SHRI G S INSTITUTE OF TECHNOLOGY & SCIENCE, INDORE

DEPARTMENT OF APPLIED PHYSICS & OPTOELECTRONICS

Date : 22th May 2019

Minutes of the meeting of Board of Studies held on 22th May 2019 at 3.30 pm

Meeting of Board of Studies (BOS) of Department of Applied Physics & Optoelectronics was held on 22th May 2019 at 3.30 pm in the board room of the department.

Following members attended the meeting:

1. Dr. (Mrs.) S. Kumbhaj	Chairman
2. Dr. (Mrs.) P. Sen, Dean, Faculty of Engg. Science,	External Member
3. Dr. J. T. Andrews	Member
4. Mr. Gireesh G. Soni	Member
5. Dr. Pragya Ojha	Member
6. Dr. Vipin Kaushik	Member
7. Dr. Fozia Aziz	Special Invitee
8. Dr. Vishakha Vibhute	Special Invitee

Following members could not attend the meeting

9. Dr. Shashi Prakash, Prof. & Head, Appl. Sc. & Instru. Engg., IET-DAVV	External Member
10. Ms. Nidhi Oswal	Member

The Chairman welcomed the new members of BOS. The deliberations of the meeting are as follows:

Agenda 1: To review and revise the scheme and syllabus of B.E. 1st Year course, if needed.
Agenda 2: To review and revise the scheme and syllabus of M.Sc. course, if needed.
Agenda 3: To review and revise the scheme and syllabus of M.Tech. course, if needed.
Agenda 4: Any other item with the permission of the Chair.

B.E. 1st Year (Physics)

The comments and suggestions given by Chairman, NBA accreditation committee during recent visit was considered seriously. After long discussions and considering the input from all stake holders, the syllabus of "Physics" course is updated. Also the course objectives and outcome to match with the PO/PSO of the UG programs of the Institute are also mapped. Old and modified syllabii are enclosed as Annexures - 1A and 1B, respectively.

As major changes are proposed, the paper code may be changed.

M.Sc. (Applied Physics)

Input from faculty members received on the following papers:

PH 19104: MATHEMATICAL METHODS & NUMERICAL ANALYSIS
Minor changes are done. The old and new syllabus are enclosed as Annexures - 2A and 2B, respectively.

PH 19204: SOLID STATE PHYSICS
The course content is revised to match with the modern and old text books available on the topic. The old and new syllabus are enclosed as Annexures - 3A and 3B, respectively.

PH 97205: ATOMIC AND MOLECULAR PHYSICS
Minor changes are proposed. The old and new syllabus are enclosed as Annexures - 4A and 4B, respectively.

As no students have papers pending on the above three M.Sc. Physics subjects and only minor changes are incorporated, there is no need to change the paper codes.

M.Tech (Optoelectronics)

The Scheme and Syllabus of M.Tech (Optoelectronics) courses are revised and approved in the previous Academic Council, hence no changes are proposed.

With the permission of Chair, the BOS also discussed on the Mission and Vision of the department. It is found that Mission and Vision of the department are matching with the Mission and Vision of the Institute. The course objectives, course outcome, student outcomes and performance indicators of all subjects were discussed and approved by members of BOS. The performance indicators is enclosed as Annexure -5 .

The session concluded with the vote of thanks to the chair.

Dr.(Mrs.) S. Kumbhaj
Chairman, BOS-Dept. of Appl. Phys. & OE
& Prof. & Head
Dept. of Appl. Phys. & OE
SGSITS, Indore

PH1000X - Physics											
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PH1000X	Physics	**3**	**1**	**2**	**30**	**70**	**20**	**30**	**4**	**1**	**5**

COURSE OBJECTIVES

CO #1 To provide knowledge and understanding capacity of basic, applied and modern physics.
CO #2 To generate attitude and interest to solve problems at macro, micro to nanoscale level systems.
CO #3 To update the knowledge of physics tools, instruments and techniques.
CO #4 To identify, conduct, formulate and solve engineering problems with the basics and applied knowledge of Physics.

COURSE CONTENTS

Unit-1. ***Electrodynamics & Special Theory of Relativity****: Gradient,, divergence and curl; significance. Maxwell's equations, em wave equations for plane waves in dielectric medium and free space, Poynting theorem; postulates of special theory of relativity, time dilation length contraction, twin paradox, mass-energy relation.*

Unit-2. ***Optics:*** *Principle of superposition. Conditions for sustained interference, Division of wavefront and amplitude, Newton's rings. Fresnel and Fraunhofer class of diffraction, diffraction at singlet, double and N (grating) slits. Rayleigh's criteria, resolving power of grating and telescope.*

Unit-3. ***Quantum Theory:*** *Planck's radiation formula, Ultraviolet catastrophe, Compton's effect, de Broglie's concept of matter waves, Heisenberg's uncertainty relations, Schrodinger's wave equation, Physical interpretation of wave function, Particle in a box..*

Unit-4. ***Lasers & Fiber Optics:*** *Spontaneous and Stimulated emission, components of lasers, Einstein's A & B coefficients, Population inversion, optical resonator, Ruby and He-Ne lasers; Classification of optical fiber, acceptance angle, numerical aperture, V-number, attenuation, FO communication system.*

Unit-5. Solid State Materials: *Crystalline and amorphous solids, crystal defects, covalent crystal, crystal bonds, Weidemann-Franz law, band theory, semiconductor devices- junction diode and light emitting diode.*

Text Books

1. N. Subramanyam and B. Lal : A Text book of Optics, (S. Chand, New Delhi) 2010.
2. A. Beiser, S. Mahajan, S. R. Choudhary : Concepts of Modern Physics, 6th Edition,(SIE, Tata-McGraw-Hill, New Delhi) 2012.
3. A. Ghatak : Optics, 4th Edition, (Tata McGraw-Hill, New Delhi) 2009.

Reference books

1. R.P. Feynman, R.B. Leighton and M.Sands : Feynman Lectures on Physics Vol. 1 -3 (Addison-Wesley, Delhi 1995).
2. W.H. Hayt : Engineering Electromagnetic, 5th Ed. (Tata-McGraw Hill, New Delhi) 1995.
3. M.N.O. Sadiku : Elements of Electromagnetic, 3rd Ed. (Oxford Press, New Delhi) 2000.
4. S.M. Sze, Physics of Semiconductor Devices (Wiley Eastern Ltd. New Delhi) 1982.

Course outcome

At the end of one-semester course, the students are armed with

CO #1 The knowledge of multiphysics to understand engineering problems

CO #2 The skills to use logic and attitude towards engineering problems with multiphysics implementation.

CO #3 The ability to use modern engineering physics techniques and tools including software.

Annexure-2A

PH 97108 : MATHEMATICAL METHODS & NUMERICAL ANALYSIS										
PH 97108	Mathematical Methods & Numerical Analysis	4	-	2	30	70	20	30	4	1	5

Proposed Objective – To impart knowledge about Fourier series and transforms and to make mathematical correlation among numerical interpretation of functions, derivatives and integrals.

Expected Outcome – Student will be likely to understand the basic signals and systems through properties of Fourier transform. With the help of numerical analysis and modern calculus, they can improve the logical ability for solving physical problems to mathematical problems.

1. Fourier Series and Integrals : Fourier series of period 2π and period T. Fourier half range cosine and sine series. Fourier integral. Fourier cosine and sine transforms and their applications in solution of diffusion and wave equations. Fourier transforms. Method of separation of variables in the solution of wave, diffusion and Laplace equations. Laplace transforms and it's inverse. Theorem on Laplace transform, Application to solve ordinary differential equations and simultaneous ordinary differential equations.
2. Special Functions : Legendre, Bessel, Hermite and Legauree differential equations and their properties. Recurssion relations, orthogonal properties, Generating functions.
3. Complex variables : Analytic function, Cauchy-Riemann equations, conjugate functions. Cauchy's integral theorem and Cauchy's integral formula. Taylor's and Laurents series. Singularities, poles. Residues and residue theorem Elementary conformal mapping.
4. Numerical computation : Introduction, number systems and errors, floating point arithmetic, numerical instability. Transcendental and polynomial equations : Newton Raphson method, multipoint integration method, method for complex roots, polynomial equations – the Birge Vieta methods, Graeffe's root squaring method.
5. Differentiation and integration : Numerical differentiation methods based on interpolation, finite differences and undetermined coefficients. Numerical integration – basic rules, Gaussian rules, composite rules. Romberg integration, double integration. The solution of differential equations : Mathematical preliminaries, simple difference equations, Runge Kutta methods.

References :

1. E. Kreyszing, Advanced Engineering Mathematics, 10th Ed. (Wiley India.) 2011.
2. B. L. Gupta, Mathematical Physics, 3rd Ed., 2004 (Vikash Publishing House Pvt. Ltd., New Delhi) 2004.
3. H.K. Dass and R. Verma, Mathematical Physics, 6th Revised (S. Chand Ltd., New Delhi) 2011.
4. L M.K. Jain, S.R.K. Lyengar and R.K. Jain, Numercial Methods for Sientific & Engineering Computation, 4th Ed. (New Age International Pvt. Ltd., New Delhi) 2003.
5. S.D. Conte & C.de Boor, Elementary Numerical Analysis : An Algorithm Approach, 3rd Ed. (McGraw Hill, USA) 1981.

Satya Prakash, Mathematical Physics (Sultan Chand & Sons., New Delhi) 2007

PH 97108: MATHEMATICAL METHODS & NUMERICAL ANALYSIS											
PH19104	Mathematical Methods & Numerical Analysis	4	-	2	30	70	20	30	4	1	5

Course Objectives:

CO1: To learn the fundamentals of Fourier series, Fourier and Laplace transforms, their inverse transforms.
CO2: To gain insight of curvilinear coordinates, vector algebra and their typical applications in physics.
CO3: To get introduced to Special functions and their recurrence relations for applicability in different areas of physics.
CO4: To have a good grasp of the basic elements of complex analysis.
CO5: To learn about special type of matrices and tensors that are relevant in physics.

Expected outcome: By the end of the course student will be able:
1. To expand functions in Fourier components and solve differential equations using Laplace transform.
2. To learn applications of Curvilinear coordinates, Special functions, Complex analysis, Matrices and Tensors in various streams of Physics.

1. **Integral Transforms:** Fourier series, Fourier integral theorem, Fourier transform, Parseval's identity – related problems – Laplace transform – convolution theorem – transform of derivates – application to ordinary differential equation.

2. **Vector calculus:** Introduction to vectors, gradient, divergence, and surface integral, Gauss's theorem, curl of a vector field and Stokes's theorem, orthogonal curvilinear co-ordinates, cylindrical and spherical polar co-ordinates, applications to hydrodynamics, heat flow in solids and electromagnetic theory.

3. **Special Functions:** Legendre, Bessel, Hermite and Legaure differential equations and their properties. Recursion relations, orthogonal properties, generating functions.

4. **Complex variables:** Analytic function, Cauchy-Riemann equations, Cauchy's integral theorem and Cauchy's integral formula. Taylor's and Laurents series, Singularities, poles, Residues and residue theorem, Elementary conformal mapping.

5. **Matrices and Tensor Analysis:** Definitions and types of matrices – solution of linear algebraic equations –characteristic equation and diagonal form – Cayley-Hamilton theorem – functions of matrices – application in solving linear differential equation. Cartesian tensor in three space, Curves in three space and Frenet Formula, General Tensor analysis.

References:

1. M.L. Boas, Mathematical Methods in the Physical Sciences, 3rd Ed.,2006 (Wiley,Inc)
2. B. L. Gupta, Mathematical Physics, 3rd Ed., 2004 (Vikash Publishing House Pvt. Ltd., New Delhi) 2004.
3. Arfken, Weber and Harris, Mathematical methods for Physicists, 7th edition (Academic Press, Elsevier) 2012.

4. Satya Prakash, Mathematical Physics (Sultan Chand & Sons., New Delhi) 2007.

Annexure-3A

PH 97208 : SOLID STATE PHYSICS											
PH 97208	Solid State Physics	4	-	2	30	70	20	30	4	1	5

Proposed Objective: The aim of this course is to give you an extended knowledge of the principles and techniques of solid state physics and the physical understanding of matter from an atomic view point. Fundamental theories are introduced and then extended to show the irrelevance to important applications in current -day technology and research.

Expected Outcome: The student will able to explain the fundamental concepts of matter, methods available to determine their structure and properties. They can apply the knowledge gained to solve problems in solid state physics using relevant mathematical tools.

1. X-ray crystallography : Basics of crystal structures, symmetry, reciprocal lattice, Bravis lattice, imperfection in crystals, crystal diffraction, deBroglie hypothesis, x-ray diffraction, Bragg's law, Brillouin zones, XRD, power XRD, rotation XRD, correction to Bragg's law. Vibrations of crystals with monoatomic basis, two atoms per primitive basis, quantization of elastic waves, phonon momentum, phonon heat capacity, density of states in 1D and 3D.
2. Free electron Fermi gas : Energy levels and density of orbitals in one and three dimensions, effect of temperature on Fermi Dirac distribution, electron transport phenomena and recombination, heat capacity of an electron gas, electrical conductivity and Ohm's law, electron motion in a magnetic field and hall effect thermal conductivity of metals.
3. Superconductivity : Occurrence ad destruction of superconductivity by magnetic fields ; Meissner effect energy gap and isotop effect ; thermodynamics of superconducting transitions, Londou equation, coherence length, elementary ideas of BCS theory, flux quantization, type II superconductors, single particle tunneling, DC and AC Josephson effects ; elementary idea about high Tc superconductivity.
4. Energy bands and semiconductor crystals : Nearly free electron model, Bloch functions, Kroning-Penney model, wave equation of electron in a periodic potential number of orbitals in a band. Metals and insulators, Band-gap, equation of motion, intrinsic carrier concentration, impurity conductivity.
5. Dielectric function of the electron gas, plasmons, electrostatic screening, polaritons, electron-electron interaction, Polarons, Optical reflectance, excitons, optical properties of semiconductors. Radiant semiconductor interactions.

References

1. C. Kittel, Introduction to Solid State Physics, 5th Ed. (Wiley Eastern Ltd., New Delhi) 1993.
2. Verma and Shrivastava, Science of Engineering Materials –(Wiley Eastern Ltd., New Delhi) 1982.
3. S. M. Sze, Physics of Semiconductor Devices, (Wiley Eastern Ltd., New Delhi) 1993.
4. S. O. Pillai, Solid State Physics, (New Age International (P) Ltd., New Delhi) 1997.
5. R.L. Singhal, Solid State Physics, (Kedarnath Ram Nath Publishers, New Delhi) 2012.

Annexure – 3B

PH 97208 : SOLID STATE PHYSICS											
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PH 97208	Solid State Physics	4	-	2	30	70	20	30	4	1	5

Course objectives:

CO1: To understand basics of Crystallography and crystal diffraction.
CO2: To Gain insight of phonons and their dynamics, and to evaluate their dispersive and thermal properties.
CO3: To calculate thermal and electrical properties in the free-electron model.
CO4: To comprehend the basic concepts of superconductivity and related phenomena and its applications.
CO5: To understand the fundamental principles of semiconductors via energy band formation.

Expected Outcome: By the end of the course student will be able:
1. To explain the fundamental concepts of matter, methods available to determine their structure and properties.
2. To explain electronic and thermodynamic properties of solid state systems and their technological applications.

1. **X-Ray Crystallography** : Basics of crystal structures, symmetry, reciprocal lattice, Bravis lattice, imperfection in crystals, crystal diffraction, de-Broglie hypothesis, X-ray diffraction, Bragg's law, Brillouin zones, XRD, power XRD, rotation XRD, correction to Bragg's law.
2. **Lattice Vibrations**: Vibrations of one-dimensional monatomic and diatomic lattices, quantization of elastic waves, Normal modes and phonons, phonon momentum, Review of Debye's theory of lattice specific heat, density of states in 1D and 3D.
3. **Free electron Fermi gas :** Energy levels and density of orbitals in one and three dimensions, effect of temperature on Fermi Dirac distribution, electron transport phenomena and recombination, heat capacity of an electron gas, electrical conductivity and Ohm's law, electron motion in a magnetic field and hall effect thermal conductivity of metals.
4. **Superconductivity :** Occurrence ad destruction of superconductivity by magnetic fields; Meissner effect energy gap and isotope effect ; thermodynamics of superconducting transitions, London equation, coherence length, elementary ideas of BCS theory, flux quantization, type II superconductors, single particle tunneling. DC and AC Josephson effects; elementary idea about high T_c superconductivity.
5. **Energy bands and semiconductor crystals:** Nearly free electron model, Bloch functions, Kroning-Penney model, wave equation of electron in a periodic potential number of orbitals in a band. Metal, insulator and semiconductors. Band-gap, Intrinsic and extrinsic semiconductors. Carrier concentration and Fermi levels of intrinsic and extrinsic semi-conductors Bandgap. Direct and indirect gap semiconductors.

References

1. C. Kittel, Introduction to Solid State Physics, 5th Ed. (Wiley Eastern Ltd., New Delhi) 1993.
2. S. O. Pillai, Solid State Physics, (New Age International (P) Ltd., New Delhi) 1997.
3. S. M. Sze, Physics of Semiconductor Devices, (Wiley Eastern Ltd., New Delhi) 1993.
4. R.L. Singhal, Solid State Physics, (Kedarnath Ram Nath Publishers, New Delhi) 2012.

5. S. M. Sze, Physics of Semiconductor Devices, (Wiley Eastern Ltd., New Delhi) 1993.

PH 97205 : ATOMIC AND MOLECULAR PHYSICS											
PH 97205	Atomic and Molecular Physics	**4**	**-**	**2**	**30**	**70**	**20**	**30**	**4**	**1**	**5**

Proposed Objective: Atomic and molecular physics describes the structure of atoms and molecules on the basis of quantum mechanics. The course will develop the in depth understanding of various aspects of the simple atoms, diatomic molecules, their electronic states, vibrations and rotations spectra. This simple model is the conceptual basis of magnetic resonance and of coherent optics.

Expected Outcome: The student will able to understand the electronic structure of atoms and molecules and will be able to explain how these will interact with electromagnetic waves. They can also establish the principles of magnetic resonance, Raman spectra and X-ray optics.

1. Production and analysis of spectrum : Methods of production of emission and absorption spectra, spectra of atoms and molecules, ultraviolet and infrared spectroscopic techniques, Luminescence and fluorescence spectra.
2. Atomic spectra : Hydrogen spectrum, electron spin and vector atom model, pauli's principle, doublet fine structure of alkali elements normal and anomalous Zeeman effect, explanation, stern Gerlac's expt., selection and intensity rules, various coupling schemes.
3. Hyperfine and x-ray spectra : Hyperfine spectra of atoms and explanation, nuclear magnetic resonance, nuclear quadrupole resonance, electron spin resonance techniques, characteristic and continuous X-ray spectra, Moseley's law, spin and relativity doublets, explanation, Paschene back and Stark effect.
4. Molecular spectra : Molecular spectra of diatomic molecules, rotation, vibrationa and electronic bands, isotropic effect and spin effect of the nucleus, anharmonicity of spectra, intensity of rotation, vibration and electronic bands.
5. Raman spectra : Raman spectroscopy, Raman spectra, stokes and antistokes lines, explanation, application of Raman spectra for molecular studies. Laser Raman spectroscopy.

References

1. M.C. Gupta, Atomic & Molecular Spectroscopy, (New Age International (P) Ltd. New Delhi) 2001.
2. Rajkumar, Atomic and Molecular Spectra : Laser, 5th Ed. (Kedarnath Ramnath Pub. Ltd., New Delhi) 2012.
3. S. L. Gupta, V. Kumar and R.C. Sharma, Elements of spectroscopy, 2nd Ed. (Pragati Prakashan, New Delhi) 1973.
4. J. B. Rajan, Atomic Physics, (S. Chand & Co., New Delhi) 1960.
5. P. F. Bernath, Spectra of Atoms of Molecules, 2nd Ed. (OXFORD Univ. Press, New York) 2005.

PH 97205 : ATOMIC AND MOLECULAR PHYSICS

PH 97205	Atomic and Molecular Physics	4	-	2	30	70	20	30	4	1	5

Course Objective (CO):
1. To relate quantum mechanics for structural understanding of atoms and molecules.
2. To demonstrate vibrational, rotational and electronic states spectra of atoms and molecules.
3. To learn the nuclear spin for the understanding of hyperfine spectra of atoms and molecules.
4. To bring the understanding of X-ray and Raman spectra.

Expected Course Outcome (ECO): By the end of the course the students will able
1. To understand the electronic structure of atoms and molecules
2. To explain how the atoms and molecules interact with electromagnetic waves.
3. To establish the principles of magnetic resonance, Raman and X-ray spectra.
4. To solve the problems attributed to the vibrational, rotational and electronic states transition of atoms.

1. **Production and analysis of spectrum:** Methods of production of emission, absorption, luminescence and fluorescence spectra. Spectra of atoms and molecules, Hydrogen and He atom spectra.
2. **Atomic spectra:** vector atom model (spin and angular momentum), L-S and J-J coupling schemes. Fine structure of alkali elements, normal and anomalous Zeeman effect, Stern Gerlac's experiment, Paschene back and Stark effect.
3. **Hyperfine and x-ray spectra:** Hyperfine spectra of atoms and explanation, nuclear magnetic resonance, nuclear quadrupole resonance, electron spin resonance techniques, characteristic continuous X-ray spectra, Moseley's law, spin and relativity doublet.
4. **Molecular spectra:** Molecular spectra of diatomic molecules, rotation, vibrationa and electronic bands, isotropic effect and spin effect of the nucleus, anharmonicity of spectra, intensity of rotation, vibration and electronic bands.
5. **Raman spectra:** Raman spectroscopy, Raman spectra, stokes and antistokes lines, explanation, application of Raman spectra for molecular studies. Laser Raman spectroscopy.

References

1. M.C. Gupta, Atomic & Molecular Spectroscopy, (New Age International (P) Ltd. New Delhi) 2001.
2. Rajkumar, Atomic and Molecular Spectra: Laser, 5th Ed. (Kedarnath Ramnath Pub. Ltd., New Delhi) 2012.
3. S. L. Gupta, V. Kumar and R.C. Sharma, Elements of spectroscopy, 2nd Ed. (Pragati Prakashan, New Delhi) 1973.
4. J. B. Rajan, Atomic Physics, (S. Chand & Co., New Delhi) 1960.
5. P. F. Bernath, Spectra of Atoms of Molecules, 2nd Ed. (OXFORD Univ. Press, New York) 2005.