morphology of galaxies.
- Emission of relativistic jets in active galactic nuclei.

The stellar evolution and in-depth understanding of binary stars.

Unit I Cosmology and Relativity:

The Expanding Universe, Newtonian Cosmology, Assumptions of Cosmology, Redshift, The Hubble diagram, Big Bang Nucleosynthesis, The Cosmic Microwave background, Beyond the Standard Model, General Relativity, Metric, Geodesic Equation, Spacetime Curvature, The principle of equivalence, Einstein equations, Dark Matter and Dark Energy.

Unit II Stellar Evolution:

Theoretical and Observational H-R diagram, Properties of stars on the Main sequence, Evolution of High Mass Stars, Evolution of Low Mass Stars, Late-Stage evolution of stars, Supernova, White Dwarfs – Electron Degeneracy Pressure, Chandrasekhar Limit, Neutron Stars and Black holes, Pulsar, Pulsar Emission Mechanism.

Unit III Galaxies:

Galaxy Morphology, Quiet and Active Galaxies, Active Galaxies and classification, Unified model, Accretion discs, Thin accretion discs, Thick accretion discs, Accretion discs in galactic nuclei, Luminosities and Spectra, Relativistic Jets, The X-Ray Corona. Quasars, Blazars, superluminal sources and Gamma-ray sources.

Unit IV Radiative Processes in Astrophysics:

Radiative processes in astrophysical systems: Bremsstrahlung, Thermal Bremsstrahlung Emission, Relativistic Bremsstrahlung, synchrotron radiation, spectrum of synchrotron radiation, Compton Scattering, Inverse Compton power and spectra for single scattering, Kompaneets equation, Macroscopic description of radiation field, Moments of radiative transfer equations and simple approximate solutions, Ionisation and recombination processes.

Books Recommended:

1. Radiative Processes in Astrophysics, George B. Rybicki and Alan P. Lightman, ISBN-13: 978-0-471-82759-7, ISBN-111: 0-471-82759-2
2. The Physical Universe: An Introduction to Astronomy, Frank Shu, University Science Books, California.
3. Accretion Power in Astrophysics, J. Frank, A. King, D. Raine, Cambridge University Press.
4. Black Holes, White Dwarfs and Neutron Stars: The Physics of Compact Objects, S. L. Shapiro, S. A. Teukolsky, WILEY-VCH Verlag GmbH & Co.
5. Theoretical Astrophysics, Vol II: Stars and Stellar Systems, T. Padmanbhan, Cambridge University Press.
6. High Energy Astrophysics, M. S. Longair, Cambridge University Press, ISBN 0-521-38374
7. Quasars and Active Galactic Nuclei, A. K. Kembhavi and J. V. Narlikar, Cambridge University Press, 1999, ISBN 10: 0521479894 ISBN 13: 9780521479899.
8. Modern Cosmology, Scott Dodelson, Academic Press, ISBN-13: 978-0-12-219141-1

Course Title: Advanced Fourier Optics

Course Code: PHY907E
Credits: 4
Marks: 100

Course Objective

The objective is to introduce mathematical analysis of various concepts of optics and image processing. The course will help student in understanding Fourier analysis of basic as well as advanced ideas of imaging and systems. Further, it will prepare student for higher studies in the field.

Course Outcome

Student will be able to understand:
• Fourier analysis of signals.
• Sampling concepts and principle.
• Concepts involved in image formation and reconstruction process.
• Diffraction theory, coherence and polarization ideas.
• Image formation using coherent and incoherent illumination.
• Principles of various imaging applications.

Unit I: Signals and Sampling

Signals and systems, Spatial frequency and space frequency localization, Sampling theorem: Poisson summation formula, Whitkar-Shannon Sampling Theorem, Space band width product. Fast Fourier transform (FFT) and usage of 2D FFT for problems in Optics.

Unit II: Imaging

Linear systems: linearity and superposition integral, Invariant Linear systems: Transfer function, Ill posedness of inverse problems, Inverse filter, Wiener Filter. Image denoising, Image deconvolution by optimization, Blind image deconvolution, Compressive imaging, Random variables, Gaussian or Normal distribution, Central limit Theorem, Spectral Density: Wiener Khintchine theorem.

Unit III: Diffraction theory

Review of Maxwell Equations; Integral theorem of Helmholtz and Kirchoff, Diffraction from a planar screen: Kirchoff Solution, Rayleigh Somerfeld Solution. Angular spectrum method, Fresnel diffraction, Self Imaging, Fraunhoffer diffraction, Spatial and Temporal Coherence, Van Citterete and Zernike theorem, Polarization of light: Jones matrix formalism and QHQ geometric phase shifter.

Unit IV: Imaging Applications

Fourier transform properties of lenses and image formation by a lens. Frequency response of a diffraction-limited system under coherent and incoherent illumination, OTF effects of aberration and apodization, Comparison of coherent and incoherent imaging. Abbe Porter experiment, Zernike phase contrast microscopy, Coherent optical information processing systems, Vander Lugt filter; Joint-transform correlator; Synthetic Aperture Radar, Digital holography, Phase retrieval, PSF engineering, Super-resolution: Structured Illumination microscopy.

Books Recommended:

- Introduction to Fourier optics, J. W. Goodman, McGraw-Hill, New York, 1996
- Fourier Optics and Computational Imaging, Khare, Kedar, John Wiley and Sons, 2016
- Computational Fourier Optics, Jim Bernard Breckinridge, David George Voelz, SPIE press 2011
- Fourier Optics, E. G. Steward, Dover Publications, 2004
- Fourier Optics in Image Processing, Neil Collings, CRC press, 2018

Course Title: Quantum Computation and Information

Course Code: PHY908E

Credits: 4

Marks: 100

Course Objective

The objective of the course is to introduce the mathematical formalism of Quantum Computation and Information followed by its advanced theory, along with brief idea of classical Computation and introduction to different realizations of Quantum Computers.

Course Outcomes

- To develop the advance comprehension of Quantum Computation and Information as preliminary of exploratory research.
- To build a research-oriented proficiency about different realizations of Quantum Computers.
- To acquire research expertise in Quantum error corrections.
- To become acquainted with Quantum Cryptography.
- To develop understanding of communication in Quantum computation.

Unit I: Fundamental Concepts

Advance Quantum Mechanics: Density Matrix, General Measurements, Schmidt Decomposition, EPR and Bell Inequality. Brief idea of Turing Machine and Complexity classes, Landauer's Principle, Reversible computation, Quantum Bits, Quantum Gates and Circuits, Bell States and Quantum Teleportation, Deutsch Algorithm, Deutch-Jozsa Algorithm, Quantum Information.

Unit II: Quantum Computation

Quantum Circuits: Single Qubit Gates, Bloch Sphere, Controlled Quantum Gates, Measurements, Universal Quantum Gates. Physical Realization of Quantum Computers: Conditions for Quantum Computation, Harmonic Oscillator Quantum Computer, Optical Photon Quantum Computer, Optical Cavity Quantum Computer, Ion Traps, Superconducting Quantum computing. Quantum Fourier Transform, Quantum Search Algorithm.

Unit III: Quantum Communication

Entanglement, Quantum Operations, Environment, Operator Sum Representation, Trace and Partial Trace, Bit-flip and Phase-flip Channels, Depolarizing Channel, Amplitude and Phase Damping, Master Equation, Distance Measures: Trace Distance, Fidelity, Quantum Teleportation, Classical Cryptography, Quantum Cryptography, Quantum protocol, Quantum key distribution: BB84, Ekert.

Unit IV: Quantum Information

No-cloning Theorem, Dense Coding, Quantum Error Correction, Shor Code, Theory of Quantum Error Correction, Shannon Entropy, Von Neumann Entropy, The Holevo Bound, Shannon's Noiseless Channel Coding Theorem, Schumacher's Noiseless Channel coding Theorem, Communication over Noisy Channel.

Books Recommended:

- Quantum computation and Quantum information by Michael A. Nielsen and Isaac L. Chuang 10th Anniversary Edition Cambridge Press.
- Principles of Quantum Computation and Information: A Comprehensive Textbook by Giuliano Strini and Giulio Casati 2nd Edition World Scientific.
- Entangled Systems: New Directions in Quantum Physics by Jurgen Audretsch 1st Edition WILEY.
- Quantum Key Distribution: An Introduction with Exercises by Ramona Wolf 1st Edition Springer.