जम्मू केंद्रीय विश्वविद्यालय
Central University of Jammu
राया-सुचानी (बागला), जिला: सांबा - 181143, जम्मू-कश्मीर, भारत
Rahya-Suchani (Bagla), District: Samba – 181143, Jammu & Kashmir, India
भौतिकीऔरखगोलीयविज्ञानविभाग/ **Department of Physics and Astronomical Sciences**

संख्या-CUJ/DPHY/2024/ 137 12 **अप्रैल, 2024**

The Dean
School of Basic and Applied Sciences
Central University of Jammu
Rahya-Suchani (Bagla)

Sub: Submission of Minutes of the 10th meeting of Board of Studies-Reg.

Sir

Please find enclosed Minutes of the 10th meeting of Board of Studies of the Department of Physics and Astronomical Sciences held on 15.03.2024. It is requested that the items may be approved in anticipation to the School Board School of Basic and Applied Sciences and forward the same to the Academics section for notification please.

Thanking you

भवदीय
12/4/24.

Head/अध्यक्ष
Deptt. of Physics
& Astronomical Sciences

प्रमुख/Head भौतिकी एवं खगोलीय विज्ञान विभाग
Deptt. of Physics and Astronomical Sc.
जम्मू केन्द्रीय विश्वविद्यालय, साम्बा
Central University of Jammu, Samba

Approved in anticipation of coming School Board. forwarded for n/a please
12/4/24.
(Prof. Vinay Kumar)
अधिष्ठाता/Dean
आधारिक एवं अनुप्रयुक्त विज्ञान विद्यालय
School of Applied Sciences
Central University of Jammu
Dean, Academics

Central University of Jammu

Department of Physics & Astronomical Sciences

10th Board of Studies

Agenda and Minutes of Meetings

Date: March 15, 2024

जम्मू केंद्रीय विश्वविद्यालय

Central University of Jammu

राया-सूचानी (बागला),साम्बा-181143, जम्मू (जम्मू और कश्मीर)

Rahya-Suchani (Bagla), Samba-181143, Jammu (J & K)

Agenda

The agenda of the meeting was as follows:

Item No. 1
Approval of ATRs of 9th Meeting of Board of Studies held on 31.07.2023

Item No. 2
Approval of Course matrix and Syllabus for 5th and 6th semester as per NEP-2020 w.e.f. academic session 2022-23.

Item No. 3
Revision of course matrix scheme for Ph.D. coursework and addition of subject/research specific courses.

Item No. 4
Updation of the list of Panel of Paper Setter for B.Sc./M.Sc. and Examiners for Ph.D. thesis evaluation.

Item No. 5
Permission for pursuing the Ph.D. programme for JRF Mr. Ritvik Gupta working under SERB Research project of Prof. Suram Singh

Item No. 6
To consider the progress report of Ph.D. research scholars upto Dec 2023.

Item No. 7
Recognition of newly joined Faculty as Ph.D. supervisor.

Item No. 8
Approval for opting six (6) extra credits [4 from MOOC/SWAYAM and 2 from OEC] in addition to earlier approved credits for the Int B.Sc (H)-M.Sc. (IV) semester students of academic session 2023-24.

Minutes of the 10th Board of Studies, Department of Physics & Astronomical Sciences, Central University of Jammu, held on March 15, 2024

The 10th Board of Studies meeting was held in the Department of Physics & Astronomical Sciences, Central University of Jammu, Samba through online/offine mode on March 15, 2024. The following members were present in the meeting:

Member(s) of the Board of Studies

1.	Prof. Vinay Kumar Professor & Head of the Department of Physics & Astronomical Sciences	Chairman
2.	Prof. Suram Singh, Professor, Department of Physics & Astronomical Sciences, CU Jammu	Member and Dean Academics
3.	Prof. Kusum Kumari, Professor, Department of Physics & Astronomical Sciences, CU Jammu	Member
4.	Prof. Rajni Kant, Department of Physics, University of Jammu.	Subject Expert
5.	Prof. Pankaj Sharma, Applied Science Department National Institute of Technical Teachers Training & Research (NITTR), Chandigarh	Subject Expert
6.	Dr. Sujata Kundan, Assistant Professor, Department of Chemistry and Chemical Sciences	Member

Special Invitee:

7.	Dr. Uday Pratap Singh, Associate Dean Academics
8.	Dr. Ashish Kumar, Associate Professor, Department of Physics & Astronomical Sciences, CU Jammu
9.	Dr. Onkar Nath Verma, Assistant Professor, Department of Physics & Astronomical Sciences, CU Jammu
10.	Dr. Manvi Rajput, Assistant Professor, Department of Physics & Astronomical Sciences, CU Jammu

The members who have not attended the meeting due to their unavoidable reasons:

Prof. R. K. Puri, Department of Physics, Panjab University, Chandigarh	Subject Expert
Dr. Amit Tomar, Assistant Professor, Department of Physics & Astronomical Sciences, CU Jammu	Member

On behalf of the Board of Studies, Prof. Vinay, Head of the Department of Physics and Astronomical Sciences extended a warm welcome to external members of the Board of Studies,

Akundan Atish Rajni Kant Kusum Manvi Rajput

Prof Rajni Kant and Prof. Pankaj Sharma. He said the department is delighted to have you as part of our esteemed group and looks forward to working together towards the common goal of advancing our academic programs and enhancing the quality of education. He also welcomed and introduced new members Prof. Kusum Kumari, Dr. Ashish Kumar, Dr. Manvi Rajput and Dr. Onkar Nath Verma who have joined the Department of Physics and Astronomical Sciences, CUJ as regular faculty members. He believed that their unique experiences and diverse backgrounds will undoubtedly enhance our collective understanding and improve the outcomes of our endeavours. He also welcomed Dr. Uday Pratap Singh, Associate Dean Academics as a special invitee to the meeting and appreciated his valuable suggestions.
He said that member's contributions will enrich academic discussions and decision-making processes. He said that the department greatly appreciates the willingness of all individuals to share their time, talent, and dedication with us.
He encouraged everyone to actively participate, share their ideas, and engage in fruitful discussions.

All agenda items were thoroughly discussed, and the following decisions were pointed:

Item No. 1

Approval of ATRs of 9th Meeting of Board of Studies held on 31.07.2023

Item	ATR
Approval of ATRs of 9th Meeting of Board of studies held on 31-07-2023	Notification for Course matrix and Syllabus for Semester III and IV for the batch 2022-23 issued vide notification no. 181/2023 dated 20-11-2023 Link: https://drive.google.com/file/d/1h9HqiGXsFpmmPgguCUJ25rDF62OgMm83/view?usp=sharing MOM of BOS https://drive.google.com/file/d/1UPytYU3gOneaK3Ex3x1obT4ffv95Terg/view?usp=drive_link

Decision: The BOS approved the ATR of the 9th Meeting of the Board of Studies held on 31.07.2023.

Item No. 2

Approval of Course matrix and Syllabus for 5th and 6th semester as per NEP-2020 w.e.f. academic session 2022-23.

Semester – V

Course Code	Course	Type	Credits	Contact hours per week (L-T-P)
IPHY3C001T	Elementary Quantum Mechanics (Theory +Lab)	CC	3+1	3-0-2
IPHY3C002T	Solid State Physics (Theory +Lab)	CC	3+1	3-0-2
	Open Elective Course-9	OEC	4	3-1-0
	Open Elective Course-10	OEC	4	3-1-0
	Open Elective Course-11	AEC	4	3-1-0
	Total		20	

Semester – VI

Course Code	Course	Type	Credits	Contact hours per week (L-T-P)
IPHY3C003T	Introduction to Nuclear Physics (Theory +Lab)	CC	3+1	3-0-2
IPHY3C004T	Statistical Mechanics (Theory +Lab)	CC	3+1	3-0-2
	Open Elective Course-12	OEC	4	3-1-0
	Open Elective Course-13	OEC	4	3-1-0
	Open Elective Course-14	OEC	4	3-1-0

	Total		20	

List of Open Electives courses offered by the Department of Physics and Astronomical Sciences

Sr. No.	Level (UG/PG)	Course Name	Nature of Open Elective
1.	UG	Plasma Physics	OEC
2.	UG	Electromagnetic theory	OEC
3.	UG	Special theory of Relativity	OEC
4.	UG	Atomic and Molecular Physics	OEC
5.	UG	Nanomaterials and its applications	OEC
6.	UG	Energy conversion and storage system	OEC

Decision: The BOS recommended and approved the 5th and 6th Semester Course matrix and Syllabus for Integrated B.Sc.(H)-M.Sc. (Physics) programme detailed in Annexure I

Item No. 3
Revision of course matrix scheme for Ph.D. coursework and addition of subject/research -specific courses.

For Ph.D. batch 2021 and 2022, the course work is of a minimum 10 credits

S. No	Course	Credit	Marks
1	Research and Publication Ethics	2	50
2	Research Methodology	4	100
3	Subject Specific Paper*	4	100
	Total	10	250

*To be opted from an online platform/MOOC/NPTL or from a basket of departmental approved courses.

For Ph.D. batch 2023-24 onwards, the course work is of a minimum 12 credits

S. No	Course	Credit	Marks
1	Research and Publication Ethics	2	50
2	Research Methodology	4	100

3	Two Subject Specific Paper**	6	150
	Total	12	300

*To be opted from an online platform/MOOC/NPTL or from basket of departmental-approved courses.

The following courses are to be added to the basket of courses offered by the department for PhD course work:

S. No	Course title	Credits	Marks
1	Latex – Typesetting software	2	50
2	Solar Cells: Materials and Device Physics	4	100

Decision: The BOS recommended and approved the revision of the course matrix scheme for Ph.D. coursework and the addition of subject/research-specific courses as per Annexure II

Item No. 4

Updation of the list of Panel of Paper Setter for B.Sc./M.Sc. and Examiners for Ph.D. thesis evaluation.

Decision: The BOS recommended and approved the updated list of the Panel of Paper Setters for B.Sc./M.Sc. and Examiners for Ph.D. thesis evaluation. The BOS also authorized HOD to add or delete any other reputed Examiner(s) if such a need arises in future.

Item No. 5

Permission for pursuing the Ph.D. programme for JRF Mr. Ritvik Gupta working under SERB Research project of Prof. Suram Singh

One of the student who is working under the SERB research project of Prof. Suram, Mr Ritvik Gupta has requested to apply in the PhD program at Central University of Jammu while working under the Research project. The supervisor has recommended his request. And forwarded for consideration by the Board of Studies for their recommendation.

https://drive.google.com/file/d/1XLNBVoOhCxC4Z0OD0SvpzreYds3ndLTR/view?usp=drive_link

Decision: The BOS recommended and granted permission to pursue the Ph.D. programme for JRF Mr. Ritvik Gupta working under SERB Research project of Prof. Suram Singh

Item No. 6

To consider the progress report of Ph.D. research scholars as recommended by DRC/RAC conducted on 18-12-2023.

https://drive.google.com/file/d/1YEz8PkAfJ10sPluE4LULAY8RzbiEK_WI/view?usp=drive_link

To consider the progress report of Ph.D. research scholars upto Dec 2023.

S. No.	Entry No.	Name of the Candidate	Supervisor	Research title for Ph.D.	Remarks of RAC/DRC
1	0152020	Rajan Singh	Dr. Vinay Kumar	Effect of Temperature on Alkaline Orthophosphate Based Phosphors: Luminescence and Related Studies	**Good**
2.	0252020	Isha Charak	Dr. Vinay Kumar	Synthesis and Luminescence Studies of Rare Earth Ion Doped Borate Phosphors	**Good**
3	21PPHY01	Aneeqa Basheer	Prof. Suram Singh	Systematic study of Quasiparticle Structure of Some Non-magic Transitional Nuclei	**Good**
4	21PPHY02	Ayesha Bhandari	Prof. Vinay Kumar	Synthesis and Effect of Doping on TiO2 Powder / thin films for Optical and Sensing Applications	**Good**
5	21PPHY03	Bandhna Verma	Prof. Vinay Kumar	Synthesis and Characterization of Organic-Inorganic Material Based Heterojunction for Optoelectronic Applications	**Good**
6	21PPHY04	Umera Nawaz	Prof. Suram Singh	Phenomenological Study of Some Deformed Nuclei in the Heavy Mass Regions	**Good**
7	22PPHY01	Meena Sharma	Prof. Suram Singh	Theoretical investigation of structure of some deformed nuclei in medium mass region	**Good**

Decision: The BOS appreciated and approved the progress report of PhD research scholars as recommended by DRC/RAC up to Dec 2023.

Item No. 7
Recognition of newly joined Faculty members as Ph.D. supervisor.

The HOD inform the BOS that the following faculty members have recently joined the Department of Physics and Astronomical Sciences:

S. No.	Name of the Faculty	Designation	Area of Research
1.	Dr. Kusum Kumari	Professor	Condensed Matter Physics
2.	Dr. Ashish Kumar	Associate Professor	Condensed Matter Physics
3.	Dr. Onkar Nath Verma	Assistant Professor	Condensed Matter Physics
4.	Dr. Manvi Rajput	Assistant Professor	Theoretical Nuclear Physics

Decision: The BOS found that all the faculty members are eligible for Ph.D. supervision as per the University Ordinance therefore BOS recommended and recognised the above faculty as PhD supervisors.

Item No. 8

Approval for opting six (6) extra credits [4 from MOOC/SWAYAM and 2 from OEC] in addition to earlier approved 20 credits for the Int B.Sc (H)-M.Sc. (IV) semester students of academic session 2023-24

Integrated B.Sc. (H)-MSc. Physics IV semester students of academic session 2023-24 have shown their willingness to opt for the following two extra courses in addition to their approved credits for the semester:

Sr. No.	Name of the course	Code	Mode
1.	Atomic and Molecular Physics	noc24-ph04	MOOC
2.	Introduction to Latex	UPHY0O006T	OEC

These two courses are important and helpful in their higher semester, the matter is please for information and ratification.

Decision: For the benefit of students, the BOS approved opting six (6) extra credits [4 from MOOC/SWAYAM and 2 from OEC] in addition to the earlier approved 20 credits for the Int B.Sc (H)-M.Sc. (IV) semester students of academic session 2023-24.

All the subject experts appreciated the progress of the department

The meeting ends with votes of thanks.

Dr. Sujata Kundan

Dr. Ashish Kumar

Prof. Kusum Kumari

Prof. Rajni Kant

Manvi Rajput

Prof. Pankaj Sharma

Dr. Onkar Nath Verma

Dr. Manvi Rajput

Prof. Suram Singh
15/08/24

Dr. Uday Pratap Singh

Prof. Vinay Kumar

Annexure-1

Int. B.Sc.(H)-M.Sc. Physics			
Semester :	V	Type:	CORE
Course Name:	Elementary Quantum Mechanics	Course Code:	
Credits:	3+1	L T P:	3-0-2

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO 1 Develop a foundational understanding of quantum mechanics principles, including wave-particle duality, superposition, and quantum measurement.

CO 2 Apply quantum mechanics principles to simple systems, such as the quantum harmonic oscillator and the particle in a box, to solve problems and predict outcomes.

CO 3 Learn about important quantum mechanical models, such as the Schrödinger equation, and how to use them to describe physical systems.

CO 4 Explore the various interpretations of quantum mechanics, such as the Copenhagen interpretation and many-worlds interpretation, and understand their implications for the nature of reality.

CO 5 Study the applications of quantum mechanics in modern technology, and understand their potential impact on society.

Unit-I

Inadequacies in classical physics: blackbody radiation, quantum theory of light, photoelectric effect, Compton effect, Franck-Hertz experiment; wave nature of matter: de Broglie hypothesis, wave–particle duality, Davisson- Germer experiment, two slit experiment with electrons.

Unit-II

Basic postulates and formalism of quantum mechanics: energy, momentum and Hamiltonian operators; time-independent Schrodinger wave equation for stationary states, properties of wave function, probability density and probability current density; normalization, linearity and superposition principles, Eigenvalues and Eigenfunctions; expectation values.

Unit-III

Wave function of a free particle, normalized one and three-dimensional wave packets, wave description of particles by wave packets, group and phase velocities and the relation between them; Heisenberg uncertainty principle and its applications, expectation values.

Unit-IV

Particle in a one-dimensional box, bound state problems: general features of a bound particle system, one-dimensional simple harmonic oscillator: energy levels and wave functions, zero point energy, quantum theory of hydrogen atom: particle in a spherically symmetric potential, principal quantum number, orbital, magnetic quantum number; quantization of energy and angular momentum;

Unit-V

Scattering problems in one dimension: (1) finite potential step-reflection and transmission, attractive and repulsive potential barriers, (2) quantum phenomenon of tunnelling: tunnel diode (qualitative description) (3) finite potential well (square well).

Text Books and References:

1. L.I. Schiff, Quantum Mechanics, (McGraw Hill Bool Co. New York).
2. E. Merzbacher, Quantum Mechanics, (John Wiley & Sons).
3 J.L. Powell & B. Crasemann, Quantum Mechanics, (Addition- Welsey).
4. A.Ghatak & S. Lokanathan, Quantum Mechanics: Theory and Applications, (Macmillan India)
5. E.M. Lifshitz and L.D. Landau, Quantum Mechanics: Non–Relativistic Theory, (Butterworth – Heinemann).
6. Arno Bohm, Quantum Mechanics: Foundations and Applications, (New York: Springer-Verlag).

Laboratory based experiments:

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{\hbar^2}[V(r) - E] \text{ where } V(r) = -\frac{e^2}{r}$$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 (eVÅ)$^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511x10^6 eV/c^2.

2. **Solve the s-wave radial Schrodinger equation for an atom:**

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{\hbar^2}[V(r) - E]$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -\frac{e^2}{r}e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 (eVÅ)$^{1/2}$, m = 0.511x10^6 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2m}{\hbar^2}\,[V(r) - E]$$

For the anharmonic oscillator potential

$$V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$$

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}In these units, $c\hbar$ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r)u(r),\ A(r) = \frac{2\mu}{\hbar^2}\,[V(r) - E]$$

Where μ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D\left(e^{-2ar'} - e^{-ar'}\right),\qquad r' = \frac{r - r_o}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.

Take: $m = 940\text{x}10^6 eV/C^2$, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

5. To study the photoelectric effect.
6. Study of Electron spin resonance-determine magnetic field as a function of the resonance frequency.
7. Study of Zeeman effect: with external magnetic field; Hyperfine splitting.
8. To Show the tunnelling effect in tunnel diode using I-V characteristics.
9. Determination of e/m for the electron.
10. To determine the value of Planck's constant.

Int. B.Sc.(H)-M.Sc. Physics			
Semester :	V	**Type:**	Core
Course Name:	Solid State Physics	**Course Code:**	
Credits:	3+1	**L T P:**	3-0-2

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO 1 *Understand the basic principles of crystal structure, lattice vibrations, and thermal properties of solids.*

CO 2 *Describe the electronic band structure of solids and its relation to electrical and thermal conductivity.*

CO 3 *Apply theoretical models to describe the behavior of solids under various physical conditions.*

CO 4 *Analyze experimental data related to the properties of solids using appropriate theoretical models.*

CO 5 *Critically evaluate the current research and advancements in the field of Solid State Physics.*

UNIT-I

Amorphous and Crystalline Materials. Crystal structure. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Bragg's Law. Atomic and Geometrical Factor

UNIT-II

Lattice Vibrations and Phonons, Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law

UNIT-III

Wave Function in a periodic lattice and Bloch theorem, Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Measurement of conductivity (4 probe method), Hall Effect & Hall coefficient.

UNIT-IV

Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius-Mossotti Equation. Classical Theory of Electric Polarizability. Langevin-Debye equation. Optical Phenomena. Plasma Oscillations, Plasma Frequency, Plasmons, Ferroelectric Properties of Materials, Structural phase transition, Classification of crystals, Piezoelectric effect, Ferroelectric effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop

UNIT-V

Dia-, Para-, Ferri- and Ferromagnetic Materials. Langevin Theory of Dia- and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. Superconductivity: Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors,

Akundan Ashish

Reference Books

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
3. Applied Solid State Physics, Rajni Kant, New Delhi Wiley India
4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
5. Elementary Solid State Physics, M. Ali Omar, 1999, Pearson India
6. Solid State Physics by S. O. Pillai, New Age International, 2005.
7. Quantum Mechanics, Statistical Mechanics and Solid State Physics, 2010, S.Chand & Company.
8. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

List of Practicals

1. To study PE hysteresis of ferroelectric crystal.
2. To study BH hysteresis of ferromagnetic material.
3. Measurement of susceptibility of paramagnetic solution by Quink's tube method.
4. Measurement of magnetic susceptibility of solids.
5. Determination of variation of dielectric constant with frequency.
6. Measurement of hall voltage by four probe method.
7. To study temperature coefficient of a semiconductor (NTC thermistor).

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

Five years Integrated B.Sc.(H)-M.Sc. Physics			
Semester :		**Type:**	OEC
Course Name:	Plasma Physics	**Course Code:**	
Credits:	4	**L T P:**	3-1-0

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO 1 *Define plasma and explain its key properties*

CO 2 *Describe methods for plasma production and diagnostics in laboratory settings.*

CO 3 *Explain the principles of controlled thermonuclear fusion and differentiate between open and closed systems (e.g., Tokamak).*

CO 4 *Analyze the concepts of charge neutrality, Debye length, and plasma frequency.*

CO 5 *Explain fundamental plasma processes like collisions, diffusion, and basic principles governing plasma behavior (e.g., Ohm's Law).*

Unit-I

Definition and properties of plasma, plasma production in laboratory and diagnostics, microscopic description; motion of a charged particle in electric and magnetic fields-curvature, gradients and external force drift, controlled thermonuclear devices, magnetically confined open and closed systems (linear pinch, mirror machine and Tokamak); laser plasmas- inertially confined system.

Unit-II

Plasma definition and general properties of charge neutrality and collective behavior, Debye length, Plasma frequency concept of equilibrium, plasma temperature and plasma in nature; basic plasma processes: charged particle interactions in plasma, elastic and inelastic collisions, cross-section, frequencies, diffusion, mobility, Einstein relationship, Ohms law, Excitation, ionization, recombination processes, radiation from plasma.

Unit-III

Statistical description of plasmas, Bogoliubov–Born–Green–Kirkwood–Yvon (BBGKY) hierarchy of equations, Boltzmann-Vlasov equation, equivalence of particle orbit theory and the Vlasov equation, Boltzmann and landau collision integral H-theorem, B.G.K. model, Fokker-Planck term, solution of Boltzmann equation (brief outline); transport coefficient-electrical conductivity, diffusion.

Unit-IV

Source of ionization, formation of an ionized layer, the ionospheric regions, distribution of ion in the topside ionosphere, magnetic field variation and concepts of atmospheric dynamo and motor, moments in the atmospheric plasma and neutral atmospheric interaction currents in ionosphere, storm time distribution, motion in the upper atmosphere; production of irregularities in the ionosphere

Unit-V

Small amplitude plasma oscillations, oscillations in warm field-free plasma, Landau damping, Nyquist method-Penrose criterion of stability, two stream stability (linear and quasi linear theory); Vlasov theory of magnetized plasma, loss cone stability, quasilinear theory of gently bump instability, non-linear electrostatic waves.

Text Books and References:

1. F.F. Chen, Introduction to Plasma Physics, (Plenum Press).
2. N.A. Krall and Trivelpiece, Principles of Plasma Physics, (San Fransisco Press).
3. G. Schimdt, Physics of High Temperature Plasmas, (Academic Press).
4. R.D. Hazeltine & F.L. Waelbroeck, The framework of Plasma Physics, (Perseus Books).
5. R.J. Goldston and P.H. Rutherford, Introduction to Plasma Physics, (IOP).

Five years Integrated B.Sc.(H)-M.Sc. Physics			
Semester:		**Type:**	**OEC**
Course Name:	**Electromagnetic theory**	**Course Code:**	
Credits:	**4**	**L T P:**	**3-1-0**

Course Outcomes: After the completion of this course, the students will be able to:

CO 1	Understand the fundamentals of mathematical concepts for electromagnetic vector fields.
CO 2	Explain principles of electrostatics to find solutions of problems related to electric field, electric potential and boundary conditions.
CO 3	Explain principles of magnetostatics to find solutions of problems related to magnetic field, magnetic potential and boundary conditions.
CO 4	Discuss the concept of Maxwell's equations and about electromagnetic waves in terms of different parameters.
CO 5	Analyse the concept of radiation of accelerated charge in electromagnetic fields, and wave guides.

Unit I

Vector algebra: vector operation, position, displacement and separation vectors; Differential calculus: gradient, divergence and curl; Integral calculus: line, surface and volume integrals, basic of fundamental theorem of gradient, divergence and curl; curvilinear coordinate (spherical polar and cylindrical), Dirac delta function.

Unit II

Coulomb's law and electric field; Gauss's law and its application; Poisson and Laplace equations; formal solution for potential with Green's functions; boundary value problems; multipole expansion; dielectrics, polarization of a medium.

Unit III

Biot-Savart law; differential equation for static magnetic field; vector potential; magnetic field from localized current distributions; Ampere's theorem.; Faraday's law of induction; energy densities of electric and magnetic fields.

Unit IV

Maxwell's equations in vacuum; Vector and Scalar potentials in electrodynamics; gauge invariance and gauge fixing, Coulomb and Lorentz gauges; displacement current; Electromagnetic energy and momentum; conservation laws; Plane waves in a dielectric medium; reflection and refraction at dielectric interfaces, Frequency dispersion in dielectrics and metals; dielectric constant and anomalous dispersion; wave propagation in one dimension; group velocity; boundary conditions.

Unit V

EM Field of a localized oscillating source; Fields and radiation in dipole and quadrupole approximations; radiation by moving charges; Lienard-Wiechert potentials; total power radiated by an accelerated charge, metallic wave guides; boundary conditions at metallic surfaces; propagation modes in wave guides; TE, TM and TEM modes; rectangular and cylindrical wave guides.

Text Books and References:

1. D.J. Griffiths, Introduction to Electrodynamics, Prentice Hall.
2. J.D. Jackson, Classical Electrodynamics, Wiley.
3. A. Das, Lectures on Electromagnetism, Hindustan Book Agency.
4. J.R. Reitz, F.J. Milford and R.W. Christy, Foundations of Electromagnetic Theory Addison-Wesley.
5. W.K.H. Panofsky and M. Phillips, Classical Electricity and Magnetism, Dover.
6. R.P. Feynman, Feynman Lectures on Physics (Vol. II), Addison-Wesley.
7. A. Zangwill, Modern Electrodynamics, Cambridge University Press.

Five years Integrated M.Sc. Physics			
Semester :		Type:	OEC
Course Name:	Special Theory of Relativity	Course Code:	
Credits:	4	L T P:	3-1-0

COURSE OUTCOMES: After the completion of this course, the learner will be able to:

CO 1	Demonstrate knowledge and broad understanding of Special Relativity.
CO 2	Explain the meaning and significance of the postulate of Special Relativity.
CO 3	Recall the setup and significance of Michelson-Morley experiment.
CO 4	Explain the true nature of Lorentz transformation and Doppler effect.
CO 5	Explain relativistic momentum and Einstein field equations.

Unit-I

Forces and equations of motion, Lorentz force, motion of a charged particle in a uniform constant magnetic field, charged particle in a uniform alternating electric field.

Unit-II

Inertial reference frames, absolute and relative accelerations and velocity, Galilean transformation, conservative of momentum, fictitious forces, collisions, velocity and acceleration in rotating coordinate systems.

Unit-III

Michelson- Morley experiment, basic postulates of special relativity, Lorentz transformations, simultaneity and causality in relativity, length contraction, time-dilation, velocity transformations, space- like and time – like intervals, aberration of light, Doppler effect.

Unit-IV

Conservation of momentum, relativistic momentum, relativistic energy, transformation of momentum and energy, equivalence of mass and energy, particles with zero rest-mass, transformation of force, four vectors.

Unit-V

Acceleration of charged particles by constant longitudinal electric field, acceleration by a transverse electric field, charged particle in a magnetic field, centre of mass system and threshold energy, energy available from moving charge, anti-proton threshold, photo production of mesons.

Text Books and References:

1. Robert Resnick, Introduction to Special Relativity. John Wiley & Sons, 1968.
2. K.D. Krori, Fundamentals of Special and General Relativity. PHI, 2010.
3. Robert Katz, An Introduction to Special Theory of Relativity. 2008.
4. Ajoy Ghatak, Special Theory of Relativity. Anshan, 2009.
5. T.M. Helliwell, Special Relativity. University Science Books, 2010.
6. George Gamow, Mr. Tompkins in Wonderland. Cambridge University Press, 1993.
7. C.W. Misner, K. Thorne & J. Wheeler, Gravitation. Princeton University Press, 2017.
8. H S. Hans and S.P. Puri, Mechanics. Tata McGraw Hill.
9. R.G. Takwale & Puranik, Introduction to Classical Mechanics. Tata McGraw- Hill.

Int. B.Sc.(H)-M.Sc. Physics			
Semester :		**Type:**	OEC
Course Name:	**ATOMIC AND MOLECULAR PHYSICS**	**Course Code:**	
Credits:	4	**L T P:**	3-1-0

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO 1 *Understand about the atoms and atomic spectra*

CO 2 *Understand about the Zeeman's Effect*

CO 3 *explain the change in behavior of atoms in external applied electric*

CO 4 *explain rotational, vibrational, electronic and Raman spectra of molecules.*

UNIT-I

Inadequacy of Bohr atomic model, correction due to finite mass of the nucleus, Rydberg constant in terms of reduced mass, Excitation and Ionisation potentials, Franck-Hertz experiment, Bohr-Sommerfeld Model of atom, vector model of an atom, Electron spin, space quantisation, magnetic moment of an electron due to its orbital motion. Stern-Gerlach experiment and its theory, Spin-orbit interaction and Fine structure of spectral lines

UNIT-II

Quantum numbers and selection rules, Pauli's exclusion principle, Electronic configuration of atoms, Pauli Exclusion principle and electron configuration, quantum states, Spectral notations of quantum states. Spin-Orbit Interaction (Single valence electron atom), Energy levels of Na atom, selection rules, sodium Doublet. Spectral terms of two electron atoms, terms for equivalent electrons, LS and JJ coupling schemes. Singlet Triplet separation for interaction energy of LS coupling. Lande's Interval rule, Problems.

UNIT-III

Early discoveries and developments, Experimental arrangement, Normal and anomalous Zeeman Effect Problems, Stark effect (Qualitative discussion), X-ray spectroscopy: Nature of X-rays, Discrete and continuous X-ray spectra, Daune and Hunt's Rule, X-ray emission spectra, Mosley's law and its applications, Auger effect , Problems

UNIT-IV

Molecular formation, the H molecular ion, H_2 – molecule. Salient features of molecular spectra. Rotation, vibration and electronic spectra of molecules, associated quantum numbers and selection rules, Theory of pure rotation and rotation- vibration spectra, Raman and IR spectra, simple applications.

UNIT-V

Classical theory of Raman Effect. Molecular polarizability, Quantum theory of Raman Effect, Experimental set up for Raman Effect, Applications of Raman spectroscopy

Books Recommended:

1. Atomic Physics (Modern Physics), S N Ghosal, (S. Chand)
2. Concepts of Modern Physics 4th edition, Arthur Baiser (McGraw Hill International edition)
3. Introduction to Atomic spectra, H. E White. (McGraw Hill International edition)
4. Introduction to Atomic and Molecular Spectroscopy , V.K.Jain, Narosa Publication.
5. Molecular Structure And Spectroscopy, 2nd Edition, G. Aruldhas (PHI Learning).
6. Physics of Atoms and Molecules, 2nd edition B H Bransden and C J Joachain, Pearson International.

Int. B.Sc.(H)-M.Sc. Physics			
Semester :		**Type:**	**OEC**
Course Name:	**NANOMATERIALS AND APPLICATIONS**	**Course Code:**	
Credits:	**4**	**L T P:**	**3-1-0**

Pre-Requisites:

Knowledge of different materials and their basic properties such as crystal structure, band diagram

Course Outcomes:

At the end of the course, the student will be able to:

CO1	Comprehend the unique properties of nanomaterials for their applications in different fields.
CO2	Solve the Schrödinger equations for 2D, 1D and 0D quantum confined nanostructures.
CO3	Understand the principles of nanomaterial synthesis and fabrication techniques.
CO4	Comprehend different characterization methods used to analyze nanomaterials.
CO5	Analyze emerging research trends in nanomaterial applications and addressing challenges in integrating nanomaterials into various fields

UNIT-1:

Introduction to Nanostructured materials and their technological significance, Classification of Low dimensional Systems-2D, 1D, and 0D systems, Quantum dots, Nanowires, Nanorods, Surface effect and Quantum Confinement effect, Schrödinger equations for 2D, 1D and 0D systems, Density of States in bulk and low dimensional Systems- derivation and explanation.

UNIT-2:

Size dependent Properties of Nanomaterials-Physical, Chemical, Optical, Electronic, Mechanical and Magnetic Properties.

UNIT-3:

Bottom-up and top-down approaches, Physical and Chemical Techniques, Nucleation and Growth Mechanism of thin film and nanostructure formation; Thermal Evaporation and Electron beam Evaporation, Arc-discharge, Laser Ablation, Chemical Vapor Deposition, Colloidal synthesis, Self-assembly techniques, Spin coating, Dip coating, Spray pyrolysis; Nanofabrication-photolithography and Electron-beam Lithography.

UNIT-4:

X-Ray Diffraction, Electron microscope (SEM, TEM), and Scanning probe microscopes (STM, AFM); Applications of Nanomaterials in Modern Nanodevices- Biological, Optoelectronic and Sensing devices.

UNIT-5:

Carbon-based nanomaterials (graphene, carbon nanotubes) and Semiconductor nanomaterials (quantum dots, nanowires) based FETs, Applications of nanomaterials in the field of medicine and drug delivery, energy and Environmental Science.

Reference Books:

1. T. Pradeep, Nano: The Essentials; Tata McGraw-Hill, 2008.
2. W.R. Fahrner, Nanotechnology and Nanoelectronics; Springer,2006.
3. Rechard Booker and Earl Boysen, Nanotechnology, Wiley, 2006.
4. B.S. Murty, P. Shankar, Baldev Raj, B B Rath and James Murday, Textbook of nanoscience and Nanotechnology, Universities Press, 2012
5. Charles P. Poole, Frank J. Owens, Introduction to Nanotechnology, Wiley 2012
6. M.A. Shah and Tokeer Ahmad , Principles of Nanoscience and Nanotechnology, Narosa, 2011.
7. Raul J. Martin-Palma, Akhlesh Lakhtakia, Nanotechnology, SPIE Press, USA, 2010.
8. Robert Kelsall, Ian Hamley and Mark Geoghegan, Nanoscale Science and Technology, Wiley, 2005.

Int. B.Sc.(H)-M.Sc. Physics			
Semester :		**Type:**	**OEC**
Course Name:	**ENERGY CONVERSION AND STORAGE SYSTEMS**	**Course Code:**	
Credits:	**4**	**L T P:**	**3-1-0**

Fundamentals of Renewable Energy sources, concepts of physics, materials science and Introductory chemistry

Course Outcomes:

At the end of the course, the student will be able to:

CO1	*Understand principles and mechanisms of energy conversion and storage*
CO2	*Comprehend the importance of technological aspects of various energy conversion technologies and their applications*
CO3	*Analyze performance metrics and efficiency of energy conversion and storage systems.*
CO4	*Explore different fabrication techniques of Energy storage devices*
CO5	*Develop critical thinking in understanding the operation of different types of batteries, super capacitors and fuel cells.*

UNIT-1:

Introduction to Energy Conversion: Overview of various energy sources (fossil fuels, renewable energy), Principles of energy conversion, efficiency and sustainability considerations.

UNIT-2:

Combustion and Heat Engines- Basics of combustion processes, Introduction to heat engines (internal combustion engines, gas turbines), efficiency and environmental impacts. Thermoelectric Conversion-Introduction to thermoelectric effect and materials, Seebeck effect and Peltier effect, applications of thermoelectric materials in waste heat recovery and power generation.

UNIT-3:

Photovoltaic Conversion: Fundamentals of Solar radiation, Solar constant, Concept of Air Mass, inclination angle, zenith angle. Solar Thermal Systems: solar water heater, space heating active and passive methods and their applications, Solar cells: types of solar cells and their characteristics, fabrication of solar cell, solar cell characteristics, Thin film solar cell technologies.

UNIT-4:

Wind Energy Conversion: Introduction to wind energy and wind turbine technology, types of wind turbines and their performance, wind energy integration and challenges in grid systems. Hydroelectric Conversion: Principles of hydroelectric power generation, types of hydroelectric plants and their operation.

UNIT-5:

Energy Storage Systems: Overview of energy storage technologies and their applications, role of energy storage in grid stability and renewable energy integration. Battery Technologies: Principles of electrochemical energy storage, types of batteries and their characteristics and applications. Supercapacitors: capacitance-based energy storage, comparison with batteries and applications in hybrid systems. Fuel Cells: Principles of electrochemical energy conversion, types of fuel cells and their applications.

Reference Books:

1. Fundamentals of Energy Storage, J. Jensen , B. Squrensen, John Wiley, NY

2. Electrochemical Power Sources: Primary and Secondary Batteries , P. Peregrines, IEE

3. Supercapacitors: Materials, Systems, and Applications ,Kindle Edition, Francois Beguin , Elzbieta Frackowiak ,Wiley-VCH

4. Non -Conventional Energy Sources and Utilization, Er.R.K.Rajput, S.Chand Publishers

5. Non -Conventional Energy Resources, third edition B. H. Khan, Mc Graw Hil Education Pvt. Ltd

6.Solar Photovoltaics - Fundamentals, Technologies and Applications, third edition by Chetan Singh Solanki, PHI Learning Pvt. Ltd.

7. Science and Technology of Photovoltaics, second edition by P. Jayarama Reddy, BS Publications.

Int. B.Sc.(H)-M.Sc. Physics				
Semester :	VI		**Type:**	Core
Course Name:	Introduction to Nuclear Physics		**Course Code:**	
Credits:	3+1		**L T P:**	3-0-2

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO 1 *Understand the basic properties of atomic nuclei, including nuclear size, shape, and stability.*

CO 2 *Describe the different models of the atomic nucleus, such as the liquid drop model and the shell model.*

CO 3 *Explain the processes of nuclear decay, including alpha, beta, and gamma decay, as well as nuclear reactions..*

CO 4 *Analyze experimental data related to nuclear phenomena using appropriate theoretical models..*

CO 5 *Critically evaluate the current research and advancements in the field of Nuclear Physics.*

UNIT-I

Mass, radius, angular momentum, magnetic moment, electric quadrupole moment, parity, estimation of mass, basic concepts of mass spectrographs, double focussing spectrograph, Coulomb scattering of a charged particle by a nucleus, Electron scattering by a nucleus, variation of nuclear radius with mass number A.

UNIT-II

Constituents of the nucleus, Nuclear forces and its properties, Binding energy, mass defect, variation of binding energy with mass number A, Liquid drop model, Semiempirical mass formula, origin of various terms, stable nucleus and conditions for stability.

UNIT-III

Energy release in nuclear fission (using BE curve) spontaneous fission and potential barrier, liquid drop model, self-sustaining chain reaction, neutron balance in a nuclear reactor, classification of reactors, uncontrolled reaction and atomic bomb, Nuclear Fusion: Energy released in nuclear fusion in stars, carbon-nitrogen and proton-proton cycle, problems of controlled fusion.

UNIT-IV

Linear accelerator, cyclotron, synchrocyclotron, betatron, synchrotron, Electron Synchrotron, proton synchrotron, Nuclear detectors: Ionisation chamber, Proportional counter, GM counter, scintillation counters, solid state detectors, neutron detector.

UNIT-V

Properties of particles, classification into leptons, mesons and baryons, matter and antimatter, conservation laws, fundamental interactions, quark model for the structure of matter.

Text/Reference Books:

1. Nuclear physics by Irving Kaplan, Oxford & IBH Pub., 1962.
2. Introduction to experimental Nuclear Physics by R. M. Singru, Wiley Eastern Pvt. Ltd.
3. Nuclear Physics by S. N. Ghoshal, S. Chand, 2006.
4. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
5. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).

List of Practicals

1. Detection of γ radiation with a scintillation counter.
2. Quantitative observation of the Compton effect.
3. Demonstrating the tracks of α particles in a Wilson cloud chamber.
4. Rutherford scattering: measuring the scattering rate as a function of the scattering angle and the atomic number.
5. Deflection of beta radiation in a magnetic field.
6. Recording and calibrating a γ spectrum.
7. Determining the energy loss of α radiation in air.
8. Study the characteristics of a G.M counter Characteristics & Determine the Pleatau Value.
9. Study the Absorption Factors using Different Thickness of Aluminium Sheets.
10. Study Half Life.
11. Inverse Law using Distribution Method.
12. To determine the endpoint energy of beta particle of a given radioactive source using gm counter
13. Study the characteristics of a G.M counter and verify the inverse square law.
14. Study of β- absorption in aluminium foil using G.M counter.
15. Study of variation of modulus of rigidity of a given specimen as a function of temperature.
16. To reproduce the Binding Energy curve for the whole mass range.
17. Semi empirical mass formula .
18. Any other experiments of the equivalent standard can be set.

Int. B.Sc.(H)-M.Sc. Physics			
Semester :	VI	**Type:**	Core
Course Name:	Statistical Mechanics	**Course Code:**	
Credits:	3+1	**L T P:**	3-0-2

COURSE OUTCOMES:

After the completion of this course, the learner will be able to:

CO 1 *Understand the fundamental principles of statistical mechanics, including ensembles, probability distributions, and the concept of entropy.*

CO 2 *Describe the behavior of systems with a large number of particles using statistical methods, including the classical, quantum, and classical statistical ensembles.*

CO 3 *Explain the concept of equilibrium and the relationship between macroscopic observables and microscopic states.*

CO 4 *Discuss the principles of phase transitions and critical phenomena, including the Ising model and mean field theory.*

CO 5 *Apply statistical mechanics to various physical systems, including gases, solids, and liquids.*

UNIT-I

Classical statistical mechanics approach based on kinetic theory of particles, Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Law of Equipartition of Energy – Applications to Specific Heat and its Limitations, Negative Temperature.

UNIT II

Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.

UNIT III

Quantum Theory of Radiation Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan Boltzmann Law, (4) Wien's Displacement law from Planck's law.

UNIT IV

Bose-Einstein Statistics, B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

UNIT V

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals.

Reference Books

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed.,1996, Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
3. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.
4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Fran-cis W. Sears and Gerhard L. Salinger, 1986, Narosa.
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
6. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.

7. Statistical Mechanics - an elementary outline, A. Lahiri, 2008, Universities Press.

List of Practicals:

Use C/C++/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics.

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:

   a. Study of local number density in the equilibrium state (i) average; (ii) fluctuations

   b. Study of transient behavior of the system (approach to equilibrium)

   c. Relationship of large N and the arrow of time

   d. Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution

   e. Computation and study of mean molecular speed and its dependence on particle mass

   f. Computation of fraction of molecules in an ideal gas having speed near the most probable speed

2. Computation of the partition function Z (b) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose- Einstein statistics:

    a. Study of how Z (b), average energy <E>, energy fluctuation DE, specific heat at constant volume Cv, depend upon the temperature, total number of particles N and the spectrum of single particle states.

    b. Ratios of occupation numbers of various states for the systems considered above

    c. Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T .

3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

5. Plot the following functions with energy at different temperatures

    a. Maxwell-Boltzmann distribution
    b. Fermi-Dirac distribution
    c. Bose-Einstein distribution

Note: Any other experiments of the equivalent standard can be set

Reference Books

1. Elementary Numerical Analysis, K.E.Atkinson, 3 rd Edn . 20 07 , Wiley India Edition

2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.

3. Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987

4. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Fran-cis W. Sears and Gerhard L. Salinger, 1986, Narosa.

5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer

6. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.

7. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C.

8. V. Fernandez. 2014 Springer ISBN: 978-3319067896

Annexure-II

The syllabus for these courses is as:

Ph.D. course in Physics			
Course Name:	Latex – Typesetting software	**Course Code:**	
Credits:	2	**L T P:**	2-0-0

Unit I: Basics

Overview of Latex and its advantages; installation and setup; Basic document structure, writing text and formatting; commonly used packages.

Unit II: Document formatting

Different document classes- articles, report, book; generate sections, subsections and chapters; Using different fonts and styles; tables and lists; Introduction to beamer.

Unit IV: Mathematical typesetting

Mathematical symbols and expressions; Equations and alignments; Displaying and referencing equations; Mathematical environments; amsmath and amssymb packages.

Unit III: Advanced features

Cross-referencing and hyperlinking; TikZ for creating graphics and diagrams; Customizing document styles and templates; BibTeX and bibliography management.

Unit V: Final document preparation

Compiling and troubleshooting LaTeX documents; Preparing project reports, dissertations, and research articles.

Text Books and References:

1. Guide to latex, fourth edition, Helmut Kopka, Patrick W. Daly.
2. Latex: A document Preparation System, Leslie Lamport.

Ph.D. course in Physics			
Course Name:	Solar Cells: Materials and Device Physics	**Course Code:**	
Credits:	4	**L T P:**	3-1-0

Unit-1 – Introduction to Solar Energy and solar cells: Solar Energy – Solar Radiation – Atmospheric Effect on Solar Radiation - Air Mass – Types of solar cells - Generations of solar cells – difference between various types of solar cells.

Unit-2 – Characteristics of a Solar Cell: Basic physics behind solar cell and its Characterization – Quantum efficiency – Mobility – Spectral Response – I-V Curves - Short Circuit Current - Open Circuit Voltage – Fill Factor – Power Conversion Efficiency, Incident Photon Conversion Efficiency (IPCE) measurements, Shockley-Queisser limit.

Unit-3 – Silicon Solar Cells: Principles & Device physics - Direct and indirect band gap semiconductors - Intrinsic and Extrinsic silicon – p-n Junction - Czochralski growth of single crystal '*Si*' – Wafer slicing and processing – Dopant diffusion – Silicon solar cell Fabrication Module and Arrays – Stability & Degradation.

Unit-4 – Different Solar Cell Technologies *Dye-Sensitized Solar Cell* – Operations, Device assembly -Properties of TiO_2 – Light harvesting mechanism-Electron Transfer Dynamics & Recombination - Fabrication steps of DSSC – Stability; *Polymer and Organic Solar Cells-* Working Principles & Mechanism - Properties of polymer active materials, Electron transport layer/materials – Hole transport materials/layers - Electrodes for polymer solar cells – Conventional and inverted polymer solar cells - Device architecture and their functioning – Fabrication steps of polymer solar cells – Life cycle, Stability, Degradation & Efficiency.

Unit-5 – Perovskite Solar Cells : Various Perovskite materials, and materials for electron and hole transport layers, Different Architectures, Fabrication steps, Photophysics, Impedance measurements, Photoluminescence, Recombinations processes involved, defect/trap analysis, stability studies.

Books :

1. Solar Photovoltaics: Fundamentals, Technologies & Applications, C. S. Solanki, 2nd Ed., Prentice Hall of India, 2011.

2. Solar cells: Operating principles, technology & system applications, by Martin A. Green, Prentice- Hall Inc., Englewood Cliffs, NJ, USA,

3. Physics of Solar Cells: From Basic Principles to Advanced Concepts Peter Würfe Wiley-VCH; 1st Ed

Annexure-III

List of examiners for setting of Question papers/Evaluation of answer scripts/minor project for the first three years of the Integrated M. Sc. Physics Programme

Department of Physics and Astronomical Sciences

S. No.	Name of the Faculty	Affiliation	Contacts
1	Prof. Naresh Padha	Department of Physics, University of Jammu,Jammu	nareshpadha@jammuuniversity.in M:9419182875
2.	Prof. RajniKant	Department of Physics, University of Jammu, Jammu	rkantverma@jammuuniversity.in M:9419194375
3.	Prof. Anju Bhasin	Department of Physics, University of Jammu, Jammu	anjubhasin@jammuuniversity.in M:9419181423
4.	Prof .Vivek Gupta	Department of Physics, University of Jammu, Jammu	vivek_gupta2k2@hotmail.com M:9419102467
5.	Prof. Arun Bharti	Department of Physics, University of Jammu, Jammu	arunbharti_2003@yahoo.co.in M:9419134355
6.	Prof. K. K Bamazai	Department of Physics, University of Jammu, Jammu	kkbamazi@jammuuniversity.in M:9419134629
7.	Dr. Ramni gupta	Department of Physics, University of Jammu, Jammu	M:9419191509
8.	Dr. Rani	Department of Physics, University of Jammu, Jammu	rani_rakwal@yahoo.co.in
9.	Dr. Yugal Khajuria	Department of Physics, Shri Mata Vaishno Devi university ,Katra,jammu	yugal@smvdu.ac.in M:9419932508
10.	Dr. Sunil kumar Wanchoo	Department of Physics, Shri Mata Vaishno Devi University , Karta, Reasi J&K	sunilkwanchoo@gmail.com Ph:9419132848
11.	Dr Jitendra Sharma	Department of Physics, Shri Mata Vaishno Devi University ,Karta, Reasi J&K	Mobile:9622220321 jitendra.sharma@smvdu.ac.in
12.	Dr. Kamni	Department of Physics, Shri Mata Vaishno Devi University , Karta, Reasi J&K	9419633717 kamni.pathania@smvdu.ac.in
13.	Dr. Vivek K Singh	Department of Physics, Shri Mata Vaishno Devi University , Karta, Reasi J&K	9419115187 vivek.singh@smvdu.ac.in
14.	Dr. Ram Prakash	Department of Physics,	ramprakash@smvdu.ac.in 9419904015

Manni Rayput

		Shri Mata Vaishno Devi University ,Karta Jammu	
15.	Prof. Navdeep Goyal	Department of Physics Panjab University Chandigarh 160014	Email: ngoyal@pu.ac.in Phone: +91 172 2534451
16.	Prof. N. S. Saini	Department of Physics Guru Nanak Dev University Amritsar, Punjab- 143001	Email: nssaini.phy@gndu.ac.in 9417384692
17.	Dr. Sanjay Kumar Verma	Department of Physics GGM Science College, Jammu	M:9419220765
18.	Dr. B.D. Sehgal	Department of Physics, GGM Science College, Jammu	
19.	Dr. Monika Tomar	Department of Physics , Miranda House College, Delhi University, Delhi	M:9871346452
20.	Dr. Mukesh Kumar	Department of Physics, Indian Institute of Technology Ropar, Punjab, INDIA	Email id: mkumar@iitrpr.ac.in Phone: +91-1881-242147
21	Dr. Rajesh Kumar	Department of Physics Panjab University Chandigarh 160014 India	Email: rajeshbaboria@gmail.com Phone: +91 172 2534485
22	Dr. Kuldeep Singh Kakran	CSIR - Central Electrochemical Research Institute (CSIR_CECRI)i Chennai 600113, TamilNadu	Email: kuldeep.kakran@gmail.com Phone : +91-7598240297, 8586939107

The Head of the Department is authorized to add or delete any other reputed Examiner(s) if such a need arises in future.

List of examiners for the setting of question papers/Evaluation of answer scripts/dissertation/ Minor Projects for 4th and 5th year of integrated five year M.Sc. Programme

Department Physics & Astronomical Sciences

S. No	Name of the faculty	Affiliation	contacts
1.	Prof. Naresh Padha	Department of Physics, University of Jammu, Jammu	nareshpadha@jammuuniversity.in M.9419182875
2.	Prof. Rajni kant	Department of Physics, University of Jammu, Jammu	rkantverma@jammuuniversity.in M.9419194375
3.	Prof Anju Bhasin	Department of Physics, University of Jammu, Jammu	anjubhasin@jammuuniversity.in M.9419181423
4.	Prof. Vivek Gupta	Department of Physics, University of Jammu, Jammu	vivek_gupta2k2@hotmail.com M.9419102467
5.	Prof. Arun Bharti	Department of Physics, University of Jammu, Jammu	Arunbharti_2003@yahoo.co.in M.9419134355
6.	Prof. K. K. Bamzai	Department of Physics, University of Jammu, Jammu	kkbamzai@jammuuniversity.in M.9419134629
7.	Prof Manzoor Ahmad Malik	Department of Physics, Kashmir University, Kashmir	mmmalik@kashmiruniversity.ac.in
8.	Prof. S. S.malik	Department of Physics, Guru Nanak Dev Amritsar, Panjab	maliksham@kashmiruniversity.ac.in M.9464229800
9.	Prof. Amita Chandra	Department of Physics, University of Jammu, Jammu	achandra@physics.du.ac.in M.91-11-27662295
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