Sacred Heart College (Autonomous), Tirupattur District

1.2.1 List of New Courses

M.Sc Physics

SEM	Subject	Title of the Paper	Ins.Hrs	Credits
I	MC	Mathematical Physics-I	5	4
	MC	Classical Mechanics and Statistical Mechanics	5	4
	MC	Quantum Mechanics-I	5	4
	MC	Advanced Physics Practicals	5	-
	MC	Electronic Experiments	6	-
	Elective	1. Electronic Devices and Applications 2. Energy and Environmental Physics 3. Astrophysics	4	4
II	MC	Mathematical Physics-II	5	4
	MC	Electromagnetic Theory	5	4
	MC	Quantum Mechanics-II	5	4
	MC	Advanced Physics Practicals	6	6
	MC	Electronic Experiments	5	6
	Elective	1. Microprocessor 8085 and Microcontroller 8051 2. Geophysics 3. Bio Physics	4	4
	SSP	1. Ultrasonics and its Applications	-	2*
		2. Dielectric Spectroscopy	-	2*
		3. Crystal growth techniques	-	2*
III	MC	Solid State Physics	5	4
	MC	Atomic and Molecular Spectroscopy	5	4
	MC	C Programming and Research Methodology	5	4
	MC	Modern Physics Practicals	5	-
	MC	Microprocessor and C Programming Experiments	5	-
	Elective	1. Nanoscience and Technology 2. Optical Physics 3.Computational Quantum Mechanics	4	4
	SSP	1. Shock Waves and High Pressure Physics in Material Science	-	2*
		2. Electrical Appliances	-	2*
		3. Research and Publication ethics	-	2*
	Core	Project	1	-
IV	MC	Electronic Instrumentation Techniques	5	4
	MC	Nuclear and Particle Physics	5	4
	MC	Modern Physics Practicals	5	6

	MC	Microprocessor and C Programming Experiments	5	6
	MC	Project	4	5
	Elective	1. Modern Optics 2. Reactor Physics 3. Digital Signal Processing	4	4
		Human Rights	**2**	**1**
Total			**120**	**90+4***

Sacred Heart College (Autonomous), Tirupattur District

1.2.1 List of New Courses

Department: M.Sc.Physics

S.No	Course Code	Course Name
1.	P917	Solid State Physics
2.	P918	Atomic and Molecular Spectroscopy
3.	P920A	Nanoscience and Technology
4.	P920B	Optical Physics
5.	P920C	Computational Quantum Mechanics
6.	P922SSP1	Shock Waves and High Pressure Physics in Material Science
7.	SSP	Electrical Appliances
8.	P1015	Electronic Instrumentation Techniques
9.	P1016	Modern Physics Practicals
10.	PP1009	Microprocessor and C Programming Experiments
11.	P1017A	Modern Optics
12.	P1017B	Reactor Physics
13.	P1017C	Digital Signal Processing

Semester – III

Solid State Physics

Solid State Physics

Semester - III **Hours/week: 5**

Sub. Code: P917

Credits: 4

Course objectives:

1. To provide an understanding of the basics of crystal physics and X-ray diffractions
2. To introduce the concept of Lattice dynamics
3. To familiarise the various theoretical models to study the properties of matter from a microscopic point of view.
4. To provide an understanding of magnetic materials and theirproperties.
5. To familiarise with superconducting materials.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand crystal structure and diffraction of X-rays in materials	K1-K3
CO 2	Acquire knowledge; understand the behaviour of electrons in solids based on classical and quantum theories and various theories of specific heat capacities of solids.	K1-K3
CO 3	Understand theoretical backgrounds of metals and semiconductors	K1-K3
CO 4	Describe the theories of magnetic materials and how the susceptibility varies with temperature.	K1-K3
CO 5	Explore superconductivity and its applications.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	3	3	2	2	1	2.3
CO2	2	2	3	2	2	2	2	2	3	2	2.2
CO3	3	2	3	1	2	3	2	3	2	2	2.3
CO4	2	3	2	3	1	2	3	2	3	1	2.2
CO5	3	2	2	2	1	3	3	2	2	1	2.1
Mean Overall Score											2.2
Results											High

Unit - I: Crystal Structure and Binding

Lattice- Crystal systems - Bravias lattices - Miller indices- Reciprocal lattice (SC, BCC, and FCC) -simple crystal structures-NaCl- ZnS and Diamond- X-ray diffraction-Bragg's law- Structure factor-Atomic form factor - Laue equations- crystal binding- crystals of inert gases - Van der Waals-London interaction- Cohesive energy - ionic crystals - Madelung constant- covalent crystals - Metal crystals-Hydrogen bonds.

Unit – II: Lattice Dynamics

One dimensional mono atomic lattice-one dimensional diatomic lattice- acoustical and optical modes - group and phase velocities-quantization of lattice vibrations-phonon momentum-Normal process-Umklapp process-Inelastic scattering by phonons-Lattice specific heat-Dulongpetit's law-Einstein's theory of specific heat-Debye's theory of specific heat.Thermal conductivity of solids – Thermal conductivity due to electrons – Thermal conductivity due to phonons.

Unit – III: Theory of Metals and Semiconductors

Free electron gas in three dimensions- Experimental methods in Fermi surface studies- De Hass Van Alphen effect- Hall Effect: Theory and Experiment- Band theory of solids metals and semiconductors- Bloch theorem-Kronig-Penny modelBrillouin zone-construction of first and second Brillouin zones-Semiconductors: Intrinsic carrier concentration-Extrinsic carrier concentration-Impurity conductivity. Band gap engineering

Unit – IV: Magnetism

Quantum theory of para magnetism-Rare earth ion-Hund's rule - Quenching of orbital angular momentum-Adiabatic demagnetization- Quantum theory of ferro magnetism-Curie point and exchange integral-Heisenberg's interpretation of Weiss fieldMagnons-Curie temperature and susceptibility of ferrimagnets-Theory of anti-ferromagnetism-Neel temperature.

Unit – V: Super Conductivity

Experimental facts-Effect of magnetic fields and temperature-Meissner effect-Entropy and heat capacity-Energy gap-isotope effect-Type I and Type II superconductors-theoretical explanation-thermodynamics of superconducting transition-London equations-Coherence length-Penetration depth-BCS theory-single particle tunneling-Josephson tunneling-DC and AC Josephson effects-High temperature super conductors-SQUIDS (analytical treatment)-applications and limitations of superconductors.

Text Books

1. Charles Kittel, Introduction to Solid State Physics, Wiley & Sons, New York, Eighth Edition, 2018.
2. Dekker A. J, Solid State Physics, McMillan& Co, New Delhi, Reprinted, 2014.
3. Rita John, Solid State Physics, McGraw Hill Education (India) Private Limited, 2016
4. Pillai S.O, Solid State Physics,New age international publishers, New Delhi, Ninth edition 2020.
5. Gupta H. C, Solid State Physics, Vikas Publishing House Pvt. Ltd., Mumbai, 2001.

Books for Reference

1. Wahab M. A, Solid State Physics Structure and Properties of Materials, Narosa Publishing House, New Delhi, 2009.
2. Keer H. V, Principles of the Solid State, New age international publishers, New Delhi 2017.
3. Neil W. Ashcroft, David Mermin N, Solid State Physics, A Harcourt Publishers, Singapore, 2003.
4. Kachhava C. M, Solid State Physics Solid State Devices and Electronics, New age international publishers, New Delhi, 2003.

Websites for Reference

1. http://www.lcst-cn.org/SSP.html
2. http://academic.uprm.edu/pcaceres/Courses/MEMO/id32.htm
3. http://academic.uprm.edu/pcaceres/Courses/MEMO/id3.htm
4. http://en.wikipedia.org/wiki/Spin_wave
5. http://www.cmmp.ucl.ac.uk/~ahh/teaching/3C25/Lecture07p.pdf
6. http://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/syllabus/MIT3_091SCF09_aln03.pdf
7. http://griffin.ucsc.edu/teaching/08Q1-155/download/Lecture%2019%20-%20Magnetic%20Order.pdf
8. http://www.eng.utah.edu/~lzang/images/lecture-11.pdf
9. http://nptel.iitm.ac.in/courses/103104045/pdf_version/lecture20.pdf
10. http://www.eng.utah.edu/~lzang/images/lecture-12.pdf

Semester – III

Atomic and Molecular Spectroscopy

Atomic and Molecular Spectroscopy

Semester-III **Hours/week: 5**

Sub. Code: P918

Credits: 4

Course objectives:

1. To provide a knowledge of interaction of electromagnetic radiation with atoms and molecules and systematically introduce to spectra and basic theoretical concepts in spectroscopic methods.
2. To expose to the fundamental principles of various spectroscopic techniques for structural applications.
3. To understand the theory and principles of electronic and vibrational and its techniques.
4. To Study microwave spectroscopy and its advantages/applications.
5. To understand the physics behind NMR and ESR spectroscopy, Mossbauer spectroscopic techniques.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Apply their knowledge and understand different branches of spectroscopy and carry out experimental and theoretical studies on atoms and molecules with focus on the structure and dynamics.	K1-K2
CO 2	Apply the knowledge of spectroscopy in interdisciplinary subjects like chemistry, mathematics and biological systems.	K1-K3
CO 3	Handle relevant experimental equipment and evaluate experimental results obtained	K1-K2
CO 4	Excel in research field related to materials science and various spectroscopic analyses.	K1-K3
CO 5	Apply NMR and ESR spectroscopy, Mossbauer spectroscopic techniques to examine new materials for novel drugs in the field of medicine	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	3	2	3	1	1	2	2.1
CO2	2	3	3	2	1	3	2	2	2	2	2.2
CO3	2	3	2	3	2	2	2	3	1	2	2.2
CO4	2	2	2	2	3	2	2	2	2	1	2
CO5	3	2	1	2	2	2	3	1	3	2	2.1
Mean Overall Score											2.1
Results											High

Unit-I: Electronic Spectroscopy

Interaction of electromagnetic radiation with matter-scattering, dispersion and transmissionof radiation -vibrational, rotational and electronic energy levels-types of molecular spectra-band width-factors contributing to band width. Fundamental laws of absorption-Beer's law-origin of UV-Visible spectra-Instrumentation progression and sequences-Frank-Condon principle-transition probability - colour of the compounds-types of transitions -solvent effects on electronic transitions- selection rules for electronic transitions

Unit-II: Rotational Spectroscopy

Microwave Spectroscopy: Rotation of molecules - Pure rotational spectra of diatomic molecules – polyatomic molecules - study of linear molecules and symmetric top molecules – Hyperfine structure and quadruple moment oflinear molecules – Experimental techniques – Molecular structure determination – Stark effect – inversion spectrum of ammonia – applications to chemical analysis.

Unit-III: Vibrational Spectroscopy

Infrared Spectroscopy: Vibrational spectroscopy of diatomic molecules – Harmonic oscillator – Anharmonicoscillator– Rotational vibrators – Normal modes of vibration of CO_2 and H2O molecules–IR spectrometer - FTIR spectrometer – Interpretation of FTIR spectra of H_2O,CCl_4, Benzene molecules.

Raman Spectroscopy: Raman effect- Classical and Quantum theory of Raman Scattering-Rotational, vibrational Raman spectra-Stokes and anti-stokes Raman lines-selection rules-Nuclear spin and its effecton Raman spectra - FT Raman instrumentation – Comparison of IR and Raman spectra – interpretation of Raman spectra (N_2 and O_2)

Unit –IV: Resonance Spectroscopy

Nuclear Magnetic Resonance (NMR) - Introduction-Interaction of spin and magnetic field population of energy levels-Larmor precession-Relaxation times- Bloch equations — steady state solution Double resonance- Chemical shift and its measurement- Coupling constant-Coupling between several nuclei- Quadrupole effects– Instrumentation:–13C and 1H NMR - Interpretation of NMR spectra.

Principle and theory of ESR – Nuclear interaction and hyperfine structure – Relaxation effects – ESR Instrumentation – Applications of ESR.

UNIT V: Mossbauer spectroscopy and Surface Spectroscopy

Principle of Mossbauer spectroscopy: Doppler shift, recoil energy. Isomer shift, quadrupole splitting, magnetic interactions. Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds.

Electron energy loss spectroscopy (EELS)-Reflection absorption spectroscopy (RAIRS)- Photoelectron spectroscopy (PES) – Instrumentation – interpretation of spectrum; X-ray Flourescence spectroscopy (XRF)- SIMS - Surfaces for SERS study-SERS Microbes-Surface selection rules

Books for study:

1. Kaur. H, Spectroscopy, 7th Edition, PragatiPrakashan, Meerut, 2012.
2. R. Colin N. Banwell and Elaine M. Mc Cash, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill Publications, New Delhi, 2013
3. Aruldas G., Molecular Structure and Spectroscopy, 2nd Edition, Prentice Hall of India Pvt.Ltd., 2007
4. A K Saxena, Atomic and molecular spectroscopy and Lasers, S Chand Publishing company (P) Ltd., 2015

Books for Reference:

1. Satyanarayana D. N., Vibrational Spectroscopy: Theory and Applications, New AgeInternational Publications, New Delhi, 2004.
2. Donald L. Pavia,Gary M. Lampman, George S. Kriz and James A. Vyvyan,Introductionto Spectroscopy, 4th Edition, Brooks Cole, 2008.
3. Towne and Schawlow, Microwave Spectroscopy, Tata McGraw Hill, New Delhi, 1995.
4. Dr. Ramphal Sharma, Fundamentals of Atomic and Molecular Spectroscopy, HimalayaPublishing House, New Delhi, 2008.
5. Gupta, Kumar, Sharma, Elements of Spectroscopy: Atomic, Molecular and LaserPhysics, PragatiPrakashan, Meerut, 2011.
6. Rita Kakkar, Atomic and molecular spectroscopy, Basic concepts and applications,Cambridge University Press,2015.

Websites References:

1.http://en.wikipedia.org/wiki/Spectroscopy
2.http://en.wikipedia.org/wiki/Rotational_spectroscopy
3.http://classes.uleth.ca/200303/chem3810a/NotesS2.pdf
4.http://www.pharmagupshup.in/2011/12/infared-spectroscopy-free-study.html
5.http://www.infochembio.ethz.ch/links/en/spectrosc_microwave.html
6.http://www.chem.ucla.edu/harding/notes/notes_14C_nmr02.pdf
7.http://nmr.wsu.edu/files/pdf/theory.pdf
8.http://www.news-medical.net/health/Spectroscopy-Types.aspx
9.http://www.chem.uni-wuppertal.de/quasaar/han-sur-lesse/files/Wlodarczak1.pdf
10.http://www.internetchemistry.com/chemistry/microwave-spectroscopy.htm
11.http://web.mit.edu/5.33/www/lec/spec5.pdf
12.http://www.chem.ucla.edu/harding/notes/notes_14C_IR.pdf
13.http://www.chem.uic.edu/tak/chem52411/notes16/notes16-11.pdf
14. http://www.eng.uc.edu/~beaucag/Classes/Characterization/RamanCALTECH.pdf
15. https://www.patnauniversity.ac.in/e-content/science/physics/MScPhy89.pdf

Semester – III

Nanoscience and Technology

Elective: Nanoscience and Technology

Semester-III **Hours/week: 4**

Sub. Code: P920A

Credits: 4

Course objectives:

1. To provide an introduction to nanomaterials, their properties and applications.
2. To know about synthesis of nanomaterials
3. To acquire knowledge about the preparation of nanomaterials by physical methods
4. To understand basic principles and instrumentation
5. To introduce to various thin films deposition techniques and characterization techniques.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Develop an understanding of nanomaterials applications	K1-K2
CO 2	Understand Advantages and disadvantages of chemical method	K1-K3
CO 3	Know the methods of nanomaterial preparations	K1-K3
CO 4	Acquire in depth knowledge about various characterization techniques which will in turn kindle their research interest.	K1-K3
CO 5	Know some of the applications of Nanomaterials and thin films that are applicable in day today life.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	3	3	2	2	3	2	2.4
CO2	2	3	2	2	3	3	2	2	3	3	2.5
CO3	3	2	2	2	3	3	3	2	3	3	2.6
CO4	3	2	2	2	3	3	3	2	3	3	2.6
CO5	3	3	2	2	3	3	3	2	3	3	2.7
Mean Overall Score											2.6
Results											High

Unit – I: Introduction to Nanomaterials

Introduction-Historical perspectives - Advantages and disadvantages of nanomaterials - Classification of nanomaterials based on dimension-Quantum semiconductors- Quantum confinement - Quantum dots- Different forms of Carbon- Carbon nano tubes- Types of CNT – Preparation, properties and applications of CNT- Fullerenes: synthesis and applications – Self Assembled Monolayers- synthesis of gold SAMs.

Unit – II: Preparation by chemical Method

Synthesis of nanomaterials: Top-down and Bottom-up approaches – Sol gel - Spin coating –Chemical bath deposition - Electro-deposition - Hydrothermal – Precipitation method – Reflux method – Advantages and disadvantages of chemical method.

Unit– III: Preparation by Physical Method

Introduction- Methods of preparation: Need for vacuum- working of vacuum pumps: Rotary and diffusion pumps - Gauges: pirani and penning gauges-Thermal evaporation- DC Sputtering – Need for RF sputtering- Pulsed Laser deposition- Plasma arching- Ball milling technique- Spray Pyrolysis -Advantages and disadvantages of Physical method.

Unit – IV: Characterization Techniques

Basic principles andinstrumentation: Powder XRD (Calculation of grain size), HRSEM- TEM-TGA-AFM.

Unit – V: Applications of Nanomaterials and Thin Films

Nanomaterials in Photocatalysis – Thin film Solar cells - Nanostructured Gas sensors -Bio-Sensors- Drug delivery systems - Diluted magnetic semiconductor (DMS) - Quantum computers –Thin Film Transistors - NEMS and MEMS.

Text Books

1. M.A.ShahTokeer Ahmad, Principles of Nanoscience and Nanotechnology,Alpha science international,2010
2. Chris Binns, Introduction to Nanoscience and Nanotechnology, JohnWiley& sons, Inc 2010
3. Chattopadhyay K. K., Banerjee A. N., Introduction to Nanoscience and Technology, PHI learning Pvt. Ltd., New Delhi, 2009.
4. Goswami A., Thin Film Fundamentals, New Age International (P) Ltd., New Delhi, 2007.

Books for Reference

1. Shanmugam S., Nanotechnology, MJP Publishers, Chennai, 2011.
2. Bandyopadhyay A. K., Nanomaterials, New Age International (P) Ltd., New Delhi 2009.
3. Pradeep. T, Nano: The Essentials, Tata McGraw- Hill Publishers Company Ltd., New Delhi, 2007.
4. Clive Whiston, X-Ray Methods, Wiley India Pvt. Ltd., New Delhi, 2008.
5. Charles. P. Poole, Frank. J. Owens, Introduction to nanotechnology,, John Wiley & Sons publications, New Jerssey, 2003.
6. Mark Ratner, Daniel Ratner, Nanotechnology: A Gentle Introduction to the Next Big Idea, Prentice Hall**,** 2002.
7. Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama, Nanoparticle Technology Handbook, Linacre House, Jordan Hill, 2007.
8. Joseph Goldstein, Scanning Electron Microscopy and X-ray microanalysis,Springer, London, 2003.
9. William F Smith, JavadHashemi, Foundations of Materials Science and Engineering, Tata McGraw Hill, New Delhi, 2005.

Websites for Reference

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2. https://www.cheaptubes.com/carbon-nanotubes-properties-and-applications/
3. https://www.geeksforgeeks.org/difference-between-bottom-up-model-and-top-down-model/
4. http://www.ch.ic.ac.uk/harrison/Teaching/L1_Introduction.pdf
5. http://faculty.uml.edu/zgu/Teaching/documents/Lecture6Synthesis_000.pdf
6. http://inside.mines.edu/~zhiwu/courses/550/lecture07.pdf
7. http://www.asp.unijena.de/physik_international_multimedia/MultiphotonLab/2011Nanomaterials_Lecture06_semiconductors.pdf
8. http://hanyangocw.hanyang.ac.kr/ocw/fusion-materials/nano-materials-characterization/1st.pdf
9. http://www.wright.edu/~lok.lewyanvoon/440/chp4.pdf
10. http://hanyangocw.hanyang.ac.kr/ocw/fusion-materials/nano-materials characterization/6th.pdf
11. http://hanyangocw.hanyang.ac.kr/ocw/fusion-materials/nano-materials-characterization/9th.pdf
12. http://www.uccs.edu/~tchriste/courses/PHYS549/549lectures/kinetics.html

Semester – III

Optical Physics

Elective: Optical Physics

Semester-III **Hours/week: 4**

Sub. Code: P920B

Credits: 4

Course objectives:

1. To introduce the concept of waves, wave packets, polarization and Brewster angle
2. To make the students to understand the concept of coherence and interference
3. To acquire knowledge of working principle of different type of lasers
4. To get in depth knowledge on propagation of light in the fiber and wave guides
5. To understand the electro-optic and magneto-optic effects and their application

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand the concept of waves, wave packets, polarization and Brewster angle	K1-K3
CO 2	Distinguish spatial and temporal coherent and they can understand the spectral resolution	K1-K2
CO 3	Realize the working principle of different type of lasers	K1-K3
CO 4	Explain construction and applications of optical fibers	K1-K3
CO 5	Understand and appreciate the various optical devices and their applications in different fields.	K1-K2

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	2	2	3	2	2	2.1
CO2	2	2	3	2	2	2	2	2	3	3	2.3
CO3	3	2	2	2	1	3	3	2	3	3	2.4
CO4	2	2	3	2	3	2	2	2	3	2	2.3
CO5	3	2	2	3	2	2	2	2	2	3	2.3
Mean Overall Score											2.3
Results											High

Unit - I: Electromagnetic Waves

Electrical Constant-Plane Harmonic Waves-Wave packets - Doppler Effect-Relativistic Correction to the Doppler Formula-Linear Partial Polarization-Scattering & Polarization-Circular & Elliptical Polarization-Matrix Representation-Orthogonal Polarization-Eigen Vectors & Jones Matrices- Reflection and Refraction at a Plane Boundary-Amplitudes of Reflected and Refracted Waves- Brewster's Angle.

Unit - II: Coherence and Interference

Theory of Partial Coherence-Coherence Time and Coherence Length-Spectral Resolution of a Finite Wave Train-Coherence and Line Width-Spatial Coherence-Extended Sources-Measurement of Stellar Diameter-Hanbury Brown Twiss Intensity Interferometry-Fabry Perot Interferometer-Theory of Multilayer Films.

Unit - III: Lasers

Characteristics of Laser Light-Atomic Basis for Laser Action-Laser Pumping-Creating a Population Inversion-Laser Resonator-Single Mode Operation-Q Switching-Mode Locking-Helium-Neon Laser- Argon Ion Laser-Carbon dioxide Laser-Solid State Lasers-Semiconductor Laser-Applications.

Unit – IV: Optical Fibres

Propagation of Light in an Optical Fibre-Acceptance Angle-Numerical Aperture-Step and Graded Index Fibres-Fibre Fabrication Techniques-Optical Fibre as a Cylindrical Wave Guide-Wave Guide Equations- Wave Equations in Step Index Fibres-Flow of Power in SI Fibres-Fibre Losses and Dispersion- Applications.

Unit – V: Optical Devices

Electro-optic, Magneto-optic and acousto-optic effects – Material properties related to get these effects – important Ferroelectric, Liquid crystal materials for these devices—Piezoelectric, Electrostrictive and magnetostrictive effects – important materials exhibiting these properties – and their application in sensors & actuator devices –Acoustic delay line –High frequency piezoelectric devices – Surface acoustic wave devices.

Text Books

1. S.G. Lipson, H. Lipson, D.S. Tannhanser, Optical Physics, Cambridge University Press, New Delhi, 1999.
2. A. K. Ghatak, Optics, 3rd Edition, Tata McGraw Hill, New Delhi, 2002.

Books for Reference:

1. Shea D.C.O., RusellCallen W, and Rhodes W.T., Introduction to Lasers & their Applications, Addison Wesley, 2005.
2. Stewart D. Personick, Fibre Optics technology & Applications, Khanna Publishers, New Delhi, 2007.

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2. electron9.phys.utk.edu/optics421/modules/m1/reflection_and_refraction.htm
3. https://en.wikipedia.org/wiki/Hanbury_Brown_and_Twiss_effect
4. http://hyperphysics.phy-astr.gsu.edu/hbase/optmod/lasgas.html
5. http://www.worldoflasers.com/lasertypes-solid.htm
6. http://www.ques10.com/p/5043/explain-any-one-fiber-fabrication-process-with-nea/
7. https://en.wikipedia.org/wiki/Surface_acoustic_wave
8. https://www.britannica.com/technology/piezoelectric-device
9. https://en.wikipedia.org/wiki/Liquid_crystal
10. https://en.wikipedia.org/wiki/Liquid-crystal_laser

Semester – III

Computational Quantum Mechanics

Elective: Computational Quantum Mechanics

Semester - III **Hours/week: 4**

Sub. Code: P920C

Credits: 4

Course objectives:

1. To introduce modern methods of molecular modeling and culminating in electronic structure modeling.
2. To understand the Basic methods of molecular modeling.
3. To enable the students to acquire knowledge Roothaan-Hall Hartree-Fock method and its application
4. To introduce Ab initio formalism of quantum computation.
5. To explore the Knowledge on Density Functional theory and its application.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand quantum mechanical approximation models necessary for the description of molecules and atoms.	K1-K3
CO 2	Understand the relationship between the energy levels obtained as solutions to the time-independent Schrödinger equation and measurements made using spectroscopic methods.	K1-K3
CO 3	Plan and apply computer-based calculations to determine the geometry, energies and electronic properties of molecules.	K1-K2
CO 4	Describe theoretical methods and plan and conduct computer-based calculations of chemical properties in molecules	K1-K2
CO 5	Present and discuss density functional theory for computing the energy of molecules through a one-electron Schrödinger equation that includes electron correlation.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	2	2	3	2	2	2.1
CO2	2	2	3	2	2	2	2	2	3	3	2.3
CO3	3	2	2	2	2	3	3	2	3	3	2.5
CO4	2	2	3	2	3	2	2	2	3	2	2.3
CO5	3	2	3	3	2	3	2	3	2	3	2.6
Mean Overall Score											2.4
Results											High

Unit - I: Introduction to Computational Quantum Mechanics:

Schrödinger equation-Atomic orbital's - spectra of hydrogen-like (one electron) atoms and alkali atoms - variation theorem - Spin and spin wave functions-Many electron systems- electrostatic approximation- Time dependent perturbation theory for two-level and multi-level systems, Effect of constant - perturbation and oscillating perturbation.

Unit - II: Basic Methods of Molecular Modeling:

Force Field- semiempirical, *ab initio* and Density Functional methods.Applicability- comparison of accuracy - basics of electronic structure theory- Atomic units - qualitative role of kinetic and potential energy in shaping the orbitals- Bhorn- opphenier approximation-Geometric optimization.

Unit - III: Roothaan-Hall Hartree-Fock Method:

Energy expression- Slater determinantalwavefunction- Basis set expansion of the orbitals- Basis set types: atomic, plane wave and grid basis sets- Atomic basis sets: Slater-type and Gaussian functions The Self-Consistent Field (SCF) method- Fock's theorem - invariance of the total wavefunction with respect to linear combination of occupied spin-orbitals- Hund's theorem and its implications.

Unit - IV: Ab initio Calculation:

Basic principles of ab initio method – Hatreeself consistent field method-Calculation of molecular energy-minimizing energy equation – Ab initio calculation using Roothaan –Hall equation (SCF procedure) - Application to Ab initio method.

Unit - V: Density Functional Theory (DFT):

Orbital energies, Koopmans' theorem, electrostatic properties - Canonical and localized molecular orbital's - molecular properties- Density functional theory-Major exchange-correlation function - calculation of equilibrium geometries- force constants- vibrational spectra- transition states.

Books for Study

1. F. Jensen, Introduction to Computational Chemistry, John Wiley & Sons, 2004.
2. V. C. Gupta,Principles and Applications of Quantum Chemistry,Kindle Edition, 2015.
3. Errol Lewars, Computational chemistry, Introduction to the theory and application of molecular and quantum mechanics, Springer publication, 2008.
4. M.B Smith and J. March, Advanced organic chemistry, John Wiley & Sons, 2001.

Books for Reference

1. C. J. Cramer Essentials of Computational Chemistry, John Wiley &Sons ,2002.
2. T. Clark A Handbook of Computational Chemistry, Wiley, New York, 1985.
3. R. Dronskowski Computational Chemistry of Solid State Materials, Wiley-VCH ,2005.
4. D. Rogers, Computational Chemistry Using the PC, 3rd Edition, John Wiley & Sons ,2003
5. Szabo, N.S. Ostlund, Modern Quantum Chemistry, McGraw-Hill, New Delhi, 1982.

Website References

1. https://en.wikipedia.org/wiki/Computational_chemistry
2. https://www.google.co.in/?gfe_rd=cr&ei=iihZWMRIILT8gfEmKmoCQ&gws_rd=ssl#q=introduction+to+quantum+computational+chemistry
3. http://www.ccl.net/cca/documents/dyoung/topics-orig/compchem.html
4. http://nptel.ac.in/courses/104101002/downloads/lecturenotes/module1/chapter1.pdf

Semester – III

Shock Waves and High Pressure Physics in Material Science

Self-study Paper: Shock Waves and High Pressure Physics in Material Science

Semester-III
Sub.Code: P922SSP1

Credits: 2

Course objectives:

1. To create awareness about shock waves and types of shock waves
2. To import knowledge of different types of shock tubes
3. To make the students to understand the interaction of high pressure energy in atomic level in the materials
4. To enable the students to acquire knowledge on the high pressure materials science and its applications.
5. To explore the behavior of materials properties at harsh environments.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Explain the fundamental concepts of shock waves and high pressure experiments in materials.	K1-K2
CO 2	Construct table top shock tubes	K1-K3
CO 3	Develop a strong understanding about the materials properties under shock loaded and high pressure conditions.	K1-K3
CO 4	Distinguish the static shock and dynamic shock phenomena	K1-K2
CO 5	Understand the unusual behavior of materials in harsh conditions.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	1	3	2	2	3	2	2	2	2	2	2.1
CO2	2	2	3	2	2	3	2	3	3	3	2.5
CO3	3	2	3	3	2	2	2	3	2	2	2.4
CO4	3	3	3	2	3	3	1	2	3	2	2.5
CO5	2	3	2	2	3	3	1	3	2	3	2.4
Mean Overall Score											2.4
Results											High

UNIT-I: Shock Waves

Introduction of shock waves – origin: natural and artificial - types of sonic waves –difference between acoustical, ultrasonic, supersonic waves - types of shock waves: strong shock waves and weak shock waves - Mach number- Mach angle - energy conversion laws.

UNIT: II Shock Tube

Types of shock tubes –mechanism – conventional shock tubes- Table top shock tubes – Reddy tube and its generations- shock tube relations – principle, working, and calibration of P_2, P_4, T_2, T_5 - advantages of Reddy tube – shock tunnels.

UNIT: III: Behaviour of materials under shock loaded conditions

Review of fundamental concepts of shock wave loadings on materials- importance of shock wave recovery experiments in materials – applications of high shock resistance materials - recent advances in shock wave recovery experiments in crystalline materials - shock wave induced phase transitions- irreversible and reversible (crystallographic and magnetic phase transitions).

UNIT: IV Static high pressure compression of solids

High pressure compression techniques - Piston cylinder methods- Diamond Anvil Cell (DAC) - cubic press. Structure- property relationship at high pressure compression on materials- Pressure induced behavior of nanoparticles, applications of high pressure compression.

UNIT: V Materials under Extreme Conditions

Recent Trends and Future Prospects of materials in extreme condition: high temperature - hostile chemical environments - high radiation fields (gamma radiation) - high vacuum- high magnetic and electric fields – impact of extreme condition: crystallographic features - microstructures.

Text Books

1. Shock Waves Made Simple, K.P.J. Reddy, C.S. Kumar, K. Takayama, Wiley, 2014.
2. G.I. Kanel; Shock Waves in Solid State Physics, CRC Press Publisher, 2019
3. A.K. Tyagi S. Banerjee, Materials Under Extreme Conditions, Recent Trends and Future Prospects, Elsevier Publisher, 2017

Books for Reference

1. G.I.Kanel, S.V.Razoranenov, V.E.Fortov Shock wave Phenomena and the properties of Condensed matter
2. J.Wadsworth, G.W.Crabtree et al. Basic research needs for materials under extremeEnvironments. (2008) US DOE - Office of Basic Energy Sciences

Websites for references:

1. https://shock.wsu.edu/
2. https://munin.uit.no/handle/10037/10307
3. https://apps.dtic.mil/dtic/tr/fulltext/u2/692295.pdf
4. https://link.springer.com/content/pdf/bfm%3A978-3-540-30421-0%2F1.pdf
5. https://physics.wsu.edu/studying-materials-under-extreme-conditions-using-shock-waves/
6. https://link.springer.com/article/10.1007/BF00859398
7. http://aero.iisc.ac.in/people/lhsr/history.html
8. http://aero.iisc.ac.in/people/lhsr/assets/documents/LHSR_brochure.pdf
9. https://www.ias.ac.in/article/fulltext/reso/012/06/0010-0023
10.

Semester-III

ELECTRICAL APPLIANCES

Self-study Paper: ELECTRICAL APPLIANCES

Semester-III **Credits:2**

Course objectives:

1. To impart knowledge of basic electrical/electronic components
2. To understand the electrical components in our household applications
3. To apply the series and parallel electrical connections in the household appliances
4. To understand the principle and design of electric iron household appliances in our day to day life.
5. To understand the fundamentals and working of consumer electronics appliances.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Identify the different electrical/electronic components for house hold applications	K1-K3
CO 2	Realize the electrical wiring for household electrical connections.	K1-K3
CO 3	Explain the construction and working mechanism of some household electrical appliances.	K1-K2
CO 4	Infer the knowledge, principle and working mechanism of house hold electrical appliances	K1-K3
CO 5	To explain the principle and working mechanism of electrical appliances	K1-K2

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	3	2	3	3	2	2	2	2	2.4
CO2	3	3	2	3	3	3	2	2	3	3	2.7
CO3	3	2	2	2	2	3	3	2	3	3	2.5
CO4	3	2	2	2	2	2	3	2	3	3	2.4
CO5	3	3	2	2	3	2	3	2	3	3	2.6
Mean Overall Score											2.5
Results											High

UNIT-1: BASICS OF ELECTRICITY-I

Resistor and its types–capacitor and its types–Colour codes-inductance and its units– Electrical Charge–Current–Electrical Potential-Ohm's law–Galvanometer, Ammeter, Voltmeter and Multimeter-Analog and Digital-Electrical Energy-Power–Watt–kWh– Consumption and electrical power.

UNIT-II: BASICS OF ELECTRICITY-II

AC-Single phase and three phase connections-House wiring – Star and delta connection – overloading-Earthling-Color code for insulation wires- Transformers

UNIT-III: PARALLEL AND SERIES CIRCUITS

Parallel and series circuits–short and open in parallel circuits–Detecting short and open in parallel circuits–short and open in series circuits–Detecting short and open in series circuits - Fuses

UNIT-IV: ELECTRICAL APPLIANCES - I

Principle and Design: Electric iron Box- Ceiling fan - Table fan-Water Heater–Types-Wet Grinder-Mixer Grinder

UNIT-V: ELECTRICAL APPLIANCES -II

Principle and Design: Laser Printer-Refrigerator-Washing Machine–Semi and Fully Automatic-Top and Front loading-washing technique-Air Conditioner- Microwave Oven

Books for study

1. Theraja B.L, A text book in Electrical Technology, S. Chand & Co., New Delhi, 2013
2. Metha V.K, Principles of Electronics, S. Chand & Co, New Delhi., 2001.
3. Sedha R.S, A Text Book of Digital Electronics, S. Chand & Co., Ltd., New Delhi,2010
4. Bali S.P, Consumer Electronics, Pearson, 2004

Books for reference

1. Bagde and Singh, Elements of Electronics, S. Chand & Co., New Delhi, 2000.
2. Mitchel Schultz, Grob's Basic Electronics, McGraw Hill NY,2010.

Website references

1. https://www.allaboutcircuits.com/textbook/reference/chpt-2/resistor-color-codes/
2. https://www.youtube.com/watch?v=SjlnW5g9np4
3. https://circuitglobe.com/difference-between-single-phase-and-three-phase.html
4. https://www.youtube.com/watch?v=r_DGW3OrPVg
5. https://www.youtube.com/watch?v=NNkoAJkXUAw
6. https://www.slideshare.net/ideseditor/533-28626238
7. https://en.wikipedia.org/wiki/Semiconductor
8. https://www.youtube.com/watch?v=CjAVfW_6juw
9. https://www.youtube.com/watch?v=7HiNABH1kYE
10. https://mrwashingmachine.in/working-principle-of-washing-machine/

Semester-IV

Electronic Instrumentation Techniques

Electronic Instrumentation Techniques

Semester-IV **Hours/week: 5**

Sub. Code: P1015

Credits: 4

Course objectives:

1. To expose the students to the principles and working of Transducers
2. To make the students to understand the digital instrumentation used in measurement of various physical quantities.
3. To make the students to understand the working of electrical and magnetic measurement instruments and to provide basic knowledge about the working of Compositional analysis instruments and Bio-medical instruments.
4. To impart the knowledge on analytical instrumentation for the identification of various elements.
5. To make the students on the application of various instrumentation used for the measurement of potentials developed by the body cells including ECG, EMG etc

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand the principles and working of Transducers and Analog and Digital Instruments used in measurement of various physical quantities.	K1-K2
CO 2	Distinguish the analog and digital instrumentation and its working principle.	K1-K3
CO 3	Apply the knowledge of electrical and magnetic property of the material in the measurement of conductivity	K1-K2
CO 4	Understand the difference in the approach of absorption and emission property of radiation in detecting the elements of the surface and also the emission of electrons.	K1-K3
CO 5	Acquire the knowledge of blood pressure, potentials produced by the cells of various organs including heart, muscle, brain and its measurement.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	3	1	2	3	3	2	1	2.2
CO2	3	2	2	1	2	1	3	2	2	3	2.1
CO3	2	3	2	3	2	1	2	3	2	2	2.2
CO4	2	3	3	1	2	3	2	3	1	2	2.2
CO5	3	2	2	1	3	2	2	3	1	2	2.1
Mean Overall Score											2.2
Results											High

Unit – I: Transducers

Transducers -Classification of Transducers –factors for selection of a transducer- Principle, construction and working of Thermistor and LVDT, Electrical strain gauges and capacitive transducers : change in area of plates and change in distance between plates, Advantages and disadvantages of capacitive transducers- Hall effect transducer - Photovoltaic transducer, Photo emissive transducer, Moving coil type velocity transducer- Sesmic type velocity transducer- Measurement of pressure using resistive transducer.

Unit – II: Digital Instrumentation

Principle, block diagram and working: Ramp type digital voltmeter, potentiometric type digital voltmeter - Digital Multimeter, digital LCR meters, digital pH meter, digital conductivity meter and digital storage Oscilloscope – introduction to virtual instrumentation, Supervisory control and data acquisition.

Unit - III: Electrical and Magnetic Measurements Instrumentation

Principles and Experimental techniques: AC and DC Photoconductivity measurement (method name)- Electrical Conductivity and Resistivity measurement by Vanderpauw four probe method - dielectric measurement, Vibrating Sample Magnetometer and magnetic susceptibility measurement by Gouy's method.

Unit – IV: Analytical Instrumentation techniques

Principles and Experimental techniques: X-ray Photoelectron Spectroscopy (XPS),Auger Electron Spectroscopy, Atomic Absorption Spectroscopy, Atomic Emission Spectroscopy, Flame Photometry-SIMS, CHNS.

Unit – V: Bio-Medical Instrumentation

Introduction- Origin of bioelectric signals-Action and resting potential - Physiological transducers to measure blood pressure, Hb meter, Blood cell counters-Bio potential electrodes- types – bio potential recorders - block diagram – ECG - waveform – electrodes and leads – Einthoven triangle – block diagram - EEG- EMG - CT scanners .

Text books

1. Kealey D. and Haines P. J., Analytical chemistry, Viva Publications, New Delhi, 2002.
2. Lakshmi Rekha R., Ravikumar C., Biomedical Instrumentation and Medical electronics, Lakshmi Publications, Chennai, 2009.
3. Douglas A.Skoog, F.James Holler, Timothy A.Nieman, Principles of Instrumental Analysis, Harcourt College publishers, 5th edition, 2001.
4. Rajendra Prasad, Electronic Measurements and Instrumentation, Khanna Publications, Chennai, 2004.
5. Ramambhadran S., Electronic Measurements and Instrumentation, Khanna Publications, Chennai, 2003.
6. R.S. Khandpur "Handbook of Biomedical Instrumentation",2nd Edition, Tata McGraw Hill, 2003.

Books for Reference

1. Cooper W. D. and Helfrick A. D., Electronic Instrumentation and Measurement Techniques, First edition, Dorling Kindersly *Pvt. Ltd. India, 2009.*
2. Bouwens A. J., Digital instrumentation, McGraw Hill international, New Delhi, 2002.
3. Robert B. Northrop, Analysis and Application of Analog Electric Circuits to Biomedical instrumentation, CRC press, Noida, 2004.

Websites for Reference

1. http://www.sjsu.edu/faculty/selvaduray/page/papers/mate210/thinfilm.pdf
2. http://www.leapsecond.com/pdf/an200.pdf
3. http://academic.amc.edu.au/~hnguyen/JEE326_10/lecture03.pdf
4. http://www.eng.hmc.edu/NewE80/PDFs/SensorsAndTransducers2012.pdf
5. http://en.wikipedia.org/wiki/Secondary_ion_mass_spectrometry
6. http://www.casaxps.com/help_manual/XPSInformation/XPSInstr.htm
7. http://en.wikipedia.org/wiki/X-ray_photoelectron_spectroscopy
8. http://www.eaglabs.com/mc/rbs-instrumentation.html
9. http://www-pub.iaea.org/MTCD/publications/PDF/te_1190_prn.pdf
10. http://www-odp.tamu.edu/publications/tnotes/tn30/tn30_10.htm
11. http://www.rsc.org/images/CHNS-elemental-analysers-technical-brief-29_tcm18-214833.pdf
12. http://cdn.intechopen.com/pdfs/26275/InTech-Atomic_absorption_spectrometry_aas_.pdf
13. http://www.intechopen.com/books/atomic-absorption-spectroscopy
14. http://biomedikal.in/2010/01/short-and-precise-lecture-notes-on-ecg-electrocardiogram/

Semester-IV

Modern Physics Practicals

Nuclear and Particle Physics

Semester-IV **Hours/week: 5**

Sub. Code: P1016

Credits: 4

Course objectives:

1. To provide brief introduction on the basic concept of nucleus including size, force and nuclear models
2. To impart the knowledge on two body system and nuclear interaction.
3. To provide an in-depth knowledge on types of nuclear reactions and its relation
4. To enhance the knowledge about various fundamental particles, their decay and transitions.
5. To make the students to understand about the basic ideas on elementary particles and its classifications and interaction of quarks

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Differentiate the different models of the nucleus and apply their idea in calculating the parameters theoretically.	K1-K3
CO 2	Solve the two body problems in connection with nuclear interaction	K1-K2
CO 3	Be able to identify the reason behind the mode of decay, transitions between the nuclear decays and have strong physical reasoning and problem solving skill and able to find solutions to the problems related with nuclear physics	K1-K3
CO 4	Be able to demonstrate the different types of nuclear reaction and its applications in day today life including nuclear fission, fusion and its role in the construction of nuclear reactor.	K1-K3
CO 5	Be able to explain the basic concept of elementary particles based on the combination quarks projection and also acquire knowledge on strong and weak interaction.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	3	3	2	3	2	3	1	2.4
CO2	3	1	3	2	2	3	3	2	2	3	2.4
CO3	1	2	3	3	2	2	2	3	1	2	2.1
CO4	2	3	2	2	3	1	1	2	2	3	2.1
CO5	3	2	1	3	2	3	2	2	3	2	2.3
Mean Overall Score											2.3
Results											High

Unit– I: Nucleus and Nuclear Models

Basic properties: Nuclear size, shape, charge distribution, spin, parity, binding energy-Magnetic dipole moment-Electric quadrupole moment-Nuclear models:Liquid drop model-Semi-empirical mass formula of Weizsacker-Application-Nuclear stability-Mass parabolas- -Shell model-Magic numbers-Spin-Orbit coupling-validity and limitations - Angular momenta and paritiesof nuclear ground state- qualitative discussion and estimation of transition rates-Magneticmoments -Collective model of Bohr and Mottelson.

Unit – II: Nuclear Interactions

Nuclear forces-characteristics-Two body problem- Deuteron-properties-Ground state ofdeuteron using square well potential -Magnetic moment-Quadrupole moment-Tensor forces-Meson theory of nuclear forces-Yukawa potential-Nucleon-nucleon scattering:Low energy npscattering-Effective range theory-Spin dependence, charge independence and chargesymmetry of nuclear forces.

Unit – III: Nuclear reactions and fission

Types of nuclear reactions, Quantum mechanical theory, Resonance scattering and reactions — BreitWigner dispersion relation; Compound nucleus formation and break-up, Statistical theory of nuclearreactions and evaporation probability, nuclear fission: Spontaneous fission- **Bohr-Wheeler theory of fission**-barrier penetration-statistical model. Elementary ideas about astrophysical reactions, Nucleosynthesis and abundance ofelements.

Unit – IV: Nuclear Decay

Elementary ideas of α, β and γ decay -Fermi's theory of beta decay-Fermi-Kurie plot-Fermiand Gamow-Teller selection rules for allowed and forbidden decays-Non-conservation ofparity-Decay rates- Theory of electron capture- Theory of neutrino- neutrino detection–Originof Gamma decay-energetics of gamma decay-Multipole transitions in nuclei-Internalconversion- Nuclear isomerism-Angular correlation in successive gamma emissions.

Unit – V: Particle Physics

Elementary particles- Classification of elementary particles-Types of interactions betweenelementary particles- Conservation laws – quantum numbers-**The problem of mass generation and the need forthe Higgs mechanism** - Elementary ideas of CP and CPT invariance-Hadrons-Classification of Hadrons- Symmetry-SU(2)-SU(3). **Quarks; Colour; Gell-Mann –Okubo mass relation.**

Text Books

1. Thayal D.C., Nuclear Physics, Himalaya Publishing house, Mumbai, 2011.
2. Goshal S. N., Nuclear Physics, S. Chand Publications, New Delhi, 2004.
3. S L Kakani Shubra Kakani, Nuclear and Particle Physics,2nd edition, VIVA books company India Ltd, 2008.
4. Suresh Chandra and Mohit K Sharma "Nuclear and Particle Physics"Narosa Publishing company, 2012.

Books for Reference

1. Roy R. R. and Nigam B. P., Nuclear Physics, New age international Ltd., New Delhi 2005.
2. Devanathan V., Nuclear Physics, Narosa publishing House Pvt. Ltd, New Delhi, 2006.
3. Hans H. S., Nuclear Physics Experimental and Theoretical, New Age International (P) Limited Publishers, New Delhi, 2001.
4. Bernard L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill Publishing, New Delhi, 2002.
5. Irving Kaplan, Nuclear Physics, Narosa publishing House Pvt. Ltd, New Delhi, 2002.
6. Santra A. B., Kailas S and Bhalerao R. S, Mesons and Quarks, Narosa publishing House Pvt. Ltd, New Delhi, 2004.
7. SatyaPrakash, Nuclear Physics and Particle Physics, Sultan Chand, 2005.
8. V K Mittal, R C Verma, S C Gupta, Introduction to Nuclear and Particle Physics3rd edition - Prentice hall India learning P(Ltd),2013.

Websites for Reference

1.http://www.sjsu.edu/faculty/watkins/nuclearstruct.htm
2.http://en.wikipedia.org/wiki/Nuclear_shell_model
3.http://www.sjsu.edu/faculty/watkins/semiempirical.htm
4.http://www.physics.lancs.ac.uk/people/kormos/P235_1b.pdf
5.http://library.thinkquest.org/3471/nuclear_forces.html
6.http://www.physicshandbook.com/topic/topicn/nuclearf.htm
7.https://www2.lbl.gov/abc/wallchart/chapters/03/0.html
8.https://www.britannica.com/science/radioactivity
9.https://www.quantamagazine.org/a-new-map-of-the-standard-model-of-particle-physics-20201022/
10. http://www.ucolick.org/~woosley/ay220-15/lectures/lecture5.4x.pdf

Semester-IV

Microprocessor and C Programming Experiments

Microprocessor, Microcontroller and C Programming Experiments

(Any 20 out of the given 25)

Semester - IV **Hours/week: 5**

Sub. Code: PP1009

Credits: 6

Course objectives:

1. To develop the skill of understanding Instruction sets and opcode of 8085 microprocessor and 8051 Microcontroller.
2. To familiarize the students with interfacing with 8085 microprocessors to other Input/ output devices.
3. To enable students to write assembly language programs for software and interfacing devices.
4. To familiarize the students about the C programming.
5. To analyze and evaluate the various theories, statistical methods and mathematical techniques using C programming.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Write assembly level language programs for both software and hardware interfacing using 8085 microprocessors.	K1-K4
CO 2	Write an assembly level language programs for software and hardware interfacing using 8051 microcontrollers.	K1-K4
CO 3	Understand the different applications of microprocessor and microcontroller.	K1-K4
CO 4	Develop C programs using the basic elements like control statements, arrays, strings and functions.	K1-K3
CO 5	Use appropriate mathematical techniques and concepts to obtain quantitative solutions to problems in Physics using C program.	K1-K4

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	1	2	3	2	3	2	3	2.5
CO2	3	3	3	3	2	2	3	3	1	2	2.5
CO3	3	3	2	3	2	3	3	2	3	3	2.7
CO4	3	2	3	2	2	3	3	2	2	3	2.5
CO5	3	3	3	3	2	3	3	1	3	2	2.6
Mean Overall Score											2.6
Results											High

List of Experiments:

Microprocessor and interfacing Programming

1. Number conversion -8 bit: BCD to Binary, Binary to BCD, Hex to ASCII using 8085.
2. Number conversion -16 bit: BCD to Binary(HEX), Binary(HEX) to BCD using 8085
3. Square and square root of BCD and HEX numbers 8 bit 8085.
4. Time delay subroutine and a clock program using 8085
5. Double and Triple precision addition and subtraction subroutine using 8085.
6. Sum of Arithmetic operation using 8085 MPU
7. Switching an array of LEDs by using 8085.
8. ADC and interfacing 0809 with MPU.
9. Analog to digital conversion using a DAC Comparator and MPU system.
10. DAC interface- wave form generation using CRO - ramp, square wave. Rectangular wave, Triangular wave and Step up followed by step down.
11. Interfacing a DC stepper motor to the MPU system - clockwise and anticlockwise - full stepping and half stepping.
12. Serial and parallel communication between two 8085 Microprocessors.
13. Interfacing Traffic controller using 8085 MPU.

Microcontroller 8051

1. Interfacing Traffic controller using 8051.
2. Interfacing seven segment displays with 8051.
3. Interfacing a Stepper motor to 8051.
4. Wave form generation using 8051.
5. Finding the sum of two numbers in decimal using 8051.
6. Addition, Subtraction, Multiplication and Division using 8051.

C Programming

1. Lagrange's interpolation.
2. Numerical integration by Trapezoidal rule.
3. Solution of a polynomial equation by Newton Raphson method.
4. Curve fitting - Least square fitting-Straight line fit.
5. Matrix multiplication

Numerical Integration by Simpson's rule.

Semester-IV

Modern Optics

Elective: Modern Optics

Semester-IV **Hours/week: 4**

Sub. Code: P1017A

Credits: 4

Course objectives:

1. Provide a thorough foundation in the optical physics of both second order and third order nonlinear optical phenomena.
2. Understand nonlinear phenomena from the fundamental perspective of quantum mechanics.
3. To understand third order nonlinear optical phenomena of the materials.
4. To expose the students to the optical fiber communication systems and to explain the importance and advantages of optical fiber communications, basic problems and possible mitigations.
5. To understand the fundamentals of optical properties of materials for various applications.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Predict the frequencies generated by a nonlinear optical process	K1-K3
CO 2	Understand stimulated Raman and Brillouin scattering	K1-K2
CO 3	Estimate the upper bound of optical power in silica fiber due to nonlinearity	K1-K3
CO 4	Recall the basic structure of an optical fiber and the pulse propagation in optical fibers and also can explain the various types of dispersions in optical fibers and their mitigations by deploying various types of optical fibers	K1-K3
CO 5	Obtain knowledge about optoelectronic materials, their properties and applications.	K1-K2

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	3	3	2	2	1	2.3
CO2	2	2	3	2	2	2	2	2	3	2	2.2
CO3	3	2	3	1	2	3	2	3	2	2	2.3
CO4	2	3	2	3	1	2	3	2	3	1	2.2
CO5	3	2	2	2	1	3	3	2	2	1	2.1
Mean Overall Score											2.2
Results											High

Unit 1: Principles of Lasers:

Emission and absorption of Radiation –Einstein Relations, pumping Mechanisms – Optical feedback - Laser Rate equations for two, three and four level lasers, pumping threshold conditions, Laser modes of rectangular cavity - Laser Systems: Gas, Liquid and Solid Lasers-Gas lasers and Energy level schemes: Argon, CO_2 Gas lasers- Applications. Solid State lasers: Neodymium - Ti-Sapphaire Lasers – Dye lasers- Applications.

Unit - II: Non-linear Optics

Linear optics - Wave propagation in isotropic and anisotropic media – Polarization response of materials to light – Nonlinear Wave Propagation – three wave mixing - nonlinear susceptibility - second harmonic generation – Kurtz and Perry method - sum and difference frequency generation – optical parametric oscillation.

Unit - III: Third order Non-linear process

Electro-optic (Pockels) effect – Electro optic Modulators - four wave mixing - third harmonic generation - nonlinear index of refraction - self focusing - self phase modulation – cross phase modulation - short pulse generation - z scan – open aperture and closed aperture scans - Quadratic electro-optical (Kerr) effect - stimulated Raman scattering - stimulated Brillouin scattering.

Unit –IV Fiber Optics

Optical fibers – basic structure – light propagation in a step index fiber – conditions – linear effects – attenuation – measuring attenuation – dispersion – inter and intra – fiber modes – V-parameter – mode field diameter - Mitigations to Linear Effects Novel Fibers: Mitigations to attenuation – repeaters – optical amplifier – semiconductor optical amplifier – Erbium doped fiber amplifier – fiber Raman amplifier – mitigations to dispersion – dispersion shifted fiber – nonzero dispersion shifted fiber – dispersion flattened fiber – dispersion compensating fiber. Fiber Bragg grating – Dispersion compensation –Photonic crystal fiber – Photonic Devices.

Unit V: Optoelectronic Materials

Optical and Optoelectronic Materials - Principles of photoconductivity – simple models – effect of impurities – principles of luminescence – types and materials.

Applications: LED materials – binary, ternary photo electronic materials – Optical storage materials – LCD materials – photo detectors – applications of optoelectronic materials.

Books for Study

1. R. Murugesan, KiruthikaSivaprasath, Modern Physics, S. Chand publisher, New Delhi, 2016.
2. AjoyGhatak K. Thyagarajan, **Fiber Optics and Lasers: The Two Revolutions, Infinity Press, 2016.**
3. Hechst, Optics, Pearson Education, 2008.
4. Robert W. Boyd, Nonlinear Optics, 3rd Edition, Academic Press, 2008.
5. G. P. Agarwal, Nonlinear Fiber Optics,4th edition, Academic press , 2007.
6. **S. Mogan, Fiber Optics and Laser Instrumentation,** MJP Publishers, 2019.
7. Kittel C, Introduction to Solid State Physics, 8th Edition, Wiley Eastern, New International Publishers, 2005.

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1. G.R.Fowles, Introduction to modern optics, Cambridge University Press, 2005.
2. Ter-Mikirtychev, Vartan, Fundamentals of Fiber Lasers and Fiber Amplifiers,Springer press, 2014.
3. AjoyGhatak, Optics, McGraw Hill Education India Private Limited, 2017
4. N. Bloembergen, Nonlinear Optics, 4th edition, World Scientific, 1996.
5. R. L. Sutherland, Handbook of Nonlinear Optics, 2nd edition, Marcel Dekker press, 2003.
6. Y. R. Shen, Principles of Nonlinear Optics, Wiley publishers, 1984.
7. P. E. Powers , Fundamentals of Nonlinear Optics, CRC Press, 2011.
8. *Liang Dong, Bryce Samson, Fiber Lasers Basics, Technology, and Applications,CRC Press, 2016.*

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1. https://www-sciencedirectcom.libproxy1.usc.edu/book/9780123694706/nonlinear-optics
2. https://www.sciencedirect.com/book/9780123970237/nonlinear-fiber-optics
3. https://www.cambridge.org/core/books/elements-of-nonlinearoptics/F6B3C66E6115CD3DE8F615DF16BBB47C
4. https://link-springercom.libproxy1.usc.edu/book/10.1007%2F978-3-540-46793-9
5. http://jonsson.eu/research/lectures
6. https://nptel.ac.in/courses/115101008/
7. https://electricalfundablog.com/optoelectronics-devices-applications/
8. https://www.laserfocusworld.com/lasers-sources/article/16550830/laser-diodes-and-leds-light-optoelectronic-devices
9. https://hithaldia.in/faculty/sas_faculty/Prof_A_B_Maity/Lecture%20Note_EI_503A.pdf
10. https://link.springer.com/chapter/10.1007/978-3-319-48933-9_33
11. http://www.fulviofrisone.com/attachments/article/404/Introduction%20to%20Modern%20Optics.pdf

Semester-IV

Reactor Physics

Elective: Reactor Physics

Semester-IV **Hours/week: 4**

Sub. Code: P1017B

Credits: 4

Course objectives:

1. To make the students to understand the concepts of nuclear reaction, cross section and chain reaction.
2. To make the students to differentiate between the types of neutrons produced in a nuclear reaction and the concept of neutron diffusion.
3. To provide an in-depth knowledge of fuels and materials used for the nuclear energy production.
4. To explain the concept of moderation of neutron in a nuclear reactor and its critical condition in the operation of a nuclear reactor
5. To provide an extravagant details on the types of nuclear reactors and it working principle.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand the basic ideas of nuclear reaction, cross section and the process of chain reaction.	K1-K2
CO 2	Identify and differentiate the various energy ranges of neutrons produced in a chain reaction and its diffusion property	K1-K3
CO 3	Explain and analyze the properties of fuels and materials used in a typical reactor	K1-K3
CO 4	Demonstrate the importance of neutron production and critical condition through diffusion equation	K1-K2
CO 5	Apply the knowledge chain reaction ,able to calculate the critical value for a typical nuclear reactor and understand the working concept of different reactors and their applications.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	3	2	2	3	1	2	2	2	2.1
CO2	2	1	2	2	3	1	3	2	2	3	2.1
CO3	2	2	3	2	3	2	3	2	2	2	2.3
CO4	3	2	2	2	1	2	3	2	2	2	2.1
CO5	3	2	2	2	2	2	2	2	2	3	2.2
Mean Overall Score											2.2
Results											High

Unit – I: Chain Reactions

Slow neutron reactions-nuclear reaction cross section-neutron cross section-determination of neutron cross section-attenuation of neutrons-macroscopic cross section and mean free path-neutron flux and reaction rate-energy dependence of neutron cross sections-fission cross section-neutron flux and reaction rate-energy dependence of neutron cross sections-fission cross section.

Unit – II: Thermal Neutrons and neutron diffusion

Energy distribution of thermal neutrons-effective cross section for thermal neutrons-the slowing down of reactor neutronsDiffusion – diffusion Equation- solution of diffusion equation for a point source in an infinite medium and for an infinite plane source in a finite medium -thermal diffusion Length- diffusion Length for a fuel-moderator mixture-fast neutron diffusion and Fermi age equation- Correction for neutron capture.

Unit – III: Nuclear fuels and structural materials

Nuclear Fuels: Introduction to Uranium, Plutonium and Thorium Fuels: Physical Properties, Ceramic Fuels: Ceramic Uranium Fuels, Uranium Dioxide (Urania), Uranium Carbide, Uranium Nitride, Plutonium-Bearing Ceramic Fuels, Thorium-Bearing Ceramic Fuels.

Fundamentals of iron carbon alloys and phase diagram, time temperature transformation diagram and heat treatments, special steels and their properties for nuclear reactor components, Pressure vessel steels, Nickel-base alloys-stellites.

Unit – IV: Neutron Moderation and Critical Equation

Energy loss in elastic collision - moderation of neutrons in Hydrogen - Space dependent slowing down - Moderation with absorption-Diffusion equation applied to a thermal reactor-thermal neutron source as obtained from the Fermi age equation-critical equation and reactor buckling-the non-leakage factors-criticality of large thermal reactors-critical equation for reactors with heterogeneous moderators-critical size and geometrical buckling-extrapolation length correction-effect of reflector.

Unit – V: Nuclear Reactors

Classification of reactors-Heterogeneous reactors-properties of heterogeneous system-resonance capture and resonance escape probability-calculation of the thermal utilization-resonance escape probability and fast fission factor-Commercial reactors: Pressurized Water Reactor (PWR)- Boiling Water Reactor (BWR)- Heavy Water Reactor (HWR)- Water Moderated Enriched Reactors- The breeder reactor- future of nuclear fission power.Generation-I, II, III, IV Reactors-Nuclear Reactors in India.

Text Books

1. John R. Lamarsh, Introduction to Nuclear Reactor Theory, Addison Wisley, 2002.
2. Samuel Glasstone, Milton C. Edlund, The Elements of Nuclear Reactor Theory, Van Nostrand, 1995.
3. James J Duderstadt,Louis J Hamilton, Nuclear reactor analysis,Wiley India Pvt Ltd,2013
4. Robert E.Masterson, "Introduction to Nuclear reactoir Physics" CRC Press, 1st edition 2018

Books for Reference

1. Thayal D.C., Nuclear Physics, Himalaya Publishing house, Mumbai, 2007.
2. Goshal S. N., Nuclear Physics, S. Chand Publications, New Delhi, 2004.
3. Bannet D. J. and Thomson J. R, The elements of nuclear power, Longman Scientific and Technical, New York, 1989.
4. Murray R. L., Nuclear Physics, 5th edition Butterworth, Heineman, 2001.

Websites for Reference

1. http://faculty.ksu.edu.sa/adokhane
2. http://www.studymode.com/essays/Reactor-Physics
3. https://en.wikipedia.org/wiki/Chain_reaction
4. www.ans.org/PowerPlants
5. www.world-nuclear.org/info/inf53.html
6. npcil.nic.in/main/AllProjectOperationDisplay.aspx
7. https://www.amacad.org/sites/default/files/academy/pdfs/nuclearReactors.pdf
8. https://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power reactors/advanced-nuclear-power-reactors.aspx
9. https://www.imetllc.com/training-article/phase-diagram/
10. https://www.tandfonline.com/doi/abs/10.1080/00223131.2016.1208593
11. https://www.coursera.org/lecture/ferrous-technology-2/iron-carbon-system-aUbv1

Semester-IV

Digital Signal Processing

Elective: Digital Signal Processing

Semester - IV **Hours/week: 4**

Sub. Code: P1017C

Credits: 4

Course objectives:

1. To introduce the basic principles of digital signal processing (DSP) and provide an understanding of the fundamentals, implementation and applications of DSP techniques.
2. To introduce signals, systems, time and frequency domain concepts and the associated mathematical tools those are fundamental to all DSP techniques.
3. To provide a thorough understanding and working knowledge of design, implementation, analysis and comparison of digital filters for processing of discrete time signals.
4. To impart the knowledge of spectral properties of discrete-time systems through the use of Discrete Fourier transform (FFT) of sequences.
5. To introduce various sampling techniques and different types of filters.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand the fundamental concepts such as linearity, time-invariance, frequency response, z-transforms and the discrete time Fourier transform as applied to discrete time signal processing systems.	K1-K3
CO 2	Understand the analytical tools such as Fourier transforms, Discrete Fourier transforms, Fast Fourier Transforms and Z-Transforms required for digital signal processing.	K1-K3
CO 3	Get familiarized with various structures of IIR and FIR systems.	K1-K2
CO 4	Design and realize various digital filters for digital signal processing.	K1-K3
CO 5	Familiarize with techniques of analysis of discrete-time signals and the use of Z-transforms	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	2	2	3	2	2	2.1
CO2	2	3	3	2	3	2	2	2	3	3	2.5
CO3	3	2	2	2	2	3	3	2	3	3	2.5
CO4	2	2	3	2	2	2	3	2	3	2	2.3
CO5	3	3	3	1	1	3	3	3	2	3	2.5
Mean Overall Score											2.4
Results											High

Unit-I: Introduction to DSP:

Signals, systems and signal processing, classification of signals, elements of digital signal processing system, concept of frequency in continuous and discrete time signals, Periodic Sampling, Frequency domain representation of sampling, Reconstructions of band limited signals from its samples

Unit-II: Discrete-Time Signals and Systems:

Z-transform & Inverse z-transform, Linear convolution and its properties, Linear Constant Coefficient Difference equations, Frequency domain representation of Discrete-Time Signals & Systems, Representation of sequences by discrete time Fourier Transform, (DTFT), Properties of discrete time Fourier Transform, and correlation of signals, Fourier Transform Theorems.

Unit-III: Structures for Discrete Time Systems:

Block Diagram and signal flow diagram representations of Linear Constant-Coefficient Difference equations, Basic Structures of IIR Systems, lattice and lattice-ladder structures, Transposed forms, Direct and cascade form Structures for FIR Systems, Linear Phase FIR structure, Effects of Co-efficient quantization.

Unit-IV: Filter Design Techniques:

Design of Discrete-Time IIR filters from Continuous-Time filters Approximation by derivatives, Impulse invariance and Bilinear Transformation methods; Design of FIR filters by windowing techniques.

Unit-V: Advance DSP Techniques:

Multirate Signal Processing: Decimation, Interpolation, Sampling rate conversion by rational factor Adaptive filters: Introduction, Basic principles of Forward Linear Predictive filter and applications such as system identification, echo cancellation, equalization of channels, and beam forming.

Books for Study

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", PHI learning 4th Edition, New Delhi, 2008.
2. Alan V. Oppenheim, Ronald W. Schafer, and John R. Buck, "Discrete-Time SignalProcessing" Pearson Education India,2nd Edition, 2013
3. P.RameshBabu, "Digital Signal processing", Scitech Publications, 2007.

Books for Reference

1. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing" PHI Learning, New Delhi, 1998.
2. Mitra, Sanjit K, Digital Signal Processing : A Computer Based Approach, 4th Edition, McGraw-Hill, 2011.
3. KuoSen M, Lee Bob H and TianWenshun, Real-Time Digital Signal Processing: Implementations and Applications, 2nd Edition, John Wiley, 2006.
4. Oppenheim Alan V, Schafer Ronald W, and Buck John R, Discrete-Time Signal Processing, 3rd Edition, Prentice-Hall, 2009.
5. Lapsley Phil, DSP Processor Fundamentals: Architectures and Features, IEEE Press, 1997.
6. Ackenhusen John G, Real Time Signal Processing: Design and Implementation of Signal Processing Systems, Prentice-Hall, 1999.

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2. https://www.tutorialspoint.com/digital_signal_processing/dsp_basic_ct_signals.htm
3. https://www.tutorialspoint.com/digital_signal_processing/dsp_basic_dt_signals.htm
4. https://www.tutorialspoint.com/digital_signal_processing/dsp_classification_ct_signals.htm
5. https://www.youtube.com/watch?v=6dFnpz_AEyA
6. https://www.youtube.com/watch?v=1mVbZLHLaf0
7. https://www.tutorialspoint.com/digital_signal_processing/dsp_static_systems.htm
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11. https://www.tutorialspoint.com/digital_signal_processing/dsp_discrete_fourier_transform_introduction.htm
12. https://www.tutorialspoint.com/digital_signal_processing/dsp_discrete_time_frequency_transform.htm
13. https://www.tutorialspoint.com/digital_signal_processing/dsp_z_transform_introduction.htm
14. https://www.tutorialspoint.com/digital_signal_processing/dsp_operations_on_signals_convolution.htm

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