Annexume 1.1.2 51.2.2

IK Gujral Punjab Technical University, Kapurthala **Department of Physical Sciences**

Ref No.: IKGPTU/PS/9 21

Date: 12 0 4 0 1 8

Subject: Proceedings of the Board of Studies (BoS), Physical Sciences (Material Science/Nano Science and Technology) meeting held on 27.03.2018.

A meeting of members of Board of Studies (BoS), Physical Sciences (Material Science/Nano Science and Technology) was held on 27.03.2018 in the Department of Physical Sciences, I K Gujral Punjab Technical University, Kapurthala. The agenda of the meeting was discussed in detail and recommendations were made on point. The proceedings of the meetings were recorded in the minutes of the meeting as enclosed as an Annexure-A.

In the meeting, the syllabus of the Engineering Physics for B. Tech. 1st Year and M.Sc.(Physics) was approved for adoption from 2018-19 which is enclosed as an Annexure-B and Annexure-C.

Submitted for necessary action.

Convener- BoS Dr. Hitesh Sharma

Chairman, Board of Studies Head, Physical Sciences.

I.K. Gujral Punjab Technical University, Kapurthala Department of Physical Sciences

Minutes of Meeting

A meeting of members of Board of Studies (BoS), Physical Sciences (Material Science/Nano Science and Technology) was held on 27.03.2018 in the Department of Physical Sciences, I K Gujral Punjab Technical University, Kapurthala.

The following were present in the meeting:

- 1. Dr. Amit Sarin (Chairperson)
- 2. Dr. Ravi Kumar, Member
- 3. Dr Rakesh Dogra, Member
- 4. Dr. Arvind Kumar, Member
- 5. Dr. Ranjan Kumar, Member
- 6. Dr. Kanchan L. Singh, Member
- 7. Dr. Hitesh Sharma, Member
- 7. Dr. rattesii Sharma, Member
- 8. Dr. Maninder Kaur, Member
- 9. Dr. Y S Brar, Chairperson(EE) as Special invitee
- 10. Dr. Rajiv Chauhan, Chairperson (Civil Eng) as Special invitee
- 11. Dr. Vikas Chawla, Chairperson(ME) as Special invitee
- 12. Dr. A S Bhuttar, Chairperson(ECE) as Special invitee
- 13. Dr. Varinderjit Singh (Special invitee)
- 14. Dr. Neetika (Special invitee)
- 15. Ms.Jaskaranpreet M.Sc.(2nd Year)-Student representative
- 16. Mr.Nikhil M.Sc.(1st Year)-Student representative

The following members could not attend the meeting:

- 1. Dr. Davinder Mehta, Member
- 2. Dr. R. K. Bedi, Member
- 3. Dr. Harpreet Kaur Grewal, Member
- 4. Dr. B D Gupta, Member
- 5. Dr. Rajiv Malhotra, Member
- 6. Dr. P. Arumugam, Member
- 7. S. Navdeepak Sandhu, Member
- 8. Dr. Harkirat Singh, (Special invitee)
- 9. Dr. Monika Sachdeva, (Special invitee)

The Board of Studies discussed on all the agenda points and following recommendations were made:

Agenda item 1: To consider the revision of Engineering Physics course in B.Tech-1st Year (for all Engineering Branches) as per model syllabus of AICTE:

All BoS members discussed in detail the new model syllabi proposed for Engineering Physics by AlCTE for adoption. All members agreed with the recommendations of AlCTE which has proposed to offer branch specific Engineering Physics subjects to B.Tech-1st Year Students and decided to implement same in IKG Punjab Technical University. The Engineering branches for which AlCTE has not proposed any theory and Lab subject, the new course subjects prepared by combining the different modules proposed by the AlCTE, were approved. All engineering specializations which are being offered at present by the IKG Punjab Technical University have been categorized in seven (07) groups. Accordingly, seven (07) theory and seven (07) practical papers as mentioned below were recommended for adoption in IKGPTU from 2018-19.

S.No.	Groups	Related Branches	Course codes	Course title	Credits
1	Civil Engineering	1. Civil Engineering	BTPH101	Mechanics of solids	4
		2. Construction Engineering &	BTPHIII	Mechanics of solids	1.5

Department of Physical Sciences

Department of Physical Sciences

I.K. Gujral Punjab Technical Charersity

Main Campus

-		Management		Lab	T
Howell by Jones and	2 Electrical Engineering	1. Electrical Engineering	ВТРН10	2 Optics and Modern Physics	\dagger
	W. C.	2. Automation & Robotics	ВТРН11		+
	-	3. Electrical & Electronics		Physics Lab	
		Engineering	14		
		Electronics & Electrical Engineering			
		 Electrical Engineering & Industrial 	trial		
		6. Instrumentation & Control Engineering			
1.0	Mechanical	1. Mechanical Engineering	BTPH103	Electromagnetism	+
	Engineering	2. Marine Engineering	BTPH113		-
		3. Production Engineering			
		4. Industrial Engineering			
	The state of the s	5.Tool Engineering			
		6. Automobile Engineering			
		7. Aerospace Engineering			
		8. Aeronautical Engineering			
	B.Tech (Mechanical Engineering)-2nd Year	I. Mechanical Engineering	BTPH201	Optics and Waves	
4	Computer Science Engineering		BTPH104	Semi-Conductor Physics	4
		2.Computer Science Engineering	BTPH114	Semi-Conductor	1.
		3.Information technology		Physics Lab	
		4.3D Animation Engineering			
i	Electronics and communication Engineering	Electronics & Communication Engineering	BTPH105	Introduction to Semiconductor Physics	4
		Electronics & Computer Engineering	BTPH115	Semi-Conductor Physics Lab	1.5
		Electronics & Instrumentation Engineering		1 17 112	
		Electronics & Telecomm Engineering			
-		5. Electronics Engineering			
The second second	Chemical Sciences	Chemical Engineering	BTPH106	Optics and Electromagnetism	4
1		Petrochem & Petroleum Refinery Engineering	ВТРН116	Optics and Electromagnetism Lab	1.5
-		3. Textile Engineering			
distance of the last		4. Food Technology			
+		1. Bio-Technology	DODULCO		
Contractor of the last		Dic-reciniology	BTPH107	Introduction to Physics: Biotechnology	4
-			BTPH117	Physics Lab	1.5

BOS members also approved one course on Optics and Waves for B.Tech-Mechanical Engineering (2nd Year) as recommended by AICTE. The copy of approved syllabus for different branches is attached as Annexure A.

2/2

Agenda item 2: To consider the revision of Course outcomes of M.Sc. (Physics) as per NAAC requirements

All BoS members discussed the educational objectives of the M.Sc.(Physics) course and with vision of the Department of Physical Sciences. After incorporating suggestions, BOS members approved the Vision, Mission, Program Educational objectives (PEO), Program outcome (PO), Program specific outcomes and Course outcomes(CO) of course subjects for M.Sc. (Physics) w.e.f. 2018-19. The copy of the revised scheme and syllabus with PO and COs is enclosed as Annexure B.

Agenda item 3: To consider the Revision in Course Scheme and Syllabus of M. Tech. (Nanotechnology)

The scheme and syllabus for M. Tech. (Nanotechnology) could not discussed in the meeting and shall be considered in the next BOS meeting.

Dr. Amit Sarin

Chairperson- BoS, Physical Sciences

Dean Academics

Department of Physical Sciences

I.K. Gujral Punjab Technical University

Main Campus

M.Sc. Physics

Course Structure and Syllabus
(Based on Choice Based Credit System)
2018 onwards



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IK Gujral Punjab Technical University

VISION

To be an institution of excellence in the domain of higher technical education that serves as the fountainhead for nurturing the future leaders of technology and techno- innovation responsible for the techno-economic, social, cultural and environmental prosperity of the people of the State of Punjab, the Nation and the World

MISSION

- To provide seamless education through the pioneering use of technology, in partnership with industry and society with a view to promote research, discovery and entrepreneurship and
- To prepare its students to be responsible citizens of the world and the leaders of technology and techno-innovation of the 21st Century by developing in them the desirable knowledge, skill and attitudes base for the world of work and by instilling in them a culture for seamlessness in all facets of life.

OBJECTIVES

- To offer globally-relevant, industry-linked, research-focused, technology- enabled seamless education at the graduate, postgraduate and research levels in various areas of engineering & technology and applied sciences keeping in mind that the manpower so spawned is excellent in quality, is relevant to the global technological needs, is motivated to give its best and is committed to the growth of the Nation;
- To foster the creation of new and relevant technologies and to transfer them to industry for effective utilization;
- To participate in the planning and solving of engineering and managerial problems of relevance to global industry and to society at large by conducting basic and applied research in the areas of technologies;
- To develop and conduct continuing education programmes for practicing engineers and managers with a view to update their fundamental knowledge base and problem-solving capabilities in the various areas of core competence of the University;

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

Head

Department of Physical Sciences

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I.K. Gujral Punjab Technical University 2 of 71

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 To develop strong collaborative and cooperative links with private and public sector industries and government user departments through various avenues such as undertaking of consultancy projects, conducting of collaborative applied research projects, manpower development programmes in cutting-edge areas of technology, etc;

 To develop comprehensive linkages with premier academic and research institutions within the country and abroad for mutual benefit;

 To provide leadership in laboratory planning and in the development of instructional resource material in the conventional as well as in the audio- visual, the video and computer-based modes;

 To develop programmes for faculty growth and development both for its own faculty as well as for the faculty of other engineering and technology institutions;

To anticipate the global technological needs and to plan and prepare to cater to them;

 To interact and participate with the community/society at large with a view to inculcate in them a feel for scientific and technological thought and endeavour; and

To actively participate in the technological development of the State of Punjab through the
undertaking of community development programmes including training and education
programmes catering to the needs of the unorganized sector as well as that of the
economically and socially weaker sections of society.

ACADEMIC PHILOSOPHY

The philosophy of the education to be imparted at the University is to awaken the "deepest potential" of its students as holistic human beings by nurturing qualities of self-confidence, courage, integrity, maturity, versatility of mind as well as a capacity to face the challenges of tomorrow so as to enable them to serve humanity and its highest values in the best possible way.

Department of Physical Science University

Afain Campus

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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DEPARTMENT OF PHYSICAL SCIENCES

VISION

To be a knowledge nerve centre in Physical Sciences, Pure and Applied Research and industry requirements for creating sustainable infrastructure and enhancing quality of life

MISSION

- To offer globally-relevant, industry-linked, research-focused, technology-enabled seamless education at the graduate, postgraduate and research levels in various areas of Physical sciences keeping in mind that the manpower so spawned is excellent in quality, is relevant to the global scientific and technological needs, is motivated to give its best and is committed to the growth of the Nation;
- 2. To develop and conduct continuing education programmes for Science graduates with a view to update their fundamental knowledge base and problem-solving capabilities in the various areas of core specialization of the University;
- 3. To develop comprehensive linkages with premier academic and research institutions within the country and abroad for mutual benefit.

Head

Department of Physical Sciences

Department of Physical Sciences

I.K. Gujral Punjab Technical University

Main Gampus

M.Sc. (Physics) Program

Duration: 2 Years (Semester System)

This M.Sc. (Physics) Program includes various core, electives, and other interdisciplinary courses. The diverse lab experiments allow students to understand the fundamental aspects of the subject. A choice of advanced elective courses offers a glimpse in the frontier areas of research and allow students to work on one-year research project as an integral part of their M.Sc. programme. The programme also provide adequate exposure to the students for pursuing higher education in the field of technology (M. Tech.), Physics (M.Phil./Ph.D.) and other job opportunities in academia and industry.

Eligibility:

Pass B.Sc. with 50% marks having Physics as one of the subject. A relaxation of 5% is given in case of candidates belonging to SC/ST category.

Head

Department of Physical Sciences of the Physical Sciences of the Physical Sciences of the Physical Punishing Compus

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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PROGRAM EDUCATIONAL OBJECTIVES: The Program Educational Objectives are the knowledge skills and attitudes which the students have at the time of post-graduation. At the end of the program, the student will be able to:

PEO1	Apply the scientific knowledge of Physics, Mathematics, Chemistry, and Physics specialization for deeper understanding of the nature.
PEO2	Identify, formulate, research literature, and analyze advanced scientific problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PEO3	Design solutions for advanced scientific problems and design system components or processes.
PEO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PEO5	Create, select, and apply appropriate techniques, resources, and modern scientific and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PEO6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional scientific practice.
PEO7	Communicate effectively on complex Scientific activities with the Scientific/engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PEO8	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of scientific and technological change.

Department of Physical Sciences

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I.K. Gujral Punjab Technical University

Niam Campus

PROGRAM OUTCOMES: At the end of the program, the student will be able to:

PO1	Apply principles of basic science concepts in understanding, analysis and prediction of physical systems.
PO2	To introduce interdisciplinary subjects/concepts/ideas for interdisciplinary application of Physics concepts.
PO3	To introduce advanced ideas and techniques required in emergent area of Physics.
PO4	To develop human resource with specialization in theoretical and experimental techniques required for career in academia and industry.
PO5	Engage in lifelong learning and adapt to changing professional and societal needs.

PROGRAM SPECIFIC OUTCOMES: At the end of the program, the student will be able to:

PSO1	Understand and apply principles of physics for understanding the scientific
	phenomenon in classical domain.
PSO2	Understand and apply mathematical techniques for describing and deeper understanding of physical systems.
PSO3	Understand and apply statistical methods for describing the classical and quantum particles in various physical systems and processes.
PSO4	Understand and apply inter-disciplinary concepts and computational skills for understanding and describing the natural phenomenon.
PSO5	Understand and apply principles of Quantum mechanics for understanding the physical systems in quantum realm.
PSO6	Provide exposure in various specialization of Physics (Solid State Physics/Nuclear Physics/Particle Physics).
PSO7	Provide exposure to advanced experimental/theoretical methods for measurement, observation, and fundamental understanding of physical phenomenon/systems.
PSO8	Engage in research and life-long learning to adapt to changing environment.

SEMESTER FIRST

Course Code	Course Title	70 0	Load	d	Ma	arks	Total	Credit
		All	ocat	ion	Distri	bution	Marks	S
		L	T	P	Internal	External		

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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	TOTAL	15	5	12	250	400	650	26
MSPH417-18	Computational Physics Lab-I	-	-	6	50	25	75	3
MSPH416-18	Electronics Lab	-		6	50	25	75	3
MSPH415-18	Computational Physics	3	1	-	30	70	100	4
MSPH414-18	Electronics	3	1	-	30	70	100	4
MSPH413-18	Quantum Mechanics-I	3	1	-	30	70	100	4
MSPH412-18	Classical Mechanics	3	1	-	30	70	100	4
MSPH411-18	Mathematical Physics-I	3	1	-	30	70	100	4

SEMESTER SECOND

Course Code	Course Title		Load Allocation		Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
MSPH421-18	Mathematical Physics-II	3	1	-	30	70	100	4
MSPH422-18	Statistical Mechanics	3	1	-	30	70	100	4
MSPH423-18	Quantum Mechanics-II	3	1	-	30	70	100	4
MSPH424-18	Classical Electrodynamics	3	1	-	30	70	100	4
MSPH425-18	Atomic and Molecular Physics	3	1	-	30	70	100	4
MSPH426-18	Atomic, Nuclear, and Particle Physics Lab	-	-	6	50	25	75	3
MSPH427-18	Computational Physics Lab-II	-	-	6	50	25	75	3
	TOTAL	15	5	12	250	400	650	26

L: Lectures T: Tutorial P: Practical

SEMESTER THIRD

Course Code	Course Title	Load Marks Distribu Allocation			istribution	Total Marks	Credits	
		L	T	P	Internal	External		
MSPH531-18	Condensed Matter Physics	3	1	-	30	70	100	4
MSPH532-18	Nuclear Physics	3	1	-	30	70/	100	4

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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I. K. Gujral Punjab Technical University, Kapurthala

MSPH533-18	Particle Physics	3	1	3.75	30	70	100	4
MSPH534-18	Elective Subject-I	3	1	-	30	70	100	4
MSPH535-18								
MSPH536-18					E E SUIT			
MSPH537-18	Elective Subject-II	3	1		30	70	100	4
MSPH538-18		-	1 - 311				1.00	1100
MSPH539-18								
MSPH540-18	Condensed Matter Physics Lab	-	•	6	50	25	75	3
	TOTAL	15	5	6	200	375	575	23

SEMESTER FOURTH

Course Code	Course Title	Load Marks Allocation Distribution				I HIGH THE CONTRACTOR OF THE C		Total Marks	Credits
		L	T	P	Internal	External			
MSPH541-18 MSPH542-18 MSPH543-18	Elective Subject-III	3	1	Ī	30	70	100	4	
MSPH544-18 MSPH545-18	Elective Subject-IV	3	1	-70.	30	70	100	4	
MSPH546-18	M.Sc. Research Project		12		Satisfact	ory/Unsati	isfactory	12	
	TOTAL	6	14		60	140	200	20	

TOTAL NUMBER OF CREDITS = 95

LIST OF DEPARTMENTAL/INTERDISCIPLINARY ELECTIVES

Elective Subject-I

S. No.	Name of the Subject	Code
1	Fibre optics and non-linear optics	MSPH534-18
2	Plasma Physics	MSPH535-18
3	Nonlinear Dynamics	MSPH536-18

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Elective Subject -II

1	Radiation Physics	MSPH537-18
2	Structures, Spectra and Properties of Biomolecules	MSPH538-18
3	Science of Renewable source of Energy	MSPH539-18

Elective-III

S.No.	Name of the Subject	Code
1	Physics of Nanomaterials	MSPH541-18
2	Experimental techniques in Nuclear and Particle Physics	MSPH542-18
3	Superconductivity and Low Temperature Physics	MSPH543-18

Elective-IV

1	Advanced Condensed Matter Physics	MSPH544-18
2	Advanced Particle Physics	MSPH545-18

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Examination and Evaluation

Theory			
S. No.	Evaluation criteria	Weightage in Marks	Remarks
1.	Mid term/sessional Tests	20	Internal evaluation (30 Marks)
2	Attendance	5	MSTs, Quizzes, assignments, attendance, etc. constitute internal
3	Assignments	5	evaluation. Best of two mid semester test will be considered for evaluation
4	End semester examination	70	External evaluation (70 Marks) Conduct and checking of the answer sheets will at the Department level in case of University teaching Department or Autonomous institutions. For other colleges examination will be conducted at the university level.
5	Total	100	Marks may be rounded off to nearest integer.
ractic	al		ni
1	Daily evaluation of practical record/Viva Voice	30	Internal evaluation (50 Marks)
2	Attendance	5	
3	Seminar/Presentation	15	
4	Final Practical Performance + Viva Voice	25	External evaluation (25 Marks)
5	Total	75	Marks may be rounded off to nearest integer.

MSPH411-18	MATHEMATICAL PHYSICS-I	L-3, T-1, P-0	4 Credits
	11:		

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Pre-requisite: None

Course Objectives: The objective of the course on **Mathematical Physics-I** is to equip the M.Sc. students with the mathematical techniques that he/she needs for understanding theoretical treatment in different courses taught in this class and for developing a strong background if he/she chooses to pursue research in physics as a career.

CO1	Understand the use of complex variables for solving definite integral.
CO2	Understand and use the Delta and Gamma functions for describing physical systems
CO3	Solve partial differential equations using boundary value problems.
CO4	Understand special functions to solve the physics problems.
CO5	Use statistical methods to analysis the experimental data.

Mapping of course outcomes with the program specific outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	2
CO3	3	3	3	3	3	3	3	2
CO4	3	3	3	3	2	3	3	2
CO5	3	3	3	3	2	2	2	1

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- Complex Variables: Introduction, Cauchy-Riemann conditions, Cauchy's Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals, Dispersion relation. (Lectures 10)
- Delta and Gamma Functions: Dirac delta function, Delta sequences for one dimensional function, properties of delta function, Gamma function, factorial notation and applications, Beta function. (Lectures 7)
- 3. **Differential Equations:** Partial differential equations of theoretical physics, boundary value, problems, Neumann & Dirichlet Boundary conditions, separation of variables, singular points, series solutions, second solution. (Lectures 8)
- 4. **Special Functions:** Bessel functions of first and second kind, Generating function, integral representation and recurrence relations for Bessel's functions of first kind, orthogonality. Legendre functions: generating function, recurrence relations and special properties, orthogonality, various definitions of Legendre polynomials, Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite functions, Laguerre functions.

(Lectures 10)

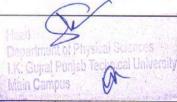
5. Elementary Statistics: Introduction to probability theory, random variables, Binomial, Poisson and Normal distribution. (Lectures 5)

Text Books:

1. Mathematical Methods for Physicists: G. Arfken and H.J. Weber (Academic Press, SanDiego) 7th edition, 2012.

Reference Books:

- 1. Mathematical Physics: P.K. Chattopadhyay (Wiley Eastern, New Delhi), 2004.
- 2. Mathematical Physics: A.K. Ghatak, I.C. Goyal and S.J. Chua (MacMillan, India, Delhi), 1986.
- 3. Mathematical Methods in the Physical Sciences M.L. Boas (Wiley, New York) 3rd edition, 2007.
- 4. Special Functions: E.D. Rainville (MacMillan, New York), 1960.
- 5. Mathematical Methods for Physics and Engineering: K.F. Riley, M.P. Hobson and S.J. Bence (Cambridge University Press, Cambridge) 3rd ed., 2006.



MSPH412-18

CLASSICAL MECHANICS

L-3, T-1, P-0

4 Credits

			31								
Pre-requis	ite: None										
students of in the mode	M.Sc. studern branche	The aim and dents in the est of physics, etc.	Lagrangians s such as C	and Hami	ltonian forr	nalisms so	that they ca	in use these			
Course Ou	itcomes: A	at the end of	f the course	e, the studer	nt will be al	ole to					
CO1	Understand the necessity of Action, Lagrangian, and Hamiltonian formalism.										
CO2	Describe	Describe the motion of a mechanical system using Lagrange-Hamilton formalism.									
CO3		Use d'Alambert principle and calculus of variations to derive the Lagrange equations of motion.									
CO4		Understand essential features of a classical problem (like motion under central force, periodic motions), use them to set up and solve the appropriate physics problems.									
CO5	Understand the theory of rigid body motion which is important in several areas of physics e.g., molecular spectra, acoustics, vibrations of atoms in solids, coupled mechanical oscillators, electrical circuits, etc										
	Mapp	ing of cour	rse outcom	es with the	program	specific ou	tcomes				
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8			
CO1	3	3	3	3	1	2	2	3			
CO2	3	3	3	3	2	2	2	3			
CO3	3	3	3	3	2	2	2	3			
CO4	3	3	3	3	2	2	2	3			
CO5	3	3	3	3	1	2	1	3			

1. Lagrangian Formulation: Mechanics of a system of particles; constraints of motion, generalized coordinates, d'Alembert Principle and Lagrange's velocity-dependent forces and the dissipation function, Applications of Lagrangian formulation.

(Lectures 7)

2. **Hamilton's Principles:** Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to nonholonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.

(Lectures 7)

3. Hamilton's Equations: Legendre Transformation, Hamilton's equations of motion, Cyclic coordinates, Hamilton's equations from variational principle, Principle of least action.

(Lectures 7)

- 4. Canonical Transformation and Hamilton-Jacobi Theory: Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton-Jacobi equations for principal and characteristic functions, Action-angle variables for systems with one-degree of freedom. (Lectures 10)
- 5. Rigid Body Motion: Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top.

 (Lectures 10)

Text Books:

1. Classical Mechanics by H. Goldstein (Narosa), 2001.

2. Mechanics by L.D. Landau & E.M. Lifschz (Pergamon), 1976.

Reference Books:

- 1. Classical Mechanics: H. Goldstein, C.Poole and J.Safko (Pearson Education Asia, New Delhi), 3rd ed 2002.
- 2. Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, New Delhi), 1988.

3. Classical Mechanics- J. W. Muller- Kirsten (World Scientific) 2008.

- 4. Advanced Classical & Quantum Dynamics by W. Dittrich, W. And M Reuter, M. (Springer) 1992.
- 5. Classical mechanics by T.W.B. Kibble and Frank H. Berkshire (Imperial College Press) 2004.
- 6. Mathematical Methods of Classical Mechanics by V. I. Arnold, (Springer) 1978.

MSPH413-18	Quantum Mechanics-I	L-3, T-1, P-0	4 Credits
		PRODUCTION OF THE PARTY OF THE	

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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Pre-requisite: basic knowledge of wave mechanical quantum mechanics

Course Objectives: The aim and objective of the course on Quantum Mechanics-I is to introduce the students of M.Sc. class to the formal structure of the subject and to equip them with the techniques of vector spaces, angular momentum, perturbation theory, and scattering theory so that they can use these in various branches of physics as per their requirement.

CO1	Understand the need for quantum mechanical formalism and basic principles.
CO2	Appreciate the importance and implication of vector spaces, dirac ket bra notations, eigen value problems, generalized uncertainty principle in quantum mechanics.
CO3	Better understanding of the mathematical foundations of angular momentum of a system of particles.
CO4	Applications of various approximation methods in solving the Schrodinger equation.

Mapping of course outcomes with the program specific outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	2	3	3	3	3	3	2	2
CO2	2	3	3	3	3	3	2	1
CO3	1	3	3	3	3	3	2	3
CO4	-	3	3	3	3	3	3	3
CO5	_	3	3	3	3	3	1	2

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I.K. Gujral Punjab Technical University
Main Campus

- 1. Linear Vector Space and Matrix Mechanics: Vector spaces, Schwarz inequality, Orthonormal basis, Operators: Projection operator, Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Postulates of quantum mechanics, uncertainty relation, Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg, Schroedinger and Interaction representations, Exchange operator and identical particles, Density Matrix and Mixed Ensemble.

 (Lectures 12)
- Angular Momentum: Angular part of the Schrödinger equation for a spherically symmetric potential, orbital angular momentum operator. Eigen values and eigenvectors of L2 and Lz. Spin angular momentum, General angular momentum, Eigen values and eigenvectors of J2 and Jz. Representation of general angular momentum operator, Addition of angular momenta, C.G. coefficients. (Lectures 7)
- 3. **Stationary State Approximate Methods:** Non-Degenerate and degenerate perturbation theory and its applications, Variational method with applications to the ground states of harmonic oscillator and other sample systems. (Lectures 7)
- 4. **Time Dependent Perturbation:** General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light.

(Lectures 7)

5. Scattering Theory: Scattering Cross-section and scattering amplitude, partial wave analysis, Low energy scattering, Green's functions in scattering theory, Born approximation and its application to Yukawa potential and other simple potentials. Optical theorem, Scattering of identical particles.

(Lectures 7)

Text Books:

- 1. A Text book of Quantum Mechanics: P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi) 2nd edition, 2004.
- 2. Quantum Mechanics: V.K. Thankappan (New Age, New Delhi), 2004.

Reference Books:

- 1. Quantum Mechanics: M.P. Khanna, (Har Anand, New Delhi), 2006.
- 2. Modern Quantum Mechanics: J.J. Sakurai (Addison Wesley, Reading), 2004.
- 3. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi), 1995.
- 4. Quantum Physics: S. Gasiorowicz (Wiley, New York), 3rd ed. 2003.
- 5. Quantum Physics: Concepts and Applications: Nouredine Zettili (Wiley, New York), 2nd ed. 2009

MSPH414-18 Electronics

L-3, T-1, P-0

4 Credits

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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				Egi	Total						
Pre-requisite:	Basic k	nowledge	about elect	ronics	A CONTRACTOR						
Course Objects students of M. of semiconduction analog circuits of physics as p	Sc. class ctor phy and intermediate	s to the for ysics, basi roduction requireme	mal structu c circuit a to digital el nt.	nre of the su nalysis, fir ectronics s	abject and to st-order no that they	o equip the onlinear ci can use the	m with the rcuits, OPA	knowledge AMP based			
Course Outco	mes: A	t the end o	the course	e, the stude	nt will be a	ble to					
CO1	100000000000000000000000000000000000000	Understand working of Different Semiconductor devices (Construction, Working Principles and V-I characteristics) and their applications.									
CO2		rn about th	e construct	tion and wo	orking of T	hyristors ar	nd various a	application			
CO3	Und	erstand Ar	nalog and I	Digital Instr	uments and	l their appli	ications.				
CO4	Ena	ble them fo	or using Bo	olean algel	ora and Kai	naugh map	os.				
CO5	Intro	oduce then	n to the Sec	quential and	l Integrated	circuits.					
	Mappi	ng of cour	se outcom	es with the	program	specific ou	tcomes				
	PS O1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8			
CO1	3	2	2	2	3	1	3	3			
CO2	2	2	1	11	1	1	3	2			
CO3	-	1	1	1		2	3	3			
CO4	-	3	-	-	-	-	3	2			
CO5	-	2	2	2	1	3	3	1			

Head
Department of Physical Sciences
L.K. Gujral Punjab Technical Univers
Main Campus

 Semiconductor Devices and applications: Direct and indirect semiconductors, Drift and diffusion of carriers, Photoconductors, Semiconductor junctions, Metal-semiconductor junctions - Ohmic and rectifying contacts, Zener diode, Schottky diode, Switching diodes, Tunnel diode, Light emitting diodes, Photodiodes, Solar cell, Liquid crystal displays.

(Lectures 7)

- 2. UJTs and Thyristors: Operational Principle of UJT: UJT Relaxation Oscillator circuit; PNPN Diode: Characteristics- As a Relaxation Oscillator-Rate Effect; SCR: V-I Characteristics-Gate Triggering Characteristics; DIAC and TRIAC; Thyristors: Basic Parameters- As Current Controllable Devices- Thyristors in Series and in Parallel; Applications of Thyristors- as a Pulse Generator, Bistable Multivibrator, Half and Full Wave Controlled Rectifier, TRIAC based AC power control, SCR based Crowbar Protection; Gate Turn-Off Thyristors; Programmable UJT. (Lectures 10)
- 3. Analog and Digital Instruments: OPAMP and its applications, Time Base; 555 Timer, Basic Digital Frequency Meter System; Reciprocal Counting Technique; Digital Voltmeter System.

(Lectures 8)

- 4. Digital circuits: Boolean algebra, de Morgans theorem, Karnaugh maps. (Lectures 5)
- 5. Sequential circuits: Flip-Flops RS, JK, D, COcked, preset and clear operation, race around conditions in JK Flip-flops, master-slave JK flip-flops, Switch contact bounce circuit. Shift registers, Asynchronous and Synchronous counters, Counter design and applications.

(Lectures8)

6. Integrated Circuits as Digital System Building Blocks: Binary Adders: Half Adder-Parallel Operation-Full Adder-MSI Adder-Serial Operation; Decoder/Demultiplexer: BCD to Decimal Decoder-4-to-16 line Demultiplexer; Data Selector/Multiplexer:16-to-1 Multiplexer; Encoder; ROM: Code Converters-Programming the ROM-Applications; RAM:Linear Selection-Coincident Selection-Basic RAM Elements Bipolar RAM-Static and Dynamic MOS RAM; Digital to Analog Converters: Ladder Type D/A Converter-Multiplying D/A Converter; Analog to Digital Converters: Successive Approximation A/D Converter.

(Lectures 8)

Text Books:

- 1. Text Book of Electronics: S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006.
- 2. Digital Principles and Applications: A.P. Malvino and D.P. Leach, Tata McGraw-Hill, Publishing Co., New Delhi.

Reference Books:

- 1. Electronics Principles and Applications: A.B. Bhattacharya, New Central Book Agency P.Ltd., Kolkata, 2007.
- 2. Integrated Electronics Analog and Digital Circuits and Systems: *J. Millman, C.C Halkins and C. Parikh*, 2nd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.

MSPH415-18

Computational Physics

L-3, T-1, P-0

4 Credits

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Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

in Campus (A)

Pre-requis	site: None							
familiarize programm	the of ing using a	The aim M.Sc. stud	ents with el languag	the nume	erical meth	nods used	in compu	itation and
Course O	utcomes:	At the end o	f the course	e, the stude	nt will be a	ble to		
CO1		oly basics blems.	knowledge	of comp	outational	physics in	solving t	he physics
CO2		gramme wit	th the C++	or any othe	r high leve	l language.		
CO3	Use	various nu	merical me	thods in so	lving physi	cs problem	S.	
CO4		Analyze the outcome of the algorithm/program using graphic plot						
CO5		Apply physics knowledge in understanding interdisciple						concepts.
	Марр	oing of cour	se outcom	es with the	program	specific ou	tcomes	
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	1	1	2	3	3	3
CO2	1	-	1 = 1 = 3	-			2	1
CO3	3	3	2	2	2	2	3	3
CO4	2	3	2	1	2	1	2	3
CO5	2	3	3	2	3	2	3	3



- 1. Introduction to Computational Physics: Need and advantages of high level language in physics, programming in a suitable high level language (Matlab/Mathematica/Scilab/Octave), input/output, interactive input, loading and saving data, loops branches and control flow, Matrices and Vectors, Matrix and array operations, Graphic tools: Gnuplots, Origin, Sigmaplot, Visual Molecular Dynamics, Mathematica, etc. (Lectures 12)
- 2. **Programming with C++:** Introduction to the Concept of Object Oriented Programming; Advantages of C++ over conventional programming languages; Introduction to Classes, Objects; C++ programming syntax for Input/Output, Operators, Loops, Decisions, simple and inline functions, arrays, strings, pointers; some basic ideas about memory management in C+. (Lectures 15)
- 3. Numerical methods: Computer algorithms, interpolations-cubic spline fitting, Numerical differentiation Lagrange interpolation, Numerical integration by Simpson and Weddle's rules, Random number generators, Numerical solution of differential equations by Euler, predictor-corrector and Runge-Kutta methods, eigenvalue problems, Monte Carlo simulations.

(Lectures 15)

Text Books:

- 1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford & IBH Book Co.) 6th ed., 1979.
- 2. A first course in Computational Physics: P.L. DeVries (Wiley) 2nd edition, 2011.

Reference Books:

- 1. Computer Applications in Physics: S. Chandra (Narosa) 2nd edition, 2005.
- 2. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 2000.
- 3. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 4th edition 2008.

MSPH416-18 Electronics Lab L-3, T-1, P-0 4 Credits

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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Department of Physical Sciences
L.K. Gujral Punjab Technical University
Main Campus

Pre-requi	site: N	None		K.T.							
students o	f M.S read	c. cla	ss to exper	imental tec	e of the lab chniques in classes and	electronic	s so that th	ey can ver	ify some o		
Course O	utcon	nes: A	it the end o	f the cours	e, the stude	nt will					
CO1	7 5 7 6	Acq	uire hands	on experie	nce of hand	lling and bu	ilding elec	tronics circ	uits.		
CO2	ks.				us compone			capacitor, i	nductor, IC		
CO3		Be a	chips and how to use these components in circuits. Be able to understand the construction, working principles and V-I characteristics of various devices such as PN junction diodes, UJT, TRIAC etc.								
CO4		Capa	Capable of using components of digital electronics for various applications.								
CO5			Able to design and perform scientific experiments as well as accurately record and analyze the results of experiments.								
	N	Iappi	ing of cour	se outcom	es with the	program	specific ou	tcomes			
	PS	01	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	1		2	2	1	2	2	3	3		
CO2	1		2	2 3 4	1	- 4	2	2	3		
CO3	1		3	3	1	2	3	3	2		
CO4	-		3	-	2	1	3	3	2		
CO5	2		2	3	3	2	3	3	3		



Note: Students are expected to perform atleast 10 experiments out of following list.

- 1. Study the forward and reverse characteristics of a Semiconctor/Zener diode.
- 2. Construction of adder, subtracter, differentiator and integrator circuits using the given OP-Amp.
- 3. Study the static and drain characteristics of a JFET.
- 4. Construction of an Astable multivibrator circuit using transistor.
- 5. Construction of a single FET amplifier with common source configuration.
- 6. To study the operation of Analog to Digital convertor.
- 7. To study the operation of Digital to Analog convertor.
- 8. Construction of a low-pass filter circuit and study its output performance.
- 9. Construction of a high-pass filter circuit and study its output performance.
- 10. To verify the Dmorgan's law using Logic Gates circuit.
- 11. To study the Characteristics of Tunnel Diode.
- 12. To study Amplitude Modulation.
- 13. To study Frequency Modulation.
- 14. To study the Characteristics of SCR.
- 15. To study the Characteristics of MOSFET.
- 16. To study the Characteristics of UJT.
- 17. To study the Characteristics of TRIAC.
- 18. To verify the different Logic and Arithmetic operations on ALU system.
- 19. To study the operation of Encoders and Decoders.
- 20. To study the operation of Left and right shift registers.
- 21. To study the operation of Counters, Ring counters.
- 22. To determine the thermal coefficient of a thermistor.
- 23. To study the operation of an Integrated Circuit Timer.

Text Books:

- 1. Text Book of Electronics: S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006.
- 2. Digital Principles and Applications: A.P. Malvino and D.P. Leach, Tata McGraw-Hill, Publishing Co., New Delhi.

Reference Books:

- 1. Electronics Principles and Applications: A.B. Bhattacharya, New Central Book Agency P.Ltd., Kolkata, 2007.
- 2. Integrated Electronics Analog and Digital Circuits and Systems: *J. Millman, C.C Halkins and C. Parikh*, 2ndEdition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.

MSPH417-18	Computational Physics Lab-I	L-3, T-1, P ₀ 0 en 4 Credits
	ing of a moon	A K. Gujral Flunjab Technical University
Pre-requisite: No	one	Controls A

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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Course Objectives: The aim and objective of the course on **Computational Physics Lab-I** is to familiarize the of M.Sc. students with the numerical methods used in computation and programming using C++ language so that they can use these in solving simple problems pertaining to physics.

CO1	Apply basics knowledge of computational Physics in solving various physical problems.
CO2	Programme with the C++ or any other high level language.
CO3	Use various numerical methods in describing/solving physics problems.
CO4	Solve problem, critical thinking and analytical reasoning as applied to scientific problems.
CO5	Explore new areas of research in physics and allied fields of science and

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

Mapping of course outcomes with the program specific outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	2	1	1	2	3	3	3
CO2	3	2	-	1	70	2	2	1
CO3	3	2	3	2	2	2	3	3
CO4	3	2	2	1	2	1	2	3
CO5	2	2	3	2	3	2	3	3



Note: Students are expected to perform atleast 10 experiments out of following list.

- 1. To find the standard deviation, mean, variance, moments etc. of at least 25 entries.
- 2. To choose a set of 10 values and find the least squared fitted curve.
- 3. Find y for a given x by fitting a set of values with the help of cubic spline fitting technique.
- 4. To find the Roots of an Algebraic Equation by Bisection method and secant method
- 5. To find the Roots of an Algebraic Equation by Newton-Raphson Method.
- 6. To find the Roots of Linear Equations by Gauss Elimination Method.
- 7. To find the Roots of Linear Equations by Gauss-Seidal Iterative Method.
- 8. Find first order derivative at given x for a set of values with the help of Lagrange interpolation.
- 9. To perform numerical integration of a function by Trapezoidal Rule.
- 10. To perform numerical integration of a function by Simpson's Rule.
- 11. To perform numerical integration of a function by Weddle's rule.
- 12. To solve a Differential Equation by Euler's method and Modified Euler's Method.
- 13. To solve a Differential Equation by Runge Kutta method.
- 14. To find the determinant of a matrix and its eigenvalues and eigenvectors.
- 15. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.

Text Books:

- 1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford & IBH Book Co.) 6th ed., 1979.
- 2. A first course in Computational Physics: P.L. DeVries (Wiley) 2nd edition, 2011.

Reference Books:

- 1. Computer Applications in Physics: S. Chandra (Narosa) 2nd edition, 2005.
- 2. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 2000.
- 3. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 4th edition 2008.

Head
Department of Physical Sciences
(LK-Gujral Punjab Technical University
Main Campus)

MSPH421	MSPH421-18		hematical Phy	sics-II	L-3, T	-1, P-0	4 Cı	edits		
Pre-requis	ite: N	None		3433	1 (100/2012					
the M.Sc. theoretical	Stuc	lents with ment in d	m and objective the mathematisifferent course to pursue res	ical technics taught in	ques that n this clas	he/she needs and for	eds for un	derstandin		
Course Ou	itcom	es: At the e	end of the cours	se, the stude	nt will able	to				
C01		Understan problems.	d the aplication	ns of group	heory in al	I the brancl	nes of Phys	ics		
CO2		Use Fourie	er series and tra	nsformation	ns as an aid	for analyz	ing experin	nental data		
CO3		Use integr	al transform to	solve mathe	ematical pro	oblems of i	interest in Physics.			
CO4			and express a transforms.	physical law	in terms o	f tensors ar	nd simplify	it by use o		
CO5		Develop m	athematical sk	ills to solve	quantitativ	e problems	in physics			
	N	lapping of	course outcon	nes with the	program	specific ou	tcomes			
	PS	O1 PSC	D2 PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	1	3	1	3	3	1	2	3		
CO2	1	3	2	2	2	2	2	3		
CO3	1	3	2	2	2	2	2	3		
CO4	1	3	2	3	2	-	2	3		
CO5	1	3	3	2	2	1	1	3		

- 1. **Group Theory:** What is a group? Multiplication table, conjugate elements and classes, subgroups, Isomorphism and Homomorphism, Definition of representation and its properties, Reducible and irreducible representations, Schur's lemmas (only statements), characters of a representation. Example of C4v, Topological groups and Lie groups, three dimensional rotation group, special unitary groups SU(2) and SU(3).

 (Lectures 10)
- 2. **Tensors:** Introduction, definitions, contraction, direct product. Quotient rule, Levi-Civita symbol, Noncartesian tensors, metric tensor, Covariant differentiation.

(Lectures 7)

- 3. Fourier Series and Integral Transforms: Fourier series, Dirichlet conditions, General properties, Advantages and applications, Gibbs phenomenon, Fourier transforms, Development of the Fourier integral, Inversion theorem, Fourier transforms of derivatives; Momentum representation. Laplace transforms, Laplace transforms of derivatives, Properties of Laplace transform, Inverse Laplace transformation. (Lectures 15)
- 4. **Integral Equations:** Definitions and classifications, integral transforms and generating functions. Neumann series, Separable Kernels, Hilbert-Schmidt theory, Green's functions in one dimension. (Lectures 10)

Text Books:

- 1. Group Theory for Physicists: A.W. Joshi (Wiley Eastern, New Delhi) 2011.
- 2. Mathematical Methods for Physicists: G. Arfken and H.J. Weber, (Academic Press, San Diego) 7th edition, 2012.

Reference Books:

- 1. Matrices and Tensors in Physics: A.W. Joshi (Wiley Eastern, New Delhi) 2005.
- 2. Numerical Mathematical Analysis: J.B. Scarborough (Oxford Book Co., Kolkata) 4th edition.
- 3. A First Course in Computational Physics: P.L. Devries (Wiley, New York) 1994.
- 4. Mathematical Physics: P.K. Chatopadhyay (Wiley Eastern, New Delhi) 2011.
- 5. Introduction to Mathematical Physics: C. Harper (Prentice Hall of India, New Delhi) 2006.

Head
Department of Physical Sciences
LKv Gujral Punjab Technical University
Main Campus

	Mecha ics-I	Markey 1								
Pre-requi	isite: Pre	liminary	course of Qua	intum Mechai	nics					
introduce technique	the M.S s of Rel	c. studen ativistic o	aim and objects to the form quantum mech physics as pe	al structure of hanics and Q	of the subjection	ct and to e	quip him/h	er with the		
Course O	utcome	s: At the	end of the cou	rse, the stude	nt will be a	ble to				
COI		Jnderstan heory.	d relativistic	effects in qua	ntum mech	anics and n	eed for qua	ntum field		
CO2			ate the Lorent tor fields, ele		The state of the s	The state of the s		Hamiltonian for quantisation.		
CO3				ne symmetries and the implications of Noether's Theorem in trents and charges.						
CO4	1	Jnderstan	d the interacti	ion picture, S	-matrix, and	d Wick's Th	neorem.			
CO5		0.00	e origin of Fe udes for elem	·		0.700	nman rules	to derive		
	Ma	apping of	course outco	mes with the	program	specific ou	tcomes	2012		
	PSO	1 PSC	D2 PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	1	1	2	2	2	2	2	3		
CO2	1	2	2	2	2	2	3	1		
CO3	1	2	3	3	2	1	2	2		
CO4	1	3	3	3	2	1	2	3		
CO5	1	2	1	3	2	2	3	3		

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Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

1. **Relativistic Quantum Mechanics-I:** Klein-Gordon equation, Dirac equation and its plane wave solutions, significance of negative energy solutions, spin angular momentum of the Dirac particle, the non-relativistic limit of Dirac equation.

(Lectures 10)

2. **Relativistic Quantum Mechanics-II:** Electron in electromagnetic fields, spin magnetic moment, spin-orbit interaction, Dirac equation for a particle in a central field, fine structure of hydrogen atom, Lamb shift.

(Lectures 10)

- 3. Quantum Field Theory: Resume of Lagrangian and Hamiltonian formalism of a classical field, Noether theorem, Quantization of real scalar field, complex scalar field, Dirac field and electromagnetic field, Covariant perturbation theory, Wick's theorem, Scattering matrix.

 (Lectures 10)
- 4. **Feynman diagrams**: Feynman rules, Feynman diagrams and their applications, Yukawa field theory, calculations of scattering cross-sections, decay rates with examples, Quantum Electrodynamics, calculations of matrix elements for first order and second order.

(Lectures 12)

Text Books:

- 1. Relativistic quantum Mechanics, J D Bjorken and S D Drell, (Tata McGraw Hill, New Delhi) 2013.
- 2. A first book of Quantum Field Theory, A. Lahiri & P. Pal, (Narosa Publishers, New Delhi), 2nd ed. 2005.
- 3. Introduction to Quantum Field Theory, M. Peskin & D.V. Schroeder. (Levant Books).

Reference Books:

- 1. Quantum Field Theory in a nutshell: A Zee (University Press), 2013. Lecture on Quantum Field Theory, A. Das (World Scientific), 2008.
- 2. Text Book of Quantum Mechanics-P.M. Mathews & K. Venkatesan (Tata McGraw Hill, New Delhi), 2004.
- 3. Quantum Field Theory: H. Mandl and G. Shaw (Wiley, New York), 2010.
- 4. Advance Quantum Mechanics: J.J. Sakurai (Addison-Weslay, Reading), 2004.



MSPH424-18 | Classical Electrodynamics

L-3, T-1, P-0

4 Credits

Pre-requi	site: No	one								
Magnetosi electromaş time varyi	tatics i gnetic wing source		xwell equ ctrics; EM	ations, an waves in b	d their a ounded me	applications edia, waveg	s to prop	agation of		
Course O	utcome	s: At the end of	of the cours	e, the stude	nt will be a	ible to				
CO1 Understand and apply the laws of electromagnetism and Maxwell's equation different forms and different media.										
CO2	5	Solve the elect	ric and mag	gnetic fields	problems	for differer	nt configura	itions.		
CO3		Provide solution to real life plane wave problems for various boundary conditions.								
CO4	(Calculate reflection and transmission of waves at plane interface.								
CO5	1	Analyze propagation of electromagnetic waves through different waveguides.								
	Ma	apping of cou	rse outcom	es with the	program	specific ou	tcomes			
	PSO	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	3	3	1	2	1	2	1	2		
CO2	3	3	1	2	2	2	2	2		
CO3	3	3	1	3	2	1	2	2		
CO4	3	3	2	3	2	2	1	2		
CO5	3	3	1	3	2	2	2	2		

1. Electrostatics: Laplace and Poisson's equations, Electrostatic potential and energy density of the electromagnetic field, Multipole expansion of the scalar potential of a charge distribution, dipole moment, quadrupole moment, Multipole expansion of the energy of a charge distribution in an external field, Static fields in material media, Polarization vector, macroscopic equations, classification of dielectric media, Molecular polarizability and electrical susceptibility, Clausius-Mossetti relation, Models of Molecular polarizability, energy of charges in dielectric media (Maxwell stress tensor).

(Lectures 10)

2. **Magnetostatics:** The differential equations of magnetostatics, vector potential, magnetic fields of a localized current distribution, Singularity in dipole field, Fermi-contact term, Force and torque on a localized current distribution. (Magnetic stress tensor)

(Lectures 8)

- 3. **Boundary value problems:** Uniqueness theorem, Dirichlet and Neumann Boundary conditions, Earnshaw theorem, Green's (reciprocity) theorem, Formal solution of electrostatic boundary value problem with Green function, Method of images with examples, Magnetostatic boundary value problems.

 (Lectures 8)
- 4. Time varying fields and Maxwell equations: Faraday's law of induction, displacement current, Maxwell equations, scalar and vector potential, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, General expression for the electromagnetic fields energy, conservation of energy, Poynting Theorem, Conservation of momentum.

(Lectures 8)

5. Electromagnetic Waves: wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Poynting theorem for a complex vector field, waves in conducting media, skin depth, Reflection and refraction of e.m. waves at plane interface, Fresnel's amplitude relations, Reflection and Transmission coefficients, polarization by reflection, Brewster's angle, Total internal reflection, Stoke's parameters, EM wave guides, Cavity resonators, Dielectric waveguide, optical fibre waveguide.

(Lectures 10)

Text Books:

- 1. Classical Electrodynamics: S.P. Puri (Narosa Publishing House) 2011.
- 2. Classical Electrodynamics: J.D. Jackson, (New Age, New Delhi) 2009.
- 3. Introduction to Electrodynamics: D.J. Griffiths (Prentice Hall India, New Delhi) 4th ed., 2012.

Reference Books:

- 1. Classical Electromagnetic Radiation: J.B. Marion and M.A. Heald(Saunders College Publishing House) 3rd edition, 1995.
- 2. Electromagnetic Fields, Ronald K. Wangsness (John Wiley and Sons) 2nd edition, 1986.
- 3. Electromagnetic Field Theory Fundamentals: Bhag Singh Guru and H.R. Hiziroglu

MSPH424-18 Atomic and Molecular Physics L-3, T-1, P-0 4 Credits

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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					n Specific	Serry File			
Pre-requi	site: N	one		7 75	ci Specia	CODY		76.	
the studer	nts of	M.Sc.	Physics	is to equ	ip them w	urse on Atvith the kn	omic and I	Molecular of Atomic,	Physics f Rotationa
Course O	utcom	es: At	the end o	of the cours	e, the stude	nt will be a	ble to		
CO1		Under	stand bas	sic element	s of atomic	and molec	ular spectro	oscopy	CIEVE -
CO2		Understand classical/Quantum description of electronic, vibrational rotational spectra							
CO3		Correlate spectroscopic information of known and unknown molecules with the physical description							
CO4		Understand and use Raman Spectroscopy for analysis of molecules							
CO5		Understand Spin Resonance Spectroscopy with focus on NMR for molecular analysis							
	M	lappin	g of cour	se outcom	es with the	program	specific ou	tcomes	
	PSC	01	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3		3	3	2	3	2	2	3
CO2	3		3	3	3	3	3	3	3
CO3	3		3	3	3	3	3	3	3
CO4	3		3	3	2	3	3	3	3
CO5	3		3	3	2	3	3	3	3

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- 1. Electronic Spectroscopy of Atoms: Bohr-Sommerfeld model of atomic structure, Electronic wave function and atomic quantum numbers hydrogen spectrum orbital, spin and total angular momentum fine structure of hydrogen atom many electron spectrum: Lithium atom spectrum, angular momentum of many electrons term symbols the spectrum of helium and alkaline earths equivalent and non-equivalent electrons –X-ray photoelectron spectroscopy. (Lectures 8)
- 2. **Electronic Spectroscopy of Molecules:** Diatomic molecular spectra: Born-Oppenheimer approximation vibrational spectra and their progressions Franck-Condon principle dissociation energy and their products –rotational fine structure of electronic-vibration transition molecular orbital theory the spectrum of molecular hydrogen change of shape on excitation chemical analysis by electronic spectroscopy reemission of energy fundamentals of UV photoelectron spectroscopy. (Lectures 9)
- 4. Infra-red and Raman Spectroscopy: The energy of diatomic molecules Simple Harmonic Oscillator—the Anharmonic oscillator—the diatomic vibrating rotator—vibration-rotation spectrum of carbon monoxide—breakdown of Born-Oppenheimer approximation—the vibrations of polyatomic molecules—influence of rotation on the spectra of polyatomic molecules (linear and symmetric top molecules)—Raman activity of vibrations—vibrational Raman spectra—vibrations of Spherical top molecules.

(Lectures 8)

5. **Spin Resonance Spectroscopy** Spin and magnetic field interaction – Larmor precession – relaxation time – spin-spin relaxation - spin-lattice relaxation - NMR chemical shift - coupling constants – coupling between nuclei – chemical analysis by NMR – NMR for nuclei other than hydrogen – ESR spectroscopy - fine structure in ESR. (Lectures 8)

Text Books:

- 1. Fundamentals of Molecular Spectroscopy by Colin N. Banwell and Elaine M. McCash (Tata McGraw-Hill Publishing Company limited).
- 2. Physics of Atoms and Molecules by B. H. Bransden and C. J. Joachain.

Reference Books:

- 1. Physical method for Chemists (Second Edition) by Russell S. Drago (Saunders College Publishing).
- 2. Introduction to Atomic Spectra: H.E. White-Auckland McGraw Hill, 1934.
- 3. Spectroscopy Vol. I, II & III: Walker & Straughen
- 4. Introduction to Molecular spectroscopy: G.M. Barrow-Tokyo McGraw Hill, 196
- 5. Spectra of diatomic molecules: Herzberg-New York, 1944.

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MSPH42	6-18	A		clear, and Pa ysics Lab	article	L-3, T	-1, P-0	4 Cr	edits
Pre-requi	site: I	Vone		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Ta La				
expose the	e stude	ents o erify	f M.Sc. stu some of the	and objective dents to expe he results ob	erimental	techniques	in atomic	and nuclear	r physics s
Course O	utcon	nes: A	at the end o	f the course,	the stude	nt will be a	ble to		
CO1			uire hands itillation co	on experienc	e of usin	g particle c	letectors su	ch as GM	counter an
CO2	handle oscilloscope for visualisation of various input and output signals.								
CO3		Understand the basic of nuclear safely management.							
CO4				tific experiment		well as ac	curately re	cord and	analyze th
CO5		Solv	e applied r	nuclear proble	ems with	critical thir	nking and a	nalytical re	asoning.
	ľ	Марр	ing of cour	'se outcomes	with the	program	specific ou	tcomes	
	PS	01	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
C01	1		2	1	2	1	3	3	3
CO2	1		1	1	3	1	3	1	3
CO3	1		1	1	3	1	3	1	2
CO4	1		3	3	3	1	3	3	3
CO5	1		3	3	3	1	3	3	3
			5 5 6 1 2 8	A SECOND TO		THE RIVE			

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Note: Students are expected to perform atleast 10 experiments out of following list.

- 1. Determination of e/m of electron by Normal Zeeman Effect using Febry Perot interferometer.
- 2. To verify the existence of Bohr's energy levels with Frank-Hertz experiments.
- 3. Determination of Lande's factor of DPPH using Electron-spin resonance (E.S.R.) spectrometer.
- 4. Determination of ionization Potential of Lithium.
- 5. Analysis of pulse height of gamma ray spectra.
- 6. To study the characteristics of G.M. tube.
- 7. To verify the inverse square law using GM counter.
- 8. To determine the dead time of G.M. counter.
- 9. To study absorption of beta particles is matter using GM counter.
- 10. To study Gaussian distribution using G.M. counter.
- 11. To estimate the efficiency of GM detector for Gamma and Beta source.
- 12. Determination of Planck's constant using Photocell and interference filters.
- 13. Verification of Inverse square law using Photocell.
- 14. To study Gaussian distribution using scintillation counter.
- 15. To study absorption of gamma radiation by scintillation counter.
- 16. To estimate the efficiency of Scintillator counter.

Text Books:

- 1. Fundamentals of Molecular Spectroscopy: Colin N. Banwell and Elaine M. McCash (Tata McGraw-Hill Publishing Company limited).
- 2. Physics of Atoms and Molecules: B. H. Bransden and C. J. Joachain.

Reference Books:

- 1. Physical method for Chemists (Second Edition) by Russell S. Drago (Saunders College Publishing).
- 2. Introduction to Atomic Spectra: H.E. White-Auckland McGraw Hill, 1934.
- 3. Spectroscopy Vol. I, II & III: Walker & Straughen
- 4. Introduction to Molecular spectroscopy: G.M. Barrow-Tokyo McGraw Hill, 1962.
- 5. Spectra of diatomic molecules: Herzberg-New York, 1944.

MSPH427-18	Computational Physics Lab-II	L-3, T-1, P-0	4 Credits
Pre-requisite: N	one		

Course Objectives: The aim and objective of the lab on Computational Physics-II is to train the students of M.Sc. class in understanding numerical methods, the usage of high level language such as C++ language for simulation of results for different physics problems and graphic analysis of

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Course O	utcom	es: At th	ne end o	f the course	, the stude	nt will be a	ble to		
CO1			tand and	d apply bas	sics knowl	ledge of nu	imerical m	ethods in	solving th
CO2				ne with the	C++ or an	y other hig	h level lang	guage.	
CO3		Learn u	ise of gr	aphical met	hods in da	ta analysis	and solving	physics pr	oblems.
CO4		Solve physical problem, enabling development of critical thinking and a reasoning.							d analytica
CO5		explore	applica	tion of com	putational	physics in	frontier are	as of pure	and applie
			h in phy	sics and all					
	M	researc		sics and all	ied fields.	program	specific ou	tcomes	
	M	researc			ied fields.	PSO5	specific ou	tcomes PSO7	PSO8
CO1		researchiapping	of cour	se outcome	ied fields. es with the				
CO1	PSC	research lapping	of cour	PSO3	es with the	PSO5	PSO6	PSO7	PSO8
- Same	PSC 1	research lapping	of cour PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO2	PSC 1 2	research lapping	PSO2	PSO3	PSO4 3 3 2	PSO5 3 3	PSO6 1 2	PSO7 3 3	PSO8 3 3

- 1. Write a program to study graphically the EM oscillations in a LCR circuit (use Runge-Kutta Method). Show the variation of (i) Charge vs Time and (ii) Current vs Time.
- 2. Study graphically the motion of falling spherical body under various effects of medium (viscous drag, buoyancy and air drag) using Euler method.
- 3. Study graphically the path of a projectile with and without air drag using FN method. Find the horizontal and maximum height in either case. Write your comments on the findings.
- 4. Study the motion of an artificial satellite.
- 5. Study the motion of (a) 1-D harmonic oscillator (without and with damping effects).(b) two coupled harmonic oscillators. Draw graphs showing the relations: i) Velocity vs Time, ii) Acceleration vs Time iii) Position vs Time, also compare the numerical and analytical results.
- 6. To obtain the energy eigenvalues of a quantum oscillator using the Runge-Kutta method.
- 7. Study the motion of a charged particle in: (a) Uniform electric field, (b) Uniform Magnetic field, (c) in combined uniform electric and magnetic fields. Draw graphs in each case.
- 8. Use Monte Carlo techniques to simulate phenomenon of (i) Nuclear Radioactivity. Do the cases in which the daughter nuclei are also unstable with half life greater/lesser than the parent nucleus. (ii) to determine solid angle in a given geometry. (iii) simulate attenuation of gamma rays/neutron in an absorber and (iv) solve multiple integrals and compare results with Simpson's method.
- 9. To study phase trajectory of a Chaotic Pendulum.
- 10. To study convection in fluids using Lorenz system.

Text Books:

- 1. Numerical Recipes in C++ The Art of Scientific Computing, William H. Press, Saul, A.Teukolsky, William T. Vetterling, and Brian P. Flannery, (Cambridge), 2nd ed. 2002.
- 2. A First Course in Computational Physics: P.L. DeVries (John Wiley) 2000.

Reference Books:

- 1. An introduction to Computational Physics: Tao Pang (Cambridge), 2nd ed. 2006.
- 2. Computer Applications in Physics: S. Chandra (Narosa), 2006.
- 3. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age), 2005.
- 4. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill), 5th ed. 2011.

MSPH531-18

Condensed Matter Physics

L-3, T-1, P-0

4 Credits

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			121	CES TOTAL	TSEON STATE		2017/01/2		
Pre-requis	site: No	ne	100	nagra i	ddd				
expose the properties, used in inv	studen energy estigati	es: The aim a ts of M.Sc. cl band theory a ng these aspec	lass to the tand transpo	opics like e rt theory so atter in con	elastic cons that they densed pha	tants, lattic are equippo se.	e vibration	s, dielectric	
Course O	utcome	s: At the end of	of the course	e, the stude	nt will be a	ble to			
CO1	1	Understand basic elements of crystal structure of condensed matter.							
CO2		Understand accurate description of lattice dynamics and thermal propertic crystalline solids.							
CO3	1	Understand ori	igin of ener	gy bands in	solids with	focus on s	emiconduc	tors.	
CO4]	Describe and u	inderstand b	pasics of tra	nsport prop	perties acro	ss solids.		
CO5	J	Describe and u	inderstand r	nagnetic an	d dielectric	behavior of	of solids.		
	Ma	apping of cou	rse outcom	es with the	program	specific ou	tcomes	Page 5	
	PSO	1 PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO1	3	3	3 .	3	2	1	3	2	
CO2	3	3	3	3	3	3	3	3	
CO3	3	3	3	3	3	3	3	3	



CO₄

CO₅

1. Crystal binding and Elastic constants: Binding in solids; Cohesive energy, Crystals of Inert gases, ionic crystal, Covalent Crystals, Analysis of elastic strains: dilation, stress components; Elastic Compliance and Stiffness: elastic constants, elastic waves in cubic crystals.

(Lectures 6)

- Lattice Dynamics and Thermal Properties: Vibrations of crystal with monatomic and two
 atom per primitive Basis; Quantization of Elastic waves, Phonon momentum; Inelastic
 scattering by phonons, Phonon Heat Capacity, Planck Distribution, normal modes; Density of
 states, Debye T3 model; Einstein Model; anharmonic crystal interactions; thermal
 conductivity expansion. (Lectures 9)
- Energy Band Theory: Electrons in a periodic potential: Bloch theorem, Nearly free electron
 model; Kronig Penney Model; Electron in a periodic potential; tight binding method; WignerSeitz Method Semiconductor Crystals, Band theory of pure and doped semiconductors;
 effective mass elementary idea of semiconductor superlattices.

(Lectures 9)

4. Transport Theory: Electronic transport from classical kinetic theory; Introduction to Boltzmann transport equation; electrical and thermal conductivity of metals; thermoelectric effects; Hall effect and magneto resistance.

(Lectures 8)

5. **Dielectrics and Ferro Electrics:** Polarization mechanisms, Dielectric function from oscillator strength, Clausius-Mosotti relation; piezo, pyro- and ferro-electricity; Dipole theory of ferroelectricity; thermodynamics of ferroelectric transition.

(Lectures 8)

Text Books:

- 1. Introduction to Solid State Physics: C. Kittel (Wiley, New York), 8th ed. 2005.
- 2. Quantum Theory of Solids: C. Kittel (Wiley, New York) 1987.

Reference Books:

- 1. Principles of the Theory of Solids: J. Ziman (Cambridge University Press) 1972
- 2. Solid State Theory: Walter A. Harrison (Tata McGraw-Hill, New Delhi) 1970.
- 3. Liquid Crystals: S. Chandrasekhar (Cambridge University), 2nd ed. 1992.

F Denartment of Physical Sciences

R Denartment of Physical Sciences

R Coural Punjab Technical University

MSPH532-18

Nuclear Physics

L-3, T-1, P-0

Credits

					Tar ever	The state of			
Pre-requi	isite: N	one			Marchedova	ic i att			
students of radioactive	or M.So e decay	c. class /s, nucl	to the	basic aspec	ets of Nucl models, an	arse on Nu lear Physic d nuclear r	s like stati	c propertie	s of nucle
Course O	utcom	es: At t	he end o	of the cours	e, the stude	ent will be a	ıble to		
CO1	CO1 Understand structure and properties of nuclei, radioactive decay, and different types of nuclear reactions.								lifferent
CO2		Understand Quantum behavior of atoms in external electric and magnetic fie							etic fields.
CO3		Compa	re vario	us nuclear	models and	properties	of the nucl	eus.	
CO4						their depen			meters.
CO5		Descril	be vario	us types of	nuclear rea	ctions and	their prope	rties.	
	M	apping	of cour	rse outcom	es with the	program	specific ou	tcomes	
	PSC	01	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	1		2	3	3	3	3	3	3
CO2	1		3	1	3	3	3	3	3
CO3	1		3	1 - 15 0	3	3	3	3	3
CO4	1		3	1	3	3	3	3	3
CO5	1		3	2	3	2	3	3	3

- 1. Nuclear Models: Liquid drop model, Binding energy; fission and fusion, Experimental evidence for shell effects, Shell Model, Spin-Orbit coupling, Magic numbers, Application of Shell Model like Angular momenta and parities of nuclear ground states, Collective modelnuclear vibrations spectra and rotational spectra.
- Static properties of nucleus: Nuclear radii and measurements, nuclear binding energy (review), nuclear moments and systematic, wave-mechanical properties of nuclei, hyperfine (Lectures 5) structure, effect of external magnetic field.
- Nuclear decay: Review of barrier penetration of alpha decay & Geiger-Nuttal law. Beta decays, Fermi theory, Kurie plots and comparative half-lives, Allowed and forbidden transitions, Experimental evidence for Parity-violation in beta decay, Electron capture probabilities, Neutrino, detection of neutrinos, Multipolarity of gamma transitions, internal conversion process, transition rates. (Lectures 10)
- Nuclear forces: Evidence for saturation of nuclear density and binding energies (review), types of nuclear potential, Ground and excited states of deuteron, dipole and quadrupole moment of deuteron, n-p scattering at low energies, spin-dependence of n-p scattering, p-p scattering, exchange forces & single and triplet potentials, meson theory of nuclear forces. (Lectures 10)
- 5. Nuclear reactions: Nuclear reactions and cross-sections, Resonance, Breit- Wigner dispersion formula for 1=0 and higher values, compound nucleus, Direct reactions, Transfer reactions. (Lectures 7)

Text Books:

- 1. Nuclear Physics: Irving Kaplan (Narosa), 2002.
- Theory of Nuclear Structure: R.R. Roy and B.P. Nigam (New Age, New Delhi) 2005.

Reference Books:

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- Basic Ideas and Concepts in Nuclear Physics: K. Hyde (Institute of Physics) 2004.
- Nuclear physics: Experimental and Theoretical, H.S. Hans (New Academic Science) 2nd ed (2011).
- Nuclear Physics and its applications by John Lile
- 4. Nuclear Physics by V. Devnathan

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Pre-requisite: course on Quantum mechanics and Quantum field Theory

The aim and objective of the course on **Particle Physics** is to introduce the M.Sc. students to the invariance principles and conservation laws, hadron-hadron interactions, relativistic kinematics, static quark model of hadrons and weak interactions so that they grasp the basics of fundamental particles in proper perspective.

CO1	Overview of particle spectrum, their interaction and major historical and latest developments.
CO2	Various invariance principles and symmetry properties in particle physics.
CO3	Basic rules of Feynman diagrams and the quark model for hadrons.
CO4	Properties of neutrons and protons in terms of a simple nonreltivistic quark model.
CO5	Weak interaction between quarks and how that this is responsible for β decay.

Mapping of course outcomes with the program specific outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	2	2	2	3	3	1	2	3
CO2	2	2	2	3	3	1	2	3
CO3	2	2	1	3	3	1	2	3
CO4	1	1	1	3	3	2	3	3
CO5	1	1	2	3	3	2	3	2



1. **Introduction:** Fermions and bosons, particles and antiparticles, quarks and leptons, interactions and fields in particle physics, classical and quantum pictures, Yukawa picture, types of interactions - electromagnetic, weak, strong and gravitational, units.

(Lectures 7)

- 2. Invariance Principles and Conservation Laws: Invariance in classical mechanics and quantum mechanics, Parity, Pion parity, Charge conjugation, Positronium decay, Time reversal invariance, CPT theorem. (Lectures 7)
- 3. **Hadron-Hadron Interactions:** Cross section and decay rates, Pion spin, Isospin, Two nucleon system, Pion-nucleon system, Strangeness and Isospin, G-parity, Total and Elastic cross section, Particle production at high energy. (Lectures 7)
- 4. **Relativistic Kinematics and Phase Space:** Introduction to relativistic kinematics, particle reactions, Lorentz invariant phase space, two-body and three-body phase space, recursion relation, effective mass, dalitz, K-3 p-decay, t-θ puzzle, dalitz plots for dissimilar particles, Breit-Wigner resonance formula, Mandelstem variables. (Lectures 7)
- 5. Static Quark Model of Hadrons: The Baryon decuplet, quark spin and color, baryon octer, quark-antiquark combination. (Lectures 7)
- 6. Weak Interactions: Classification of weak interactions, Fermi theory, Parity non conservation in β-decay, experimental determination of parity violation, helicity of neutrino, K-decay, CP violation in K- decay and its experimental determination.

(Lectures 7)

Text Books:

1.

- 1. Introduction to High Energy Physics: D.H. Perkins (Cambridge University Press), 42000.
- 2. Gauge Theory of Elementary Particle Physics, T.P Cheng & L.F. Li (Oxford).
- 3. An Introductory Course of Particle Physics, Palash Pal (CRC Press).

Reference Books:

- 1. Elementary Particles: I.S. Hughes (Cambridge University Press), 3rded. 1991.
- 2. Introduction to Quarks and Partons: F.E. CLose (Academic Press, London), 1979.
- 3. Introduction to Particle Physics: M.P. Khanna (Prentice Hall of India, New Delhi), 2004.
- 4. Dynamics of the Standard Model: J.F. Donoghue (Cambridge University Press).
- 5. First Book of Quantum Field Theory: A. Lahiri & P. Pal, Narosa, New Delhi.
- 6. Introduction to Quantum Field Theory: M. Peskin & D.V. Schroeder. (Levant Books).

Elective Subject -l

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MSPH534-	-18 Fi	bre Optics a	and Non-li	near optics	L-3, T	-1, P-0	4 Cı	redits		
Pre-requisi	te: None	e		PULS TRANSP						
Course Ob and Nonlin field of option	ear Op	tics is to ex	pose the N	1.Sc. studen	d objective ts to the b	e of the co	ourse on F e challengi	ibre Optic ng researc		
Course Out	comes:	At the end of	of the cours	e, the studer	nt will be a	ible to				
CO1	Un	derstand the	structure o	of optical fib	er and des	scribe prope	erties of op	tical fibers		
CO2	Un	Understand and compare the various processes of fibers fabrication								
CO3		Understand the principles of fiber optics communication in different media								
CO4	An	alyze the ele	ectro-optic	and acousto	optic effe	cts in fiber	S			
CO5	Un	derstand no	n-linear eff	ects in optic	al fibers.			2		
	Map	ping of cou	rse outcom	es with the	program	specific ou	tcomes			
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	-	2	-	2	-	1	2	3		
CO2	2	2	H	2	-	1.E	1	3		
CO3	-	1	-	2	1-	-	1	3		
CO4	-	2	27-0 8 17	2	-	•	1	3		
CO5	-	2	-	2	-	-	1	3		



- 1. **Optical fibre and its properties:** Introduction, basic fibre construction, propagation of light, modes and the fibre, refractive index profile, types of fibre, dispersion, data rate and band width, attenuation, leaky modes, bending losses, cut-off wavelength, mode field diameter, other fibre types. (Lectures 7)
- 2. **Fiber fabrication and cable design:** Fibre fabrication, mass production of fiber, comparison of the processes, fiber drawing process, coatings, cable design requirements, typical cable design, testing. (Lectures 5)
- 3. Optics of anisotropic media: Introduction, the dielectric tensor, stored electromagnetic energy in anisotropic media, propagation of monochromatic plane waves in anisotropic media, directions of D for a given wave vector, angular relationships between D, E, H, k and Poynting vector S, the indicatrix, uniaxial crystals, index surfaces, other surfaces related to the uniaxial indicatrix, Huygenian constructions, retardation, biaxial crystals, intensity through polarizer/waveplate/polarizer combinations. (Lectures 10)
- 4. Electro-optic and acousto-otpic effects and modulation of light beams: Introduction to the electro-optic effects, linear electro-optic effect, quadratic electro-optic effects, longitudinal electro-optic modulation, transverse electro optic modulation, electro optic amplitude modulation, electro-optic phase modulation, high frequency wave guide, electro-optic modulator, strain optic tensor, calculation of LM for a logitudinal acoustic wave in isotropic medium, Raman-Nath diffraction, Raman-Nath acousto-optic modulator.

(Lectures 10)

5. **Non-linear optics/processes:** Introduction, anharmonic potentials and nonlinear polarization, non-linear susceptibilities and mixing coefficients, parametric and other nonlinear processes, macroscopic and microscopic susceptibilities. (Lectures 8)

Text Books:

1. The Elements of Fibre Optics: S.L. Wymer and Meardon (Regents/Prentice Hall), 1993.

Reference Books:

- 1. Lasers and Electro-Optics: C.C. Davis (Cambridge University Press), 1996.
- 2. Optical Electronics: Gathak & Thyagarajan (Cambridge Univ. Press), 1989.
- 3. The Elements of Non-linear Optics: P.N. Butcher & D. Cotter (Cambridge University Press), 1991.

Elective Subject -I

MSPH535	5-18	Plas	ma Physic	-1, P-0	4 Cr	edits				
Pre-requis	site: Cou	rse on Electr	odynamics		The Late					
Course Ol M.Sc. stud	bjective : lents to t	: The aim a he basics of t	nd objecti he challeng	ve of the c	course on F ch field Plas	Plasma Ph ma physic	ysics is to s.	expose th		
Course Ou	itcomes	At the end o	of the cours	e, the stude	nt will be a	ble to				
CO1		Understand the origin of plasma, conditions of plasma formation and proof plasma.								
CO2		Distinguish between the single particle approach, fluid approach and lestatistical approach to describe different plasma phenomena.								
CO3		Classify propagation of electrostatic and electromagnetic waves in magnand non-magnetized plasmas								
CO4		escribe the bookility for bo				-	-	ffusion an		
CO5	th	ormulate the ermodynamic uilibrium.								
	Maj	ping of cour	rse outcom	es with the	program	specific ou	tcomes			
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	3		2	2	3	3	1	-		
CO2	3	3	,3	3	3	3	1	-		
CO3	3	3	3	3	3	3	2	-		
CO4	3	3	3	3	3	3	1	1		
CO5	3	3	3	3	3	3	2	1		
					- T-0					

- 1. **Introduction:** Plasma State, elementary concepts and definitions of temperature and other parameters, occurrence and importance of plasma for various applications, Production of Plasma in the laboratory, Physics of glow discharge, electron emission, ionization, breakdown of gases, Paschen's laws and different regimes of E/p in a discharge, Townsend discharge and the evolution of discharge. (Lectures 8)
- 2. Plasma diagnostics: Probes, energy analyzers, magnetic probes and optical diagnostics, preliminary concepts. (Lectures 5)
- 3. Single particle orbit theory: Drifts of charged particles under the effect of different combinations of electric and magnetic fields, Crossed electric and magnetic fields, Homogenous electric and magnetic fields, spatially varying electric and magnetic fields, time varying electric and magnetic fields, particle motion in large amplitude waves.

(Lectures 8)

- 4. Fluid description of plasmas: distribution functions and Liouville's equation, macroscopic parameters of plasma, two and one fluid equations for plasma, MHD approximations commonly used in one fluid equations and simplified one fluid and MHD equations. dielectric constant of field free plasma, plasma oscillations, space charge waves of warm plasma, dielectric constant of a cold magnetized plasma, ion- acoustic waves, Alfven waves, Magnetosonic waves.

 (Lectures 10)
- 5. Stability of fluid plasma: The equilibrium of plasma, plasma instabilities, stability analysis, two stream instability, instability of Alfven waves, plasma supported against gravity by magnetic field, energy principle. microscopic equations for my body system: Statistical equations for many body systems, Vlasov equation and its properties, drift kinetic equation and its properties.

 (Lectures 7)

Text Books:

1. Introduction to Plasma Physics, F.F. Chen

Reference Books:

- 1. Principles of Plasma Physics, Krall and Trievelpice
- 2. Introduction to Plasma Theory, D.R. Nicholson
- 3. The Plasma State, J.L. Shohet
- 4. Introduction to Plasma Physics, M. Uman
- 5. Principles of Plasma Diagnostic, I.H. Hutchinson

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MSPH536	-18	Nonline	ear Dynam		L-3, T-	-1, P-0	4 Cr	edits
Pre-requis	ite: None			al Co. 15	han .			
	tudents wi	The aim an ith the basic						
Course Ou	tcomes: A	At the end o	f the course	e, the stude	nt will be a	ble to		
CO1 Understand basic knowledge of nonlinear dynamics and phenomenology of chaos.								
CO2	CO2 Apply the tools of dynamical systems theory in context to models.							
CO3		Learn skills by solving problems on solving nonlinear problems using numerhods.						
CO4	Unc	lerstand Ha	milton appr	oach for d	escribing va	arious phys	ical system	
CO5	Qua	intify classi	cal chaos a	nd Quantur	m chaos.			
	Mapp	ing of cour	se outcom	es with the	program	specific ou	tcomes	
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	2	3	3	3	3	2	3	1
CO2	-	3	3	3	3	2	3	1
CO3	1	3	3	3	3	1	3	1
CO4	3	3	3	3	3	1	3	2
CO5	3	3	3	3	3	2	3	2

- 1. **Phenomenology of Chaos**: Linear and nonlinear systems, A nonlinear electrical system, Biological population growth model, Lorenz model; determinism, unpredictability and divergence of trajectories, Feigenbaum numbers and size scaling, self similarity, models and universality of chaos.

 (Lectures 8)
- 2. Dynamics in State Space: State space, autonomous and nonautonomous systems, dissipative systems, one dimensional state space, Linearization near fixed points, two dimensional state space, dissipation and divergence theorem. Limit cycles and their stability, Bifurcation theory, Heuristics, Routes to chaos. Three-dimensional dynamical systems, fixed points and limit cycles in three dimensions, Lyapunov exponents and chaos. Three dimensional iterated maps, U-sequence. (Lectures 10)
- 3. **Hamiltonian System**: Non-integrable systems, KAM theorem and period doubling, standard map. Applications of Hamiltonian Dynamics, chaos and stochasticity.

(Lectures 8)

4. **Quantifying Chaos**: Time series, Lyapunov exponents. Invariant measure, Kolmogorov - Sinai entropy. Fractal dimension, Statistical mechanics and thermodynamic formalism.

(Lectures 7)

5. Quantum Chaos: Quantum Mechanical analogies of chaotic behaviour, Distribution of energy eigenvalue spacing, chaos and semi-classical approach to quantum mechanics.

(Lectures 7)

Text Books:

1. Chaos and Non Linear Dynamics: R.C. Hilborn (Oxford Univ. Press), 2001.

Reference Books:

- 1. Chaos in Dynamical Systems: E. Ott (Cambridge Univ. Press), 2002.
- 2. Applied Nonlinear Dynamics: A.H. Nayfeh and B. Balachandran (Wiley), 1995.
- 3. Chaos in Classical and Quantum Mechanics: M.C. Gutzwiller (Springer-Verlag), 1990.

Elective Subject -II

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MSPH537	-18	Radia	tion Physi	cs	L-3, T-	-1, P-0	4 Cr	edits
Pre-requis	ite: None	e						
students of that they u	M.Sc. cl nderstand	The aim ar ass to the rel the details oclear physici	atively adva	anced topic rlying aspe	s Radiation	Physics ar	nd nuclear	reactions s
Course Ou	itcomes:	At the end o	f the course	e, the stude	nt will be a	ble to		
CO1 Understand various modes of interaction of electromagnetic radiations charged particles with matter.								
CO2	Di	stinguish var	rious types	of radiation	ns based on	their intera	ction with	matter.
CO3	Le	arn and unde	erstand abou	ut different	detectors a	nd their us	e for spectr	oscopy.
CO4		e different and electron sp				PIXE, neut	ron activat	ion analys
	Map	ping of cour	rse outcom	es with the	program	specific ou	tcomes	
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	1	3	1	3	3	3	3	3
CO2	1	3	1	2	2	3	3	3
CO3	1	1	1	3	3	3	3	3
CO4	1	1	1	3	3	3	3	3
			1	1				2



1. Interaction of electromagnetic radiations with Matter: Different photon interaction processes viz. photoelectric effect, Compton scattering and pair production. Minor interaction processes, Energy and Z dependence of partial photon interaction processes. Attenuation coefficients, Broad and narrow beam geometries. Multiple scattering.

(Lectures 8)

2. Interaction of charged particles with Matter: Elastic and inelastic collisions with electrons and atomic nucleus. Energy loss of heavy charged particles. Range-energy relationships, Straggling. Radiative collisions of electrons with atomic nucleus.

(Lectures 8)

3. Nuclear Detectors and Spectroscopy: General characteristics of detectors, Gas filled detectors, Organic and inorganic scintillation detectors, Semi-conductor detectors [Si(Li), Ge(Li) HPGe]. Room temperature detectors, Gamma ray spectrometers. Gamma ray spectrometry with NaI(Tl) scintillation and semiconductor detectors.

(Lectures 8)

- 4. Nuclear spectrometry and applications: Analysis of nuclear spectrometric data, Measurements of nuclear energy levels, spins, parities, moments, internal conversion coefficients, Angular correlation, Perturbed angular correlation, Measurement of g-factors and hyperfine fields.

 (Lectures 8)
- 5. Analytical Techniques: Principle, instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis (NAA) techniques. Theory, instrumentation and applications of electron spin resonance spectroscopy (ESR). Experimental techniques and applications of Mossbauer effect, Rutherford backscattering. Applications of elemental analysis, Diagnostic nuclear medicine, Therapeutic nuclear medicine.

(Lectures 8)

Text Books:

- 1. The Atomic Nucleus: R.D. Evans, Tata Mc Graw Hill, New Delhi.
- 2. Nuclear Radiation Detectors: S. S. Kapoor and V. S. Ramamurthy, New Age, International, New Delhi.

Reference Books:

- 1. Radiation Detection and Measurements: G. F. Knoll, Wiley & Sons, New Delhi.
- 2. Introductory Nuclear Physics: K. S. Krane, Wiley & Sons, New Delhi.
- 3. An Introduction to X-ray Spectrometry: Ron Jenkin, Wiley.
- 4. Techniques for Nuclear and Particle Physics Experiments: W. R. Leo, Narosa Publishing House, New Delhi.
- 5. Introduction to experimental Nuclear Physics: R.M. Singru, Wiley & Sons, New Delhi.

Electrical a Whay a hazast Elective Subject-II

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Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

MSPH538	-18	Struc		ectra and Pr omolecules	operties	L-3, T-	-1, P-0	4 Cr	edits
Pre-requisi	te: N	Vone							
of Biomole	cule	s is to	familiari	d objective of ze the M.Sc. uctures, Spec	students	with the	basics of	the recently	
Course Ou	tcon	nes: At	the end o	f the course, t	he studer	nt will be a	ble to		
CO1		Desci	ribe variou	is structural a	nd chemi	cal bondin	g aspects o	f Biomolec	ules.
CO2 Understand structure and theoretical techniques and their applic Biomolecules.								lication t	
CO3 Understand use of various spectroscopic techniques and their applicate Biomolecules.						ation to th			
CO4	7-1-1	Unde	rstand the	structure-Fur	nction rel	ationship a	nd modelin	ng of biomo	lecules.
CO5		Outli	ne and cor	relate for pro	viding so	lution to in	nterdiscipli	nary proble	m.
	N	Aappir	ng of cour	se outcomes	with the	program	specific ou	tcomes	
	PS	01	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3		3	3	3	3	2	3	2
CO2	3		3	3 4 4 4	3	3	3	3	3
CO3	3		3	3	3	3	3	3	3
CO4	3		3	3	3	3	3	3	3
CO5	3		3	3	3	3	2	3	2

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- Structure Aspects of Biomolecule: Conformational Principles, Conformation and Configuration Isomers and Derivatives, Structure of Polynucleotides, Structure of Polypeptides, Primary, Secondary, Tertiary and Quaternary Structure of Proteins, Structure of Polysaccharides. (Lectures 10)
- 2. Theoretical Techniques and Their Application to Biomolecules: Hard Sphere Approximation, Ramachandran Plot, Potential Energy Surface, Outline of Molecular Mechanics Method, Brief ideas about Semi-empirical and Ab initio Quantum Theoretical Methods, Molecular Charge Distribution, Molecular Electrostatic Potential and Field and their uses. (Lectures 10)
- 3. Spectroscopic Techniques and their Application to Biomolecules: Use of NMR in Elucidation of Molecular Structure, Absorption and Fluorescence Spectroscopy, Circular Dichroism, Laser Raman Spectroscopy, IR spectroscopy, Photo-biological Aspects of Nucleic Acids.

 (Lectures 10)
- 4. Structure-Function Relationship and Modeling: Molecular Recognition, Hydrogen Bonding, Lipophilic Pockets on Receptors, Drugs and Their Principles of Action, Lock and Key Model and Induced fit Model. (Lectures 10)

Text Books:

1. Srinivasan & Pattabhi: Structure Aspects of Biomolecules.

Reference Books:

- 1. Govil & Hosur: Conformations of Biological Molecules
- 2. Price: Basic Molecular Biology
- 3. Pullman: Quantum Mechanics of Molecular Conformations
- 4. Lehninger: Biochemistry
- 5. Mehler&Cordes: Biological Chemistry
- 6. Smith and Hanawait: molecular Photobiology, Inactivation and Recovery

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Elective Subject - II

MSPH539-	18 S		enewable so Energy	- a Annual de Antonia	L-3, T-	-1, P-0	4 Credits	
Pre-requisi	te: None		(SILIP		1.0			
	o expose	the M.Sc.					of renewal	
Course Out	comes:	At the end o	f the course,	the stude	nt will be a	ble to		
CO1 Know the energy demand of world and India.								
CO2	2 Understand traditional and alternative form of energy.							
CO3	Und	Understand concept of solar energy radiation, making of solar cell and its						
CO4	Ide	ntify hydrog	gen as energy	y source, it	ts storage a	nd transp	ortation metl	nods.
CO5	Cor	mpare wind	energy, wav	e energy a	nd ocean tl	nermal en	ergy convers	sion.
1,140	Марр	ing of cour	rse outcome	s with the	program	specific o	utcomes	
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	-	3	-	3	1	2	2	3
CO2	(s .	2	-	3	1	2	2	3
CO3	-	3	- 211	3	2	1	3	3
CO4	-	3	-	3	2	1	3	3
CO5		3	-	3	1	1	3	3

- 1. **Introduction**: Production and reserves of energy sources in the world and in India, need for alternatives, renewable energy sources. (Lectures 8)
- 2. Solar Energy: Thermal applications, solar radiation outside the earth's atmosphere and at the earth's surface, fundamentals of photovoltaic energy conversion. Direct and indirect transition semi-conductors, interrelationship between absorption coefficients and band gap recombination of carriers. Types of solar cells, p-n junction solar cell, Transport equation, current density, open circuit voltage and short circuit current, description and principle of working of single crystal, polycrystalline and amorphous silicon solar cells, conversion efficiency. Elementary ideas of Tandem solar cells, solid-liquid junction solar cells and semiconductor-electrolyte junction solar cells. Principles of photo electrochemical solar cells. Applications.
- 3. **Hydrogen Energy**: Environmental considerations, solar hydrogen through photo electrolysis and photocatalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells, hydride batteries.

(Lectures 10)

4. Other sources: Nature of wind, classification and descriptions of wind machines, power coefficient, energy in the wind, wave energy, ocean thermal energy conversion (OTEC), system designs for OTEC.

(Lectures 8)

Text Books:

1. Solar Energy: S.P. Sukhatme (Tata McGraw-Hill, New Delhi), 2008.

Reference Books:

- 1. Solar Cell Devices: Fonash (Academic Press, New York), 2010.
- 2. Fundamentals of Solar Cells, Photovoltaic Solar Energy: Fahrenbruch and Bube (Springer, Berlin), 1983.
- 3. Photoelectrochemical Solar Cells: Chandra (New Age, New Delhi).



	-18 C	ondensed N	Matter Physics Lab	L-3, T-	1, P-0	4 Cr	edits		
Pre-requisi	te: None								
to train the physics so	students that they	of M.Sc.	d objective of the coclass to advanced estigate various relative the data.	xperimental	techniques	in conder	ised matte		
Course Ou	tcomes: A	at the end o	f the course, the stud	ent will be a	ble to				
CO1	Mea	sure condu	ctivity, resistivity an	d thermo-dyr	namical pro	perties of s	solids.		
CO2	Mea	sure magne	etic properties and m	agnetic beha	vior of mag	gnetic mate	rials.		
CO3		Describe the lattice dynamics of simple lattice structures in terms of dispersive relations.							
CO4			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				20 0		
		770	rry out scientific exults of experiments.	periments a	s well as	accurately	record and		
CO5	anal	yze the res					record and		
CO5	Solv	yze the res	ults of experiments.	s and analytic	cal reasonii	ng.	record and		
CO5	Solv	yze the res	ults of experiments.	s and analytic	cal reasonii	ng.	PSO8		
CO5	Solv Mapp	yze the resi	with critical thinking	g and analytic	cal reasonii	ng.			
	Solv Mapp PSO1	yze the resize problem ing of cour	with critical thinking rse outcomes with the PSO3 PSO4	g and analytic ne program s	cal reasonii specific ou PSO6	ng. tcomes	PSO8		
CO1	Solv Mapp PSO1	yze the resize problem ing of course PSO2	with critical thinking recourse with the PSO3 PSO4 - 3	PSO5	PSO6	rig. tcomes PSO7	PSO8 3		
CO1	Solv Mapp PSO1 3 3	yze the resize problem ing of course PSO2 3 3	with critical thinking rese outcomes with the PSO3 PSO4 - 3 - 3	PSO5 3 3	PSO6	PSO7	PSO8 3 3		



Note: Students are expected to perform atleast ten experiments out of following list.

- 1. To study temperature dependence of conductivity of a given semiconductor crystal using four probe method.
- 2. Verification of curie-weiss law for the electrical susceptibility of a ferroelectric material.
- 3. To determine charge carrier density and Hall coefficient by Hall effect.
- 4. To determine magnetic susceptibility of material using Quink 's tube method.
- 5. To determine energy gap and resistivity of the semiconductor using four probe method.
- 6. To study the B-H loop characteristics.
- 7. To determine dielectric constant of a material with Microwave set up.
- 8. To measure the Curie temperature of a given PZT sample.
- 9. To measure the velocity of ultrasonic wave in liquids.
- 10. To study dispersion relation for Mono-atomic and Diatomic lattices using Lattice dynamic kit.
- 11. To study the properties of crystals using X-Ray Apparatus.

Text Books:

- 1. Introduction to Solid State Physics: C. Kittel (Wiley, New York), 8th ed. 2005.
- 2. Quantum Theory of Solids: C. Kittel (Wiley, New York) 1987.

Reference Books:

- 1. Principles of the Theory of Solids: J. Ziman (Cambridge University Press) 1972
- 2. Solid State Theory: Walter A. Harrison (Tata McGraw-Hill, New Delhi) 1970.
- 3. Liquid Crystals: S. Chandrasekhar (Cambridge University), 2nd ed. 1992.

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Elective Subject -III

MSPH541	-18	Phys	sics of Nan	omaterials	Ha. 1154	L-3, T-	1, P-0	4 Cr	edits	
Pre-requis	ite: (Conde	nsed matt	er physics	, in Associated and cheur	ilon, pr				
familiarize	the s	tuden	ts of M.Sc.	to the vari	ious aspects	s related to	preparation	Nano-maten, character his emergin	ization and	
Course Ou	itcon	nes: A	t the end o	f the course	e, the stude	nt will be a	ble to			
CO1	CO1 Demonstrate techniques of microscopy for investigations on the nanometer atomic scales									
CO2				_	basic appr f-assembly		-	e inorgani es	c colloida	
CO3		Understand and describe the use of unique optical properties of nanos metallic structures for analytical and biological applications							` nanoscal	
CO4					and chem		erties of c	arbon nan	otubes and	
CO5					tionships in		rials as wel	l as the con	cepts,	
	I	Марр	ing of cour	se outcom	es with the	program	specific ou	tcomes		
	PS	O1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO1	-		3	3	3	3	3	3	3	
CO2	2		3	3	3	3	3	3	3	
CO3	2		3	3	3	3	3	3	3	
CO4	-	7	3	3	3	3	3	3	3	
CO5 -		3	3	3	3	3	3	3		

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- 1. **Introductory Aspects:** Free electron theory and its features, Idea of band structure—metals, insulators and semiconductors. Density of state in one, two and three dimensional bands and its variation with energy, Effect of crystal size on density of states and band gap. Examples of nanomaterials.

 (Lectures 8)
- 2. **Preparation of Nanomaterials:** Bottom up: Cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques and Top down: Ball Milling.

(Lectures 8)

- 3. General Characterization Techniques: Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photo luminescence peaks, variation in Raman spectra of nanomaterials, photoemission microscopy, scanning force microscopy.

 (Lectures 8)
- 4. Quantum Dots: Electron confinement in infinitely deep square well, confinement in one and two-dimensional wells, idea of quantum well structure, Examples of quantum dots, spectroscopy of quantum dots.

 (Lectures 8)
- 5. Other Nanomaterials: Properties and applications of carbon nanotubes and nanofibres, Nanosized metal particles, Nanostructured polymers, Nanostructured films and Nano structured semiconductors.

 (Lectures 8)

Text Books:

- 1. Nanotechnology-Molecularly Designed Materials: G.M. Chow & K.E. Gonsalves (American Chemical Society), 1996.
- 2. Nanotechnology Molecular Speculations on Global Abundance: B.C. Crandall (MIT Press), 1996.

Reference Books:

- 1. Quantum Dot Heterostructures: D. Bimerg, M. Grundmann and N.N. Ledentsov (Wiley), 1998.
- 2. Nanoparticles and Nanostructured Films-Preparation, Characterization and Application: J.H.Fendler (Wiley), 1998.
- 3. Nanofabrication and Bio-system: H.C. Hoch, H.G. Craighead and L. Jelinski (Cambridge Univ. Press), 1996.
- 4. Physics of Semiconductor Nanostructures: K.P. Jain (Narosa), 1997.
- 5. Physics of Low-Dimension Semiconductors: J.H. Davies (Cambridge Univ. Press) 1998.
- 6. Advances in Solid State Physics (Vo.41): B. Kramer (Ed.) (Springer), 2001.

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Elective Subject -III

MSPH542				tal Technic d Particle		L-3, T-	1, P-0	4 Cr	edits
Pre-requis	ite: C	ourse or	n Nuclea	r and Partio	cle Physics	be that			
Nuclear ar	nd Pa	rticle Pl	hysics is	to expose	the student	ts of M.Sc.	students to	ental Teclo experiment particle phy	ntal aspects
Course Ou	itcom	es: At th	ne end o	f the course	e, the stude	nt will be al	ole to		
CO1 Understand various experimental techniques for describing interaction of radiations with matter.									
CO2	CO2 Use various statistical methods for experimental data.								
CO3	Knowledge about the different types of the radiation detectors applications.							and the	
CO4		Introdu	ced to n	eutron phy	sics, metho	ds to detect	or slow an	d fast neutr	ons.
CO5		The state of the s			nowledge a the world.		perimental	methods u	sed in the
	N	lapping	of cour	se outcom	es with the	program	specific ou	tcomes	
	PSO	D1 1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	1		2	1	2	3	3	3	3
CO2	1		3	3	2	1	3	3	3
CO3	1		1	1	3	1	3	3	3
CO4	1		3	1	3	3	3	3	3
CO5 1			3	1	3	1	3	3	3

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- 1. **Detection of radiations:** Interaction of gamma-rays, electrons, heavy charged particles, neutrons, neutrinos and other particles with matter. General properties of Radiation detectors, energy resolution, detection efficiency and dead time. Statistics and treatment of experimental data.

 (Lectures 8)
- 2. **Detectors:** Gas-filled detectors, Proportional counters, space charge effects, energy resolution, time characteristics of signal pulse, position-sensitive proportional counters, Multiwire proportional chambers, Drift chamber, Time projection chamber. Organic and inorganic scintillators and their characteristics, light collection and coupling to photomultiplier tubes and photodiodes, description of electron and gamma ray spectrum from detector, Cherenkov detector. Semiconductor detectors, Ge and Si(Li) detectors, Charge production and collection processes, semiconductor detectors in X- and gamma-ray spectroscopy, Pulse height spectrum, Compton-suppressed, Semiconductor detectors for charged particle spectroscopy and particle identification. General background and detector shielding.

(Lectures 15)

- 3. **Neutron Physics:** Interaction of neutrons with matter, Neutron detectors, Detection of fast and slow neutrons-nuclear reactions for neutron detection. (Lectures 6)
- 4. Experimental methods: Large gamma and charge particle detector arrays, heavy-ion reaction analysers, production of radioactive ion beams. Detector systems for high energy experiments: Collider physics (brief account), Particle Accelerators (brief account), Modern Hybrid experiments- CMS and ALICE.

 (Lectures 8)

Text Books:

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994.

Reference Books:

- 1. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010.
- 2. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001.
- 3. Detectors for particle radiation by Konrad Kleinknecht (Cambridge University Press), 1999.

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Elective Subject -III

MSPH543-	A Committee of the Comm	Superconductivity and Low Temperature Physics		OW_	L-3, T-	1, P-0	4 Cre	dits
Pre-requisi	te: Cond	ensed Matte	r Physics	normal i	rest			
Physics is supercondu trends in th important t achievable background	to bui ctivity. So e experiment to experiment to experiment to experiment to form to the experiment	The object Id fundamental technologier rich jure now is comperature to At the end o	ental as we not only le iques as we physics of lose to few echniques a	vell as averaged as an theore ell. Low to supercondu MK. Studens well as the	dvanced utical aspect emperature uctivity. Was will also he high-Tes	inderstandi is but also is one of the ith latest to be introdusupercondu	ng in the acquainted the most ve echnology uced to the	field of with latest ersatile and the lowest
CO1		eoretical unc			eren erineren e		rity.	
CO2	Company of the Compan							n origin of
CO3		scribe app perconductor		heoretical	model	for desc	ribing be	havior of
CO4		ovide exposu derstanding				ictors and t	heoretical	
CO5	sup	ovide exposure or conductive ping of cour	ity.	fertinaria (of
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
COI	1	3	3	3	3	3	3	1
CO2	2	3	3	3	3	3	3	1
CO3	2	3	3	3	3	3	3	-
CO4	2	3	3	3	3	3	3	115.
CO5	2	3	3	3	3	3	3	1

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- 1. Superconductivity: Introduction, Thermodynamics, The London Equations, penetration depth, Superconductors in magnetic field, Ginzberg-Landau Theory, Type I and II superconductors, BCS theory, second quantization, Cooper Pairing, energy gap Tunnelling, Josephson effects and SIS tunneling.

 (Lectures 10)
- Preparation and measurement techniques: Single crystal growth: Optical image furnace, seeded melt growth, Thin film deposition: Pulsed laser deposition, sputtering, Resistivity measurements, magnetic measurements, Point contact spectroscopy, scanning tunneling microscopy and spectroscopy.
 (Lectures 10)
- 3. Cryogenics: Thermal and electrical properties of different materials at low temperatures, Cooling methods above 1K, Joule-Thompson, Gifford-McMohan, Evaporation cooling, Liquefication of Helium, Cooling methods below 1K, dilution refrigeration, adiabatic demagnetisation.

 (Lectures 10)
- 4. Introduction to high-Tc superconductors: Discovery of high-Tc superconductors, Mechanisms of superconductivity in high-Tc superconductors, Introduction to high-Tc superconducting compound like YBCO, Synthesis, Structure and properties, Electronics and applications.

 (Lectures 10)

Text Books:

1. Introduction to superconductivity: Michael Tinkham, Courier Corporation, 2004.

Reference Books:

- 1. Introduction to superconductivity: A.C. Rose-Innes and E.H. Rhoderick, Pergamon Press, 2004.
- 2. Experimental techniques in low temperature physics: G.K. White and P.J. Meeson, Oxford Univ. Press, 2002.
- 3. Experimental low temperature physics: A. Kent, MacMillan Press, 1993.
- 4. The theory of superconductivity in high-TC Cuprates: P.W. Anderson, Princeton Series Publications.

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Elective Subject -IV

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MSPH544-	18 Adv Phy	vanced Con sics	densed Ma	atter	L-3, T-	1, P-0	4 Cro	edits
Pre-requisi	te: course	on Conden	sed Matter	Physics	in the			
Course Ob familiarize to superconducto to use the re	the M.Sc.	students wagnetic reso	ith relative nance tech	ly advance niques and	d topics lik	te optical p	roperties, 1	magnetisn
Course Ou	tcomes: /	At the end o	f the course	e, the stude	nt will be a	ble to		
COI	CO1 Understand and describe Optical properties of solids							
CO2	CO2 Understand and describe magnetic properties of solids							
CO3	Understand use of NMR methods for describing solids							
CO4	Uno	derstand and	l explain th	e behavior	of superco	nductors		De la
CO5	Und	derstand the	effect of d	efects and	deformation	on the bel	navior of so	olids
	Марр	ing of cour	se outcom	es with the	program	specific ou	tcomes	
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	2	3
CO2	1	3	3	3	3	3	2	3
CO3	1	3	3	3	3	3	3	3
CO4	1	3	3	3	3	3	2	1
CO5	2	3	3	3	3	3	3	3



- 1. Optical Properties: Macroscopic theory; Reflectance and Transmittance of a slab; generalized susceptibility, Kramers- Kronig relations, Brillouin scattering, Raman effect in crystals; interband transitions. (Lectures 10)
- Magnetism: Dia and para-magnetism in materials; Langevin theory of diamagnetism, quantum theory of diamagnetism and paramagnetism, Exchange interaction. Heisenberg Hamiltonian; Hubbard model; mean field theory; Ferro-, ferri- and antiferromagnetism; Magnons: spin waves, thermal excitation of magnons; Bloch T3/2 law. (Lectures 10)
- Nuclear Magnetic Resonance in Solids: Origin of NMR in solids
 – equations of motion, line width, motional narrowing, Knight shift.
 (Lectures 10)
- 4. **Superconductivity:** Experimental Survey; Basic phenomenology; Vortex state of a Type II superconductors; BCS pairing mechanism and nature of BCS ground state; Flux quantization; Tunneling Experiments; High Tc superconductors; Ginzburg-Landau theory; Greens functions at zero temperature; Applications of Greens functions to superconductivity. (Lectures 10)
- 5. **Disordered Solids:** Basic concepts in point defects and dislocations; Noncrystalline solids: diffraction pattern, Glasses, Amorphous semiconductors and Ferromagnets, Heat capacity and Thermal conductivity of amorphous solids; Quasicrystals. (Lectures 10)

Text Books:

- 1. Introduction to Solid State Physics: C. Kittel (Wiley, New York) 2005.
- 2. Quantum Theory of Solids: C. Kittel (Wiley, New York) 1987.

Reference Books:

- 1. Principles of the Theory of Solids: J. Ziman (Cambridge University Press) 1972.
- 2. Solid State Physics: H. Ibach and H. Luth (Springer, Berlin), 3rd. ed. 2002.
- 3. A Quantum Approach to Solids: P.L. Taylor (Prentice-Hall, Englewood Cliffs), 1970.
- 4. Intermediate Quantum Theory of Solids: A.O.E. Animalu (East-West Press, New Delhi), 1991.
- 5. Solid State Physics: Ashcroft and Mermin (Reinhert & Winston, Berlin), 1976.

Elective Subject -I'

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Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

MSPH545	5-18		Advanced	Particle P	hysics	L-3, T-	-1, P-0	4 Cr	edits
Pre-requis	site: K	nowle	edge of par	rticle physic	cs	1.16.10			
								780	
students of field theor	f M.So y, star o that	c. class ndard they u	s to the rel model of	atively adv particle ph	vanced topionsics, QCI	cs related to and quar	o symmetr k model, a	ysics is to y breaking nd various d to pursue	in quantun unification
Course O	utcom	es: A	t the end o	f the course	e, the stude	nt will have	e understan	ding of	
CO1	Various global and local gauge symmetries of system, invariance of a symmetry breaking, and Higgs mechanism.								
CO2		Need for standard model of particle physics and its limitations and the proof QCD.							
CO3	CO3 The problem of divergencies in quantum field theories and the renomethods.						the renorma	alisation	
CO4					nfrared slav			upling cons	tant in
CO5		Phys	ics beyond	the Standa	ard Model I	Physics.			
	N	1appi	ng of cour	se outcom	es with the	program	specific ou	tcomes	
	PS	01	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3		3	3	3	3	3	3	3
CO2	3		2	1	3	3	3	3	3
CO3	2		3	2	3	3	3	3	3
CO4	2		2	3	2	3	3	3	3
CO5	1		3	3	2	3	3	3	3
						-			ALC IN THE SECOND

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Head
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- 1. Symmetries and Symmetry Breaking in QFT: Continuous groups: Lorentz group SO(1,3) and its representations, Dirac, Weyl and Majorana fermions, Unitary groups and Orthogonal groups and their representations, Discrete symmetries: Parity, Charge Conjugation and Time reversal Invariance, CP, CPT. (Lectures 8)
- 2. Global and Local invariances of the Action: Approximate symmetries, Noethers theorem, Spontaneous breaking of symmetry and Goldstone theorem, Higgs mechanism, Abelian and Non-Abelian gauge fields, Lagrangian and gauge invariant coupling to matter fields.

 (Lectures 8)
- 3. Standard Model of Particle Physics: SU(3) x SU(2) x U(1) gauge theory, Coupling to Higgs and Matter fields of 3 generations, Gauge boson and fermion mass generation via spontaneous symmetry breaking, CKM matrix, Low energy Electroweak effective theory and Decoupling, Elementary electroweak scattering processes. (Lectures 8)
- 4. QCD and quark model: Asymptotic freedom and Infrared slavery, confinement hypothesis, Approximate flavor symmetries of the QCD lagrangian, Classification of hadrons by flavor symmetry: SU(2) and SU(3) multiplets of Mesons and Baryons, Chiral symmetry and chiral symmetry breaking, Sigma model, Parton model and Deep inelastic scattering structure functions. (Lectures 8)
- 5. **Beyond The Standard Model:** Neutrino mass and neutrino oscillations, Models of Neutrino mass, Left Right symmetric models, Pati-Salam, SU(5) and SO(10) Grand Unification, Unification of gauge and Yukawa couplings via RG flows, Supersymmetry and Supersymmetric Unification, Exotic processes and their phenomenology, Higgs Physics, Collider Physics, Dark matter, Baryon asymmetry generation, Leptogenesis.

(Lectures 8)

Text Books:

- 1. Gauge Theory of Elementary Particle Physics: T.P Cheng & L.F. Li (Oxford).
- 2. An Introductory Course of Particle Physics: Palash Pal (CRC Press).

Reference Books:

- 1. First Book of Quantum Field Theory: A. Lahiri & P. Pal, Narosa, New Delhi.
- 2. Introduction to Quantum Field Theory: M. Peskin & D.V. Schroeder. (Levant Books).
- 3. Dynamics of the Standard Model: J.F. Donoghue (Cambridge University Press).

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Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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MSPH546	5-18	Research	Project w	vork	L-0, T-1	2, P-0	12 Cr	edits		
Pre-requis	ite: Knov	vledge of spe	ecific branc	h of physic	S					
preliminari	es and net the opp	The aim onethodology ortunity to post.	of research	ch in Theo	retical Phy	sics and I	Experiment	al Physics		
Course O	itcomes:	At the end o	f the course	e, the stude	nt will be al	ole to				
Explain the significance and value of problem in physics, both scientifical in the wider community.										
CO2		Design and carry out scientific experiments as well as accurately record the results of experiments.								
CO3		Critically analyse and evaluate experimental strategies, and decide which is mappropriate for answering specific questions.								
CO4	to	search and c condensed m ctronic form	natter physi	cs/Nuclear	High Energ	gy Physics,	in oral, wr			
CO5		plore new hnology.	areas of r	esearch in	physics a	nd allied	fields of s	cience and		
	Мар	ping of cour	rse outcom	es with the	program	specific ou	tcomes			
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	3	3	3	3	3	3	3	3		
CO2	3	2	3	3	3	3	3	3		
CO3	3	3	3	3	3	3	3	3		
CO4	2	3	2	3	3	3	3	3		
CO5	2	3	3	3	3	3	3	3		
								3.50		

Guidelines for the Project:

The aim of project work in M.Sc. 4th semesters is to expose the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data, etc.. Project work can be in Experimental or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department before the end of the 3rd semester. A report about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the Head of Department.

Assessment of the work done under the project will be carried out by a committee on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva-voce/seminar, etc. as per course guidelines.

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Wain Campus

IK Gujral Punjab Technical University, Kapurthala Department of Physical Sciences

Ref No.: IKGPTU/PS/ 104 5

Date: 27:04.2018

Subject: Proceedings of the Board of Studies (BoS), Physical Sciences (Material School Plant School and Technology) meeting held on 23.04.2018

A meeting of members of Board of Studies (BoS), Physical Sciences (Material Science/Nano Science and Technology) was held on 23 04.2018 in the Department of Physical Sciences, I.K. Gujral Punjab Technical University, Kapurthala, The agenda of the meeting was discussed in detail and recommendations were made on point. The proceedings of the meetings were recorded in the form of minutes of meeting (attachange the back).

In the meeting, all members approved the Program Educational objectives (PEO), Program outcome (PO) Program specific outcomes and Course outcomes(CO) of course subjects and scheme and course syllabus for M.Tech. (Nano Science and Technology), enclosed here to Annexure A. Also, the syllabus, course objective (CO) and program objective: (PO) of M So. (Physics) 2016 Batch and Engineering Physics for B. Tech. 1st Visite. 1st twere approved for adoption which are enclosed as Annexure-B and Annexure-C.

Submitted for necessary actions

Dige Convener- BoS Dr. Hitesh Sharma

Chairman, Board of Studies Head, Physical Sciences.

Dr. Neetika

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2018

I.K. Gujral Punjab Technical University, Kapurthala Department of Physical Sciences

Minutes of Meeting

A meeting of members of Board of Studies (BoS), Physical Sciences (Material Science/Nano Science and Technology) was held on 23.04.2018 in the Department of Physical Sciences, I K Gujral Punjab Technical University, Kapurthala.

The following were present in the meeting:

- 1. Dr. Amit Sarin (Chairperson)
- 2. Dr. Kanchan L. Singh, Member
- 3. Dr. Hitesh Sharma, Member
- 4. Dr. Maninder Kaur, Member
- 5. Dr. A. S. Bhuttar, (Chairperson, ECE, IKGPTU main campus) as Special invitee
- 6. Dr. Gazal Sharma (Food Science, IKGPTU main campus) as Special invitee
- 7. Dr. Jagmeet Bawa (IKGPTU main campus) as Special invitee
- 8. Dr Priyanka Mahajan (IKGPTU main campus) as Special invitee
- 9. Dr. Gaurav Bhragava (Chemistry, IKGPTU main campus) as Special invitee
- 10. Dr. Chander Parkash (Chemistry, !KGPTU main campus) as Special invitee
- 11. Dr. Varinderjit Singh, Member (Special Invitee)
- 12. Dr. Harkirat Singh, Member (Special invitee)
- 13. Dr. Neetika Sharma. Member (Special invitee)
- 14. S. Navdeepak Sandhu, Member

The following members could not attend the meeting:

- 1. Dr. Davinder Mehta, Member
- 2. Dr. Ravi Kumar, Member
- 3. Dr. Rakesh Dogra, Member
- 4. Dr. Arvind Kumar, Member
- 5. Dr. Ranjan Kumar, Member
- 6. Dr. R. K. Bedi, Member
- 7. Dr. Harpreet Kaur Grewal, Member
- 8. Dr. B D Gupta, Member
- 9. Dr. Rajiv Malhotra, Member
- 10. Dr. P. Arumugam, Member

The Board of Studies discussed on all the agenda points and following recommendations were made:

Agenda item 1 To consider the Revision of scheme and syllabus for M.Tech. (Nano Science



implemented in the revised M.Tech. (Nano Science and Technology). All members approved the Program Educational objectives (PEO), Program outcome (PO), Program specific outcomes and Course outcomes(CO) of course subjects for M.Tech. (Nano Science and Technology). The scheme and course syllabus of all core and elective subjects were also approved. The copy of the approved scheme and syllabus with PO and COs is enclosed as **Annexure A**.

Agenda item 2: To approve the program objectives and course outcomes of M.Sc. (Physics) 2016 batch and Engineering Physics (Batch-2011) as per NAAC requirements

All BoS members approved the educational objectives of the old M.Sc.(Physics) 2016 batch and Engineering Physics (Batch-2011) as per NAAC requirements. The copy of the revised scheme and syllabus with PO and COs of M.Sc.(Physics) 2016 batch is enclosed as **Annexure B** and Engineering Physics (Batch-2011) as **Annexure C**.

Dr. Amit Sarin

Chairperson- BoS, Physical Sciences

Dean Academics

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LK Guiral Punjab Technical University
Main Campus

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ZZZ Annexure-B

M.Sc. Physics

Course Structure and Syllabus
(Based on Choice Based Credit System)
2016-17

Head Department of Physical Sciences LK: Guiral Punjab Technical University Main Campua

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DEPARTMENT OF PHYSICAL SCIENCES

VISION

To be a knowledge nerve centre in Physical Sciences, Pure and Applied Research and industry requirements for creating sustainable infrastructure and enhancing quality of life

MISSION

- To offer globally-relevant, industry-linked, research-focused, technology-enabled seamless education at the graduate, postgraduate and research levels in various areas of Physical sciences keeping in mind that the manpower so spawned is excellent in quality, is relevant to the global scientific and technological needs, is motivated to give its best and is committed to the growth of the Nation;
- To develop and conduct continuing education programmes for Science graduates with a
 view to update their fundamental knowledge base and problem-solving capabilities in
 the various areas of core specialization of the University;
- 3. To develop comprehensive linkages with premier academic and research institutions within the country and abroad for mutual benefit;



I. K. Gujral Punjab Technical University, Kapurthala

M.Sc. (Physics) Program

Duration: 2 Years (Semester System)

This M.Sc. (Physics) Program includes various core, electives, and other interdisciplinary courses. The diverse lab experiments allow students to understand the fundamental aspects of the subject. A choice of advanced elective courses offers a glimpse in the frontier areas of research and allow students to work on one-year research project as an integral part of their M.Sc. programme. The programme also provide adequate exposure to the students for pursuing higher education in the field of technology (M. Tech.), Physics (M.Phil./Ph.D.) and other job opportunities in academia and industry.

Eligibility:

Pass B.Sc. with 50% marks having Physics as one of the subject. A relaxation of 5% is given in case of candidates belonging to SC/ST category.

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LK, Gujral Punjab Technical University
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PROGRAM EDUCATIONAL OBJECTIVES: The Program Educational Objectives are the knowledge skills and attitudes which the students have at the time of post-graduation. At the end of the program, the student will be able to:

PEO1	Apply the scientific knowledge of Physics, Mathematics, Chemistry, and Physics specialization for deeper understanding of the nature.
PEO2	Identify, formulate, research literature, and analyze advanced scientific problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PEO3	Design solutions for advanced scientific problems and design system components or processes.
PEO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PEO5	Create, select, and apply appropriate techniques, resources, and modern scientific and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PEO6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional scientific practice.
PEO7	Communicate effectively on complex Scientific activities with the Scientific/engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PEO8	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of scientific and technological change.



PROGRAM OUTCOMES: At the end of the program, the student will be able to:

PO1	Apply principles of basic science concepts in understanding, analysis and prediction of physical systems.
PO2	To introduce interdisciplinary subjects/concepts/ideas for interdisciplinary application of Physics concepts.
PO3	To introduce advanced ideas and techniques required in emergent area of Physics.
PO4	To develop human resource with specialization in theoretical and experimental techniques required for career in academia and industry.
PO5	Engage in lifelong learning and adapt to changing professional and societal needs.

PROGRAM SPECIFIC OUTCOMES: At the end of the program, the student will be able to:

PSO1	Understand and apply principles of physics for understanding the scientific phenomenon in classical domain.
PSO2	Understand and apply mathematical techniques for describing and deeper understanding of physical systems.
PSO3	Understand and apply statistical methods for describing the classical and quantum particles in various physical systems and processes.
PSO4	Understand and apply inter-disciplinary concepts and computational skills for understanding and describing the natural phenomenon.
PSO5	Understand and apply principles of Quantum mechanics for understanding the physical systems in quantum realm.
PSO6	Provide exposure in various specialization of Physics (Solid State Physics/Nuclear Physics/Particle Physics).
PSO7	Provide exposure to advanced experimental/theoretical methods for measurement, observation, and fundamental understanding of physical phenomenon/systems.
PSO8	Engage in research and life-long learning to adapt to changing environment.

SEMESTER FIRST

Course Code	Course Title		Load locat		1000	arks bution	Total Marks	Credits
		L	T	P	Internal	External	ddiment of Pi Gujrel Punjal	Technical U

Scheme & Syllabus (M.Sc. Physics) Batch 2016 & Onwards

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PHS411	Mathematical Physics-I	3	1	1-	30	70	100	4
PHS412	Classical Mechanics	3	1	-	30	70	100	4
PHS413	Quantum Mechanics-I	3	1	-	30	70	100	4
PHS414	Statistical Mechanics	3	1	-	30	70	100	4
PHS415	Atomic and Molecular Physics	3	1	-	30	70	100	4
PHS416	Physics Lab-I		-	3	25	50	75	3
	TOTAL	15	5	3	175	400	575	23

SEMESTER SECOND

Course Code	Course Title		Load Marks Allocation Distribution		Total Marks	Credits		
	The state of the s	L	T	P	Internal	External		
PHS421	Mathematical Physics-II	3	1		30	70	100	4
PHS422	Nuclear Physics	3	1	-	30	70	100	4
PHS423	Quantum Mechanics-II	3	1	-	30	70	100	4
PHS424	Computational Physics	3	1	-	30	70	100	4
PHS425	Condensed matter Physics-I	3	1	-	30	70	100	4
PHS426	Physics Lab-II	-	-	3	25	50	75	3
PHS427	Computational Lab	-	-	3	25	50	75	3
	TOTAL	15	5	6	200	450	650	26

L: Lectures T: Tutorial P: Practical



SEMESTER THIRD

Course Code	Course Title		Load Marks Distribution Allocation		Total Marks	Credits		
		L	T	P	Internal	External		
PHS531	Condensed Matter Physics-II	3	1	-	30	70	100	4
PHS532	Classical Electrodynamics	3	1	9 <u>=</u>	30	70	100	4
PHS533	Particle Physics	3	1	-	30	70	100	4
PHS534	Electronics	3	1	-	30	70	100	4
PHS535 PHS536 PHS537 PHS538	Elective Subject-I	3	1	-	30	70	100	4
PHS539	Seminar	-	-	-	Satisfacto	ory/Unsatis	factory	2
PHS540	Physics Lab-III	-	C.II	3	25	50	75	3
	TOTAL	15	5	3	175	400	575	23

SEMESTER FOURTH

Course Code	Course Title		Load ocat	2	The state of	ırks bution	Total Marks	Credits
		L	T	P	Internal	External		
PHS541 PHS542	Elective Subject-II	3	1	-	30	70	100	4
PHS543 PHS544	Elective Subject-III	3	1		30	70	100	4
PHS545	M.Sc. Research Project		12		Satisfact	ory/Unsat	isfactory	12
	TOTAL	15	5	3	60	140	200	20

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Main Campus O

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Elective Subjects:

S.No.	Name of the Subject	Code
1	Fibre optics and non-linear optics	PHS535
2	Plasma Physics	PHS536
3	Nonlinear Dynamics	PHS537
4	Structures, Spectra and Properties of Biomolecules	PHS538
5	Experimental techniques in Nuclear and Particle Physics	PHS541
6	Physics of Nanomaterials	PHS542
7	Environmental Physics	PHS543
8	Science of Renewable source of Energy	PHS544

Examination and Evaluation

S. No.		Weightage	Remarks
1.	Mid term/sessional Tests	25%	Best of two mid semester test will be considered for evaluation.
2	Attendance/Seminar/ Assignments	5%	And any acres
3	End semester examination	70%	Conduct and checking of the answer sheets will at the Department level in case of University teaching Department or Autonomous institutions. For other colleges examination will be conducted at the university level.
4	Total	100%	Marks may be rounded off to nearest integer.
Practic	cal	Anale N	remited to the second s
1	Daily evaluation of practical record/Viva Voice/Attendance etc.	50%	Internal evaluation
2	Final Practical Performance + Viva Voice	50%	External evaluation
3	Total	100%	Marks may be rounded off to nearest integer.

MATHEMATICAL PHYSICS-I L-3, T-1, P-0 4 Credits **PHS411** Page & of 64
Department of Physical School University
Cuiral Puniab Technical University

Scheme & Syllabus (M.Sc. Physics) Batch 2016 & Onwards

Pre-requisite:	None
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Course Objectives: The objective of the course on **Mathematical Physics-I** is to equip the M.Sc. students with the mathematical techniques that he/she needs for understanding theoretical treatment in different courses taught in this class and for developing a strong background if he/she chooses to pursue research in physics as a career.

COI	Formulate and express a physical law in terms of tensors and simplify it by use of coordinate transforms.
CO2	Understand the use of complex variables for solving definite integral.
CO3	Solve partial differential equations using boundary value problems.
CO4	Understand the integral equations to solve the physics problems.
CO5	Use statistical methods to analysis the experimental data.

Mapping of course outcomes with the program specific outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	2
CO3	3	3	3 1 2 / 2	3	3	3	3	2
CO4	3	3	3	3	2	3	3	2
CO5	3	3	3 13111	3	2	2	2	1

- 1. Vector fields and Tensors: Scalar and Vector fields, Scalar and Vector products: Curl, Divergent and Introduction to tensors and definitions, contraction, direct product. Quotient rule, Levi-Civita symbol, Non-Cartesian tensors, metric tensor, Covariant differentiation.
- 2. Complex Variables: Introduction, Cauchy-Riemann conditions, Cauchy's Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals, Dispersion relation.
- 3. **Differential Equations:** Partial differential equations of theoretical physics, boundary value problems, Neumann & Dirichlet Boundary conditions, separation of variables, singular points, series solutions, second solution.
- 4. **Integral Equations:** Definitions and classifications, integral transforms and generating functions. Neumann series, Separable Kernels, Hilbert-Schmidt theory. Green's functions in one dimension.
- 5. Numerical Techniques: Roots of functions, Interpolation, Extrapolation, Differentiation, integration by trapezoid and Simpson's rule, RungeKutta method and finite difference method.
- **6. Elementary Statistics:** Introduction to probability theory, random variables, Binomial, Poisson and Normal distribution

Text Books:

1. Mathematical Methods for Physicists: G. Arfken and H.J. Weber (Academic Press, SanDiego) 7th edition, 2012.

Reference Books:

- 1. Mathematical Physics: P.K. Chattopadhyay (Wiley Eastern, New Delhi), 2004.
- 2. Mathematical Physics: A.K. Ghatak, I.C. Goyal and S.J. Chua (MacMillan, India, Delhi), 1986.
- 3. Mathematical Methods in the Physical Sciences M.L. Boas (Wiley, New York) 3rd edition, 2007.
- 4. Special Functions: E.D. Rainville (MacMillan, New York), 1960.
- 5. Mathematical Methods for Physics and Engineering: K.F.Riley, M.P.Hobson and S.J. Bence (Cambridge University Press, Cambridge) 3rd ed., 2006.

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I. K. Gujral Punjab Technical University, Kapurthala

PHS412		CLASSIC	AL MECH	IANICS	L	-3, T-1, P-0	4 (Credits			
Pre-requi	site: None	pts a				ne N					
students of in the mod	f M.Sc. stu	dents in the es of physic	Lagrangia cs such as (e of the con n and Hami Quantum M	ltonian for	malisms so	that they ca	an use these			
Course O	utcomes: A	At the end o	f the course	e, the studer	nt will be a	ble to					
CO1	Underst	and the nec	essity of A	ction, Lagra	ingian, and	Hamiltonia	n formalis	m.			
CO2	Describ	e the motio	n of a mech	nanical syste	em using L	agrange-Ha	milton for	nalism.			
CO3		Use d'Alambert principle and calculus of variations to derive the Lagrange equations of motion.									
CO4		Understand essential features of a classical problem (like motion under central force, periodic motions), use them to set up and solve the appropriate physics problems.									
CO5	physics	e.g., mole	cular spec	d body mo tra, acousti cal circuits,	cs, vibratio						
	Mapp	ing of cou	rse outcom	es with the	program	specific ou	tcomes				
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8			
CO1	3	3	3 112	3	1	2	2	3			
CO2	3	3	3	a 3 at ay sic	2 ·	2	2	3			
CO3	3	3	3	3	2	2	2	3			
CO4	3	3	3 1167 15	3 caused	2	2	2	3			

1. Lagrangian Formulation: Mechanics of a system of particles; constraints of motion, generalized coordinates, d'Alembert Principle and Lagrange's velocity-dependent forces and the dissipation function, Applications of Lagrangian formulation.

(Lectures 7)

2. **Hamilton's Principles:** Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to nonholonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.

(Lectures 7)

3. **Hamilton's Equations:** Legendre Transformation, Hamilton's equations of motion, Cyclic coordinates, Hamilton's equations from variational principle, Principle of least action.

(Lectures 7)

- 4. Canonical Transformation and Hamilton-Jacobi Theory: Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton- Jacobi equations for principal and characteristic functions, Action-angle variables for systems with one-degree of freedom. (Lectures 10)
- 5. Rigid Body Motion: Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top.

 (Lectures 10)

TUTORIALS: Relevant problems given at the end of each chapter in different books.

Text Books:

- 1. Classical Mechanics: H. Goldstein, C.Poole and J.Safko (Pearson Education Asia, New Delhi), 3rd ed 2002.
- 2. Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, New Delhi), 1988.

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PHS413	Qua	ntum Mec	hanics-I	Y .9	L-3	3, T-1, P-0	40	Credits	
Pre-requis	site: wave	mechanics,							
the studen techniques	ts of M.S of vector	c. class to spaces, ang	the formal	of the course structure on entum, pertury sysics as per	of the sub rbation the	ject and to eory, and so	equip the	m with th	
Course O	utcomes:	At the end o	of the course	e, the studer	it will be a	ble to			
CO1	Und	erstand the	need for qu	antum mecl	nanical for	malism and	l basic prin	ciples.	
CO2	nota			ce and impoblems, ger					
CO3		Better understanding of the mathematical foundations of angular momentum system of particles.							
CO4		lications o	f various	approximat	ion metho	ods in sol	ving the	Schrodinge	
CO5	App	ly the pertu	rbation theo	ory to scatte	ring matrix	and partia	l wave ana	lysis.	
2405	Марр	oing of cou	rse outcom	es with the	program	specific ou	tcomes		
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO1	2	3	3, 10,12,13	3 3 13	3	3	2	2	
CO2	2	3	3	3 282	3	3	2	1	
CO3	1	3	3	3	3	3	2	3	
CO4	-	3	3	3	3	3	3	3	
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Main Campus

- 1. Linear Vector Space and Matrix Mechanics: Vector spaces, Schwarz inequality, Orthonormal basis, Operators: Projection operator, Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Postulates of quantum mechanics, uncertainty relation, Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg, Schroedinger and Interaction representations, Exchange operator and identical particles, Density Matrix and Mixed Ensemble. (Lectures 12)
- 2. Angular Momentum: Angular part of the Schrödinger equation for a spherically symmetric potential, orbital angular momentum operator. Eigen values and eigenvectors of L2 and Lz. Spin angular momentum, General angular momentum, Eigen values and eigenvectors of J2 and Jz. Representation of general angular momentum operator, Addition of angular momenta, C.G. coefficients.

 (Lectures 7)
- 3. **Stationary State Approximate Methods:** Non-Degenerate and degenerate perturbation theory and its applications, Variational method with applications to the ground states of harmonic oscillator and other sample systems. (Lectures 7)
- 4. **Time Dependent Perturbation:** General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light.

(Lectures 7)

5. **Scattering Theory:** Scattering Cross-section and scattering amplitude, partial wave analysis, Low energy scattering, Green's functions in scattering theory, Born approximation and its application to Yukawa potential and other simple potentials. Optical theorem, Scattering of identical particles. (Lectures 7)

Text Books:

- 1. A Text book of Quantum Mechanics: P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi) 2nd edition, 2004.
- 2. Quantum Mechanics: V.K. Thankappan (New Age, New Delhi), 2004.

Reference Books:

- 1. Quantum Mechanics: M.P. Khanna, (Har Anand, New Delhi), 2006.
- 2. Modern Quantum Mechanics: J.J. Sakurai (Addison Wesley, Reading), 2004.
- 3. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi), 1995.
- 4. Quantum Physics: S. Gasiorowicz (Wiley, New York), 3rd ed. 2003.

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I.K. Gujral Punjab Technical University
Main Campus

Scheme & Syllabus (M.Sc. Physics) Batch 2016 & Onwards

I. K. Gujral Punjab Technical University, Kapurthala

	Sta	tistical Me	chanics		L-3, T-	-1, P-0	4 Cr	edits			
Pre-requis	site: None	HW Park			a series and a						
M.Sc. stud	lent with th	ne techniqu	es of Ense	of the cour mble theory bulk in term	so that he	she can u	se these to	understand			
Course O	utcomes: A	At the end o	f the cours	e, the studer	it will be a	ble to					
CO1	CO1 Understand Equations of state and thermodynamic potentials for elements systems of particles.										
CO2	Lea	Learn Modern aspects of equilibrium and non-equilibrium statistical Physics.									
CO3		Describe the features and examples of Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics.									
CO4		k with v	arious m	odels of I	hase tran	nsitions a	nd thermo	-dynamica			
		Describe physical quantities in quantum systems.									
CO5	Des	cribe physi	cal quantiti	es in quantu	m systems						
CO5			se outcom	es in quantu	program s		tcomes				
CO5			se outcom	es with the	program s		tcomes PSO7	PSO8			
CO5	Mapp	ing of cour	se outcom	es with the	program s	specific ou		PSO8 3			
	Mapp PSO1	PSO2	PSO3	es with the	PSO5	PSO6	PSO7	Li			
CO1	Mapp PSO1 3	PSO2	PSO3	es with the	PSO5	PSO6	PSO7	3			
CO1 CO2	PSO1 3	PSO2	PSO3	PSO4	PSO5	PSO6 3	PSO7 3 2	3			

- 1. The Statistical Basis of Thermodynamics: The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution.

 (Lectures 8)
- 2. **Ensemble Theory:** Phase space and Liouville's theorem, the microcanonical ensemble theory and its application to ideal gas of monatomic particles; The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory, density and energy fluctuations. (Lectures 8)
- 3. Quantum Statistics of Ideal Systems: Quantum states and phase space, an ideal gas in quantum mechanical ensembles, statistics of occupation numbers; Ideal Bose systems: basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field); Ideal Fermi systems: thermodynamic behaviour of an ideal Fermi gas, discussion of heat capacity of a free electron gas at low temperatures, Pauli paramagnetism.

(Lectures 10)

- 4. Elements of Phase Transitions: Introduction, a dynamical model of phase transitions, Ising model in zeroth approximation. (Lectures 4)
- 5. Fluctuations: Thermodynamic fluctuations, random walk and Brownian motion, introduction to nonequilibrium processes, diffusion equation. (Lectures 3)

TUTORIALS: Relevant problems given in the end of each chapter in the text book.

Text Books:

1. Statistical Mechanics: R.K. Pathria and P.D. Beale (Butterworth-Heinemann, Oxford), 3rd edition, 2011.

Reference Books:

- 1. Statistical Mechanics: K. Huang (Wiley Eastern, New Delhi), 1987.
- 2. Statistical Mechanics: B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi) 2nd edition, 2011.
- 3. Elementary Statistical Physics: C. Kittel (Wiley, New York), 2004.
- 4. Statistical Mechanics: S.K. Sinha (Tata McGraw Hill, New Delhi), 1990.

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Department of Physical Sciences

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Main Campus

PHS41	5	At	omic and	Molecular	Physics	L-3, T	-1, P-0	4 Cr	edits	
Pre-requis	site: No	one								
the studen	nts of	M.Sc	. Physics		ip them w				Physics for Rotational,	
Course O	utcome	es: At	t the end o	f the course	e, the stude	nt will be a	ble to	THE P		
CO1		Unde	erstand bas	sic elements	s of atomic	and molec	ular spectro	scopy		
CO2			erstand c	lassical/Qu ra	antum de	scription	of electro	nic, vibra	tional and	
CO3		Correlate spectroscopic information of known and unknown molecules with the physical description								
CO4		Unde	erstand and	l use Rama	n Spectroso	copy for an	alysis of m	olecules		
CO5		Unde analy	CONTRACTOR OF THE PARTY OF THE	in Resonan	ce Spectros	copy with	focus on N	MR for mo	lecular	
	M	appi	ng of cour	se outcom	es with the	program	specific ou	tcomes		
	PSC)1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO1	3		3	3	2	3	2	2	3	
CO2	3		3	3	3	3	3	3	3	
CO3	3		3	3	3	3	3	3	3	
CO4	3		3	3	2	3	3	3	3	
CO5	3		3	3	2	3	3	3	3	

1. Electronic Spectroscopy of Atoms: Bohr-Sommerfeld model of atomic structure, Electronic wave function and atomic quantum numbers – hydrogen spectrum – orbital, spin and total angular momentum - fine structure of hydrogen atom – many electron spectrum: Lithium atom spectrum, angular momentum of many electrons – term symbols – the spectrum of helium and alkaline earths – equivalent and non-equivalent electrons –X-ray photoelectron spectroscopy. (Lectures 8)

2. Electronic Spectroscopy of Molecules: Diatomic molecular spectra: Born-Oppenheimer approximation – vibrational spectra and their progressions – Franck-Condon principle – dissociation energy and their products –rotational fine structure of electronic-vibration transition - molecular orbital theory – the spectrum of molecular hydrogen – change of shape on excitation – chemical analysis by electronic spectroscopy – reemission of energy – fundamentals of UV photoelectron spectroscopy. (Lectures 9)

3. Microwave and Raman Spectroscopy: Rotation of molecules and their spectra – diatomic molecules – intensity of line spectra – the effect of isotropic substitution – non-rigid rotator and their spectra – polyatomic molecules (linear and symmetric top molecules) – Classical theory of Raman effect - pure rotational Raman spectra (linear and symmetric top molecules).

(Lectures 8)

4. Infra-red and Raman Spectroscopy: The energy of diatomic molecules — Simple Harmonic Oscillator—the Anharmonic oscillator—the diatomic vibrating rotator—vibration-rotation spectrum of carbon monoxide—breakdown of Born-Oppenheimer approximation—the vibrations of polyatomic molecules—influence of rotation on the spectra of polyatomic molecules (linear and symmetric top molecules)—Raman activity of vibrations—vibrational Raman spectra—vibrations of Spherical top molecules.

(Lectures 8)

5. **Spin Resonance Spectroscopy** Spin and magnetic field interaction – Larmor precession – relaxation time – spin-spin relaxation - spin-lattice relaxation - NMR chemical shift - coupling constants – coupling between nuclei – chemical analysis by NMR – NMR for nuclei other than hydrogen – ESR spectroscopy - fine structure in ESR. (Lectures 8)

Text Books:

1. Fundamentals of Molecular Spectroscopy by Colin N. Banwell and Elaine M. McCash (Tata McGraw-Hill Publishing Company limited).

Reference Books:

- 1. Physical method for Chemists (Second Edition) by Russell S. Drago (Saunders College Publishing).
- 2. Introduction to Atomic Spectra: H.E. White-Auckland McGraw Hill, 1934.
- 3. Spectroscopy Vol. I, II & III: Walker & Straughen
- 4. Introduction to Molecular spectroscopy: G.M. Barrow-Tokyo McGraw Hill, 1962.
- 5. Spectra of diatomic molecules: Herzberg-New York, 1944.
- 6. Molecular spectroscopy: Jeanne L. McHale

PHS416 Physics Lab- I

L-3, T-1, P-0

4 Credits

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Scheme & Syllabus (M.Sc. Physics) Batch 2016 & Onwards

Pre-requi	site: N	one	and the le	A region	-	- <u>h</u>		E al			
students o	f M.Sc d in th	ves: The aim and a class to expendence or	erimental set	ups in elec	tronics so	that they	can verify	some of th			
Course O	utcom	es: At the end	of the course	e, the studen	nt will						
CO1		Acquire hands	on experier	nce of hand	ling and bu	ilding elec	tronics circ	uits.			
CO2			Be familiar with the various components such as resistors, capacitor, inductor, IC chips and how to use these components in circuits.								
CO3		Be able to understand the construction, working principles and V-I characteristic of various devices such as PN junction diodes, UJT, TRIAC etc.									
CO4		Capable of usi	ng compone	nts of digit	al electron	ics for vari	ous applica	tions.			
CO5		Able to designand analyze th				ents as we	ll as accura	ately recor			
	M	apping of cou	rse outcom	es with the	program	specific ou	tcomes				
	PSC	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8			
CO1	1	2	2	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	2	2	3	3			
CO2	1	2	2	1	-	2	2	3			
CO3	1	3	3	1 10000	2	3	3	2			
CO4	-	3		2	1	3	3	2			
			3	3 / (1991)	2	3	3				

Scheme & Syllabus (M.Sc. Physics) Batch 2016 & Onwards

LK. Gujral Punjab Technical University.
Main Campus

List of experiments:

- Study the forward and reverse characteristics of a Zener diode.
- Construction of adder, subtracter, differentiator and itergrator circuits using the given OP-
- Study the static and drain characteristics of a JFET
- Construction of an Astable multivibrator circuit using transistor
- Construction of a single FET amplifier with common source configuration 5.
- Construction of an A/D converter circuit and study its performance
- Construction of an D/A converter circuit and study its performance
- Construction of a low-pass filter circuit and study its output performance
- Construction of a high-pass filter circuit and study its output performance
- 10. Electron Spin Resonance Spectrometer Experiment
- 11. Four Probe Method- Determination of resistivity of semiconductor at different temperature
- 12. To study pulse amplitude, Pulse width and Pulse position modulation
- 13. To study the frequency response of an operational amplifier
- 14. To study the characteristics of multivibrators- bistable, Astable, monostable
- 15. To find the wavelength of sodium light using Michelson interferometer.

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PHS421			Mathem:	atical Phys	ics-II	L-3, T	-1, P-0	4 Cr	edits
Pre-requis	site: I	None							
the M.Sc. theoretical	Stud	dents tment	with the in differe	mathematic	of the cou cal technic s taught in earch in phy	ues that this clas	he/she nee ss and for	eds for un	derstanding
Course O	utcon	nes: A	t the end o	f the course	e, the stude	nt will able	e to		
CO1	- 7	Appl	y of group	theory in a	all the branc	hes of Phy	sics.		
CO2		Use I	Fourier ser	ries and tran	nsformation	s as an aid	for analyz	ing experin	nental data.
CO3		Use i	ntegral tra	insform to s	solve mathe	matical pro	oblems of i	nterest in P	hysics.
CO4		Understand the applications of Delta and gamma functions in all the brance. Physics.							
CO5		Deve	lop mathe	matical ski	lls to solve	quantitativ	e problems	in physics	
	N	Mappi	ng of cour	se outcom	es with the	program	specific ou	tcomes	
	PS	O1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	1		3	1	3	3	1	2	3
CO2	1		3	2	2	2	2	2	3
CO3	1		3	2	2	2	2	2	3
CO4	1		3	2	3	2	-	2	3
CO5	1		3	3	2	2	1	1	3



- 1. Group Theory: What is a group? Multiplication table, conjugate elements and classes, subgroups, Isomorphism and Homomorphism, Definition of representation and its properties, Reducible and irreducible representations, Schur's lemmas (only statements), characters of a representation. Example of C4v, Topological groups and Lie groups, three dimensional rotation group, special unitary groups SU(2) and SU(3).
- 2. Delta and Gamma Functions: Dirac delta function, Delta sequences for one dimensional function, properties of delta function, Gamma function, factorial notation and applications, Beta function.
- 3. Special Functions: Bessel functions of first and second kind, Generating function, integral representation and recurrence relations for Bessel's functions of first kind, orthogonality. Legendre functions: generating function, recurrence relations and special properties, orthogonality, various definitions of Legendre polynominals. Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite functions, Laguerre functions.
- 4. Fourier Series and Integral Transforms: Fourier series, Dirichlet conditions. General properties. Advantages and applications, Gibbs phenomenon. Fourier transforms, Development of the Fourier integral, Inversion theorem, Fourier transforms of derivatives; Momentum representation. Laplace transforms, Laplace transforms of derivatives, Properties of Laplace transform, Inverse Laplace transformation.

Text Books:

- 1. Group Theory for Physicists: A.W. Joshi (Wiley Eastern, New Delhi) 2011.
- 2. Mathematical Methods for Physicists: G. Arfken and H.J. Weber, (Academic Press, San Diego) 7th edition, 2012.

Reference Books:

- 1. Matrices and Tensors in Physics: A.W. Joshi (Wiley Eastern, New Delhi) 2005.
- 2. Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co., Kolkata) 4th edition.
- 3. A First Course in Computational Physics: P.L. Devries (Wiley, New York) 1994.
- 4. Mathematical Physics: P.K. Chatopadhyay (Wiley Eastern, New Delhi) 2011.
- 5. Introduction to Mathematical Physics: C. Harper (Prentice Hall of India, New Delhi) 2006.

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Carratis

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I. K. Gujral Punjab Technical University, Kapurthala

PHS42	22	Nuc	lear Physic	es	L-3, T	-1, P-0	4 Cı	redits
Pre-requi	site: None	2						
students o radioactiv	of M.Sc. of decays, i	The aim ar lass to the nuclear forcused in stud	basic aspects, nuclear	cts of Nucl models, an	ear Physic	s like stati	c propertie	s of nucle
Course O	utcomes:	At the end o	of the cours	e, the stude	nt will be a	ible to		
CO1	Harris .	derstand str			of nuclei, ra	adioactive o	lecay, and o	lifferent
CO2	Un	derstand Qu	antum beh	avior of ato	ms in exter	nal electric	and magn	etic fields.
CO3	Co	mpare vario	us nuclear	models and	properties	of the nucl	eus.	
CO4	Un	derstand ab	out nuclear	forces and	their depen	idence on v	arious para	meters.
CO5	De	scribe vario	us types of	nuclear rea	ctions and	their prope	rties.	
250,0-10,	Map	ping of cou	rse outcom	es with the	program	specific ou	tcomes	THE
or house	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	1	2	3	3	3	3	3	3
CO2	1	3	1 *****	3	3	3	3	3
CO3	1	3	1 2 2/4(1)	3	3	3	3	3
CO4	1	3	1,000	3	3	3	3	3
CO5	1	3	2	3	2	3	3	3



- 1. Nuclear Models: Liquid drop model, Binding energy; fission and fusion, Experimental evidence for shell effects, Shell Model, Spin-Orbit coupling, Magic numbers, Application of Shell Model like Angular momenta and parities of nuclear ground states, Collective model-nuclear vibrations spectra and rotational spectra. (Lectures 8)
- 2. Static properties of nucleus: Nuclear radii and measurements, nuclear binding energy (review), nuclear moments and systematic, wave-mechanical properties of nuclei, hyperfinestructure, effect of external magnetic field, Nuclear magnetic resonance. (Lectures 5)
- 3. Nuclear decay: Review of barrier penetration of alpha decay & Geiger-Nuttal law. Beta decays, Fermi theory, Kurie plots and comparative half-lives, Allowed and forbidden transitions, Experimental evidence for Parity-violation in beta decay, Electron capture probabilities, Double beta decay, Neutrino, detection of neutrinos, measurement of the neutrino helicity. Multipolarity of gamma transitions, internal conversion process, transition rates. (Lectures 6)
- 4. **Nuclear forces:** Evidence for saturation of nuclear density and binding energies (review), types of nuclear potential, Ground and excited states of deuteron, dipole and quadrupole moment of deuteron, n-p scattering at low energies, partial wave analysis, scattering length, spin-dependence of n-p scattering, effective-range theory, coherent and incoherent scattering, central and tensor forces, p-p scattering, exchange forces & single and triplet potentials, meson theory of nuclear forces. (Lectures 8)
- 5. Neutron physics: Neutron production, slowing down power and moderating ratio, neutron detection. (Lectures 3)
- 6. Nuclear reactions: Nuclear reactions and cross-sections, Resonance, Breit-Wigner dispersion formula for l=0 and higher values, compound nucleus, Coulomb excitation, nuclear kinematics and radioactive nuclear beams. (Lectures 4)

Text Books:

- 1. Nuclear Physics: Irving Kaplan (Narosa), 2002.
- 2. Theory of Nuclear Structure: R.R. Roy and B.P. Nigam (New Age, New Delhi) 2005.

Reference Books:

- 1. Basic Ideas and Concepts in Nuclear Physics: K. Hyde (Institute of Physics) 2004.
- 2. Nuclear physics: Experimental and Theoretical, H.S. Hans (New Academic Science) 2nded (2011).
- 3. Nuclear Physics and its applications by John Liley
- 4. Nuclear Physics V. Devnathan



					(0)				
Pre-requi	site: P	reliminary cou	rse of Quan	tum Mecha	nics				
introduce techniques	the M	ves: The aim Sc. students to elativistic quar pranches of phy	the formal ntum mecha	structure onics and Q	of the subjountum fie	ect and to	equip him/l	ner with th	
Course O	utcom	es: At the end	of the cours	e, the stude	ent will be a	ible to			
CO1 Understand relativistic effects in quantum mechanics and need for quantum theory.									
CO2		Demonstrate the Lorentz covariant form of Lagrangian and Hamiltonian for scalar, vector fields, electromagnetic fields and their second quantisation.							
CO3	Understand the symmetries and the implications of Noether's Theorem in conserved currents and charges.							n in	
CO4		Understand th	e interaction	n picture, S	-matrix, an	d Wick's Tl	neorem.		
CO5		Explain the or the amplitudes		A CONTRACTOR OF THE PARTY OF TH	ON THE RESIDENCE OF RESIDENCE OF THE PARTY O		nman rules	to derive	
	M	apping of cou	rse outcom	es with the	program	specific ou	itcomes		
	PSC	D1 PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	
CO1	1	1	2 (2.01)	2, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,	2	2	2	3	
CO2	1	2	2	2	2	2	3	1	
CO3	1	2	3	3	2	1	2	2	
CO4	1	3	3	3	2	1	2	3	
CO5	1	2	1	3	2	2	3	3	

1. Relativistic Quantum Mechanics-I: Klein-Gordon equation, Dirac equation and its plane wave solutions, significance of negative energy solutions, spin angular momentum of the Dirac particle, the non-relativistic limit of Dirac equation.

(Lectures 12)

2. Relativistic Quantum Mechanics-II: Electron in electromagnetic fields, spin magnetic moment, spin-orbit interaction, Dirac equation for a particle in a central field, fine structure of hydrogen atom, Lamb shift.

(Lectures 10)

3. Quantum Field Theory: Resume of Lagrangian and Hamiltonian formalism of a classical field, Quantization of real scalar field, complex scalar field, Dirac field and e.m. field, Covariant perturbation theory, Wick's theorem, Scattering matrix.

(Lectures 12)

4. **Feynman diagrams**: Feynman diagrams and their applications, Wick's theorem, Scattering matrix, QED.

(Lectures 8)

Text Books:

- 1. Text Book of Quantum Mechanics -P.M. Mathews & K. Venkatesan-Tata McGraw Hill 2010
- 2. Quantum Mechanics G Aruldhas Prentice Hall of India 2006
- 3. Introduction to Quantum Mechanics David J.Griffiths Pearson Prentice Hall, 2005
- 4. Quantum Mechanics A Devanathan Narosa Publishing-New Delhi
- 5. Quantum Mechanics L.I Schiff McGraw Hill 1968
- 6. Quantum Mechanics A.K. Ghatak and S. Loganathan-McMillan India
- 7. Principles of Quantum Mechanics R.Shankar, Springer 2005
- 8. Quantum Mechanics Satya Prakash- KatharNathRamnath Meerut

Head Department of Physical Sciences

I.K. Gujral Punjab Technical University

Main Campus

MSPH 4	24 Co	mputationa	l Physics		L-3, T-	-1, P-0	4 Cr	edits		
Pre-requis	site: None						<u> </u>			
familiarize programmi	the of ing using	M.Sc. stud	lents with rel languag	tive of the the numer e such as Fo	ical meth	nods used	in compu	itation and		
Course O	itcomes:	At the end o	f the cours	e, the studen	t will be a	ble to				
CO1		ply basics blems.	knowledge	e of compu	tational	physics in	solving t	he physic		
CO2	Pro	gramme wi	th the C++	or any other	high leve	l language.) <u> </u>			
CO3	Uso	Use various numerical methods in solving physics problems.								
CO4	An	Analyze the outcome of the algorithm/program using graphic plots.								
CO5	Ap	ply physics	knowledge	in understan	iding inter	disciplinar	y problem/	concepts.		
	Марр	oing of cour	rse outcom	es with the	program	specific ou	tcomes			
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	3	3	1 118	1	2	3	3	3		
CO2	1		-11	r (1 10#100.04)		-	2	1		
CO3	3	3	2	2	2	2	3	3		
CO4	2	3	2	il sals	ing 2	1	2	3		
CO5	2	3	3	2	3	2	3	3		



- 1.Introduction to high level language: Need and advantages of high level language in physics, programming in a suitable high level language (Matlab/Mathematica/Scilab/ Octave), input/output, interactive input, loading and saving data, loops branches and control flow. Matrices and Vectors, Matrix and array operations, eigenvalues and eigen vectors.

 (Lectures 12)
- **2.Sub programs:** Advantages of modular programming, built-in functions, scripts, functions, sharing of variables between modules. (Lectures 8)
- **3.Graphics:** 2D plots, style options, axis control, overlay plots, subplot, histogram, 3D plots, mesh and surface plots, contour plots. (*Lectures 8*)
- **4.Numerical computation:** Computer programs for: solving linear system of simultaneous equations, nonlinear algebraic equation, roots of polynomials, curve fitting, polynomial curve fitting, least square curve fitting, interpolation, data analysis and statistics, numerical integration, Monte-Carlo simulation, ordinary differential equation, first order and second order ODEs, event location.

 (Lectures 15)

5. List of experiments:

- 1.Black body radiation (computation and graphical representation)
- 2. Reflection and transmission of an electromagnetic wave
- 3. Statistical distributions at different temperatures
- 4. Binding energy curve for nuclei using liquid drop model
- 5. Eigen-value problem: 1-D square potential well
- 6. Eigen-values and wave-functions of a simple harmonic oscillator
- 7. Monte-Carlo simulation
- 8.Linear/Projectile motion (simulation and solutions)

Text Books:

- 1. Pratap R, "Getting started with MATLAB 7", Oxford Univ. Press, 2006
- 2. Gilat A, "Matlab: An introduction with applications", Wiley, 2008
- 3. Eaton J W, Batchman D and Hauberg S "GNU Octave Manual Version 3", Network Theory Ltd.2008
- 4. Campbell S, Chancelier J P and Nikoukhah R, "Modeling and simulation in Scilab", Springer 2005
- 5. "Mathematica Information Center ('MathSource')": http://library.wolfram.com/infocenter/2009
- 6. Gerald C F and Wheatley P O, "Applied Numerical Analysis", 7th Ed, Addison Wesley, 2003

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At of Physical Sciences

PHS42	5	Co	ndensed	Matter Pl	nysics-I	L-3, T-	-1, P-0	4 Cr	edits
Pre-requis	site: N	Vone					n Dejta a	78 IX.	
expose the properties,	stude	ents of M gy band	M.Sc. cl theory a	ass to the t	opics like e rt theory so	lastic cons that they	tants, lattic are equippe	e vibration	vsics-I is to s, dielectric techniques
Course O	utcom	es: At t	he end o	f the course	e, the stude	nt will be a	ble to		
CO1				sic elements		The state of the s	THE RESERVE OF THE PERSON NAMED IN COLUMN TWO IS NOT THE PERSON NAMED IN COLUMN TWO IS NAME	d matter.	
CO2			stand ac	curate desc ds.	ription of	lattice dyn	amics and	thermal pr	roperties of
CO3		Under	stand ori	gin of energ	gy bands in	solids with	focus on s	semiconduc	tors.
CO4		Descri	be and u	nderstand b	asics of tra	nsport prop	perties acro	ss solids.	
CO5		Descri	be and u	nderstand r	nagnetic an	d dielectric	behavior of	of solids.	
	N	Iapping	g of cour	rse outcom	es with the	program	specific ou	tcomes	
	PS	01	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3		3	3	3	2	1	3	2
CO2	3		3	3	3	3	3	3	3
CO3	3		3	3	3	3	3	3	3
CO4	3		3	3	3	3	3	3	3
CO5	3		3	3	3 1-18 -11	3	3	3	3



1. Elastic constants:

Binding in solids; Stress components, stiffness constant, elastic constants, elastic waves in crystals.

2. Lattice Dynamics and Thermal Properties:

Rigorous treatment of lattice vibrations, normal modes; Density of states, thermodynamic properties of crystal, anharmonic effects, thermal expansion.

3. Energy Band Theory:

Electrons in a periodic potential: Bloch theorem, Nearly free electron model; tight binding method; Semiconductor Crystals, Band theory of pure and doped semiconductors; elementary idea of semiconductor superlattices.

4. Transport Theory:

Electronic transport from classical kinetic theory; Introduction to Boltzmann transport equation; electrical and thermal conductivity of metals; thermoelectric effects; Hall effect and magneto resistance.

5. Dielectric Properties of Materials:

Polarization mechanisms, Dielectric function from oscillator strength, Clausius-Mosotti relation; piezo, pyro- and ferro-electricity.

6.Liquid Crystals:

Thermotropic liquid crystals, Lyotropic liquid crystals, long range order and order parameter, Various phases of liquid crystals, Effects of electric and magnetic field and applications, Physics of liquid crystal devices.

TUTORIALS: Relevant problems given in the books listed below.

Text Books:

- 1. Introduction to Solid State Physics: C. Kittel (Wiley, New York), 8th ed. 2005.
- 2. Quantum Theory of Solids: C. Kittel (Wiley, New York) 1987.

Reference Books:

- 1. Principles of the Theory of Solids: J. Ziman (Cambridge University Press) 1972
- 2. Solid State Theory: Walter A. Harrison (Tata McGraw-Hill, New Delhi) 1970.

3. Liquid Crystals: S. Chandrasekhar (Cambridge University), 2nd ed. 1992.

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PHS42	26		Physics Lab-	П	L-3, T	-1, P-0	4 Cı	edits		
Pre-requi	site: N	None								
M.Sc. stud	dents 1	to experime	im and objecti ental technique d in theory and	s in atomic	and nuclea	r physics s	so that they	can verify		
Course O	utcom	es: At the	end of the cour	se, the stude	ent will be a	ble to				
CO1 Acquire hands on experience of using particle detectors such as GM count a Scintillation counter.										
CO2		handle os	cilloscope for v	risualisation	of various	nput and o	utput signa	ls.		
CO3	8 - 1	Understand the basic of nuclear safely management.								
CO4		Perform scientific experiments as well as accurately record and analytic results of nuclear experiments.								
CO5		Solve app	lied nuclear pro	oblems with	critical thir	iking and a	nalytical re	asoning.		
	N	Tapping of	course outcor	nes with the	program	specific ou	tcomes			
	PS	O1 PS	O2 PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	1	2	1	2	1	3	3	3		
CO2	1	1	1.55	3	1	3	1	3		
CO3	1	1	1	3	1	3	1	2		
CO4	1	3	3	3	1	3	3	3		
CO5	1	3	3 7 4 7	3	1	3	3	3		

Note: Students are expected to perform atleast 10 experiments out of following list.

- 1. Determination of e/m of electron by Normal Zeeman Effect using Febry Perot interferometer.
- 2. To verify the existence of Bohr's energy levels with Frank-Hertz experiments.
- 3. Determination of Lande's factor of DPPH using Electron-spin resonance (E.S.R.) spectrometer
- 4. Determination of ionization Potential of Lithium
- 5. Analysis of pulse height of gamma ray spectra
- 6. To study the characteristics of G.M. counter
- 7. To determine the dead time of G.M. counter
- 8. To study absorption of beta particles is matter
- 9. To study Gaussian distribution using G.M. counter
- 10. Source strength of a beta source using G.M counter
- 11. Determination of Planck's constant using Photocell and interference filters.
- 12. Recording and calibrating a gamma ray spectrum by scintillation counter
- 13. Detecting gamma radiation with a scintillation counter
- 14. To study absorption of gamma radiation by scintillation counter
- 15. Identifying and determining the activity of weakly radioactive samples

Text Books:

- 1. Fundamentals of Molecular Spectroscopy by Colin N. Banwell and Elaine M. McCash (Tata McGraw-Hill Publishing Company limited).
- 2. Physics of Atoms and Molecules by B. H. Bransden and C. J. Joachain.

Reference Books:

- 1. Physical method for Chemists (Second Edition) by Russell S. Drago (Saunders College Publishing).
- 2. Introduction to Atomic Spectra: H.E. White-Auckland McGraw Hill, 1934.
- 3. Spectroscopy Vol. I, II & III: Walker & Straughen
- 4. Introduction to Molecular spectroscopy: G.M. Barrow-Tokyo McGraw Hill, 1962.
- 5. Spectra of diatomic molecules: Herzberg-New York, 1944.

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	7		Compu	itational L	ab	L-3, T-	-1, P-0	4 Cr	edits
Pre-requis	ite: N	None							
students of as C++ lar	M.Songuag	c. class e for si	in unders imulation	tanding nu of results	merical me for differer	thods, the u	sage of his	hysics-II is gh level lan nd graphic olving phy	guage such analysis o
Course Ou	ıtcon	nes: At	the end o	f the course	e, the stude	nt will be a	ble to		
CO1			rstand and		sics knowl	edge of nu	ımerical m	nethods in	solving the
CO2		Write	programn	ne with the	C++ or an	y other high	h level lang	guage.	
CO3		Learn	use of gra	aphical me	thods in da	a analysis	and solving	g physics pr	oblems.
CO4			physical	problem, e	nabling dev	velopment (of critical t	hinking an	d analytica
		1 Casol							
C05		exploi	re applica			physics in	frontier are	eas of pure	and applied
CO5	N	exploi resear	re applica	sics and all					and applied
CO5	N PS	exploi resear Iappin	re applica	sics and all	ied fields.				and applied
CO5		exploi resear Iappin	re applica ch in phys g of cour	sics and all	ied fields. es with the	program	specific ou	tcomes	
	PS	exploi resear Iappin	re applica ch in physica g of cour	sics and all	es with the	program s	specific ou	tcomes PSO7	PSO8
CO1	PS 1	exploi resear Iappin	re applica ch in physica g of cour PSO2	PSO3	es with the PSO4	PSO5	PSO6	PSO7	PSO8
CO1 CO2	PS 1	exploi resear Iappin	re applica rch in physical gof cour PSO2	PSO3	PSO4 3 3	PSO5 3 3	PSO6	PSO7 3 3	PSO8 3 3

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Department of Physical Sciences -I.K. Gujral Punjab Technical Univer Main Campus: 100

- 1. Black body radiation (computation and graphical representation)
- 2. Reflection and transmission of an electromagnetic wave
- 3. Statistical distributions at different temperatures
- 4. Binding energy curve for nuclei using liquid drop model
- 5. Eigen-value problem: 1-D square potential well
- 6. Eigen-values and wave-functions of a simple harmonic oscillator
- 7. Monte-Carlo simulation
- 8. Linear/Projectile motion (simulation and solutions)

Text Books:

- 1. Pratap R, "Getting started with MATLAB 7", Oxford Univ. Press, 2006
- 2. Gilat A, "Matlab: An introduction with applications", Wiley, 2008
- 3. Eaton J W, Batchman D and Hauberg S "GNU Octave Manual Version 3", Network Theory Ltd.2008
- 4. Campbell S, Chancelier J P and Nikoukhah R, "Modeling and simulation in Scilab", Springer 2005
- 5. "Mathematica Information Center ('MathSource')": http://library.wolfram.com/infocenter/2009
- 6. Gerald C F and Wheatley P O, "Applied Numerical Analysis", 7th Ed, Addison Wesley,2003

Head Physical Sciences
Pepartment of Physical Sciences
Pepartm

PHS53	31	(Condensed	Matter Ph	ysics-II	L-3, T	-1, P-0	4 Cr	edits
Pre-requi	site: N	Vone							
expose the properties,	stude energ	ents o	f M.Sc. cl nd theory a	ass to the t and transpo	opics like of rt theory so	elastic cons	tants, lattic are equipp	Matter Ple vibration ed with the	s, dielectric
Course O	utcon	ies: A	t the end o	f the course	e, the stude	nt will be a	ble to		
CO1		Und	erstand and	describe (Optical pro	perties of so	olids		
CO2		Und	erstand and	d describe r	nagnetic pr	operties of	solids	DATE A	
CO3		Und	erstand use	of NMR r	nethods for	describing	solids		
CO4		Und	erstand and	d explain th	e behavior	of superco	nductors		
CO5		Und	erstand the	effect of d	efects and	deformation	n on the be	navior of so	olids
	N	Iappi	ing of cour	se outcom	es with the	program	specific ou	tcomes	
	PS	01	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3		3	3	3	2	1	3	2
CO2	3		3	3	3	3	3	3	3
CO3	3	T _M ,	3	3	3	3	3	3	3
CO4	3		3	3	3	3	3	3	3
CO5	3		3	3	3	3	3	3	3
					Maria Wall				



- 1. **Optical Properties**: Macroscopic theory generalized susceptibility, Kramers- Kronig relations, Brillouin scattering, Raman effect; interband transitions. (Lectures 8)
- 2. Magnetism: Dia- and para-magnetism in materials, Pauli paramagnetism, Exchange interaction. Heisenberg Hamiltonian mean field theory; Ferro-, ferri-and antiferromagnetism; spin waves, Bloch T3/2 law. (Lectures 8)
- 3. Principles of Magnetic Resonance: ESR and NMR equations of motion, line width, motional narrowing, Knight shift. (Lectures 8)
- 4. Superconductivity: Experimental Survey; Basic phenomenology; BCS pairing mechanism and nature of BCS ground state; Flux quantization; Vortex state of a Type II superconductors; Tunneling Experiments; High Tc superconductors. (Lectures 8)
- Disordered Solids: Basic concepts in point defects and dislocations; Noncrystalline solids: diffraction pattern, glasses, amorphous semiconductors and ferromagnets, heat capacity and thermal conductivity of amorphous solids, nanostructures short expose; Quasicrystals. (Lectures 8)

Text Books:

- 1. Introduction to Solid State Physics: C. Kittel (Wiley, New York) 2005.
- 2. Quantum Theory of Solids: C. Kittel (Wiley, New York) 1987.

Reference Books:

- 1. Principles of the Theory of Solids: J. Ziman (Cambridge University Press) 1972.
- 2. Solid State Physics: H. Ibach and H. Luth (Springer, Berlin), 3rd. ed. 2002.
- 3. A Quantum Approach to Solids: P.L. Taylor (Prentice-Hall, Englewood Cliffs), 1970.
- 4. Intermediate Quantum Theory of Solids: A.O.E. Animalu (East-West Press, New Delhi), 1991.
- 5. Solid State Physics: Ashcroft and Mermin (Reinhert & Winston, Berlin), 1976.

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Main Campus

100	WW	-	FA	14
	H		-	

			BEST BETT					
Pre-requi	site: Noi	ne		7- 1-1				
Magnetost	tatics in	res: The Called Ma aves in dielectes.	xwell equ	ations, an	d their a	applications	to prop	agation of
Course O	utcomes	: At the end o	of the cours	e, the stude	nt will be a	ible to		
CO1 Understand and apply the laws of electromagnetism and Maxwell's equation different forms and different media.								equations in
CO2	S	olve the elect	ric and mag	gnetic field:	s problems	for differen	nt configura	ntions.
CO3		Provide solution to real life plane wave problems for various bound conditions.						
CO4	C	alculate refle	ction and tr	ansmission	of waves a	at plane inte	erface.	
CO5	A	nalyze propa	gation of el	ectromagn	etic waves	through dif	ferent wave	eguides.
	Ma	pping of cou	rse outcom	es with the	e program	specific ou	itcomes	
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	1 30,00	2	111	2	1	2
CO2	3	3	1	2	2	2	2	2
CO3	3	3	1	3	2	1	2	2
CO4	3	3	2	3	2	2	1	2
CO5	3	3	1	3	2	2	2	2



1. **Electrostatics:** Laplace and Poisson's equations, Electrostatic potential and energy density of the electromagnetic field, Multipole expansion of the scalar potential of a charge distribution, dipole moment, quadrupole moment, Multipole expansion of the energy of a charge distribution in an external field, Static fields in material media, Polarization vector, macroscopic equations, classification of dielectric media, Molecular polarizability and electrical susceptibility, Clausius-Mossetti relation, Models of Molecular polarizability, energy of charges in dielectric media (Maxwell stress tensor). (Lectures 10)

2. Magnetostatics: The differential equations of magnetostatics, vector potential, magnetic fields of a localized current distribution, Singularity in dipole field, Fermi-contact term,

Force and torque on a localized current distribution. (Magnetic stress tensor)

(Lectures 8)

3. **Boundary value problems:** Uniqueness theorem, Dirichlet and Neumann Boundary conditions, Earnshaw theorem, Green's (reciprocity) theorem, Formal solution of electrostatic boundary value problem with Green function, Method of images with examples, Magnetostatic boundary value problems. (Lectures 8)

4. Time varying fields and Maxwell equations: Faraday's law of induction, displacement current, Maxwell equations, scalar and vector potential, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, General expression for the electromagnetic fields energy, conservation of energy, Poynting Theorem, Conservation of momentum.

(Lectures 8)

- 5. Electromagnetic Waves: wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Poynting theorem for a complex vector field, waves in conducting media, skin depth, Reflection and refraction of e.m. waves at plane interface, Fresnel's amplitude relations, Reflection and Transmission coefficients, polarization by reflection, Brewster's angle, Total internal reflection, Stoke's parameters, EM wave guides, Cavity resonators, Dielectric waveguide, optical fibre waveguide, Waves in rarefied plasma (ionosphere) and cold magneto-plasma, Frequency dispersive characteristics of dielectrics, conductors and plasmas. (Lectures 8)
- 6. Radiation from Localized Time varying sources: Solution of the inhomogeneous wave equation in the absence of boundaries, Fields and radiation of a localized oscillating source, electric dipole and electric quadrupole fields, center fed antenna. (Lectures 4)

Text Books:

- 1. Classical Electrodynamics: S.P. Puri (Narosa Publishing House) 2011.
- 2. Classical Electrodynamics: J.D. Jackson, (New Age, New Delhi) 2009.
- 3. Introduction to Electrodynamics: D.J. Griffiths (Prentice Hall India, New Delhi) 4th ed., 2012.

Reference Books:

- 1. Classical Electromagnetic Radiation: J.B. Marion and M.A. Heald(Saunders College Publishing House) 3rd edition, 1995.
- 2. Electromagnetic Fields, Ronald K. Wangsness (John Wiley and Sons) 2nd edition, 1986, 1986
- 3. Electromagnetic Field Theory Fundamentals: Bhag Singh Guru and H.R. Hiztroglad

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I. K. Gujral Punjab Technical University, Kapurthala

PHS53	13	Part	icle Physic	es	L-3, T-	-1, P-0	4 Cr	edits
Pre-requi	site: course	e on Quantu	ım mechani	ics and Qua	ntum field	Theory		
invariance static quar	principles	e of the cou and conser hadrons an rspective.	vation laws	, hadron-ha	dron intera	ctions, rela	itivistic kin	ematics,
Course O	utcomes: A	At the end o	f the course	e, the stude	nt will be a	ble to unde	rstand	WWS.
COI	THE STATE OF THE S	erview of pelopments.	article spec	ctrum, their	interaction	n and majo	or historica	l and lates
CO2	Vari	ious invaria	nce princip	les and syn	nmetry pro	perties in p	article phys	sics.
CO3	Bas	ic rules of I	eynman di	agrams and	the quark	model for l	nadrons.	- 10 76 - 1
CO4	Proj	perties of a	neutrons at	nd protons	in terms	of a simpl	e nonreltiv	vistic quarl
CO5	Wea	ak interaction	n between	quarks and	how that the	his is respo	nsible for f	decay.
		21 2	ee outcom	os with the			Victoria de la companya della companya della companya de la companya de la companya della compan	
	Марр	ing of cour				specific ou	tcomes	
4	PSO1	PSO2		PSO4		PSO6	PSO7	PSO8
CO1			a dale into		inid			PSO8 3
CO1	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	1001 119V5000 70000
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	3
CO2	PSO1 2 2	PSO2 2 2	PSO3 2 deserted 2	PSO4 3 3 3	PSO5 3 3 3	PSO6 1 1	PSO7 2 2	3

Scheme & Syllabus (M.Sc. Physics) Batch 2016 & Onwards

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1. **Introduction:** Fermions and bosons, particles and antiparticles, quarks and leptons, interactions and fields in particle physics, classical and quantum pictures, Yukawa picture, types of interactions - electromagnetic, weak, strong and gravitational, units.

(Lectures 7)

- 2. Invariance Principles and Conservation Laws: Invariance in classical mechanics and quantum mechanics, Parity, Pion parity, Charge conjugation, Positronium decay, Time reversal invariance, CPT theorem. (Lectures 7)
- 3. **Hadron-Hadron Interactions:** Cross section and decay rates, Pion spin, Isospin, Two nucleon system, Pion-nucleon system, Strangeness and Isospin, G-parity, Total and Elastic cross section, Particle production at high energy. (Lectures 7)
- 4. **Relativistic Kinematics and Phase Space:** Introduction to relativistic kinematics, particle reactions, Lorentz invariant phase space, two-body and three-body phase space, recursion relation, effective mass, dalitz, K-3 p-decay, t-θ puzzle, dalitz plots for dissimilar particles, Breit-Wigner resonance formula, Mandelstem variables. (Lectures 7)
- 5. Static Quark Model of Hadrons: The Baryon decuplet, quark spin and color, baryon octer, quark-antiquark combination. (Lectures 7)
- 6. Weak Interactions: Classification of weak interactions, Fermi theory, Parity non conservation in β-decay, experimental determination of parity violation, helicity of neutrino, K-decay, CP violation in K- decay and its experimental determination.

(Lectures 7)

Text Books:

1.

1. Introduction to High Energy Physics: D.H. Perkins (Cambridge University Press), 42000.

Reference Books:

- 1. Elementary Particles: I.S. Hughes (Cambridge University Press), 3rded. 1991.
- 2. Introduction to Quarks and Partons: F.E. COse (Academic Press, London), 1979.
- 3. Introduction to Particle Physics: M.P. Khanna (Prentice Hall of India, New Delhi), 2004.

Head Then of Physical University
Department of Physical Technical University
I.K. Gural Punjab Technical University
Main Campus

PHS534 Electronics L-3, T-1, P-0 4 Credits

Pre-requisite: Basic knowledge about electronics Course Objectives: The aim and objective of the course on Electronics is to introduce the students of M.Sc. class to the formal structure of the subject and to equip them with the knowledge of semiconductor physics, basic circuit analysis, first-order nonlinear circuits, OPAMP based analog circuits and introduction to digital electronics so that they can use these in various branches of physics as per their requirement. Course Outcomes: At the end of the course, the student will be able to CO₁ Understand working of Different Semiconductor devices (Construction, Working Principles and V-I characteristics) and their applications. CO₂ Learn about the construction and working of Thyristors and various applications of Thyristors. CO₃ Understand Analog and Digital Instruments and their applications. CO₄ Enable them for using Boolean algebra and Karnaugh maps. CO₅ Introduce them to the Sequential and Integrated circuits. Mapping of course outcomes with the program specific outcomes PSO₁ PSO₂ PSO₃ PSO₄ PSO₅ PSO6 PSO7 PSO8 CO₁ 3 2 2 2 3 3 3 CO₂ 2 2 1 1 1 1 3 2 CO3 1 1 1 2 3 3 CO4 3 3



3

3

2

2

2

CO5

1

- 1. Analog and Digital Instruments: Introduction-Basic Emitter Follower Voltmeter; FET Input Voltmeter; Voltage Follower Voltmeter; Amplifier Type OP AMP Voltmeter; Voltage to Current Converter; Current Measurement with Analog Electronic Instrument; Time Base; Basic Digital Frequency Meter System; Reciprocal Counting Technique; Digital Voltmeter System; Digital LCR Measurements. (Lectures 8)
- 2. UJTs and Thyristors: Operational Principle of UJT: UJT Relaxation Oscillator circuit; PNPN Diode: Characteristics- As a Relaxation Oscillator-Rate Effect; SCR: V-I Characteristics - Gate Triggering Characteristics; DIAC and TRIAC; Thyristors: Basic Parameters- As Current Controllable Devices- Thyristors in Series and in Parallel; Applications of Thyristors-As a Pulse Generator, BistableMultivibrator, Half and Full Wave Controlled Rectifier, TRIAC based AC power control, SCR based Crowbar Protection; Gate Turn-Off Thyristors; Programmable UJT. (Lectures 10)
- 3. Digital Integrated Circuits: 7400 TTL; TTL Parameters; TTL-MOSFET's; CMOS FET's; Three State TTL Devices; External drive for TTL Loads; TTL Driving External Loads; 74C00 CMOS; CMOS Characteristics; TTL to CMOS Interface; CMOS to TTL interface; Current Tracers. (Lectures 7)
- 4. Integrated Circuits as Analog System Building Blocks: Electronic Analog Computation; Active Filters: Butterworth Filter-Practical Realization-High Pass Filter-Band Pass Filter-Band Reject Filter; Delay Equalizer; Switched Capacitor Filters; Comparators; Sample and Hold Circuits; Waveform Generators: Square Wave Generator Pulse Generator-Triangle wave Generator-Sawtooth Generator; Regenerative Comparator: Schmitt Trigger.
- 5. Integrated Circuits as Digital System Building Blocks: Binary Adders: Half Adder-Parallel Operation-Full Adder-MSI Adder-Serial Operation; Decoder/Demultiplexer: BCD to Decimal Decoder-4-to-16 line Demultiplexer; Data Selector/Multiplexer:16-to-1 Multiplexer; Encoder; ROM:Code Converters-Programming the ROM-Applications; RAM:Linear Selection-Coincident Selection-Basic RAM ElementsBipolar RAM-Static and Dynamic MOS RAM; Digital to Analog Converters: Ladder Type D/A Converter-Multiplying D/A Converter; Analog to Digital Converters: Successive Approximation A/D Converter. (Lectures 8)

Text Books:

- 1. Text Book of Electronics: S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006.
- 2. Digital Principles and Applications: A.P. Malvino and D.P. Leach, Tata McGraw-Hill, Publishing Co., New Delhi.

Reference Books:

- 1. Electronics Principles and Applications: A.B. Bhattacharya, New Central Book Agency P.Ltd., Kolkata, 2007.
- 2. Integrated Electronics Analog and Digital Circuits and Systems: J. Millman, C.C Halkins and C. Parikh, 2nd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.

Flective Subject -I

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PHS53	5 F	ibre Optics a	nd Non-lin	near optics	L-3, T	-1, P-0	4 Cı	edits
Pre-requi	site: No	ne						
and Nonli	inear O	es: Course O ptics is to ex res and their u	pose the M	.Sc. student				
Course O	utcomes	: At the end o	of the course	e, the studer	nt will be a	ble to		
CO1	U	Inderstand the	e structure o	f optical fib	er and des	cribe prope	erties of op	tical fibers.
CO2	t	Inderstand and	d compare t	he various p	orocesses (of fibers fal	orication	
CO3	τ	Inderstand the	principles	of fiber opti	ics commu	nication in	different n	nedia
CO4	A	analyze the ele	ectro-optic a	and acousto	optic effe	cts in fibers	5	
CO5	L	Inderstand no	n-linear effe	ects in optic	al fibers.			
	Ma	pping of cou	rse outcom	es with the	program	specific ou	tcomes	
	PSOI	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	= =	2	The totals	2		1	2	3
CO2	-	2	101.18	2		3 m	1	3
CO3		1	A TOTAL	2	e - e'		1	3
CO4	-	2	7 Isarela	2 11/01/5			1	3
CO5	92	2	a refer	2			1	3



- 1. Optical fibre and its properties: Introduction, basic fibre construction, propagation of light, modes and the fibre, refractive index profile, types of fibre, dispersion, data rate and band width, attenuation, leaky modes, bending losses, cut-off wavelength, mode field diameter, other fibre types.

 (Lectures 7)
- 2. **Fiber fabrication and cable design:** Fibre fabrication, mass production of fiber, comparison of the processes, fiber drawing process, coatings, cable design requirements, typical cable design, testing.

 (Lectures 5)
- 3. Optics of anisotropic media: Introduction, the dielectric tensor, stored electromagnetic energy in anisotropic media, propagation of monochromatic plane waves in anisotropic media, directions of D for a given wave vector, angular relationships between D, E, H, k and Poynting vector S, the indicatrix, uniaxial crystals, index surfaces, other surfaces related to the uniaxial indicatrix, Huygenian constructions, retardation, biaxial crystals, intensity through polarizer/waveplate/polarizer combinations. (Lectures 10)
- 4. Electro-optic and acousto-otpic effects and modulation of light beams: Introduction to the electro-optic effects, linear electro-optic effect, quadratic electro-optic effects, longitudinal electro-optic modulation, transverse electro optic modulation, electro optic amplitude modulation, electro-optic phase modulation, high frequency wave guide, electro-optic modulator, strain optic tensor, calculation of LM for a logitudinal acoustic wave in isotropic medium, Raman-Nath diffraction, Raman-Nath acousto-optic modulator.

(Lectures 10)

5. **Non-linear optics/processes**: Introduction, anharmonic potentials and nonlinear polarization, non-linear susceptibilities and mixing coefficients, parametric and other nonlinear processes, macroscopic and microscopic susceptibilities. (Lectures 8)

Text Books:

1. The Elements of Fibre Optics: S.L. Wymer and Meardon (Regents/Prentice Hall), 1993.

Reference Books:

- 1. Lasers and Electro-Optics: C.C. Davis (Cambridge University Press), 1996.
- 2. Optical Electronics: Gathak & Thyagarajan (Cambridge Univ. Press), 1989.
- 3. The Elements of Non-linear Optics: P.N. Butcher & D. Cotter (Cambridge University Press), 1991.

Elective Subject -I

PHS53	36	Plas	sma Physic	es	L-3, T	-1, P-0	4 Cı	edits
Pre-requi	site: Cour	se on Electr	odynamics					
Course O M.Sc. stu	bjectives: dents to th	The aim a	and objecti the challeng	ve of the co	ourse on l	Plasma Ph sma physic	ysics is to s.	expose the
Course O	utcomes:	At the end o	of the cours	e, the studer	nt will be a	ible to		
CO1 Understand the origin of plasma, conditions of plasma formation and proper of plasma.								
CO2				single part cribe differe				and kinetic
CO3		ssify propa I non-magne		electrostatic mas	and elect	romagnetic	waves in	magnetized
CO4				ort phenome zed and non				ffusion and
CO5	the			ns for descim, or non-e				
	Марј	oing of cour	rse outcom	es with the	program	specific ou	tcomes	
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	1 1 2 2	2	2	3	3	1	-
CO2	3	3	3	3	3	3	1	-
CO3	3	3	3	3	3	3	2	
CO4	3	3	3	3	3	3	1	1
CO5	3	As 100 to 100	3	3	3	3	2	1

Head.

Department of Physical Sciences

I.K. Gujral Punjab Technical University

Main Campus

- 1. **Introduction:** Plasma State, elementary concepts and definitions of temperature and other parameters, occurrence and importance of plasma for various applications, Production of Plasma in the laboratory, Physics of glow discharge, electron emission, ionization, breakdown of gases, Paschen's laws and different regimes of E/p in a discharge, Townsend discharge and the evolution of discharge. (Lectures 8)
- 2. Plasma diagnostics: Probes, energy analyzers, magnetic probes and optical diagnostics, preliminary concepts. (Lectures 5)
- 3. Single particle orbit theory: Drifts of charged particles under the effect of different combinations of electric and magnetic fields, Crossed electric and magnetic fields, Homogenous electric and magnetic fields, spatially varying electric and magnetic fields, time varying electric and magnetic fields, particle motion in large amplitude waves.

(Lectures 8)

- 4. Fluid description of plasmas: distribution functions and Liouville's equation, macroscopic parameters of plasma, two and one fluid equations for plasma, MHD approximations commonly used in one fluid equations and simplified one fluid and MHD equations. dielectric constant of field free plasma, plasma oscillations, space charge waves of warm plasma, dielectric constant of a cold magnetized plasma, ion- acoustic waves, Alfven waves, Magnetosonic waves.

 (Lectures 10)
- 5. **Stability of fluid plasma:** The equilibrium of plasma, plasma instabilities, stability analysis, two stream instability, instability of Alfven waves, plasma supported against gravity by magnetic field, energy principle. microscopic equations for my body system: Statistical equations for many body systems, Vlasov equation and its properties, drift kinetic equation and its properties. (Lectures 7)

Text Books:

1. Introduction to Plasma Physics, F.F. Chen

Reference Books:

- 1. Principles of Plasma Physics, Krall and Trievelpice
- 2. Introduction to Plasma Theory, D.R. Nicholson
- 3. The Plasma State, J.L. Shohet
- 4. Introduction to Plasma Physics, M. Uman
- 5. Principles of Plasma Diagnostic, I.H. Hutchinson

Department of Physical Sciences

I.K. Guiral Punjab Technical University

Main Campus

PHS53	37	Nonlin	ear Dynar	nics	L-3, T	-1, P-0	4 Cı	redits		
Pre-requi	site: None									
the M.Sc.	bjectives: students w an systems	The aim are ith the basi	nd objective cs of the re	e of the cou cently eme	rse on Non rging resea	llinear Dyn rch field of	namics is to dynamics	o familiariz of nonlinea		
Course O	utcomes:	At the end o	of the cours	e, the stude	ent will be a	ible to	, š, bi =			
CO1	Und	derstand bases	sic knowled	ige of nonl	inear dynar	nics and ph	enomenolo	ogy of		
CO2	Apı	oly the tools	of dynami	ical system	s theory in	context to	models			
CO3	Lea	Learn skills by solving problems on solving nonlinear problems using numerical methods.								
CO4	Und	derstand Ha	milton app	roach for d	escribing v	arious phys	ical system	i		
CO5	Qua	ntify classi	cal chaos a	nd Quantui	m chaos					
	Марр	ing of cour	se outcom	es with the	e program	specific ou	tcomes			
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	2	3	3	3	3	2	3	1		
CO2	-	3	3	3	3	2	3	1		
CO3	1	3	3	3	3	1	3	1		
CO4	3	3	3	3	3	1	3	2		
CO5	3	3	3	3	3	2	3	2		



- 1. Phenomenology of Chaos: Linear and nonlinear systems, A nonlinear electrical system, Biological population growth model, Lorenz model; determinism, unpredictability and divergence of trajectories, Feigenbaum numbers and size scaling, self similarity, models and universality of chaos.

 (Lectures 8)
- 2. **Dynamics in State Space:** State space, autonomous and nonautonomous systems, dissipative systems, one dimensional state space, Linearization near fixed points, two dimensional state space, dissipation and divergence theorem. Limit cycles and their stability, Bifurcation theory, Heuristics, Routes to chaos. Three-dimensional dynamical systems, fixed points and limit cycles in three dimensions, Lyapunov exponents and chaos. Three dimensional iterated maps, U-sequence. (Lectures 10)
- 3. **Hamiltonian System**: Non-integrable systems, KAM theorem and period doubling, standard map. Applications of Hamiltonian Dynamics, chaos and stochasticity.

(Lectures 8)

4. **Quantifying Chaos**: Time series, Lyapunov exponents. Invariant measure, Kolmogorov - Sinai entropy. Fractal dimension, Statistical mechanics and thermodynamic formalism.

(Lectures 7)

5. Quantum Chaos: Quantum Mechanical analogies of chaotic behaviour, Distribution of energy eigenvalue spacing, chaos and semi-classical approach to quantum mechanics.

(Lectures 7)

Text Books:

1. Chaos and Non Linear Dynamics: R.C. Hilborn (Oxford Univ. Press), 2001.

Reference Books:

- 1. Chaos in Dynamical Systems: E. Ott (Cambridge Univ. Press), 2002.
- 2. Applied Nonlinear Dynamics: A.H. Nayfeh and B. Balachandran (Wiley), 1995.
- 3. Chaos in Classical and Quantum Mechanics: M.C. Gutzwiller (Springer-Verlag), 1990.

Elective Subject -I

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I. K. Gujral Punjab Technical University, Kapurthala

PHS5	38	of Biomolecules					redits	
Pre-requi	isite: I	None						
of Blomo	lecule	s is to familia	and objective of tructures, Spec	. students	with the	basics of	the recentl	propertie y emerging
Course O	utcon	nes: At the end	of the course,	the studer	nt will be a	ble to		
CO1		Describe vari	ous structural a	ind chemi	ical bondir	ig aspects of	of Biomole	cules.
CO2		Understand Biomolecules	structure and	theoretic	cal techni	ques and	their app	olication to
CO3		Understand u Biomolecules	se of various s	pectrosco	opic techn	iques and t	heir applic	ation to the
CO4		Understand th	ne structure-Fur	nction rel	ationship a	nd modeli	ng of biom	olecules.
CO5		Outline and co	orrelate for pro	viding so	lution to in	nterdiscipli	nary proble	m
	N	Sapping of cou	irse outcomes	with the	program	specific ou	tcomes	
	PS	O1 PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3	3	2	3	2
CO2	3	3	3	3	3	3	3	3
CO3	CO3 3		3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3
CO5 3		3	3	3	3	2	3	2



- 1. Structure Aspects of Biomolecule: Conformational Principles, Conformation and Configuration Isomers and Derivatives, Structure of Polynucleotides, Structure of Polypeptides, Primary, Secondary, Tertiary and Quaternary Structure of Proteins, Structure of Polysaccharides.

 (Lectures 10)
- 2. Theoretical Techniques and Their Application to Biomolecules: Hard Sphere Approximation, Ramachandran Plot, Potential Energy Surface, Outline of Molecular Mechanics Method, Brief ideas about Semi-empirical and Ab initio Quantum Theoretical Methods, Molecular Charge Distribution, Molecular Electrostatic Potential and Field and their uses. (Lectures 10)
- 3. Spectroscopic Techniques and their Application to Biomolecules: Use of NMR in Elucidation of Molecular Structure, Absorption and Fluorescence Spectroscopy, Circular Dichroism, Laser Raman Spectroscopy, IR spectroscopy, Photoacoustic Spectroscopy, Photo-biological Aspects of Nucleic Acids. (Lectures 10)
- 4. Structure-Function Relationship and Modeling: Molecular Recognition, Hydrogen Bonding, Lipophilic Pockets on Receptors, Drugs and Their Principles of Action, Lock and Key Model and Induced fit Model. (Lectures 10)

Text Books:

1. Srinivasan & Pattabhi: Structure Aspects of Biomolecules.

Reference Books:

- 1. Govil & Hosur: Conformations of Biological Molecules
- 2. Price: Basic Molecular Biology
- 3. Pullman: Quantum Mechanics of Molecular Conformations
- 4. Lehninger: Biochemistry
- 5. Mehler&Cordes: Biological Chemistry
- 6. Smith and Hanawait: molecular Photobiology, Inactivation and Recovery

Department of Physical Sciences

I.K. Gujral Punjab Technical University

Main Campus

PHS5	39		Seminar		L-0, 7	Γ-2, P-0	2 C	redits
Pre-requi	isite: K	nowledge of s	pecific bran	ch of physi	cs		700	
Course C	Objectiv ogy of r	ves: The aim esearch in The	of the ser	minar is to ysics and E	expose to experimental	he student	s to prelin	ninaries ai
Course O	utcome	es: At the end	of the cours	se, the stude	ent will be a	able to		
CO1		Explain the si	gnificance a	and value o	f problem i	n physics.		
CO2		Design and ca of experiment	arry out scie s.	entific expe	riments as	well as acc	curately rec	ord the da
CO3		Critically anal	yse the exp r answering	erimental s specific qu	trategies, an	nd decide w	which one is	most
CO4		Communicate Physics, in ora	the scientif	ic knowled	ge in the co	ontext of a t	topic related	d to
CO5		Explore new technology.	areas of r	esearch in	physics a	nd allied	fields of s	science ar
	M	apping of cou	rse outcom	es with the	program	specific ou	itcomes	
	PSO	1 PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	3	3	3 3 5 6 ()	3	3	3	3
CO2	3	2	3	3	3	3	3	3
CO3	3 3 3		3	3	3	3	3	3
CO4	2	3	2	3	3	3	3	3
	2	3	3	3	3			

Guidelines for the seminar:

The aim of Seminar in M.Sc. 3th semesters is to expose some of the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, analysis of data, etc. related to research Project work which can be in Experimental Physics or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department in the start of the 3rd semester. These seminars are aimed to develop in-depth subject knowledge and skill. Besides subject expertise, they help train students in the presentation and communication skill.

Department of Physical Sciences

IK Gujral Punjab Technical University

Main Campus

PHS54	10	Phy	sics Lab-I	П	L-3, T	-1, P-0	4 C	redits		
Pre-requi	site: Non	e								
students o	f M.Sc. onvestigate	s: The aim class to adva e various relea.	nced exper	imental tech	niques in	condensed	matter phy	sics so tha		
Course O	utcomes:	At the end of	of the cours	e, the studer	it will be a	ble to		<u> </u>		
CO1	M	easure condu	activity, res	istivity and 1	hermo-dy	namical pr	operties of	solids.		
CO2	M	easure magn	etic proper	ties and mag	netic beha	vior of ma	gnetic mate	erials.		
CO3	1 250	Describe the lattice dynamics of simple lattice structures in terms of dispersion relations.								
CO4	De	esign and ca	urry out scults of expe	ientific expe	eriments a	s well as	accurately	record an		
CO5	Sc	lve problem	with critica	al thinking a	nd analytic	cal reasoning	ng.			
	Мар	ping of cour	rse outcom	es with the	program	specific ou	tcomes	He Triple		
	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	3	3		3	3	2	2	3		
CO2	3	3	o product	3	3	3	2	3		
CO3	3	3	2	3	3	2	2	3		
	3	3	2	3	3	3	2	3		
CO ₄							140			

Department of Physical Sciences 11. LK. Gujtal Punjab Technical Universit Main Campus

Note: Students are expected to perform atleast ten experiments out of following list.

- 1. To study temperature dependence of conductivity of a given semiconductor crystal using four probe method.
- 2. Temperature dependence of a ceramic capacitor-verification of curie-weiss law for the electrical susceptibility of a ferroelectric material.
- 3. To determine charge carrier density and Hall coefficient by Hall effect.
- 4. To determine energy gap and resistivity of the semiconductor using four probe method.
- 5. To determine magnetic susceptibility of material using Quink 's tube method.
- 6. To determine energy gap and resistivity of the semiconductor using four probe method.
- 7. To trace hysteresis loop and calculate retentivity, coercivity and saturation magnetization.
- 8. To study the series and parallel characteristics of photovoltaic cell
- 9. To study the spectral characteristics of photovoltaic cell.
- 10. To determine the g-factor using ESR spectrometer.

Text Books:

- 1. Introduction to Solid State Physics: C. Kittel (Wiley, New York), 8th ed. 2005.
- 2. Quantum Theory of Solids: C. Kittel (Wiley, New York) 1987.

Reference Books:

- 1. Principles of the Theory of Solids: J. Ziman (Cambridge University Press) 1972
- 2. Solid State Theory: Walter A. Harrison (Tata McGraw-Hill, New Delhi) 1970.
- 3. Liquid Crystals: S. Chandrasekhar (Cambridge University), 2nd ed. 1992.

Department of Physical Sciences

A. Gujral Puniab Technical University

I. K. Gujral Punjab Technical University, Kapurthala

Elective Subject -II

PHS54	41	Experime Nuclear ar	4 C	redits				
Pre-requi	isite: Co	ourse on Nucle	ar and Parti	cle Physic	Š			
Nuclear a	ind Par	res: The aim ticle Physics ment and meth	is to expose	the studer	its of M.Sc	. students t	o experime	ental aspect
Course O	utcome	s: At the end of	of the course	e, the stude	ent will be a	ible to		
C01		Understand va adiations with	rious experi matter.	mental tec	hniques for	describing	g interaction	n of
CO2	1	Jse various sta	atistical met	hods for ex	cperimental	l data.		
CO3		Knowledge al pplications.	oout the d	ifferent ty	pes of th	e radiation	n detectors	and thei
CO4	I	ntroduced to r	neutron phys	sics, metho	ds to detec	tor slow an	d fast neuti	rons.
C05		Equipped with various laborat	the basic kr ories across	nowledge a	bout the ex	(perimental	l methods u	sed in the
	Ma	pping of cour	rse outcome	es with the	program	specific ou	itcomes	
	PSO	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	1	2	1	2	3	3	3	3
CO2	1	3	3	2	1	3	3	3
CO3	1	1	1	3 11 11	1	3	3	3
CO4	1	3	1 1 2 10	3	3	3	3	3
				3		3	3	

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- 1. Detection of radiations: Interaction of gamma-rays, electrons, heavy charged particles, neutrons, neutrinos and other particles with matter. General properties of Radiation detectors, energy resolution, detection efficiency and dead time. Statistics and treatment of experimental data. Gas-filled detectors, Proportional counters, space charge effects, energy resolution, time characteristics of signal pulse, position-sensitive proportional counters, Multiwire proportional chambers, Drift chamber, Time projection chamber. Organic and inorganic scintillators and their characteristics, light collection and coupling to photomultiplier tubes and photodiodes, description of electron and gamma ray spectrum from detector, Cherenkov detector. Semiconductor detectors, Ge and Si(Li) detectors, Charge production and collection processes, semiconductor detectors in X- and gamma-ray spectroscopy, Pulse height spectrum, Compton-suppressed, Semiconductor detectors for charged particle spectroscopy and particle identification.

 (Lectures 18)
- 2. Electromagnetic and Hadron calorimeters: Motion of charged particles in magnetic field, Magnetic dipole and quadrupole lenses, beta ray spectrometer. Detection of fast and slow neutrons nuclear reactions for neutron detection. General background and detector shielding.

 (Lectures 10)
- 3. Experimental methods: Detector systems for heavy-ion reactions: Large gamma and charge particle detector arrays, multiplicity filters, electron spectrometer, heavy-ion reaction analysers, nuclear lifetime measurements (DSAM and RDM techniques), production of radioactive ion beams. Detector systems for high energy experiments: Collider physics (brief account), Particle Accelerators (brief account), Secondary beams, Beam transport, Modern Hybrid experiments- CMS and ALICE. (Lectures 15)

Text Books:

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994.

Reference Books:

- 1. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010.
- 2. Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001.
- 3. Detectors for particle radiation by Konrad Kleinknecht (Cambridge University Press), 1999.

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I.K. Gujral Punjab Technical University

Main Cantons

Elective Subject -II

PHS542 Phy		sics of Na	nomateria	ls	L-3, 7	Γ-1, P-0	4 C	redits	
Pre-requi	isite:	Conde	ensed mat	ter physics					
familiariz	e the liffere	studen	ts of M.Sc	. to the va	rious aspec	ts related to	preparatio	Nano-ma on, characte this emerg	rization an
Course O	utcor	nes: A	t the end o	of the cours	e, the stude	ent will be a	able to		
CO1 De ato		Dem	onstrate to	echniques (of microsco	opy for inv	estigations	on the nar	nometer an
CO2		Acqu	uire know particles a	ledge of and their se	basic app lf-assembly	roaches to	synthesiz	ze inorgan	c colloida
CO3 Und			erstand ar	d describe	the use	of unique biological	optical prapplication	roperties o	f nanoscal
CO4		Understand the physical and chemical properties of carbon nanotubes and nanostructured mesoporous materials.							
CO5 the			tructure-pi pplicable	operty rela	tionships in	n nanomate	rials as we	ll as the cor	icepts,
	I	Mappi	ng of cour	rse outcom	es with the	program	specific ou	itcomes	Hu H
	PS	01	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	-		3	3	3	3	3	3	3
CO2	2		3	3	3	3	3	3	3
CO3	2		3	3	3	3	3	3	3
CO4	CO4 -		3	3	3	3	3	3	3
CO5	-		3	3	3	3	3	3	3

Scheme & Syllabus (M.Sc. Physics) Batch 2016 & Onwards

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- 1. **Introductory Aspects:** Free electron theory and its features, Idea of band structure—metals, insulators and semiconductors. Density of state in one, two and three dimensional bands and its variation with energy, Effect of crystal size on density of states and band gap. Examples of nanomaterials.

 (Lectures 8)
- 2. Preparation of Nanomaterials: Bottom up: Cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques and Top down: Ball Milling.

(Lectures 8)

- 3. General Characterization Techniques: Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photo luminescence peaks, variation in Raman spectra of nanomaterials, photoemission microscopy, scanning force microscopy.

 (Lectures 8)
- 4. Quantum Dots: Electron confinement in infinitely deep square well, confinement in one and two-dimensional wells, idea of quantum well structure, Examples of quantum dots, spectroscopy of quantum dots.

 (Lectures 8)
- 5. Other Nanomaterials: Properties and applications of carbon nanotubes and nanofibres, Nanosized metal particles, Nanostructured polymers, Nanostructured films and Nano structured semiconductors.

 (Lectures 8)

Books:

- 1. Nanotechnology-Molecularly Designed Materials: G.M. Chow & K.E. Gonsalves (American Chemical Society), 1996.
- 2. Nanotechnology Molecular Speculations on Global Abundance: B.C. Crandall (MIT Press), 1996.
- 3. Quantum Dot Heterostructures: D. Bimerg, M. Grundmann and N.N. Ledentsov (Wiley), 1998.
- 4. Nanoparticles and Nanostructured Films-Preparation, Characterization and Application: J.H.Fendler (Wiley), 1998.
- 5. Nanofabrication and Bio-system: H.C. Hoch, H.G. Craighead and L. Jelinski (Cambridge Univ. Press), 1996.
- 6. Physics of Semiconductor Nanostructures: K.P. Jain (Narosa), 1997.
- 7. Physics of Low-Dimension Semiconductors: J.H. Davies (Cambridge Univ. Press) 1998.
- 8. Advances in Solid State Physics (Vo.41): B. Kramer (Ed.) (Springer), 2001.

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Elective Subject -III

PHS54	13 En	vironment	al Physics	14 - E.E.	L-3, T	-1, P-0	4 Cı	redits		
Pre-requi	site: none)					81,54			
Course O understand	bjectives: ding of en	The objecti	ive of the c	ourse on En	nvironment effects.	al Physics	is to build f	undament		
Course O	utcomes:	At the end o	of the cours	e, the stude	ent will be a	ible to				
CO1	Un	derstand the	e essential o	of the envir	onmental p	hysics				
CO2	Ap	ply the sola	r and terres	trial radiati	ons to the e	earth atmos	phere syste	m.		
CO3 Describe the factors responsible for envir						al pollution	and degrad	lation.		
CO4		Provide exposure to envoronmental changes and understand the idea of remote sensing.								
CO5		vide exposunges.	are to the st	udenst abo	ut the globa	al and regio	nal environ	mental		
	Марр	oing of cour	rse outcom	es with the	program	specific ou	tcomes			
The grains	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	1	3	3	3	3	3	3	1		
CO2	2	3	3	3	3	3	3	1		
CO3	2	3	3	- 3	- 3	3	3			
CO4	2	3	3	3	3	3	3	-		
CO5	2	3	3	3	3	3	3			

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Department of Physical Sciences
L.K. Gujral Punjab Technical University

Scheme & Syllabus (M.Sc. Physics) Batch 2016 & Onwards

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- 1. Essentials of Environmental Physics: Structure and thermodynamics of the atmosphere, Composition of air, Greenhouse effect, Transport of matter, energy and momentum in nature, Stratification and stability of atmosphere, Lass of motion, hydrostatic equilibrium, General circulation of the topics, Elements of weather and climate of India. (Lectures 10)
- 2. Solar and Terrestrial Radiation: Physics of radiation, Interaction of light with matter, tayleigh and Mie scattering, Laws of radiation (Kirchoffs law, Planck's law, Beer's law, Wien's displacement law, etc.), Solar and terrestrial spectra, UV radiation, Ozone depletion problem, IR absorption energy balance of the earth atmosphere system

 (Lectures 8)
- 3. Environmental Pollution and degradation: Elementary fluid dynamics, Diffusion, Turbulence and turbulent diffusion, Factors governing air, Water and noise pollution, Air and water quality standards, Waste disposal, Heat island effect, Land and sea breeze, Puffs and plumes, Gaseous and particulate matters, Wet and dry deposition. (Lectures 8)
- 4. Environmental Changes and remote sensing: Energy sources and combustion processes, Renewable sources of energy, Solar energy, Wind energy, bioenergy, hydropower, fuel cells, nuclear energy, Forestry and bioenergy.

 (Lectures 7)
- 5. Global and Regional Climate: Elements of weather and climate, Stability and vertical motion of air, Horizontal motion of air and water, Pressure gradient forces, Viscous forces, Reynolds number, Enhanced Greenhouse Effect, Energy balance-a Zero-dimensional Greenhouse model, Global climate models.

 (Lectures 10)

Text and Reference Books

- 1. Egbert Boeker & Rienk Van Groundelle: Environmental Physics (John Wiley).
- 2. J. T Hougtion: The Physics of atmosphere (Cambrige University Press, 1977).
- 3. J Twidell and J Weir: Renewable energy Resources (Elbs, 1988).
- 4. Sol Wieder: An introduction t solar energy for scientists and Engineers (John Wiley, 1982)
- 5. R. N. Keshavamurthy and M. Shanker Rao: The Physics of Monsoons (Allied Publishers, 1992).
- 6. G.J. Haltiner and R.T. Williams: Numerical Weather Prediction (John Wiley, 1980).

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Main Carross

Elective Subject -III

PHS54	44	Science of	Renewable se Energy	ource of	L-3, T	`-1, P-0	4 Credits	5.0		
Pre-requi	site: N	one								
Sources 1	s to ex	ves: The aim pose the M.So energy, etc.	and objectives. students to	ve of the the basics	course on of the alt	Science ernative er	of renewa	ble Energ		
Course O	utcom	es: At the end	of the course,	the stude	nt will be a	ible to				
CO1		Know the end	ergy demand o	of world ar	nd India.					
CO2		Understand traditional and alternative form of energy.								
CO3		Understand concept of solar energy radiation, making of solar cell and its types.								
CO4		Identify hydrogen as energy source, its storage and transportation methods.								
CO5	FELE	Compare win	d energy, wav	e energy a	nd ocean thermal energy conversion.					
	M	apping of cou	irse outcome	s with the	program	specific or	itcomes			
(A)	PSC	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8		
CO1	-	3	-	3	1	2	2	3		
CO2	1	2	1 8- 7- 1	3	1	2	2	3		
CO3	-	3	Tan da	3	2-	1	3	3		
	-	3	- 12	3	2 _n	1	3	3		
CO4		Vales								

- 1. **Introduction**: Production and reserves of energy sources in the world and in India, need for alternatives, renewable energy sources. (Lectures 8)
- 2. Solar Energy: Thermal applications, solar radiation outside the earth's atmosphere and at the earth's surface, fundamentals of photovoltaic energy conversion. Direct and indirect transition semi-conductors, interrelationship between absorption coefficients and band gap recombination of carriers. Types of solar cells, p-n junction solar cell, Transport equation, current density, open circuit voltage and short circuit current, description and principle of working of single crystal, polycrystalline and amorphous silicon solar cells, conversion efficiency. Elementary ideas of Tandem solar cells, solid-liquid junction solar cells and semiconductor-electrolyte junction solar cells. Principles of photo electrochemical solar cells. Applications.

 (Lectures 12)
- 3. Hydrogen Energy: Environmental considerations, solar hydrogen through photo electrolysis and photocatalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells, hydride batteries.

(Lectures 10)

4. Other sources: Nature of wind, classification and descriptions of wind machines, power coefficient, energy in the wind, wave energy, ocean thermal energy conversion (OTEC), system designs for OTEC. (Lectures 8)

Text Books:

1. Solar Energy: S.P. Sukhatme (Tata McGraw-Hill, New Delhi), 2008.

Reference Books:

1. Solar Cell Devices: Fonash (Academic Press, New York), 2010.

2. Fundamentals of Solar Cells, Photovoltaic Solar Energy: Fahrenbruch and Bube (Springer, Berlin), 1983.

3. Photoelectrochemical Solar Cells: Chandra (New Age, New Delhi).

Head Department of Physical Sciences

T.K. Gujral Punjab Technical University

Nam Carrier

I. K. Gujral Punjab Technical University, Kapurthala

	5	Resear		work	L-0, T-	·12, P-0	12 C	redits	
Pre-requis	site: Knov	vledge of sp	ecific bran	ch of physi	cs				
preliminari	et the opp	The aim onethodology ortunity to not.	of resear	ch in The	oretical Phy	ysics and	Experimen	tal Physics	
Course Ou	itcomes:	At the end of	of the cours	e, the stude	ent will be a	ble to		N. Francis	
CO1 Explain the significance and value of print the wider community.					f problem i	n physics,	both scient	tifically an	
Design and carry out scientific experiments as well as accurately results of experiments.						record th			
CO3	Cri app	Critically analyse and evaluate experimental strategies, and decide which is most appropriate for answering specific questions.							
		1 1							
CO4	to	search and condensed notice form	natter physi	cs/Nuclear	High Energ	gy Physics,	in oral, wr		
CO4	to dele	ondensed n	natter physinats to both	cs/Nuclear scientists a	High Energ and the publ	gy Physics, ic at large.	in oral, wr	itten and	
	to delection to de	condensed netronic form	natter physinats to both areas of re	cs/Nuclear, scientists a esearch in	High Energed High Energend the public physics and physics are seen as the control of the control	gy Physics, ic at large. nd allied	in oral, wr	itten and	
	to delection to de	ondensed netronic form blore new anology.	natter physinats to both areas of re	cs/Nuclear, scientists a esearch in	High Energed High Energend the public physics and physics are seen as the control of the control	gy Physics, ic at large. nd allied	in oral, wr	itten and	
	Exp tec	condensed netronic form olore new nnology.	natter physical nation to both areas of reseoutcom	cs/Nuclear, scientists a esearch in es with the	High Energ nd the publ physics are program	gy Physics, ic at large. nd allied specific ou	in oral, wr	itten and	
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CO5	Exp tech Mapp	ondensed netronic formology. PSO2	patter physical physical physical patter physical physi	cs/Nuclear, scientists a esearch in es with the PSO4	PSO5	gy Physics, ic at large. Indicate allied Specific out PSO6 3	fields of s tcomes PSO7	PSO8	
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lead Department of Physical Sciences IV Guiral Punjab Technical University Main Campus

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Scheme & Syllabus (M.Sc. Physics) Batch 2016 & Onwards

Guidelines for the Project:

The aim of project work in M.Sc. 4th semesters is to expose the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data, etc.. Project work can be in Experimental or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department before the end of the 3rd semester. A report about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the Head of Department.

Assessment of the work done under the project will be carried out by a committee on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva-voce/seminar, etc. as per course guidelines.

Department of Physical Sciences

I.K. Gujral Puniab Technical University

Main Carriers

Minutes of Meeting

A meeting of Board of Studies Applied Science and Material Science held on 20th Jan 2016 at 11:00 am at the office of Dean Academics, IKG Punjab Technical University.

The following members were present:

- 1. Dr. Ravi Kumar, BCET Gurdaspur, (Chairman)
- 2. Dr. N.K. Verma, Thaper University, Patiala (Member)
- 3. Dr.A.K. Tyagi, SBSCET, Ferozepur (Member)
- 4. Dr. Rakesh Dogra, BCET Gurdaspur, (Member)
- 5. Dr. Kanchan L Singh DAVIET, Jalandhar (Member)
- 6. Dr. Hitesh Sharma, Punjab Technical University (Coordinator)

The following members were not present:

- 1. Dr. R. C. Singh, GNDU, Amritsar (Member)
- 2. Dr.Ajay Kumar SBSCET, Ferozepur (Member)

The Board took the agenda and following recommendations were made:

- 1. The course credits of Engineering Physics are as per Choice based credit guidelines of IKG PTU, therefore no change is required. The syllabus was discussed and revised syllabus was approved copy enclosed as Annexure-A.
- 2. Post graduate course in Physics should be named as M.Sc. (Physics) instead of M.Sc. (Applied Physics). should be adopted uniformly for the University campus as well as for affiliated colleges
- 3. The course scheme and syllabus contents of M.Sc. (Physics) for PITK, IKG PTU campus as formulated by a committee headed by Prof KN Pathak was presented in the BOS (Physics) meeting. Committee approved the item as presented. An approved copy of the same is enclosed-Annexure-B.
 - Committee members further appreciated the efforts of the committee headed by Prof. K.N. Pathak and decided that same scheme and credits of M.Sc. (Physics) be implemented uniformly for all Colleges and University Campus from 2016-2017 after minor changes, copy Enclosed- Annexure-C
- 4. The new course scheme and credits for M.Tech (Nanotechnology) was discussed thoroughly and committee felt need for revising the contents of course. Members discussed that since the course was running only in two colleges and at present there is no admission since last two years, so it was recommended that course be renamed either as M.Tech Material Science & Nano Technology or M.Tech Material Science and Engineering (with specialization in Nanotechnology) and syllabus be formulated accordingly.

Meeting ended with the vote of thanks to the Chairman, BOS (Physics, Material Science and Nanotechnology)

Dr. Hitesh Sharma

Department of Physical Sciences

K. Gujral Punjab Technical Univer

Subject: Minutes of Board of Studies in Physics, Material Science and Nanotechnology on 20th Jan 2016

A meeting of Board of Physics, Material Science and Nanotechnology held on 20th Jan 2016 at 11:00 am at the office of Dean Academics, IKG Punjab Technical University.

The following members were present:

- Dr. Ravi Kumar, BCET Gurdaspur. (Chairman)
- Dr. A.K. Tyagi, SBSCET, Ferozpur (Member)
- Dr. N.K. Verma, Thaper University (Member)
- Dr. Rakesh Dogra, BCET Gurdaspur(Member)
- Dr. Kanchan L Singh, DAVIET, Jalandhar (Member)
- Dr. Hitesh Sharma, IKG Punjab Technical University (Coordinator)

The minutes of same are enclosed for necessary action.

Dr. Hitesh Sharma

Coordinator-BOS(Physics, Material Science and Nanotechnology)

Dr. Buta Singh
Dean, Academics Incharge (Bos)

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Copy to: Dr. Hitesh to browned fleate minutes directly to the Buchary (Bus) in feature

Designation of Physical Sciences

I.K. Gujral Punjab Technical University

(6)

BTPH-101 (Engineering Physics)

Objective/s and Expected outcome:

The objective of the course is to develop a scientific temper and analytical capability in the engineering graduates through the learning of physical concepts and their application in engineering & technology. Comprehension of some basic physical concepts will enable graduates to think logically the engineering problems that would come across due to rapidly developing new technologies. The student will be able to understand the various concepts effectively; logically explain the physical concepts; apply the concept in solving the engineering problem; realize, understand and explain scientifically the new developments and breakthroughs in engineering and technology; relate the developments on Industrial front to the respective physical activity, happening or phenomenon.

PARTA

1. Electromagnetic Waves: Physical significance of Gradient. Divergence & Curl. Displacement current, Maxwell equations, Equation of EM waves in free space, velocity of EM waves, Poynting vector, Electromagnetic Spectrum (Basic ideas of different region).

2. Magnetic Materials & Superconductivity: Basic ideas of Dia, Para, Ferro & Ferri, Ferrites, Superconductivity, Superconductors as ideal diamagnetic materials, Signatures of Superconducting state, Meissner Effect, Type I & Type II superconductors, London equations, Introduction to BCS theory.

3. Elements of crystallography: Unit cell, Basis, Space lattice, Crystal Systems, Miller Indices of Planes & Directions in cubic system, Continuous & Characteristic X-Rays, X- ray diffraction and Bragg's Law, Bragg's spectrometer, X-ray radiography.

PART B

4. Lasers:

Coherence, Stimulated and spontaneous emissions, Einstein coefficients, Population Inversion, Pumping Mechanisms, Components of a laser System. Three & four level laser systems; Ruby, He-Ne, CO2 and semiconductor Lasers, Introduction to Holography.

5. Fibre Optics: Introduction, Acceptance Angle, Numerical Aperture, Normalized frequency. Modes of propagation, material dispersion & pulse broadening in optical fibres, fibre connectors, splices and couplers, applications of optical fibres.

6. Quantum Theory: Need and origin of quantum concept, Wave-particle duality. Matter waves. Group & Phase velocities, Uncertainty Principle, Significance & normalization of wave function. Schrodinger wave equation: time independent & dependent, Eigen functions & Eigen values, particle in a box. Quantum confinement nano physics and related applications (10)

Reference Books:

1. Introduction to Electrodynamics by David J. Griffiths

2. Materials science and engineering: a first course by V. Raghvan

3. Optics by Ajay Ghatak

4. Optical Fibre Communication: Principles And Practice by Senjor

5. Concepts of Modern Physics by Arthur Beiser

FIRST SEMESTER

Contact Hours: 23 Hrs.

Code	Course Title		Load Allocation			Credits
		L	Т	P		
PHS411	Mathematical Physics-I	3	1	-	100	4
PHS412	Classical Mechanics	3	1	•	100	4
PHS413	Quantum Mechanics-I	3	1	-	100	4
PHS414	Statistical Physics	3	1		100	4
PHS415	Atomic and Molecular Physics	3	1	-	100	4
PHS416	Physics Lab-I	-	-	3	75	3
TOTAL			5	3	575	23

SECOND SEMESTER

Contact Hours: 26 Hrs.

Code	Course Title		Load		Total Marks	Credits
		L	Т	P		
PHS421	Mathematical Physics-II	3	1		100	4
PHS422	Nuclear Physics	3	1		100	4
PHS423	Quantum Mechanics-II	3	1	-	100	4
PHS424	Computational Physics	3	1		100	4
PHS425	Condensed Matter Physics-I	3	1		100	4
PHS426	Physics Lab – II	-		3	75	3
PHS427	Computational Lab	-	-	3	75	3
	TOTAL			6	650	26

THIRD SEMESTER

EMESTER					Contact Hours:	23 Hrs.
Code	Course Title	Load Allocation			Total	Credits
		L	Т	P	Marks	
PHS531	Condensed Matter Physics-II	3	1	-	100	4
PHS532	Classical Electrodynamics	3	1	-	100	4
PHS533	Particle Physics	3	1	-	100	4
PHS534	Electronics	3	1	_	100	4
PHS535 PHS536 PHS537 PHS538	Elective Subject-I	3	1	-	100	4
PHS 539	Seminar) ,	ř	-	Satisfactory/ Unsatisfactory	2
PHS540	Physics Lab-III	-		3	75	3
	TOTAL	15	5	3	575	25

FOURTH SEMESTER

EM	ESTER	<u> </u>	EL.	o i saliji		Contact Hou	rs: 08 Hrs.	
Code		Course Title	itle Load Allocation		Total	Credits		
		Lister Englisher	L	T	P	Marks		
	PHS541 PHS542	Elective Subject-II	3	1	-	100	4	
	PHS543 PHS544	Elective Subject-II	3	1	-	100	4	
	PHS545	Research Project	-	- 1		Satisfactory/ Unsatisfactory	12	
		TOTAL	6	2	1-	200	20	

ELECTIVE SUBJECTS:

0.11		
S.No.	Name of the Subject	Code
1	Fiber optics and non-linear optics	PHS-535
2	Plasma Physics	PHS-536
3	Nonlinear Dynamics	PHS-537
4	Structures, Spectra and Properties of Biomolecules	PHS-538
5	Experimental techniques in Nuclear Physics and particle Physics	PHS 541
6	Physics of Nanomaterials	PHS 542
7	Environmental Physics	PHS 543
8	Science of Renewable source of Energy	PHS 544

Scheme & Syllabus (M. Sc. Phy.) Batch 2016 & Onwards

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Examination and Evaluation:

S.No.		Weightage	Remarks
Theory		80% 8	
1.	Mid term sessional Test (I/II/III)	25 %	Best of two test will be considered for evaluation and quizzes etc constitute internal evaluation
2	Attendance /Seminars/Assignments	5 %	- Internal evaluation
3	End semester examination	70%	Conduct and checking of the answer sheets will at the Department level in case of University teaching Department or Autonomous institutions. For other colleges examination will be conducted at the university level
THE TA	Total	100%	Marks may be rounded off to nearest integer
Practica			
1	Daily evaluation of practical record Assignment/Viva Voice/ Attendance etc	50%	Internal evaluation
2	Final Practical Performance + Viva Voice	50%	External evaluation
3	Total	100%	Marks may be rounded off to nearest integer



PHS411- MATHEMATICAL PHYSICS-I

Total	Credits
Marks	- COURSESSANCES
100	4

L	T	P
3	1	12

- Vector fields and Tensors: Scalar and Vector fields, Scalar and Vector products: Curl, Divergent and Introduction to tensors and definitions, contraction, direct product. Quotient rule, Levi-Civita symbol, Non-Cartesian tensors, metric tensor, Covariant differentiation.
- 2. **Complex Variables**: Introduction, Cauchy-Riemann conditions, Cauchy's Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals, Dispersion relation.
- Differential Equations: Partial differential equations of theoretical physics, boundary value, problems, Neumann & Dirichlet Boundary conditions, separation of variables, singular points, series solutions, second solution.
- 4. **Integral Equations**: Definitions and classifications, integral transforms and generating functions. Neumann series, Separable Kernels, Hilbert-Schmidt theory. Green's functions in one dimension.
- 5. **Numerical Techniques:** Roots of functions, Interpolation, Extrapolation, Differentiation, integration by trapezoid and Simpson's rule, RungeKutta method and finite difference method.
- 6. Elementary Statistics: Introduction to probability theory, random variables, Binomial, Poisson and Normal distribution

Suggested Readings/Books:

- Mathematical Methods for Physicists: G. Arfken and H.J. Weber (Academic Press, SanDiego) 7th edition, 2012.
- Mathematical Physics: P.K. Chattopadhyay (Wiley Eastern, New Delhi), 2004.
- Mathematical Physics: A.K. Ghatak, I.C. Goyal and S.J. Chua (MacMillan, India, Delhi), 1986.
- Mathematical Methods in the Physical Sciences M.L. Boas (Wiley, New York) 3rd edition, 2007.
- Special Functions : E.D. Rainville (MacMillan, New York), 1960.
- Mathematical Methods for Physics and Engineering: K.F.Riley, M.P.Hobson and S.J. Bence (Cambridge University Press, Cambridge) 3rd ed., 2006.

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PHS412 CLASSICAL MECHANICS

Total	Credits
Marks	astelenceson:
100	4

L	Т	P
3	1	-

- 1. Lagrangian Formulation: Mechanics of a system of particles; constraints of motion, generalized coordinates, D'Alembert's Principle and Lagrange's velocity dependent forces and the dissipation function, Applications of Lagrangian formulation.
- 2. **Hamilton's Principles**: Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to nonholonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.
- 3. **Hamilton's Equations:** Legendre Transformation, Hamilton's equations of motion, Cyclicco-ordinates, Hamilton's equations from variational principle, Principle of least action.
- 4. Canonical Transformation and Hamilton-Jacobi Theory: Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton-Jacobi equations for principal and characteristic functions, Action-angle variables for systems with one-degree of freedom.
- 5. Rigid Body Motion: Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top.

TUTORIALS: Relevant problems given at the end of each chapter in different books.

Suggested Readings/Books:

- Classical Mechanics: H. Goldstein, C.Poole and J.Safko (Pearson Education Asia, New Delhi), 3rded 2002.
- Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, NewDelhi), 1988.

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PHS413 QUANTUM MECHANICS-I

Total	Credits
Marks	
100	4

L	Т	P
3	1	

- 1. Linear Vector Space and Matrix Mechanics: Vector spaces, Schwarz inequality, Orthonormal basis, Operators: Projection operator, Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Postulates of quantum mechanics, uncertainty relation. Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg and Schroedinger representations, Exchange operator and identical particles. Density Matrix and Mixed Ensemble.
- Angular Momentum: Angular part of the Schrödinger equation for a spherically symmetric potential, orbital angular momentum operator. Eigen values and eigenvectors of L2 and Lz. Spin angular momentum, General angular momentum, Eigen values and eigenvectors of J2 and Jz. Representation of general angular momentum operator, Addition of angular momenta, C.G. coefficients.
- Stationary State Approximate Methods: Non-Degenerate and degenerate perturbation theory and
 its applications, Variational method with applications to the ground states of harmonic oscillator and
 other sample systems.
- 4. Time Dependent Perturbation: General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light.
- 5. **Scattering Theory**: Scattering Cross-section and scattering amplitude, partial wave analysis, Low energy scattering, Green's functions in scattering theory, Born approximation and its application to Yukawa potential and other simple potentials. Optical theorem, Scattering of identical particles.

Suggested Readings/Books:

- A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi) 2nd edition, 2004.
- Quantum Mechanics: V.K. Thankappan (New Age, New Delhi), 2004.
- Quantum Mechanics : M.P. Khanna, (HarAnand, New Delhi), 2006.
- Modern Quantum Mechanics: J.J. Sakurai (Addison Wesley, Reading), 2004.
- Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi), 1995.
- Quantum Physics: S. Gasiorowicz (Wiley, New York), 3rd ed. 2003.

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PHS 414 STATISTICAL PHYSICS

Total	Credits
Marks	
100	4

L	T	P
3	1	

- 1. The Statistical Basis of Thermodynamics: The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution.
- 2. Ensemble Theory: Phase space and Liouville's theorem, the microcanonical ensemble theory and its application to ideal gas of monatomic particles; The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory, density and energy fluctuations.
- 3. Quantum Statistics of Ideal Systems: Quantum states and phase space, an ideal gas in quantum mechanical ensembles, statistics of occupation numbers; Ideal Bose systems: basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field); Ideal Fermi systems: thermodynamic behaviour of an ideal Fermi gas, discussion of heat capacity of a free electron gas at low temperatures, Pauli paramagnetism.
- 4. Elements of Phase Transitions: Introduction, a dynamical model of phase transitions, Ising model in zeroth approximation.
- 5. **Fluctuations:** Thermodynamic fluctuations, random walk and Brownian motion, introduction tononequilibrium processes, diffusion equation.

TUTORIALS: Relevant problems given in the end of each chapter in the text book.

Suggested Readings/Books:

- Statistical Mechanics: R.K. Pathria and P.D. Beale (Butterworth-Heinemann, Oxford), 3rdedition, 2011
- Statistical Mechanics: K. Huang (Wiley Eastern, New Delhi), 1987.
- Statistical Mechanics: B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi) 2nd edition, 2011.
- Elementary Statistical Physics: C. Kittel (Wiley, New York), 2004.
- Statistical Mechanics: S.K. Sinha (Tata McGraw Hill, New Delhi), 1990.



PHS415 ATOMIC AND MOLECULAR PHYSICS

Total Marks	Credits
100	4

L	T	P
3	1	-

- Electronic Spectroscopy of Atoms: Electronic wave function and atomic quantum numbers –
 hydrogen spectrum orbital, spin and total angular momentum fine structure of hydrogen atom many
 electron spectrum: Lithium atom spectrum, angular momentum of many electrons term symbols the
 spectrum of helium and alkaline earths equivalent and non equivalent electrons basics of X-ray
 photoelectron spectroscopy.
- 2. Electronic Spectroscopy of Molecules Diatomic molecular spectra: Bom-Oppenheimer approximation vibrational spectra and their progressions Franck-Condon principle dissociation energy and their products —rotational fine structure of electronic-vibration transition molecular orbital theory the spectrum of molecular hydrogen change of shape on excitation chemical analysis by electronic spectroscopy reemission of energy fundamentals of UV photoelectron spectroscopy.
- 3. Microwave and Raman Spectroscopy: Rotation of molecules and their spectra diatomic molecules intensity of line spectra the effect of isotropic substitution non-rigid rotator and their spectra polyatomic molecules (linear and symmetric top molecules) Classical theory of Raman effect pure rotational Raman spectra (linear and symmetric top molecules).
- 4. Infra-red and Raman Spectroscopy: The energy of diatomic molecules Simple Hamonic Oscillator the Anharmonic oscillator the diatomic vibrating rotator vibration-rotation spectrum of carbon monoxide –breakdown of Born-Oppenheimer approximation the vibrations of polyatomic molecules influence of rotation on the spectra of polyatomic molecules (linear and symmetric top molecules) Raman activity of vibrations vibrational Raman spectra vibrations of Spherical top molecules.
- 5. Spin Resonance Spectroscopy Spin and magnetic field interaction Larmor precession relaxation time spin-spin relaxation spin-lattice relaxation NMR chemical shift coupling constants coupling between nuclei chemical analysis by NMR NMR for nuclei other than hydrogen ESR spectroscopy fine structure in ESR.

Suggested Readings/Books:

- Fundamentals of Molecular Spectroscopy by Colin N. Banwell and Elaine M. McCash (Tata McGraw - Hill Publishing Company limited)
- Physical method for Chemists (Second Edition) by Russell S. Drago (Saunders College Publishing)
- Introduction to Atomic Spectra: H.E. White-Auckland McGraw Hill, 1934.
- Spectroscopy Vol. I, II & III: Walker & Straughen
- Introduction to Molecular spectroscopy: G.M. Barrow-Tokyo McGraw Hill, 1962.
- Spectra of diatomic molecules: Herzberg-New York, 1944.

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PHS416-Physics Lab-I

Total	Credits
Marks	
75	3

L	T	P
-	•	3

S.No. Name of the Experiment

16

1 Study the forward and reverse characteristics of a Zener diode. 2 Construction of adder, subtracter, differentiator and itergrator circuits using the given OP-Amp. 3 Study the static and drain characteristics of a JFET 4 Construction of an Astablemulti-vibrator circuit using transistor 5 Construction of a single FET amplifier with common source configuration 6 Construction of an A/D converter circuit and study its performance 7 Construction of an D/A converter circuit and study its performance 8 Construction of a low-pass filter circuit and study its output performance 9 Construction of a high-pass filter circuit and study its output performance 10 Electron Spin Resonance Spectrometer Experiment 11 Four Probe Method- Determination of resistivity of semiconductor at different temperature 12 To study pulse amplitude, Pulse width and Pulse position modulation 13 To study the frequency response of an operational amplifier 15 To study the characteristics of multivibrators-bistable, Astable, monostable

To find the wavelength of sodium light using Michelson interferometer

PHS421 MATHEMATICAL PHYSICS-II

Total Marks	Credits
100	4

L	T	P
3	1	-

- Group Theory: What is a group? Multiplication table, conjugate elements and classes, subgroups, Isomorphism and Homomorphism, Definition of representation and its properties, Reducible and irreducible representations, Schur's lemmas (only statements), characters of a representation. Example of C4v, Topological groups and Lie groups, three dimensional rotation group, special unitary groups SU(2) and SU(3).
- 2. Delta and Gamma Functions: Dirac delta function, Delta sequences for one dimensional function, properties of delta function, Gamma function, factorial notation and applications, Beta function.
- 3. Special Functions: Bessel functions of first and second kind, Generating function, integral representation and recurrence relations for Bessel's functions of first kind, orthogonality. Legendre functions: generating function, recurrence relations and special properties, orthogonality, various definitions of Legendre polynominals. Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite functions, Laguerre functions.
- 4. Fourier Series and Integral Transforms: Fourier series, Dirichlet conditions. General properties. Advantages and applications, Gibbs phenomenon. Fourier transforms, Development of the Fourier integral, Inversion theorem, Fourier transforms of derivatives; Momentum representation. Laplace transforms, Laplace transforms of derivatives, Properties of Laplace transform, Inverse Laplace transformation.

Suggested Readings/Books:

- Group Theory for Physicists: A.W. Joshi (Wiley Eastern, New Delhi) 2011.
- Mathematical Methods for Physicists: G. Arfken and H.J. Weber, (Academic Press, San Diego)7th edition, 2012.
- Matrices and Tensors in Physics: A.W. Joshi (Wiley Eastern, New Delhi) 2005.
- Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co., Kolkata) 4th edition.
- A First Course in Computational Physics: P.L. Devries (Wiley, New York) 1994.
- Mathematical Physics: P.K. Chatopadhyay (Wiley Eastern, New Delhi) 2011.
- Introduction to Mathematical Physics: C. Harper (Prentice Hall of India, New Delhi) 2006.

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PHS422NUCLEAR PHYSICS

Total	Credits
Marks	
100	4

L	T	P
3	1	

- Nuclear Models: Liquid drop model, Binding energy; fission and fusion, Experimental evidence for shell effects, Shell Model, Spin-Orbit coupling, Magic numbers, Application of Shell Model like Angular momenta and parities of nuclear ground states, Collective model- nuclear vibrations spectra and rotational spectra.
- 2. Static properties of nucleus: Nuclear radii and measurements, nuclear binding energy (review), nuclear moments and systematic, wave-mechanical properties of nuclei, hyperfinestructure, effect of external magnetic field, Nuclear magnetic resonance.
- 3. Nuclear decay: Review of barrier penetration of alpha decay & Geiger-Nuttal law. Beta decays, Fermi theory, Kurie plots and comparative half-lives, Allowed and forbidden transitions, Experimental evidence for Parity-violation in beta decay, Electron capture probabilities, Double beta decay, Neutrino, detection of neutrinos, measurement of the neutrino helicity. Multipolarity of gamma transitions, internal conversion process, transition rates.
- 4. **Nuclear forces:** Evidence for saturation of nuclear density and binding energies (review), types of nuclear potential, Ground and excited states of deuteron, dipole and quadrupole moment of deuteron, n-p scattering at low energies, partial wave analysis, scattering length, spin-dependence of n-p scattering, effective-range theory, coherent and incoherent scattering, central and tensor forces, p-p scattering, exchange forces & single and triplet potentials, meson theory of nuclear forces.
- 5. Neutron physics: Neutron production, slowing down power and moderating ratio, neutron detection.
- 6. **Nuclear reactions:** Nuclear reactions and cross-sections, Resonance, Breit-Wigner dispersion formula for I=0 and higher values, compound nucleus, Coulomb excitation, nuclear kinematics and radioactive nuclear beams.

Suggested Readings/Books:

- Nuclear Physics: Irving Kaplan (Narosa), 2002.
- Theory of Nuclear Structure: R.R. Roy and B.P. Nigam (New Age, New Delhi) 2005.
- Basic Ideas and Concepts in Nuclear Physics: K. Hyde (Institute of Physics) 2004.
- Nuclear physics: Experimental and Theoretical, H.S. Hans (New Academic Science) 2nded (2011).
- Nuclear Physics and its applications by John Liley
- Nuclear Physics V. Devnathan

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PHS423 QUANTUM MECHANICS-II

Total Marks	Credits
100	4

L	Т	Р
3	1	

- Relativistic Quantum Mechanics-I: Klein-Gordon equation, Dirac equation and its plane wave solutions, significance of negative energy solutions, spin angular momentum of the Dirac particle. The non-relativistic limit of Dirac equation,
- Relativistic Quantum Mechanics-II Electron in electromagnetic fields, spin magnetic moment, spin-orbit interaction, Dirac equation for a particle in a central field, fine structure of hydrogen atom, Lambshift.
- Quantum Field Theory: Resume of Lagrangian and Hamiltonian formalism of a classical field, Quantization of real scalar field, complex scalar field, Dirac field and e.m. field, Covariant perturbation theory,
- 4. **Feynman diagrams**: Feynman diagrams and their applications, Wick's Theorem. Scattering matrix. QED.

Suggested Readings/Books:

- Text Book of Quantum Mechanics -P.M. Mathews & K. Venkatesan-Tata McGraw Hill 2010
- Quantum Mechanics G Aruldhas Prentice Hall of India 2006
- Introduction to Quantum Mechanics David J.Griffiths Pearson Prentice Hall, 2005

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- Quantum Mechanics A Devanathan Narosa Publishing-New Delhi
- Quantum Mechanics L.I Schiff McGraw Hill 1968
- Quantum Mechanics A.K. Ghatak and S. Loganathan-McMillan India
- Principles of Quantum Mechanics R.Shankar, Springer 2005
- Quantum Mechanics Satya Prakash- KatharNathRamnath Meerut

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PHS424 COMPUTATIONAL PHYSICS

Total	Credits
Marks	
100	4

L	Т	P
3	1	-

1. Introduction to high level language: Need and advantages of high level language in physics, programming in a suitable high level language (Matlab/Mathematica/Scilab/ Octave), input/output, interactive input, loading and saving data, loops branches and control flow. Matrices and Vectors, Matrix and array operations, eigenvalues and eigen vectors.

 Sub programs: Advantages of modular programming, built-in functions, scripts, functions, sharing of variables between modules.

3. **Graphics:** 2D plots, style options, axis control, overlay plots, subplot, histogram, 3D plots, mesh and surface plots, contour plots.

4. Numerical computation: Computer programs for: solving linear system of simultaneous equations, nonlinear algebraic equation, roots of polynomials, curve fitting, polynomial curve fitting, least square curve fitting, interpolation, data analysis and statistics, numerical integration, Monte-Carlo simulation, ordinary differential equation, first order and second order ODEs, event location.

5. List of Experiments

- a) Black body radiation (computation and graphical representation)
- b) Reflection and transmission of an electromagnetic wave
- c) Statistical distributions at different temperatures
- d) Binding energy curve for nuclei using liquid drop model
- e) Eigen-value problem: 1-D square potential well
- f) Eigen-values and wave-functions of a simple harmonic oscillator
- g) Monte-Carlo simulation
- h) Linear/Projectile motion (simulation and solutions)

Suggested Readings/Books:

- Pratap R, "Getting started with MATLAB 7", Oxford Univ. Press, 2006
- Gilat A, "Matlab: An introduction with applications", Wiley, 2008
- Eaton J W, Batchman D and Hauberg S "GNU Octave Manual Version 3", Network Theory Ltd. 2008
- Campbell S, Chancelier J P and Nikoukhah R, "Modeling and simulation in Scilab", Springer 2005
- Mathematica Information Center ('MathSource'): http://library.wolfram.com/infocenter/ 2009
- Gerald C F and Wheatley P O, "Applied Numerical Analysis", 7th Ed, Addison Wesley, 2003

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PHS425 CONDENSED MATTER PHYSICS-I

Total Marks	Credits
100	4

L	Т	P
3	1	-

1. Elastic constants:

Binding in solids; Stress components, stiffness constant, elastic constants, elastic waves in crystals.

2. Lattice Dynamics and Thermal Properties:

Rigorous treatment of lattice vibrations, normal modes; Density of states, thermodynamic properties of crystal, anharmonic effects, thermal expansion.

3. Energy Band Theory:

Electrons in a periodic potential: Bloch theorem, Nearly free electron model; tight binding method; Semiconductor Crystals, Band theory of pure and doped semiconductors; elementary idea of semiconductor superlattices.

4. Transport Theory:

Electronic transport from classical kinetic theory; Introduction to Boltzmann transport equation; electrical and thermal conductivity of metals; thermoelectric effects; Hall effect and magneto resistance.

5. Dielectric Properties of Materials:

Polarization mechanisms, Dielectric function from oscillator strength, Clausius-Mosotti relation; piezo, pyro- and ferro-electricity.

6. Liquid Crystals:

Thermotropic liquid crystals, Lyotropic liquid crystals, long range order and order parameter, Various phases of liquid crystals, Effects of electric and magnetic field and applications, Physics of liquid crystal devices.

Suggested Readings/Books:

- Introduction to Solid State Physics: C. Kittel (Wiley, New York), 8th ed. 2005.
- Quantum Theory of Solids: C. Kittel (Wiley, New York) 1987.
- Principles of the Theory of Solids: J. Ziman (Cambridge University Press) 1972
- Solid State Theory: Walter A. Harrison (Tata McGraw-Hill, New Delhi) 1970.
- Liquid Crystals: S. Chandrasekhar (Cambridge University), 2nd ed. 1992.

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PHS426-PHYSICS LAB-II

Total Marks	Credits
75	3

L	Т	Р
-	-	3

S.No.

Name of the Experiment

- Determination of e/m of electron by Normal Zeeman Effect using Febry Perot interferometer
- 2 To verify the existence of Bohr's energy levels with Frank-Hertz experiments.
- 3 Determination of Lande's factor of DPPH using Electron-spin resonance (E.S.R.) spectrometer
- Determination of ionization Potential of Lithium
- 5 Analysis of pulse height of gamma ray spectra
- 6 To study the characteristics of G.M. counter
- 7 To determine the dead time of G.M. counter
- 8 To study absorption of beta particles is matter
- 9 To study Gaussian distribution using G.M. counter
- Source strength of a beta source using G.M counter
- 11
 Determination of Planck's constant using Photocell and interference filters.
- 12 Recording and calibrating a gamma ray spectrum by scintillation counter
- 13 Detecting gamma radiation with a scintillation counter
- 14
 To study absorption of gamma radiation by scintillation counter
- 15 Identifying and determining the activity of weakly radioactive samples

PHS427-COMPUTATIONAL LAB

Total	Credits
Marks	
75	3

L	Т	P
-	·	3

List of Experiments

- 1. Black body radiation (computation and graphical representation)
- 2. Reflection and transmission of an electromagnetic wave
- 3. Statistical distributions at different temperatures
- 4. Binding energy curve for nuclei using liquid drop model
- 5. Eigen-value problem: 1-D square potential well
- 6. Eigen-values and wave-functions of a simple harmonic oscillator
- 7. Monte-Carlo simulation
- 8. Linear/Projectile motion (simulation and solutions)

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PHS531 CONDENSED MATTER PHYSICS-II

I	Total Marks	Credits
T	100	4

L	Т	P
3	1	-

- 1. **Optical Properties :**Macroscopic theory generalized susceptibility, Kramers- Kronig relations, Brillouin scattering, Raman effect; interband transitions.
- 2. **Magnetism**: Dia- and para-magnetism in materials, Pauli paramagnetism, Exchange interaction. Heisenberg Hamiltonian mean field theory; Ferro-, ferri- and antiferromagnetism; spin waves, Bloch T3/2 law.
- 3. Principles of Magnetic Resonance: ESR and NMR equations of motion, line width, motional narrowing, Knight shift.
- 4. **Superconductivity** :Experimental Survey; Basic phenomenology; BCS pairing mechanism and nature of BCS ground state; Flux quantization; Vortex state of a Type II superconductors; Tunneling Experiments; High Tc superconductors.
- 5. **Disordered Solids**: Basic concepts in point defects and dislocations; Noncrystalline solids: diffraction pattern, glasses, amorphous semiconductors and ferromagnets, heat capacity and thermal conductivity of amorphous solids, nanostructures short expose; Quasicrystals.

Suggested Readings/Books:

- Introduction to Solid State Physics : C. Kittel (Wiley, New York) 2005.
- Quantum Theory of Solids : C. Kittel (Wiley, New York) 1987.
- Principles of the Theory of Solids: J. Ziman (Cambridge University Press) 1972.
- Solid State Physics: H. Ibach and H. Luth (Springer, Berlin), 3rd. ed. 2002.
- A Quantum Approach to Solids: P.L. Taylor (Prentice-Hall, Englewood Cliffs), 1970.
- Intermediate Quantum Theory of Solids: A.O.E. Animalu (East-West Press, New Delhi),1991.
- Solid State Physics: Ashcroft and Mermin (Reinhert& Winston, Berlin), 1976.

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PHS532 CLASSICAL ELECTRODYNAMICS

Total Marks	Credits
100	4

L	Т	P
3	1	

- Electrostatics: Laplace and Poisson's equations, Electrostatic potential and energy densityof the
 electromagnetic field, Multipole expansion of the scalar potential of a charge distribution, dipole
 moment, quadrupole moment, Multipole expansion of the energy of a charge distribution in an
 external field, Static fields in material media, Polarization vector, macroscopic equations,
 classification of dielectric media, Molecular polarizability and electrical susceptibility, ClausiusMossetti relation, Models of Molecular polarizability, energy of charges in dielectric media (Maxwell
 stress tensor).
- Magnetostatics: The differential equations of magnetostatics, vector potential, magnetic fields of a localized current distribution, Singularity in dipole field, Fermi-contact term, Force and torque on a localized current distribution. (Magnetic stress tensor)
- 3. **Boundary value problems**: Uniqueness theorem, Dirichlet and Neumann Boundary conditions, Earnshaw theorem, Green's (reciprocity) theorem, Formal solution of electrostatic boundary value problem with Green function, Method of images with examples, Magnetostatic boundary value problems.
- 4. **Time varying fields and Maxwell equations**: Faraday's law of induction, displacement current, Maxwell equations, scalar and vector potential, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, General expression for the electromagnetic fields energy, conservation of energy, Poynting Theorem, Conservation of momentum.
- 5. Electromagnetic Waves: wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Poynting theorem for a complex vector field, waves in conducting media, skin depth, Reflection and refraction of e.m. waves at plane interface, Fresnel's amplitude relations, Reflection and Transmission coefficients, polarization by reflection, Brewster's angle, Total internal reflection, Stoke's parameters, EM wave guides, Cavity resonators, Dielectric waveguide, optical fibre waveguide, Waves in rarefied plasma (ionosphere) and cold magneto-plasma, Frequency dispersive characteristics of dielectrics, conductors and plasmas.

Suggested Readings/Books:

- Classical Electrodynamics: S.P. Puri (Narosa Publishing House) 2011.
- Classical Electrodynamics: J.D. Jackson, (New Age, New Delhi) 2009.
- Introduction to Electrodynamics: D.J. Griffiths (Prentice Hall India, New Delhi) 4th ed., 2012.
- Classical Electromagnetic Radiation: J.B. Marion and M.A. Heald, (Saunders CollegePublishing House) 3rd edition, 1995.
- Electromagnetic Fields, Ronald K. Wangsness (John Wiley and Sons) 2nd edition, 1986.

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· Electromagnetic Field Theory Fundamentals: Bhag Singh Guru and H.R. Hiziroglu



PHS533 PARTICLE PHYSICS

Total Marks	Credits
100	4

L	Т	P
3	1	-

- 1. **Introduction**: Fermions and bosons, particles and antiparticles, quarks and leptons, interactions and fields in particle physics, classical and quantum pictures, Yukawa picture, types of interactions electromagnetic, weak, strong and gravitational, units.
- Invariance Principles and Conservation Laws: Invariance in classical mechanics and in quantum mechanics, Parity, Pion parity, Charge conjugation, Positronium decay. Time reversal invariance, CPT theorem.
- Hadron-Hadron Interactions: Cross section and decay rates, Pion spin, Isospin, Twonucleon system, Pion-nucleon system, Strangeness and Isospin, G-parity, Total and Elastic cross section, Particle production at high energy.
- 4. Relativistic Kinematics and Phase Space: Introduction to relativistic kinematics, particlereactions, Lorentz invariant phase space, two-body and three-body phase space, recursion relation, effective mass, dalitz, K-3 p-decay, t-θ puzzle, dalitz plots for dissimilar particles, Breit-Wigner resonance formula, Mandelstem variables.
- Static Quark Model of Hadrons: The Baryon decuplet, quark spin and color, baryon octer, quarkantiquark combination.
- Weak Interactions: Classification of weak interactions, Fermi theory, Parity nonconservationin ßdecay, experimental determination of parity violation, helicity of neutrino, K-decay, CP violation in Kdecay and its experimental determination.

Suggested Readings/Books:

- Introduction to High Energy Physics : D.H. Perkins (Cambridge University Press).
- Elementary Particles: I.S. Hughes (Cambridge University Press), 3rded. 1991.
- Introduction to Quarks and Partons : F.E. Close (Academic Press, London), 1979.
- Introduction to Particle Physics: M.P. Khanna (Prentice Hall of India, New Delhi), 2004.

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PHS534 ELECTRONICS

Total Marks	Credits
100	4

L	T	P
3	1	2.7

- Analog and Digital Instruments: Introduction-Basic Emitter Follower Voltmeter; FET Input Voltmeter; Voltage Follower Voltmeter; Amplifier Type OP AMP Voltmeter; Voltage to Current Converter; Current Measurement with Analog Electronic Instrument; Time Base; Basic Digital Frequency Meter System; Reciprocal Counting Technique; Digital Voltmeter System; Digital LCR Measurements.
- 2. UJTs and Thyristors: Operational Principle of UJT: UJT Relaxation Oscillator circuit; PNPN Diode: Characteristics- As a Relaxation Oscillator-Rate Effect; SCR: V-I Characteristics Gate Triggering Characteristics; DIAC and TRIAC; Thyristors: Basic Parameters- As Current Controllable Devices-Thyristors in Series and in Parallel; Applications of Thyristors-As a Pulse Generator, BistableMultivibrator, Half and Full Wave Controlled Rectifier, TRIAC based AC power control, SCR based Crowbar Protection; Gate Turn-Off Thyristors; Programmable UJT.
- Digital Integrated Circuits: 7400 TTL; TTL Parameters; TTL-MOSFET's; CMOS FET's; Three State
 TTL Devices; External drive for TTL Loads; TTL Driving External Loads; 74C00 CMOS; CMOS
 Characteristics; TTL to CMOS Interface; CMOS to TTL interface; Current Tracers.
- 4. Integrated Circuits as Analog System Building Blocks: Electronic Analog Computation; Active Filters: Butterworth Filter-Practical Realization-High Pass Filter-Band Pass Filter-Band Reject Filter; Delay Equalizer; Switched Capacitor Filters; Comparators; Sample and Hold Circuits; Waveform Generators: Square Wave Generator Pulse Generator-Triangle wave Generator-Sawtooth Generator; Regenerative Comparator: Schmitt Trigger.
- 5. Integrated Circuits as Digital System Building Blocks: Binary Adders: Half Adder-Parallel Operation-Full Adder-MSI Adder-Serial Operation; Decoder/Demultiplexer: BCD to Decimal Decoder-4-to-16 line Demultiplexer; Data Selector/Multiplexer:16-to-1 Multiplexer; Encoder; ROM:Code Converters-Programming the ROM-Applications; RAM:Linear Selection-Coincident Selection-Basic RAM ElementsBipolar RAM-Static and Dynamic MOS RAM; Digital to Analog Converters: Ladder Type D/A Converter-Multiplying D/A Converter; Analog to Digital Converters: Successive Approximation A/D Converter.

Suggested Readings/Books:

- Text Book of Electronics by S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006.
- Digital Principles and Applications by A.P. Malvino and D.P. Leach, Tata McGraw-Hill, Publishing Co., New Delhi.
- Electronics Principles and Applications by A.B. Bhattacharya, New Central Book Agency P.Ltd., Kolkata, 2007.
- Integrated Electronics Analog and Digital Circuits and Systems by Jacob Millman, Christos C Halkins and Chetan Parikh, 2ndEdition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.

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PHS-535 FIBRE OPTICS AND NON-LINEAR OPTICS

Total Marks	Credits
100	4

L	Т	P
3	1	

- Optical fibre and its properties: Introduction, basic fibre construction, propagation of light, modes and the fibre, refractive index profile, types of fibre, dispersion, data rate and band width, attenuation, leaky modes, bending losses, cut-off wavelength, mode field diameter, other fibre types.
- Fiber fabrication and cable design: Fibre fabrication, mass production of fiber, comparison of the processes, fiber drawing process, coatings, cable design requirements, typical cable design, testing.
- 3. Optics of anisotropic media: Introduction, the dielectric tensor, stored electromagnetic energy in anisotropic media, propagation of monochromatic plane waves in anisotropic media, directions of D for a given wave vector, angular relationships between D, E, H, k and Poynting vector S, the indicatrix, uniaxial crystals, index surfaces, other surfaces related to the uniaxial indicatrix, Huygenian constructions, retardation, biaxial crystals, intensity through polarizer/waveplate/ polarizer combinations.
- 4. Electro-optic and acousto-otpic effects and modulation of light beams: Introduction to the electro-optic effects, linear electro-optic effect, quadratic electro-optic effects, longitudinal electro-optic modulation, transverse electro optic modulation, electro-optic amplitude modulation, electro-optic phase modulation, high frequency wave guide, electro-optic modulator, strain optic tensor, calculation of LM for a logitudinal acoustic wave in isotropic medium, Raman-Nath diffraction, Raman-Nath acousto-optic modulator.
- 5. **Non-linear optics/processes**: Introduction, anharmonic potentials and nonlinear polarization, non-linear susceptibilities and mixing coefficients, parametric and other nonlinear processes, macroscopic and microscopic susceptibilities.

Suggested Readings/Books:

- The Elements of Fibre Optics: S.L.Wymer and Meardon (Regents/Prentice Hall), 1993.
- · Lasers and Electro-Optics: C.C. Davis (Cambridge University Press), 1996.
- Optical Electronics: Gathak&Thyagarajan (Cambridge Univ. Press), 1989.
- The Elements of Non-linear Optics: P.N. Butcher & D. Cotter (Cambridge University Press), 1991.

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PHS-536 PLASMA PHYSICS

Total Marks	Credits
100	4

L	Т	P
3	1	-

- Introduction to the Plasma State, elementary concepts and definitions of temperature and other
 parameters, occurrence and importance of plasma for various applications, Production of Plasma in
 the laboratory, Physics of glow discharge, electron emission, ionization, breakdown of gases,
 Paschen's laws and different regimes of E/p in a discharge, Townsend discharge and the evolution
 of discharge.
- 2. **Plasma diagnostics**: Probes, energy analyzers, magnetic probes and optical diagnostics, preliminary concepts.
- 3. Single particle orbit theory: Drifts of charged particles under the effect of different combinations of electric and magnetic fields, Crossed electric and magnetic fields, Homogenous electric and magnetic fields, spatially varying electric and magnetic fields, time varying electric and magnetic fields, particle motion in large amplitude waves.
- 4. Fluid description of plasmas: distribution functions and Liouville's equation, macroscopic parameters of plasma, two and one fluid equations for plasma, MHD approximations commonly used in one fluid equations and simplified one fluid and MHD equations.dielectric constant of field free plasma, plasma oscillations, space charge waves of warm plasma, dielectric constant of a cold magnetized plasma, ion- acoustic waves, Alfven waves, Magneto sonic waves.
- 5. Stability of fluid plasma: The equilibrium of plasma, plasma instabilities, stability analysis, two stream instability, instability of Alfven waves, plasma supported against gravity by magnetic field, energy principle.microscopic equations for my body system: Statistical equations for many body systems, Vlasov equation and its properties, drift kinetic equation and its properties.

Suggested Readings/Books:

- Introduction to Plasma Physics, F.F. Chen
- Principles of Plasma Physics, Krall and Trievelpice
- Introduction to Plasma Theory, D.R. Nicholson
- The Plasma State, J.L.Shohet
- Introduction to Plasma Physics, M.Uman
- Principles of Plasma Diagnostic, I.H. Hutchinson

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PHS-537 NONLINEAR DYNAMICS

Total Marks	Credits
100	4

L	Т	Р
3	1	-

- 1. Phenomenology of Chaos: Linear and nonlinear systems, A nonlinear electrical system, Biological population growth model, Lorenz model; determinism, unpredictability and divergence of trajectories, Feigenbaum numbers and sizescaling, self similarity, models and universality of chaos.
- 2. **Dynamics in State Space:** State space, autonomous and nonautonomous systems, dissipative systems, one dimensional state space, Linearization near fixed points, two dimensional state space, dissipation and divergence theorem. Limit cycles and their stability, Bifurcation theory, Heuristics, Routes to chaos. Three-dimensional dynamical systems, fixed points and limit cycles in three dimensions, Lyapunov exponents and chaos. Three dimensional iterated maps, U-sequence.
- 3. **Hamiltonian System**: Non-integrable systems, KAM theorem and period doubling, standard map. Applications of Hamiltonian Dynamics, chaosand stochasticity.
- 4. **Quantifying Chaos**: Time series, Lyapunov exponents. Invariant measure, Kolmogorov Sinai entropy. Fractal dimension, Statistical mechanics and thermodynamic formalism.
- 5. Quantum Chaos: Quantum Mechanical analogies of chaotic behaviour. Distribution of energy eigenvalue spacing, chaos and semi-classical approachto quantum mechanics.

Suggested Readings/Books:

- Chaos and Non Linear Dynamics: R.C. Hilborn (Oxford Univ. Press), 2001.
- · Chaos in Dynamical Systems : E. Ott (Cambridge Univ. Press), 2002.
- Applied Nonlinear Dynamics: A.H. Nayfeh and B. Balachandran (Wiley), 1995.
- · Chaos in Classical and Quantum Mechanics: M.C. Gutzwiller (Springer-Verlag), 1990.

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PHS-538 STRUCTURES, SPECTRA AND PROPERTIES OF BIOMOLECULES

Total Marks	Credits
100	4

L	Т	P
3	1	-

- 1. Structure Aspects of Biomolecule: Conformational Principles, Conformation and Configuration Isomers and Derivatives, Structure of Polynucleotides, Structure of Polypeptides, Primary, Secondary, Tertiary and Quaternary Structure of Proteins, Structure of Polysaccharides.
- 2. Theoretical Techniques and Their Application to Biomolecules: Hard Sphere Approximation, Ramachandran Plot, Potential Energy Surface, Outline of Molecular Mechanics Method, Brief ideas about Semi-empirical and Ab initio Quantum Theoretical Methods, Molecular Charge Distribution, Molecular Electrostatic Potential and Field and their uses.
- Spectroscopic Techniques and their Application to Biomolecules: Use of NMR in Elucidation of Molecular Structure, Absorption and Fluorescence Spectroscopy, Circular Dichroism, Laser Raman Spectroscopy, IR spectroscopy, Photoacoustic Spectroscopy, Photo-biological Aspects of Nucleic Acids.
- 4. Structure- Function Relationship and Modeling: Molecular Recognition, Hydrogen Bonding, Lipophilic Pockets on Receptors, Drugs and Their Principles of Action, Lock and Key Model and Induced fit Model.

Suggested Readings/Books:

- Srinivasan &Pattabhi: Structure Aspects of Biomolecules.
- Govil&Hosur: Conformations of Biological Molecules
- Price: Basic Molecular Biology
- Pullman: Quantum Mechanics of Molecular Conformations
- Lehninger: Biochemistry
- Mehler&Cordes: Biological Chemistry and Luca Chemistry
- · Smith and Hanawait: molecular Photobiology, Inactivation and Recovery

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PHS539-SEMINAR

Total Marks	Credits
Satisfactory/	2
Unsatisfactory	2

L	T	P
-	-	

The aim of Seminar in M.Sc. 3th semesters is to expose some of the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, analysis of data, etc. related to research Project work which can be in Experimental Physics or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department in the start of the 3rd semester. These seminars are aimed to develop in-depth subject knowledge and skill. Besides subject expertise, they help train students in the presentation and communication skill.



PHS540-PHYSICS LAB-III

Total Marks	Credits
75	3

L	Т	P
	-	3

S.No. Name of the Experiment

- To study temperature dependence of conductivity of a given semiconductor crystal using four probe method
- Temperature dependence of a ceramic capacitor-verification of curie-weiss law for the electrical susceptibility of a ferroelectric material
- 3 To determine charge carrier density and Hall coefficient by Hall effect
- 4 To determine the band gap of a semiconductor using p-n junction diode
- 5 To determine magnetic susceptibility of material using Quink 's tube method
- 6 To determine energy gap and resistivity of the semiconductor using four probe method
- 7 To trace hysteresis loop and calculate retentivity, coercivity and saturation magnetization
- 8 To determine dielectric constant of a material with Microwave set up
- 9 To study the series and parallel characteristics of photovoltaic cell
- 10 To study the spectral characteristics of photovoltaic cell
- 11 To determine the g-factor using ESR spectrometer

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Scheme & Syllabus (M. Sc. Phy.) Batch 2016 & Onwards

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PHS-541 EXPERIMENTAL TECHNIQUES IN NUCLEAR PHYSICS AND PARTICLE PHYSICS

Total Marks	Credits
100	4

L	T	P
3	1	-

- 1.Detection of radiations: Interaction of gamma-rays, electrons, heavy charged particles, neutrons, neutrinos and other particles with matter. General properties of Radiation detectors, energy resolution, detection efficiency and dead time. Statistics and treatment of experimental data. Gas-filled detectors, Proportional counters, space charge effects, energy resolution, time characteristics of signal pulse, position-sensitive proportional counters, Multiwire proportional chambers, Drift chamber, Time projection chamber. Organic and inorganic scintillators and their characteristics, light collection and coupling to photomultiplier tubes and photodiodes, description of electron and gamma ray spectrum from detector, Cherenkov detector. Semiconductor detectors, Ge and Si(Li) detectors, Charge production and collection processes, semiconductor detectors in X- and gamma-ray spectroscopy, Pulse height spectrum, Compton-suppressed, Semiconductor detectors for charged particle spectroscopy and particle identification.
- 2. **Electromagnetic and Hadron calorimeters:** Motion of charged particles in magnetic field, Magnetic dipole and quadrupole lenses, beta ray spectrometer. Detection of fast and slow neutrons nuclear reactions for neutron detection. General background and detector shielding.
- **3. Experimental methods**: Detector systems for heavy-ion reactions: Large gamma and charge particle detector arrays, multiplicity filters, electron spectrometer, heavy-ion reaction analysers, nuclear lifetime measurements (DSAM and RDM techniques), production of radioactive ion beams. Detector systems for high energy experiments: Collider physics (brief account), Particle Accelerators (brief account), Secondary beams, Beam transport, Modern Hybrid experiments- CMS and ALICE.

Suggested Readings/Books:

- Introduction to Experimental Particle Physics by Richard Femow (Cambridge University Press), 2001.
- Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010.
- Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994.
- Detectors for particle radiation by Konrad Kleinknecht(Cambridge University Press), 1999.

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PHS 542 PHYSICS OF NANOMATERIALS

Total Marks	Credits
100	4

L	T	P
3	1	

- 1. Introductory Aspects: Free electron theory and its features, Idea of band structure-metals, insulators and semiconductors. Density of state in one, two and three dimensional bands and its variation with energy, Effect of crystal size on density of states and band gap. Examples of nanomaterials.
- 2. Preparation of Nanomaterials :Bottom up: Cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques and Top down: Ball Milling.
- 3. General Characterization Techniques: Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photo luminescence peaks, variation in Raman spectra of nanomaterials, photoemission microscopy, scanning force microscopy.
- 4. Quantum Dots: Electron confinement in infinitely deep square well, confinement in one and two-dimensional wells, idea of quantum well structure, Examples of quantum dots, spectroscopy of quantum dots.
- Other Nanomaterials: Properties and applications of carbon nanotubes and nanofibres. Nanosized metal particles, Nanostructured polymers, Nanostructured films and Nano structured semiconductors.

TUTORIALS: Relevant problems pertaining to the topics covered in the course.

Suggested Readings/Books:

- Nanotechnology Molecularly Designed Materials : G.M. Chow & K.E. Gonsalves (American Chemical Society), 1996.
- Nanotechnology Molecular Speculations on Global Abundance : B.C. Crandall (MIT Press), 1996.
- Quantum Dot Heterostructures: D. Bimerg, M. Grundmann and N.N. Ledentsov (Wiley), 1998.
- Nanoparticles and Nanostructured Films-Preparation, Characterization and Application :J.H.Fendler (Wiley), 1998.
- Nanofabrication and Bio-system: H.C. Hoch, H.G. Craighead and L. Jelinski (Cambridge Univ. Press), 1996.
- Physics of Semiconductor Nanostructures: K.P. Jain (Narosa), 1997.
- Physics of Low-Dimension Semiconductors: J.H. Davies (Cambridge Univ. Press) 1998.
- Advances in Solid State Physics (Vo.41): B. Kramer (Ed.) (Springer), 2001.

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Scheme & Syllabus (M. Sc. Phy.) Batch 2016 & Onwards

PHS-543 ENVIRONMENTAL PHYSICS

Total Marks	Credits
100	4

L	Т	P
3	1	-

- Essentials of Environmental Physics: Structure and thermodynamics of the atmosphere, Composition of air, Greenhouse effect, Transport of matter, energy and momentum in nature, Stratification and stability of atmosphere, Lass of motion, hydrostatic equilibrium, General circulation of the topics, Elements of weather and climate of India.
- Solar and Terrestrial Radiation: Physics of radiation, Interaction of light with matter, tayleigh and Mie scattering, Laws of radiation (Kirchoffs law, Planck's law, Beer's law, Wien's displacement law, etc.), Solar and terrestrial spectra, UV radiation, Ozone depletion problem, IR absorption energy balance of the earth atmosphere system.
- 3. Environmental Pollution and degradation: Elementary fluid dynamics, Diffusion, Turbulence and turbulent diffusion, Factors governing air, Water and noise pollution, Air and water quality standards, Waste disposal, Heat island effect, Land and sea breeze, Puffs and plumes, Gaseous and particulate matters, Wet and dry deposition.
- 4. Environmental Changes and remote sensing: Energy sources and combustion processes, Renewable sources of energy, Solar energy, Wind energy, bioenergy, hydropower, fuel cells, nuclear energy, Forestry and bioenergy.
- 5. Global and Regional Climate: Elements of weather and climate, Stability and vertical motion of air, Horizontal motion of air and water, Pressure gradient forces, Viscous forces, Reynolds number, Enhanced Greenhouse Effect, Energy balance-a Zero-dimensional Greenhouse model, Global climate models.

Suggested Readings/Books:

- Egbert Boeker & Rienk Van Groundelle: Environmental Physics (John Wiley).
- J. T Hougtion: The Physics of atmosphere (Cambrige University Press, 1977).
- J Twidell and J Weir: Renewable energy Resources (Elbs, 1988).
- Sol Wieder: An introduction t solar energy for scientists and Engineers (John Wiley, 1982)
- R. N. Keshavamurthy and M. Shanker Rao: The Physics of Monsoons (Allied Publishers, 1992).
- G.J. Haltiner and R.T. Williams: Numerical Weather Prediction (John Wiley, 1980).

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PHS 544 SCIENCE OF RENEWABLE SOURCE OF ENERGY

Total Marks	Credits
100	4

L	Т	P
3	1	-

- 1. **Introduction**: Production and reserves of energy sources in the world and in India, need for alternatives, renewable energy sources.
- 1. Solar Energy: Thermal applications, solar radiation outside the earth's atmosphere and at the earth's surface, fundamentals of photovoltaic energy conversion. Direct and indirect transition semi-conductors, interrelationship between absorption coefficients and band gap recombination of carriers. Types of solar cells, p-n junction solar cell, Transport equation, current density, open circuit voltage and short circuit current, description and principle of working of single crystal, polycrystalline and amorphous silicon solar cells, conversion efficiency. Elementary ideas of Tandem solar cells, solid-liquid junction solar cells and semiconductor-electrolyte junction solar cells. Principles of photo electrochemical solar cells. Applications.
- 2. Hydrogen Energy: Environmental considerations, solar hydrogen through photo electrolysis and photocatalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells, hydride batteries.
- Other sources: Nature of wind, classification and descriptions of wind machines, power coefficient, energy in the wind, wave energy, ocean thermal energy conversion (OTEC), system designs for OTEC.

Suggested Readings/Books:

- Solar Energy: S.P. Sukhatme (Tata McGraw-Hill, New Delhi), 2008.
- Solar Cell Devices: Fonash (Academic Press, New York),2010.
- Fundamentals of Solar Cells, Photovoltaic Solar Energy: Fahrenbruch and Bube (Springer, Berlin), 1983.
- Photoelectrochemical Solar Cells : Chandra (New Age, New Delhi).

Head
Department of Physical Sciences
LK: Gujral Punjab Technical University
Main Campus

PHYS 545 RESEARCH PROJECT

Total Marks	Credits
Satisfactory/	12
Unsatisfactroy	12

L	Т	P
-	-	3

The aim of project work in M.Sc. 4th semesters is to expose some of the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data, etc. Project work can be in Experimental Physics or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department before the end of the 3rd semester. A report about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the Head of Department.

Assessment of the work done under the project will be carried out by a committee on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva-voce/seminar, etc as per course guidelines.

Annexume 1.1.2 8 1.22 (111)

IK Gujral Punjab Technical University, Kapurthala Department of Physical Sciences

Ref No.: IKGPTU/PS/ 1990

Date: 15/04/2019.

Subject:

Proceedings of the Board of Studies (BoS), Physical Sciences (Material Science/Nano Science and Technology) meeting held on 29.03.2019.

20.00.2010.

A meeting of members of Board of Studies (BoS), Physical Sciences (Material Science/Nano Science and Technology) was held on 29.03.2019 in the Department of Physical Sciences, I K Gujral Punjab Technical University, Kapurthala. The agenda of the meeting was discussed in detail and recommendations were made on point. The proceedings of the meetings were recorded in the minutes of the meeting as enclosed as an Annexure -1.

Submitted for necessary action.

Convener- BoS Dr. Neetika

Chairman, Board of Studies Head, Physical Sciences.

Head
Department of Physical Sciences
LK. Gujral Punjab Technical University
Main Campus

I.K. Gujral Punjab Technical University, Kapurthala Department of Physical Sciences

Refaco: 1KGPTU) PS/1989

Minutes of Meeting

Dak: 15/04/2019

A meeting of members of Board of Studies (BoS), Physical Sciences (Material Science/Nano Science and Technology) was held on 29.03.2019 in the Department of Physical Sciences, I K Gujral Punjab Technical University, Kapurthala.

Following members of BOS and special invitees were present and actively participated in discussion:

- 1. Dr. Amit Sarin (Chairperson)
- 2. Dr. R. K. Bedi, Member
- 3. Dr Rakesh Dogra, Member
- 4. Dr. Hitesh Sharma, Member
- 5. Dr. Gaurav Bhargava, (Special invitee)
- 6. Dr. Maninder Kaur, Member
- 7. Dr. Jagmeet Bawa, (Special invitee)
- 8. Dr. Priyanka Mahajan, (Special invitee)
- 9. Dr. Sarabjit Singh Mann, (Special invitee)
- 10. Dr. Varinderjit Singh (Special invitee)
- 11. Dr. Neetika (Special invitee)
- 12. S. Navdeepak Sandhu, Member
- 13. Mr. Gurcharan Singh, M.Sc. (2nd Year)-Student representative
- 14. Mr. Nikhil M.Sc. (2nd Year)-Student representative

The following members could not attend the meeting:

- 1. Dr. Davinder Mehta, Member
- 2. Dr. Harpreet Kaur Grewal, Member
- 3. Dr. Kanchan L Singh, Member
- 4. Dr. B D Gupta, Member
- 5. Dr. Rajiv Malhotra, Member
- 6. Dr. P. Arumugam, Member
- 7. Dr. Ravi Kumar, Member
- 8. Dr. Arvind Kumar, Member
- 9. Dr. Ranjan Kumar, Member
- 10. Dr. Ashish Arora, (Special invitee)

Department of Physical Sciences

I.K. Gujral Punjab Technical University

Main Campus

The Board of Studies discussed on all the agenda points and following recommendations were made:

Agenda item 1: To consider the revision of Program Educational objectives (PEO), Program outcomes (POs), Program specific outcomes (PSOs) and Course outcomes of M.Sc. (Physics) course

All BoS members discussed the Program Educational objectives (PEO), Program outcomes (POs), Program specific outcomes (PSOs) of the M.Sc. (Physics) course and with vision of the Department of Physical Sciences. After incorporating suggestions, BOS members recommended the Program Educational objectives (PEO), Program outcomes (POs), Program specific outcomes (PSOs) and Course outcomes (COs) of various subjects for M.Sc. (Physics) w.e.f. 2018-19. The copy of revised scheme and syllabus with revised PEOs, POs, PSOs, and COs is enclosed as Annexure A.

Agenda item 2: To consider the syllabus of inter disciplinary value-added course on Personality Development for Main Campus

All BoS members discussed the syllabus of inter disciplinary value-added course on Personality Development for M.Sc. Physics students. The syllabus for audit course is designed by the Dr. Priyanka Mahajan. Board members agreed that more interdisciplinary course on Human values, Management, etc., may be added in near future. The copy of finalized syllabus of Personality Development is enclosed as Annexure-B.

Agenda item 3: To consider the study scheme and syllabus of B. Sc. (Hons) Physics for the first two semesters in the academic session 2019-2020

All BoS members discussed the study scheme of B Sc. (Hons) Physics and syllabus of 1st and 2nd semester starting from the academic session 2019-2020 in the IKGPTU Main Campus. Board members agreed that two physics core courses with their respective labs will be offered in first two semesters. Proposed study scheme and physics courses syllabus is attached here as Annexure-C. Further subject codes and open elective subjects will be discussed in the next BOS meeting.

Agenda item 4: To consider the courses on skill and employability enhancement related.

All BoS members discussed and recommended that theory and lab courses on Mathematical Physics, Electronics, Computational, Statistical, Nuclear, Condensed matter, Renewable energies, and Dissertation are essential for the employability enhancement of M.Sc. Physics students.

A

Agenda item 5: To consider syllabus of new courses in PhD Course works

All BoS members discussed and recommended the syllabus of new courses on 1) Advanced Particle Physics and 2) Renewable Energy Resources in the Curriculum of Ph. D course work as per the specialization available in the Department of Physical Sciences. The copy of approved syllabus of Advance Particle Physics and Renewable Energy Resources is enclosed as Annexure-D.

Dr. Amit Sarin

Chairperson- BoS, Physical Sciences

Dean Academics

Head Department of Physical Sciences

N.K. Gujral Punjab Technical University

Niam Campus M

M.Sc. Physics

Course Structure and Syllabus (Based on Choice Based Credit System) 2018 onwards



Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

Held

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IK Guiral Purpob Technical University

TISION

To be an institution of excellence in the domain of higher technical education that serves as the fountainhead for nurturing the function can be technology and techno- innovation responsible for the techno-economic, stream and the world.

MISSION

- To provide seamless education through the pioneering use of technology, in partnership with industry and society with a view to offernote research, discovery and entrepreneurship and
- To prepare its students to be responsible a tizens of the world and the leaders of technology and techno-innovation of the 11st (energy by developing in them the desirable knowledge, skill and attitudes base for the second of work and by instilling in them a culture for seamlessness in all facets of the

DESECTIVES

- To offer globally-relevant industry-linked, research-focused, technology- enabled seamless education at the greature, assignaduate and research levels in various areas of engineering & technology and applies sciences keeping in mind that the manpower so spawned is excellent in quanty is relevant to the global technological needs, is motivated to give its best and is commuted to the growth of the Nation;
- To foster the creation of new and relevant technologies and to transfer them to industry for effective utilization;
- To participate in the pianous as a traine of engineering and managerial problems of relevance to global industry and to sociaty at large by conducting busic and applied research in the areas of technologies.

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Scheme & Syllahus (in Ser. Physics that a recorded service)

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F.K.: Gujral Punjab Technical University

- To develop and conduct continuing education programmes for practicing engineers and managers with a view to update their fundamental knowledge base and problem-solving capabilities in the various areas of core competence of the University;
- To develop strong collaborative and cooperative links with private and public sector industries and government user departments through various avenues such as undertaking of consultancy projects, conducting of collaborative applied research projects, manpower development programmes in cutting-edge areas of technology, etc;
- To develop comprehensive linkages with premier academic and research institutions within the country and abroad for mutual benefit;
- To provide leadership in laboratory planning and in the development of instructional resource material in the conventional as well as in the audio-visual, the video and computer-based modes;
- To develop programmes for faculty growth and development both for its own faculty as well as for the faculty of other engineering and technology institutions;
- To anticipate the global technological needs and to plan and prepare to cater to them;
- To interact and participate with the community/society at large with a view to inculcate in them a feel for scientific and technological thought and endeavour; and
- To actively participate in the technological development of the State of Punjab through the
 undertaking of community development programmes including training and education
 programmes catering to the needs of the unorganized sector as well as that of the
 economically and socially weaker sections of society.

ACADEMIC PHILOSOPHY

The philosophy of the education to be imparted at the University is to awaken the "deepest potential" of its students as holistic human beings by nurturing qualities of self-confidence, courage, integrity, maturity, versatility of mind as well as a capacity to face the challenges of tomorrow so as to enable them to serve humanity and its highest values in the best possible way.

DEPARTMENT OF PHYSICAL SCIENCES

1510

To be a knowledge neare the selection sciences. Pure and Applied Research and industry requirements for creating sustainable infrastructure and enhancing quality of life

MISSION

- 1. To offer globally-relevant mousty-linked, research-focused, technology-enabled seamless education at the grazuate, postgraduate and research levels in various areas of Physical sciences keeping and a that the manpower so spawned is excellent in quality, is relevant to the grazuate and seconological needs, is motivated to give its best and is committed to the rower of the Nation:
- To develop and condition into the admittion programmes for Science graduates
 with a view to update their content inpuriedge base and problem-solving
 capabilities in the various as a companient of the Conversity.
- To develop comprehensive lineages with premier academic and research institutions
 within the country and abroad for materal benefit.

Engrament of Physical Sciences

L.K. Gujral Punjab Technical University

Main Campus

M.Sc. (Physics) Program

Duration: 2 Years (Semester System)

This M.Sc. (Physics) Program includes various core, electives, and other interdisciplinary courses. The diverse lab experiments allow students to understand the fundamental aspects of the subject. A choice of advanced elective courses offers a glimpse in the frontier areas of research and allow students to work on research project as an integral part of their M.Sc. program. The program also provides adequate exposure to the students for pursuing higher education in the field of technology, research and development in Physics and related areas (M.Phil./Ph.D.) and other job opportunities in academia and industry.

Eligibility:

Pass B.Sc. with 50% marks having Physics as one of the subject. A relaxation of 5% is given in case of candidates belonging to SC/ST category.

PROGRAM EDUCATIONAL OBJECTIVES: At the end of the program, the student will be able to:

PEO1	Apply principles of basic scientific concepts in understanding, analysis, and prediction of physical systems.
PEO2	To develop human resource with specialization in theoretical and experimental techniques required for career in academia, research and industry.
PEO3	Engage in lifelong learning and adapt to changing professional and societal needs.



PROGRAM OUTCOMES: At the end of the program, the student will be able to:

POI	Apply the scientific browled as the program, the student will be able to:
101	Apply the scientific knowledge to solve the complex physics problems.
PO2	Identify, formulate, and analyze advanced scientific problems reaching substantiated
	conclusions using first principles of mathematics, physical, and natural sciences.
PO3	Design solutions for advanced scientific problems and design system components of processes that meet the specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal consideration.
PO4	Use research-bases knowledge and methods including design of experiments.
	analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Create, select, and apply up to pitate economists, resources, and modern scientific tools to complex physics problems with an understanding of the limitations.
PO6	Apply reasoning informed by the confextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to the professional section operation.
PO7	Understand the ampact of the adjunction solutions in societal and environmental contexts, and demonstrate the knowledge of and need for sustainable development.
PO8	Apply ethical principles and colornic to the norths of scientific practice.
PO9	Function effectively as an incryidual, and as a member or leader in diverse teams, and in mumdisciplinary settings.
PO10	Communicate effects are an adiabatic accordes with the scientific/Engineering
	community and with source a single, such as, being after to comprehend and write
	effective reports and design document from make effective presentations, and give
	and receive clear instructions.
PO11	Demonstrate knowinge and materstanding of the scientific principles and apply
	these to one slowing the state of the said leader in a team, to manage projects and in multidisciplinary environment.
PO12	Recognize the necessarian and his preparation and about to engage in independent and life-tong tearning to the form as so next afreignific and technological change.

PROGRAM SPECIFIC OUTCOMES At the end of the program, the student will be able to:

PSO1	Understand the has a mederal on a concerns of a florent branches of physics.
PSO2	Perform and design to perfer a comparational physics.
PSO3	Apply the concerns the second of the second

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SEMESTER FIRST

Course Code	Course Title		Load Allocation		Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
MSPH411-18	Mathematical Physics-I	3	1	-	30	70	100	4
MSPH412-18	Classical Mechanics	3	1	-	30	70	100	4
MSPH413-18	Quantum Mechanics-I	3	1	-	30	70	100	4
MSPH414-18	Electronics	3	1	-	30	70	100	4
MSPH415-18	Computational Physics	3	1	-	30	70	100	4
MSPH416-18	Electronics Lab	-	-	6	50	25	75	3
MSPH417-18	Computational Physics Lab-I	-	-	6	50	25	75	3
	TOTAL	15	5	12	250	400	650	26

SEMESTER SECOND

Course Code	e Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
MSPH421-18	Mathematical Physics-II	3	1	-	30	70	100	4
MSPH422-18	Statistical Mechanics	3	1	-	30	70	100	4
MSPH423-18	Quantum Mechanics-II	3	1	-	30	70	100	4
MSPH424-18	Classical Electrodynamics	3	1	-	30	70	100	4
MSPH425-18	Atomic and Molecular Physics	3	1	-	30	70	100	4
MSPH426-18	Atomic, Nuclear, and Particle Physics Lab	-	-	6	50	25	75	3
MSPH427-18	Computational Physics Lab-II	-	-	6	50	25	75	3
	TOTAL	15	5	12	250	400	650	26
	T: Tutorial P: Practical				Niah	ural Punjab Tec Campus O	hnical Univers	Sity

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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SEMESTER THIRD

Course Code	Course Title		Load Allocation		Marks Distribution		Total Marks	The state of the s
		L	T	D	Internal	External		77.41
MSPH531-18	Condensed Matter Physics	3	1	-	30	70	100	4
MSPH: 32-18	Nuclear Physics	3	1	T	30	70	100	4
MSPH533-18	Particle Physics	3	+,-	-	?()	70	100	4
MSPH534-18 MSPH535-18 MSPH536-18	Elective Subject-I	3	912	-	30	70	100	4
CONTRACTOR OF THE PARTY OF THE	Elective Subject of)	±	T.,	31/	70	100	4
MSPH540-18	Condensed Muser Physics Lab			6	50	75	75	3
.,	TOTAL	15	ŗ.	6	200	375	575	23

SEMESTER FOURTH

Course Code	Course Title		Load	170	Marks Distribution		Total Marks	Credits
		1.	1	P	(m) ceres \	Esterna.	+	
MSPH541-18 MSPH542-18 MSPH543-18	Elective Subject-III	3	Ĭ	•	30	70	100	-1
MSPH544-18 MSPH545-18 MSPH546-18	Elective Subject-17	3	1	-	30	70	100	4
MSPH547-18	Dissertation		1.2		200	160	36u *	12
	TOTAL	6	14		260	240	500	20

*Evaluation criteria as and who adopted by IKCPTU

TOTAL NUMBER OF CREDITS = 95

Head
Department of Physical Sciences
I.K., Guiral Punjab Technical University
Main Campus

Scheme & Syllabus (M.Sc. Physics) Burch 2014 & con-ards

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LIST OF DEPARTMENTAL/INTERDISCIPLINARY ELECTIVES

Elective Subject-I

S. No.	Name of the Subject	Code
1	Fibre optics and non-linear optics	MSPH534-18
2	Radiation Physics	MSPH535-18
3	Nonlinear Dynamics	MSPH536-18

Elective Subject -II

S.No.	Name of the Subject	Code
1	Plasma Physics	MSPH537-18
2	Structures, Spectra and Properties of Biomolecules	MSPH538-18
3	Science of Renewable Source of Energy	MSPH539-18

Elective-III

S.No.	Name of the Subject	Code
1	Physics of Nanomaterials	MSPH541-18
2	Experimental Techniques in Nuclear and Particle Physics	MSPH542-18
3	Superconductivity and Low Temperature Physics	MSPH543-18

Elective-IV

	Name of the Subject	Code
1	Advanced Condensed Matter Physics	MSPH544-18
2	Advanced Particle Physics	MSPH545-18
3	Environment Physics	MSPH546-18

Examination and Evaluation

Theory			
S. No.	Evaluation criteria	Weightage a Marks	Remarks
1	Mid term/sessional Tests	20	Internal evaluation (20 Marks)
2	Attendance	5	MSTs, Quizzes, assignments, attendance, etc., constitute internal
3	Assignments	5	evaluation. Average of two mid remester test will be considered for evaluation.
4	End semester examination	70	External evaluation (70 Marks)
			Conduct and checking of the answer sheets will at the Department level in case of University teaching Department or Autonomous assistations.
			or other colleges examination will be conducted at the University level.
5	Total	100	Marks may be rounded off to nearest
ractica	1		
	Evaluation of practical record/ Viva Voice	30	internal evaluation (50 Marks)
2	Attendance	5	
3	Seminar/Presentation	15	
36	Final Practical Performance - Viva Voice	2.5	xternal evaluation (25 Marks)
5	Total	75	warks may be founded off to nearest

			Intern	nal Assessment	A	
	Communica		Re	esponse to queries	Maximum Marks	Evaluated by
Departmental Presentation	20			30	50	Committee Member: 1.Head 2.Supervisor 3.One of Faculty Member
Dissertation	Plagiarism	Subject Matter	Usage of Language	Publication/Presentation in Conference	150	
	25	70	25	30		
			External	Assessment		
External Examiner			Subject Ma	tter	50	
LAdimici			50			
-	Communi and Preser	11.741.041.0401.0711.0401.1	Re	sponse to queries		Committee Member:
Viva Voce	20			30	50	1.Head 2.External Expert 3.Supervisor 4. Director (MC) nominee
		To	tal	3000	300	

Evaluation Process:

- The subject matter evaluation can further be defined on the basis of Title, Review of literature/Motivation, Objectives, Methodology, Results and discussions, and Conclusion.
- 2. The usage of language and the subject matter shall be evaluated by the supervisor. Out of 300 marks, 95 marks are to be evaluated by the concerned supervisor.
- 3. Total 15% Plagiarism is admissible for submission of the dissertation. For (0-5)% of plagiarism, candidate should be awarded 25 marks. For >5%-10% candidate should be awarded 15 marks and for the range of > 10% to < 15%, candidate should be awarded 5 marks.
- 4. For publication candidate should be awarded full 30 marks and for presenting the work related to dissertation, candidate should be awarded 25 marks.

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L.K. Gujrai Punjab Technical Universit

Main Campus A

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

MS	PH41	1-18	MATI	EMA	HEAL.	PHYSI	CS-I	L-3	T-1, P	0	4 Cre	dits	
Pre-r	requis	ite: Unde	rstandin	g of gr		of mat	rematic.	<u> </u>		!			
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Cour	se Ou	teomes: A	At the en	d of the	e course,	the stud	ent wil	be able	to	Horis Hadina			
CC)1	Use con	nplex va	riables	for sulv	ng defii	ite inte	gral.		10.00.000			
CO1 Use complex variables for solving definite integral. CO2 Use the Delta and Capacia Laborates for describing physical systems.													
C(3.3	Solve pa											
CO)4	Describe									probler	ne.	
CO)5	Use stati									prome		
					SU GUILL					108	7717011		
	POI	PO2	POR	1 626		36.4	PC7	P(38	PO9	FO10	POII	POI	
CO1	3	3	2	2		1	1	-	2	· · · j	1	2	
CO2	3	3	2	1	-	1	1	-	2	1	1	2	
003	3	3	2		i i	Transcriptor	-		-2		1	2	
04	3	3	2							-			
	Territor To				2				2	1	1	2	
05	3	3	2	3.		2	1	-	2 1	-	1	2	



- Complex Variables: Introduction, Cauchy-Riemann conditions, Cauchy's Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals, Dispersion relation. (Lectures 10)
- Delta and Gamma Functions: Dirac delta function, Delta sequences for one dimensional function, properties of delta function, Gamma function, factorial notation and applications, Beta function. (Lectures 7)
- 3. **Differential Equations:** Partial differential equations of theoretical physics, boundary value, problems, Neumann & Dirichlet Boundary conditions, separation of variables, singular points, series solutions, second solution.

 (Lectures 8)
- 4. Special Functions: Bessel functions of first and second kind, Generating function, integral representation and recurrence relations for Bessel's functions of first kind, orthogonality. Legendre functions: generating function, recurrence relations and special properties, orthogonality, various definitions of Legendre polynomials, Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite functions, Laguerre functions.

(Lectures 10)

5. Elementary Statistics: Introduction to probability theory, random variables, Binomial, Poisson and Normal distribution. (Lectures 5)

Text Books:

 Mathematical Methods for Physicists: G. Arfken and H.J. Weber (Academic Press, SanDiego) 7th edition, 2011.

Reference Books:

- 1. Mathematical Physics: P.K. Chattopadhyay (Wiley Eastern, New Delhi), 2004.
- 2. Mathematical Physics: A.K. Ghatak, I.C. Goyal and S.J. Chua (MacMillan, India, Delhi), 1986.
- 3. Mathematical Methods in the Physical Sciences M.L. Boas (Wiley, New York) 2rd edition, 2007.
- 4. Special Functions: E.D. Rainville (MacMillan, New York), 1960.
- 5. Mathematical Methods for Physics and Engineering: K.F. Riley, M.P. Hobson and S.J. Bence (Cambridge University Press, Cambridge) 2rd ed., 2006.

Head Department of Physical Sciences F.K. Gujral Punjab Technical University Main Campus

MSF	PH412	-18	CLA	SSICA	L. HEL	HANIC	'S	L-3	, T-1, P-	0	4 Cre	dits		
Pre-r	equisi	te: Under	rstandin	g of grad	anate le	el phys	ies	1				******		
in the	mode	jectives: M.Sc. sturn rn branch ics, Astro	dents in es of ph	the Lag ysics su	Stage St.	and Ha	miltoma	in forma	LISTINS SC	that the	v can n	se thes		
Cour	se Out	comes: A	at the en	id of the	course,	the stuc	lent will	be able	to	*****				
CC)1	Underst	and the	necessit	y of Ac	on, Lap	grangian	and H	amiltoni	an form	alism.			
CC	Understand the necessity of Act on, Lagrangian, and Hamiltonian formalism. Use d'Alambert principle and calculus of variations to derive the Lagrange equations of motion. Describe the motion of a mechanical system using Lagrange-Hamilton formalism. Apply essential feature of a massical problem trice motion under central force.													
CC)3	Describe	the mo	tion of a	mecha	nical sy	stem usi	ng Lagi	ange-H	amilton	formalis	sm.		
CC)4	Apply e periodic	ssenia! motion	fantare Jugar		massicu ive tin	a proble approp	ent (iix) riete ph	e motio	n under	centra	force		
CO)5	Apprecia physics mechanic	e.g., m	olecule.	1, 1540	- acces	tics, vi	hich is erations	imports or ato	ant in so ms in s	everal a solids, c	reas of		
		M	apping	of cours	e duti	mes wi	sh the p	rogram	outcon	nes		~		
	POI	PG2	P03	PC=	PUL	FO6	P07	FO8	700	FO10	POH	PO12		
COI	3	2	2	2		1	i i	-	2	2	2	2		
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Department of Physical Sciences L.K. Gujral Punjab Technical University Main Campus, CD

 Lagrangian Formulation: Mechanics of a system of particles; constraints of motion, generalized coordinates, d'Alembert Principle and Lagrange's velocity-dependent forces and the dissipation function, Applications of Lagrangian formulation.

(Lectures 7)

 Hamilton's Principles: Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to nonholonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.

(Lectures 7)

 Hamilton's Equations: Legendre Transformation, Hamilton's equations of motion, Cyclic coordinates, Hamilton's equations from variational principle, Principle of least action.

(Lectures 7)

- 4. Canonical Transformation and Hamilton-Jacobi Theory: Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton- Jacobi equations for principal and characteristic functions, Action-angle variables for systems with one-degree of freedom. (Lectures 10)
- 5. Rigid Body Motion: Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top. (Lectures 10)

Text Books:

- Classical Mechanics: H. Goldstein, C.Poole and J.Safko (Pearson Education Asia, New Delhi). 2rd ed 2001.
- 2. Mechanics by L.D. Landau & E.M. Lifschz (Pergamon), 1976.

Reference Books:

- 3. Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, New Delhi), 1988.
- 4. Classical Mechanics- J. W. Muller- Kirsten (World Scientific) 2008.
- 5. Advanced Classical & Quantum Dynamics by W. Dittrich, W. And M Reuter, M. (Springer) 1991.
- 6. Classical mechanics by T.W.B. Kibble and Frank H. Berkshire (Imperial College, Press) 2004.
- 7. Mathematical Methods of Classical Mechanics by V. I. Arnold, (Springer) 1978

Department of Physical Sciences

[K. Gujral Punjab Technical University
[Main Campus DAY.]

MSF	PH413-1	8 Qu:	antum !	Mechan	ics-1			L-3, 7	T-1, P-0		4 Cred	its
Pre-	requisite	e: Basic	knowle	edge of	var e me	hanica	l quanti	ım mech	anies			
Cour the s techr	rse Obje tudents niques of can use t	of M.S	The ain se. class spaces.	n and ob to the angular	formal	the contractu	ourse on re of th	Quanti e subjec	and to	er merrin	thouse .	. iela el
Cour	se Oute	omes:	At the er	nd of the	course	he stu	dent wil	l be able	to			
(CO1	Und	erstand	the new	for au	ייו ומטוריי	echanic	al forma	lism and	irs bas	ic princi	ples.
(CO2	App	reciste	the m	Dertir is	and	mpleas	on or s	ector o	Speces	Dirac 1	
(03	Bette	er unde		ig 21 i	he mat	hematic	al found				angula
(04							systems	using a	pproxin	nate met	hods.
(005	Appl	y pertui	bation i	hears to	scatter	ng mau	ix and p	mial wa	ve anal	ysis.	
		lvi	apping	of cour	'sc oute	omes w	di the j	orogram	outcon	nes		
	POI	PO2	PO3	T i Un	105	POG	PO7	FO8	PO9	PO10	POII	POI
COI	3	2	2	10	7 2	2	11	1	2	3	2	2
002	3	2	13			3	1	i	2	2	2	2
03	3	2	· · · · ·	,			į.	ž	1	3	2	2
04	3	2	2		2	2	2	2	2	2	2	2
.04												

- Stationary State Approximate Methods: Non-Degenerate and degenerate perturbation theory
 and its applications, Variational method with applications to the ground states of harmonic
 oscillator and other sample systems. (Lectures 7)
- Time Dependent Perturbation: General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light.

(Lectures 7)

Scattering Theory: Scattering Cross-section and scattering amplitude, partial wave analysis.
 Low energy scattering, Green's functions in scattering theory, Born approximation and its application to Yukawa potential and other simple potentials. Optical theorem, Scattering of identical particles.
 (Lectures 7)

Text Books:

- A Text book of Quantum Mechanics: P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi) 1nd edition, 2004.
- 2. Quantum Mechanics: V.K. Thankappan (New Age, New Delhi), 2004.

Reference Books:

- 1. Quantum Mechanics: M.P. Khanna, (Har Anand, New Delhi), 2006.
- 2. Modern Quantum Mechanics: J.J. Sakurai (Addison Wesley, Reading), 2004.
- 3. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi), 1995.
- 4. Quantum Physics: S. Gasiorowicz (Wiley, New York), 2rd ed. 2002,
- 5. Quantum Physics: Concepts and Applications: Nouredine Zettili (Wiley New York), 2nd ed. 2009.

1. Gujraf Punjab Technical University
Main Campus

MSI	PH414-1	18 E	lectroni	CS				L-3, T-1	, P-0		4 Credi	ts
Pre-	requisit	e: Basi	c knowle	edge ab	out elect	onics						
of se analo	emis of Nemicond og circui sysics as	uctor p to and per the	ass to the physics.	e forms basin a tion to c ement.	a structi arga figural et	e of the dyses,	first-or s so the	t and to der nonlit they ca	equip the linear of n use the	tles is to nem with pircuits, nese in v	OPAM	owledg
	CO1	U	nderstan	d worl	king o	Diffe	rent Se	emicond	uctor	devices lications	(Const	ruction
	CO2	E	oplain the	e cans plicatio	ne ne	and w	ctking	of Thyr	istors (and use	Thyris	tors fo
	CO3	D	esign An	alog an	d Digita	i (nstru	rents ar	d their a	pplicati	ions.		
	CO4		oply Boo									
	C05		sign the									
-		3	fapping	of con-	rar out	- 168 A	ith the	arogran	outee	ntes		
	100	PO2	PO3	POA	Piri	PO6	PO7	PO8	PO9	PO10	PO11	PO12
COI	3	3	2			. 2		2	1	2	2	2
CO2	3	3	2	+,- :	1	1	Ti	2	1	1	2	2
CO3	2	2	j.	1			1	2		1	2	2
	3	3	2	1	2	2	1	2	1	2	2	2
CO4		A.										100

 Semiconductor Devices and applications: Direct and indirect semiconductors, Drift and diffusion of carriers, Photoconductors, Semiconductor junctions, Metal-semiconductor junctions - Ohmic and rectifying contacts, Zener diode, Schottky diode, Switching diodes. Tunnel diode, Light emitting diodes, Photodiodes, Solar cell, Liquid crystal displays.

(Lectures 7)

- 2. UJTs and Thyristors: Operational Principle of UJT: UJT Relaxation Oscillator circuit; PNPN Diode: Characteristics- As a Relaxation Oscillator-Rate Effect; SCR: V-I Characteristics-Gate Triggering Characteristics; DIAC and TRIAC; Thyristors: Basic Parameters- As Current Controllable Devices- Thyristors in Series and in Parallel; Applications of Thyristors- as a Pulse Generator, Bistable Multivibrator, Half and Full Wave Controlled Rectifier, TRIAC based AC power control, SCR based Crowbar Protection; Gate Turn-Off Thyristors; Programmable UJT. (Lectures 10)
- Analog and Digital Instruments: OPAMP and its applications, Time Base; 555 Timer, Basic Digital Frequency Meter System; Reciprocal Counting Technique; Digital Voltmeter System.

(Lectures 8)

4. Digital circuits: Boolean algebra, de Morgans theorem, Karnaugh maps.

(Lectures 5)

5. Sequential circuits: Flip-Flops – RS, JK, D, COcked, preset and clear operation, race around conditions in JK Flip-flops, master-slave JK flip-flops, Switch contact bounce circuit. Shift registers, Asynchronous and Synchronous counters, Counter design and applications.

(Lectures8)

6. Integrated Circuits as Digital System Building Blocks: Binary Adders: Half Adder-Parallel Operation-Full Adder-MSI Adder-Serial Operation; Decoder/Demultiplexer: BCD to Decimal Decoder-4-to-16 line Demultiplexer; Data Selector/Multiplexer:16-to-1 Multiplexer; Encoder; ROM: Code Converters-Programming the ROM-Applications; RAM:Linear Selection-Coincident Selection-Basic RAM Elements Bipolar RAM-Static and Dynamic MOS RAM; Digital to Analog Converters: Ladder Type D/A Converter-Multiplying D/A Converter; Analog to Digital Converters: Successive Approximation A/D Converter.

(Lectures 8)

Text Books:

- 1. Text Book of Electronics: S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006.
- 2. Digital Principles and Applications: A.P. Malvino and D.P. Leach, Tata McGraw-Hill, Publishing Co., New Delhi.

Reference Books:

- 1. Electronics Principles and Applications: A.B. Bhattacharya, New Central Book Agency P.Ltd., Kolkata, 2007.
- Integrated Electronics Analog and Digital Circuits and Systems: J. Millman, C.C Halkins and C. Parikh, 1nd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.

I.K. Gujral Punjab Technical University
Main Campus (19)

MSP	H415-18	Cor	nputati	onal Ph	ysies		1	-3, T-1,	P-0	-4	Credit	is
Pre-r	equisite:	Under	standin	g of grac	uste id	elphys	Hes					
famili progra	se Object arize the amming the ring sires	studer using a	nts of N my high	LSc. stu level la	idents	with the	numeri	cal meti	nods us	ed in co	mputat	ion and
Cour	se Outco	mes: A	it the en	d of the	COURSE	the stud	lent wil	be able	10			-
(01	App	ly basi	es knov	vledge	of con	nputatio	nal phy	sics in	solvin	g the	physic
(202	Prog	gramme	with the	6 +- 6	any of	her nigh	level la	nguage.			
(03	Use	various	Challe of	na nice	ods in a	solving p	ohysics ;	roblen	is.		
(04	Ana	lyze the	outcom	of the	algorid	m/prog	ram graj	phically	***************************************		
(05	Sim	ulate the	physica	d nysta	ns using	simula	tions.	11. 1. 10.000 00.000		**********	
		M	apping	of cours	e oute	ones wi	th the p	rogran	outcor	nes		
	POI	PO2	POS	104	7	30e	FU7	PO3	P69	PO10	POH	POI
CO1	3	3	2	2	2	1	1	2	3	2	3	2
CO2	3	3	3	,	7	1	1	1	3	2	3	2
CO3	3	3	3			1			1.	2	2	2
CO4	3	3	3	117		3		2	2	2	2	2

- 1. Introduction to Computational Physics: Need and advantages of high level language in physics, programming in a suitable high level language (Matlab/Mathematica/Scilab/Octave), input/output, interactive input, loading and saving data, loops branches and control flow, Matrices and Vectors, Matrix and array operations, Graphic tools: Gnuplots, Origin, Sigmaplot, Visual Molecular Dynamics, Mathematica, etc. (Lectures 11)
- Programming with C++: Introduction to the Concept of Object Oriented Programming; Advantages of C++ over conventional programming languages; Introduction to Classes, Objects; C++ programming syntax for Input/Output, Operators, Loops, Decisions, simple and inline functions, arrays, strings, pointers; some basic ideas about memory management in C+. (Lectures 15)
- 3. Numerical methods: Computer algorithms, interpolations-cubic spline fitting, Numerical differentiation Lagrange interpolation, Numerical integration by Simpson and Weddle's rules, Random number generators, Numerical solution of differential equations by Euler, predictor-corrector and Runge-Kutta methods, eigenvalue problems, Monte Carlo simulations.

(Lectures 15)

Text Books:

- 1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford & IBH Book Co.) 6th ed., 1979.
- 2. A first course in Computational Physics: P.L. DeVries (Wiley) Ind edition, 2011.

Reference Books:

- 1. Computer Applications in Physics: S. Chandra (Narosa) 1nd edition, 2005.
- 2. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 2000.
- 3. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 4th edition 2008.

Department of Physical Sciences
LK. Gujral Punjab Technical University

Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

Page 21 of 73

MSI	PH416-1	18 El	ectronic	es Lab				L-3, T-1	P-0		4 Credi	ts
Pre-	requisit	e: Unde	erstandi	ng of gra	iduate le	vel phy	sies exp	eriments	}		(1000)	
the th	ents of A	A.Sc. cl	ass to c	expending	friend tele-	riques	m elect	ry on El tronics s elop con	o that t	hey can	verify .	some of
Cour	se Outc	omes:	At the e	nd of the	e conse	the stu	dent wi	11	· · · · · · · · · · · · · · · · · · ·			
-	CO1	Ace	quire ha	inds on c	vperion	e of ha	ndling s	and build	ling elec	tronics	circuits.	
(CO2	Be	familia	r with th	PARTON	compe	onents s	uch as recircuits.				
(CO3	Be	able to	understa	nd the c	onstruc	tion, wo	rking pr des, UJ1	inciples TRIA	and V-I C, etc.	charac	teristics
(CO4	Cap	able of	using co	man	as of gr	gital ele	ctronics	for vari	ous app	lications	š.
(005	A.bl and	e to de analyza	sign and	l seriori ale el s	ss ier perime	ific exp	eriment	s as we	il as ac	curately	record
		.11	apping	of cam	F J.	mes v	th the p	erogran	outcor	nes		
	POI	PO2	PO3	POd	Pr 15	PO6	PO7	PO8	PO9	PO10	POH	PO12
CO1	2	2	2			2	1	2	2	2	2	2
CO2	2	1	2	?	15	?	!	2	2	2	2	2
CO3	1	1	2			1	1	2	<u> </u>	2	2	2
CO4	2	2	2	2		3	Ì	2	2	2	2	2
CO5	3	2	3	13		1	1 7	12	2	2	2	2

Note: Students are expected to perform atleast 10 experiments out of following list.

- 1. Study the forward and reverse characteristics of a Semiconctor/Zener diode.
- Construction of adder, subtracter, differentiator and integrator circuits using the given OP-Amp.
- 3. Study the static and drain characteristics of a JFET.
- 4. Construction of an Astable multivibrator circuit using transistor.
- Construction of a single FET amplifier with common source configuration.
- 6. To study the operation of Analog to Digital convertor.
- 7. To study the operation of Digital to Analog convertor.
- 8. Construction of a low-pass filter circuit and study its output performance.
- 9. Construction of a high-pass filter circuit and study its output performance.
- 10. To verify the Dmorgan's law using Logic Gates circuit.
- 11. To study the Characteristics of Tunnel Diode.
- 12. To study Amplitude Modulation.
- 13. To study Frequency Modulation.
- 14. To study the Characteristics of SCR.
- 15. To study the Characteristics of MOSFET.
- 16. To study the Characteristics of UJT.
- 17. To study the Characteristics of TRIAC.
- 18. To verify the different Logic and Arithmetic operations on ALU system.
- 19. To study the operation of Encoders and Decoders.
- 20. To study the operation of Left and right shift registers.
- 21. To study the operation of Counters, Ring counters.
- 22. To determine the thermal coefficient of a thermistor.
- 23. To study the operation of an Integrated Circuit Timer.

Text Books:

- 1. Text Book of Electronics: S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006.
- 2. Digital Principles and Applications: A.P. Malvino and D.P. Leach, Tata McGraw-Hill. Publishing Co., New Delhi.

Reference Books:

- Electronics Principles and Applications: A.B. Bhattacharya, New Central Book Agency P.Ltd., Kolkata, 2007.
- 2. Integrated Electronics Analog and Digital Circuits and Systems: *J. Millman, C.C Halkins and C. Parikh*, 1ndEdition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.

Me Zoo ny sal Sciences L.K. Stijral Punjab Technical University Main Campus

1. K. Gujral Punjab Technical University, Kapurthala

MSP	H417-18	3	Compu	tations	l Physic	(Lab-I		L-3, T-1	P-0		Credi	is
Pre-r	equisite:	Unde	rstandir	ig of gr	adente ic	ei nun	nerical i	nethods	F 515 11 (87.51 E-)		*********	
ramili	se Objectiarize the amming vsics.	e of	M.Sc.	student	S WHILE	the nu	merical	method	ds usec	in co	mputati	on and
Cour	se Outco	mes: A	At the er	nd of th	e course	the stu	dent wi	ll be able	to.		************	**********
(CO1	App	oly basi olems.	cs know	wledge	f comp	uration	al Physic	es in so	lving v	arious p	hysical
(002	THE PERSON NAMED IN COLUMN		with	200	CASTY OF	Det Lie	h level la	STRILL SERVE			
(203	L'se	various	Audier	real lac.	260 ml	Jeser bi	ng/Solvi	or plays	103 0000	lems.	
(004	Sol	ve probl olems.	em, o i	ii aal ah i	king ar	d analy	rtical rea	soning	as appti	ed to so	ientific
(CO5	Ana	lyse and	l regro.	luce the	xperira	ental G	ata.	reason marine		*********	- re- Filling
		M	apping	of cou	rse oute	mes wi	ith the	progran	outcor	nes		
- Annother	POI	PO?	1903	T Na	7. 1	27/16	POT	p()8	PO9	610.4	POLL	PO12
COI	3	3	2	7	7	1	1	2	3	2	3	2
CO2	3	3	3	1	2	1	I	1	3	2	3	2
CO3	3	3	Š	12	2	1	i	2	i	2	2	2
	3	3	2	12	1	1		1	1		1	ı
CO4	1			1								



Note: Students are expected to perform atleast 10 experiments out of following list.

- 1. To find the standard deviation, mean, variance, moments etc. of at least 15 entries.
- 2. To choose a set of 10 values and find the least squared fitted curve.
- 3. Find y for a given x by fitting a set of values with the help of cubic spline fitting technique.
- 4. To find the Roots of an Algebraic Equation by Bisection method and secant method
- To find the Roots of an Algebraic Equation by Newton-Raphson Method.
- 6. To find the Roots of Linear Equations by Gauss Elimination Method.
- 7. To find the Roots of Linear Equations by Gauss-Seidal Iterative Method.
- 8. Find first order derivative at given x for a set of values with the help of Lagrange interpolation.
- 9. To perform numerical integration of a function by Trapezoidal Rule.
- 10. To perform numerical integration of a function by Simpson's Rule.
- 11. To perform numerical integration of a function by Weddle's rule.
- 12. To solve a Differential Equation by Euler's method and Modified Euler's Method.
- 13. To solve a Differential Equation by Runge Kutta method.
- 14. To find the determinant of a matrix and its eigenvalues and eigenvectors.
- 15. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.

Text Books:

- 1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford & IBH Book Co.) 6th ed., 1979.
- 2. A first course in Computational Physics: P.L. DeVries (Wiley) 1nd edition, 2011.

Reference Books:

- 1. Computer Applications in Physics: S. Chandra (Narosa) 1nd edition, 2005.
- 2. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 2000.
- 3. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 4th edition 2008.

Head

Department of Physical Sciences

I.K. Gujral Punjab Technical University

MSI	PH421-1	18	Mati	nematic	ar Phys	008-11	1	3, T-1	P=0	4	4 Credi	ts
Pre-	requisit	e: Unde	erstand	ing of g	raduate	level n	athema	aties			A STATE OF SHAPE	
theor	M.Sc. S etical ti	students reatmen	with t in di	the ma fferent	themeta courses	taught	niques in this	that he s class as a care	she no and fo	eds for	unders	tanding
Cour	se Oute	omes:	At the e	nd of the	e course	the stu	deni wi	l able to	introducing and in the second		TOTAL MENT	
1	COI	Une	derstand vsica.	I the has	ics and	aplicatio	ons of g	roup the	ory in a	ll the bra	inches o	f
(CO2	Use	Fourie	r series :	and tran	sformati	ions as a	n aid fo	r analyz	ing phy	sical pro	blems.
(CO3	App	oly integ	rai tran	siorn 1	solve n	nathema	itical pro	blems	of Physic	es intere	st.
(CO4	Fer	mulate :	and ever transfor	es a pa	isical to	av in te	rms of te	msors a	nd simp	lify it by	use of
(CO5	Dev	elop ma	theman	car skil	s to soil	ve quant	itative p	roblem.	s in phys	ics.	
		M	apping	of con	Senta.	oro es avi	ith the p	regran	outco	nes	*****	
**************************************	POI	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	POII	PO12
COI	3	3	2	12	-	1	1	-	2	ī	1	2
CO2	3	3	2	17		1	1		?	1	1	2
03	3	3	2	12	-	i mananananan il	1		2		1	2
CO4	3	3	2	2	-	1	1	-	2	7	1	2
.04				1								

- 1. Group Theory: What is a group? Montiplication table, conjugate elements and classes, subgroups, Isomorphism and Homomorphism. Definition of representation and its properties. Reducible and irreducible representation. Schur's temmas (only statements), characters of a representation. Example of C4v. epological groups and Lie groups, three dimensional rotation group, special unitary groups \$1.00 and \$U(2). (Lectures 10)
- 2. Tensors: introduction, definitions, contraction, direct product. Quotient rule, Levi-Civita symbol, Noncartesian tensors, metric tensor, Covariant differentiation.

(Lectures 7)

- 3. Fourier Series and Integral Trumper as: Fourier series, Dirichlet conditions, General properties, Advantages and applications, Gibbs phenomenon, Fourier transforms, Development of the Fourier integral, Invenior theorem, Fourier transforms of derivatives; Momentum representation, Laplace transforms, Laplace transforms of derivatives, Properties of Laplace transform, inverse Laplace transformation. (Lectures 15)
- 4. Integral Equations: Definitions and classifications, integral transforms and generating functions. Neumann series, Separable Kernels, Hilbert-Schmidt theory, Green's functions in one dimensio...

Text Books:

- 1. Group Theory for Physicists. A. V., Joseph Wiley Eastern, New Dethi) 2011.
- Mathematical Methods for Physicists. C. Artken and H.J. Weber, (Academic Press, San Diego) 7th edition, 2011.

Reference Books:

- 1. Matrices and Tensors in Physics: A.V. Joshi (Wiley Eastern, New Delhi) 2005.
- 2. Numerical Mathematical Analysis LB Searborough (Oxford Book Co., Kolkata) 4th edition.
- 3. A First Course in Computational Physics: P. L. Devries (Wiley, New York) 1994.
- 4. Mathematical Physics: P.K. Chatometh, av (Wiley Eastern, New Delhi) 2011.
- 5. Introduction to Mathematical Physics: C. Harper (Prentice Hall of India, New Delhi) 2006.

Department of Physical Sciences
LK, Gujral Punjab Technical University

MSPI	H422-18	8	Stati	istical N	Aechan	ies	L	-3, T-1,	P-0	4	Credits	S
Pre-re	equisite	: Under	standir	ng of gr	aduate	level sta	ntistical	mechan	ies			
M.Sc. unders	student	with the	ne techn	iques o	f statist	ical ens	emble t	Statisti heory so n bulk	that h	e/she ca	n use t	hese to
Cours	e Outc	omes: A	t the en	d of the	course,	the stuc	lent will	be able	to			
(CO1	Finc	the cor	nection	betwee	n Statist	tical Me	chanics	and the	rmodyna	ımics	
(CO2	Use	ensemb	le theor	y to exp	lain the	behavio	or of Phy	sical sy	stems		
C	03		lain the		cal beha	avior of	Bose-E	Einstein	and Fer	mi-Dira	c syster	ns and
C	CO4	Woi	k with r	nodels	of phase	transiti	ons and	thermo-	dynami	cal fluct	uations.	
C	005	Desc	cribe ph	ysical p	roblems	using q	uantum	statistic	s.			
	-	М	apping	of cour	se outco	omes wi	th the p	orogram	outcor	nes		
	POI	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	POH	PO12
CO1	-	1	-	-	-	-	-	1	1	-	-0	-
CO2	3	3	3	1	3	2	1	2	2	1	1	1
CO3	3	3	3	1	2	2	1	2	2	1	1	1
CO4	3	3	3	1	2	2	1	2	2	1	1	1
CO5	3	3	3	1	2	2	1	2	2	1	1	1



- The Statistical Basis of Thermodynamics: The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution. (Lectures 7)
- 2. Ensemble Theory: Phase space and Liouville's theorem, the microcanonical ensemble theory and its application to ideal gas of monatomic particles; The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations, equipartition and virial theorems, a system of quantum harmonic oscillators as canonical ensemble, statistics of paramagnetism; The grand canonical ensemble and significance of statistical quantities, classical ideal gas in grand canonical ensemble theory, density and energy fluctuations. (Lectures 10)
- 3. Quantum Statistics of Ideal Systems: Quantum states and phase space, an ideal gas in quantum mechanical ensembles, statistics of occupation numbers; Ideal Bose systems: basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation, discussion of gas of photons (the radiation fields) and phonons (the Debye field); Ideal Fermi systems: thermodynamic behaviour of an ideal Fermi gas, discussion of heat capacity of a free electron gas at low temperatures, Pauli paramagnetism.

(Lectures 10)

- 4. Elements of Phase Transitions: Introduction, a dynamical model of phase transitions.

 Ising model in zeroth approximation.

 (Lectures 8)
- 5. Fluctuations: Thermodynamic fluctuations, random walk and Brownian motion, introduction to non-equilibrium processes, diffusion equation.

(Lectures 5)

Text Books:

Statistical Mechanics: R.K. Pathria and P.D. Beale (Butterworth-Heinemann, Oxford), 2rd edition, 2011.

Reference Books:

- 1. Statistical Mechanics: K. Huang (Wiley Eastern, New Delhi), 1987.
- 2. Statistical Mechanics: B.K. Agarwal and M. Eisner (Wiley Eastern, New Delhi) Indedition, 2011.
- 3. Elementary Statistical Physics: C. Kittel (Wiley, New York), 2004.
- 4. Statistical Mechanics: S.K. Sinha (Tata McGraw Hill, New Delhi), 1990.



MSI	PH423-	18	Qua	ntum N	lechanics-II		L-3, T-1	, P-0		4 Credi	ts
Pre-	requisi	te: Preli	minary	course ()	f Quantum Me	chanics	***************************************				ma in a su
techr these	iques of in varie	of Relations bran	student ivistic q iches of	s to the uantum physics	objective of formal injectumechanes and is Aber in the store of the st	re of the d Quanti equirem	subject im field ent.	and to theory	eanin h	im/her	with H
	CO1	De	fine the	relativis	tic QM as the c	ovariant			quantun	n mecha	nics
	CO2	Giv	e the sign	gnifican	ce of Klein Go	don and	Dirac e	quation	and exis	stence o	f
- (CO3	Ap	ply the s	ymmetr	ies principles a	nd Noetl	ner's the	orem in	calcula	ting the	
(CO4	Der	nonstrat ds.	e the sec	cond oramizati	on for so	alar. Di	rac, and	electror	nagneti	2
(CO5	Exp the	olain the	origin o	Chayranan dia Carang propinsi	grams ar	id apply	the Fey	nman ru	les to d	erive
vain day		M	lapping	of cour	se obicomes w	ith the	orogram	outco	mes		
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05	2	2	3			2	2			2	

Denarment of Physical Sciences

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 Relativistic Quantum Mechanics-I: Klein-Gordon equation, Dirac equation and its plane wave solutions, significance of negative energy solutions, spin angular momentum of the Dirac particle, the non-relativistic limit of Dirac equation.

(Lectures 10)

Relativistic Quantum Mechanics-II: Electron in electromagnetic fields, spin magnetic
moment, spin-orbit interaction, Dirac equation for a particle in a central field, fine structure
of hydrogen atom, Lamb shift.

(Lectures 10)

- 3. Quantum Field Theory: Resume of Lagrangian and Hamiltonian formalism of a classical field, Noether theorem, Quantization of real scalar field, complex scalar field, Dirac field and electromagnetic field, Covariant perturbation theory, Wick's theorem, Scattering matrix.

 (Lectures 10)
- 4. Feynman diagrams: Feynman rules, Feynman diagrams and their applications, Yukawa field theory, calculations of scattering cross-sections, decay rates with examples, Quantum Electrodynamics, calculations of matrix elements for first order and second order.

(Lectures 10)

Text Books:

- Relativistic quantum Mechanics, J D Bjorken and S D Drell, (Tata McGraw Hill, New Delhi) 2012.
- 2. A first book of Quantum Field Theory, A. Lahiri & P. Pal, (Narosa Publishers, New Delhi). 1st ed. 2005.
- 3. Introduction to Quantum Field Theory, M. Peskin & D.V. Schroeder. (Levant Books) 2015.

Reference Books:

- 1. Quantum Field Theory in a Nutshell: A Zee (University Press), 2012.
- 2. Lecture on Quantum Field Theory, A. Das (World Scientific), 2008.
- 3. Text Book of Quantum Mechanics-P.M. Mathews & K. Venkatesan (Tata McGraw Hill. New Delhi), 2004.
- 4. Quantum Field Theory: H. Mandl and G. Shaw (Wiley, New York), 2010.
- 5. Advance Quantum Mechanics: J.J. Sakurai (Addison-Wesley, Reading), 2004.



MS	PH424-	18 CI	assical	Electri	odynam	108		L-3, T-1	, P-0		4 Credi	ts
Pre-	requisi	te: Unde	erstandi	ing of g	raduate.	Vel cie	ctricity a	and magn	etism			
electi time	romagn varying	etic way	ruaing es in c	Maxw fielcetri	est equi	ations, waves i	and the bound	s cours neir app ed medi	elication a, wave	ne ten	proposio	tion
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•	CO3	Pro	vide so	lution to		e plane	wave pro	blems f	or vario	us boun	dary con	ndition
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Electrostatics: Laplace and Poisson's equations, Electrostatic potential and energy density
of the electromagnetic field, Multipole expansion of the scalar potential of a charge
distribution, dipole moment, quadrupole moment, Multipole expansion of the energy of a
charge distribution in an external field, Static fields in material media, Polarization vector,
macroscopic equations, classification of dielectric media, Molecular polarizability and
electrical susceptibility, Clausius-Mossetti relation, Models of Molecular polarizability,
energy of charges in dielectric media (Maxwell stress tensor).

(Lectures 10)

2. Magnetostatics: The differential equations of magnetostatics, vector potential, magnetic fields of a localized current distribution, Singularity in dipole field, Fermi-contact term, Force and torque on a localized current distribution. (Magnetic stress tensor)

(Lectures 8)

- 3. Boundary value problems: Uniqueness theorem, Dirichlet and Neumann Boundary conditions, Earnshaw theorem, Green's (reciprocity) theorem, Formal solution of electrostatic boundary value problem with Green function, Method of images with examples, Magnetostatic boundary value problems.

 (Lectures 8)
- 4. Time varying fields and Maxwell equations: Faraday's law of induction, displacement current, Maxwell equations, scalar and vector potential, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, General expression for the electromagnetic fields energy, conservation of energy, Poynting Theorem, Conservation of momentum.

(Lectures 8)

5. Electromagnetic Waves: wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Poynting theorem for a complex vector field, waves in conducting media, skin depth, Reflection and refraction of e.m. waves at plane interface, Fresnel's amplitude relations, Reflection and Transmission coefficients, polarization by reflection, Brewster's angle, Total internal reflection, Stoke's parameters, EM wave guides, Cavity resonators, Dielectric waveguide, optical fibre waveguide. (Lectures 10)

Text Books:

- 1. Classical Electrodynamics: S.P. Puri (Narosa Publishing House) 2011.
- 2. Classical Electrodynamics: J.D. Jackson, (New Age, New Delhi) 2009.
- 3. Introduction to Electrodynamics: D.J. Griffiths (Prentice Hall India, New Delhi) 4th ed., 2011.

Reference Books:

- 1. Classical Electromagnetic Radiation: J.B. Marion and M.A. Heald(Saunders College Publishing House) 2nd edition, 1995.
- 2. Electromagnetic Fields, Ronald K. Wangsness (John Wiley and Seps) Ind edition, 1986.
- 3. Electromagnetic Field Theory Fundamentals: Bhag Singh Gury and H.R. Hiziroglu

Department of Physical Sciences L.K. Gujral Punjab Technical University Main Campus

MSPH425-18 A		Atomic	and Mo	decular	Physic	s I	3, T-1	P-0		1 Credi	ts			
Pre-i	requisit	e: Unde	rstandin	g of gra	guare la	wel spec	etroscop	ý						
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Cour	se Outo	comes:	At the er	nd of the	e course	, the stu	dent wi	ll be able	e to			************		
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CO2		Und	Understand classical/quantum description of electronic spectra of atom and molecules											
CO3		Use	Use microwave and Raman Spectroscopy for analysis of known molecules											
CO4		Cor	Correlate infrared specta copic information of known molecules with their physical description											
(005		lerstand ysis	Spin Re	Sortane	e Spectr	oscopy	with foc	us on N	MR for	molecu	lar		
	7	M	apping	of com	se mate	mes w	ith the	orogran	auteor	nes				
	POI	PO2	PO3	116.04	div.	r'56	POT	PO8	PO9	- PO 10	POH	PO12		
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CO3	2	2	3	ķ	2	1	2	2	2	3	I	3		
CO4	2	2	3	3	2	1	2	2	2	3	1	3		
05	2	2	3	3	H		2	2	2	3	1	3		



1. Electronic Spectroscopy of Atoms: Bohr-Sommerfeld model of atomic structure, Electronic wave function and atomic quantum numbers – hydrogen spectrum – orbital, spin and total angular momentum - fine structure of hydrogen atom – many electron spectrum: Lithium atom spectrum, angular momentum of many electrons – term symbols – the spectrum of helium and alkaline earths – equivalent and non-equivalent electrons –X-ray photoelectron spectroscopy.

(Lectures 8)

Electronic Spectroscopy of Molecules: Diatomic molecular spectra: Born-Oppenheimer approximation – vibrational spectra and their progressions – Franck-Condon principle – dissociation energy and their products –rotational fine structure of electronic-vibration transition - molecular orbital theory – the spectrum of molecular hydrogen – change of shape on excitation – chemical analysis by electronic spectroscopy – reemission of energy – fundamentals of UV photoelectron spectroscopy. (Lectures 9)

3. Microwave and Raman Spectroscopy: Rotation of molecules and their spectra – diatomic molecules – intensity of line spectra – the effect of isotropic substitution – non-rigid rotator and their spectra – polyatomic molecules (linear and symmetric top molecules) – Classical theory of Raman effect - pure rotational Raman spectra (linear and symmetric top molecules).

(Lectures 8)

4. Infra-red and Raman Spectroscopy: The energy of diatomic molecules – Simple Harmonic Oscillator - the Anharmonic oscillator - the diatomic vibrating rotator – vibration-rotation spectrum of carbon monoxide –breakdown of Born-Oppenheimer approximation – the vibrations of polyatomic molecules –influence of rotation on the spectra of polyatomic molecules (linear and symmetric top molecules) – Raman activity of vibrations – vibrational Raman spectra – vibrations of Spherical top molecules.

(Lectures 8)

5. Spin Resonance Spectroscopy Spin and magnetic field interaction – Larmor precession – relaxation time – spin-spin relaxation - spin-lattice relaxation - NMR chemical shift - coupling constants – coupling between nuclei – chemical analysis by NMR – NMR for nuclei other than hydrogen – ESR spectroscopy - fine structure in ESR. (Lectures 8)

Text Books:

- Fundamentals of Molecular Spectroscopy: Colin N. Banwell and Elaine M. McCash (Tata McGraw-Hill Publishing Company limited).
- 2. Physics of Atoms and Molecules: B. H. Bransden and C. J. Joachain.

Reference Books:

- 1. Physical method for Chemists (Second Edition): Russell S. Drago (Saunders College Publishing).
- 2. Introduction to Atomic Spectra: H.E. White-Auckland McGraw Hill, 1924.
- 3. Spectroscopy Vol. I, II & III: Walker & Straughen
- 4. Introduction to Molecular spectroscopy: G.M. Barrow-Tokyo McCraw Hill, 1961,
- 5. Spectra of diatomic molecules: Herzberg-New York, 194-Department

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MSPH426-18			Atomic	, Nuclei Physic	er, and es Lab	Partich		L-3, T-1	, P-0	4 Credits				
Pre-	requisit	te: Unde	erstandi	ng of gra	iduae i	etator	nic spec	troscop	y and m	iclear pl	ysics			
so th	pose the	e studen	its of M ify som	Sc. stuc	ienis to	experim	iental te	chniques	s in ato	nic and	nuclear	nhyeir		
Cour	se Oute	comes:	At the e	nd of the	e course	the stu	dent wi	ll be ablo	e to					
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CO2		Hai	Handle oscilloscope for visualisation of various input and output signals.											
CO3			Understand the basic of nuclear safely management.											
(C O 4	Per	form so	ientifie uclear ex	experin sperime	iunts as	well a	as accur	ately re	cord ar	nd analy	vze the		
(CO5	Sol	ve appli	ed pageto	er prebl	ins wit	h eritica	d thinkir	ng and a	nalytica	reason	ing.		
			MEDICAL PROPERTY AND THE PARTY SHOW					rogran						
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CO2	1	1	1	2		2	1	2	?	2	2	2		
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Note: Students are expected to perform atleast 10 experiments out of following list.

- 1. Determination of e/m of electron by Normal Zeeman Effect using Febry Perot interferometer.
- 2. To verify the existence of Bohr's energy levels with Frank-Hertz experiments.
- 3. Determination of Lande's factor of DPPH using Electron-spin resonance (E.S.R.) spectrometer.
- 4. Determination of ionization Potential of Lithium.
- 5. Analysis of pulse height of gamma ray spectra.
- 6. To study the characteristics of G.M. tube.
- 7. To verify the inverse square law using GM counter.
- 8. To determine the dead time of G.M. counter.
- 9. To study absorption of beta particles is matter using GM counter.
- 10. To study Gaussian distribution using G.M. counter.
- 11. To estimate the efficiency of GM detector for Gamma and Beta source.
- 12. Determination of Planck's constant using Photocell and interference filters.
- 13. Verification of Inverse square law using Photocell.
- 14. To study Gaussian distribution using scintillation counter.
- 15. To study absorption of gamma radiation by scintillation counter.
- 16. To estimate the efficiency of Scintillator counter.

Text Books:

- 1. Fundamentals of Molecular Spectroscopy: Colin N. Banwell and Elaine M. McCash (Tata McGraw-Hill Publishing Company limited).
- 2. Physics of Atoms and Molecules: B. H. Bransden and C. J. Joachain.

Reference Books:

- 1. Physical method for Chemists (Second Edition): Russell S. Drago (Saunders College Publishing).
- 2. Introduction to Atomic Spectra: H.E. White-Auckland McGraw Hill, 1924.
- 3. Spectroscopy Vol. I, II & III: Walker & Straughen
- 4. Introduction to Molecular spectroscopy: G.M. Barrow-Tokyo McGraw Hill, 1961.
- 5. Spectra of diatomic molecules: Herzberg-New York, 1944.

Denartment of Physical Sciences

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MSPH427-18		Compu	tationni	Physic	Lab-I	1	L-3, T-1	, P-0		4 Credi	ts			
Pre-	requisit	te: Unde	erstandi	ng of gr	aduate la	velnum	nerical r	nethods	and C+	+		A		
as C-	ents of N ++ lang	A.Sc. cli uage fo	ass in ur r simula	nderstan nion of	ding pur	merical for diffe	method: rent ph	omputa s, the usa ysies pro f compu	age of h	igh leve	l langua	ige suc		
Cour	se Out	comes:	At the c	ed of h	e course	. the stu	dent wi	li be able	o to					
	CO1	Uno	derstand sies pro	l and application	oply Las	sics kne	wledge	of num	erical r	nethods	in solv	ing th		
	CO2	Wr	Write programme with the a ++ or any other high level language.											
CO3		Lea	Learn use of graphical methods in data analysis and solving physics problems.											
	CO4	Sol	ve physisoning.	ical pr	blom -	ubling (develop	ment of	critical	thinking	and an	alytica		
(CO5	App	oly com	putation afficil (nal phys	es in f	rontier :	areas of	pure a	nd appli	ed rese	arch ir		
		M	lapping	of cour	'at outi	oales wi	th the j	orogran	outco	nes		. 1 - 2 - 2 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -		
	POI	PO2	PO3	POA	boys	POS	PQ7	PO8	PO9	PO10	PO11	PO12		
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		lance -												



- 1. Write a program to study graphically the EM oscillations in a LCR circuit (use Runge-Kutta Method). Show the variation of (i) Charge as Time and (ii) Current vs Time.
- 2. Study graphically the motion of falling spherical body under various effects of medium (viscous drag, buoyancy and air drag) using Euler method.
- 3. Study graphically the path of a projectile with and without air drag using FN method. Find the horizontal and maximum height in either case. Write your comments on the findings.
- 4. Study the motion of an artificial satellite.
- 5. Study the motion of (a) 1-D harmonic oscillator (without and with damping effects).(b) two coupled harmonic oscillators. Draw grants showing the relations: i) Velocity vs Time. ii) Acceleration vs Time iii) Position vs Time, also compare the numerical and analytical results.
- 6. To obtain the energy eigenvalues of a quantum oscillator using the Runge-Kutta method.
- 7. Study the motion of a charged particle in: (a) Uniform electric field. (b) Uniform Magnetic field, (c) in combined uniform electric and magnetic fields. Draw graphs in each case.
- 8. Use Monte Carlo techniques to simulate phenomenon of (i) Nuclear Radioactivity. Do the cases in which the daughter nuclei are also unstable with half life greater/lesser than the parent nucleus. (ii) to determine solid angle in a given geometry. (iii) simulate attenuation of gamma rays/neutron in an absorber and (iv) some multiple integrals and compare results with Simpson's method.
- 9. To study phase trajectory of a Chaotic Pendulum.
- 10. To study convection in fluids using Lorenz system

Text Books:

- 1. Numerical Recipes in C+1 The Ast of Scientific Computing, William H. Press, Saul. A. Teukolsky, William T. Vetterling, and Enen F. Flattnery, (Cambridge), 1nd ed. 2001.
- 2. A First Course in Computational Physics P.L. DeVries (John Wiley) 2000.

Reference Books:

- 1. An introduction to Computational Physics Tac Pang (Cambridge), Ind ed. 2006.
- 2. Computer Applications in Physics: S. Charara (Nerosa), 2006.
- 3. Computational Physics: R.C. Verna L. Alawalia and K.C. Sharme New Age), 2005.
- 4. Object Oriented Programming with Case Walagurmanny, Clata Mc

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Scheme & Syllabus (M.Sc. Physics) Barer rold & Car as for

1,10	PH531	-18	Conc	lensed I	Matter 1	Physics		L-3, T-	1, P-0		4 Cred	its
Pre	-requisi	te: Und	erstandi	ng of gr	aduate l	evel sol	id state	physics				
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Cou	rse Out	comes:	At the e	end of th	e course	e, the stu	ıdent w	ill be ab	le to			
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	CO2	Di the	fferentia n explai	ate betw n therm	veen var al prope	rious laterties of	tice typ crystall	es based ine solic	d on the	eir lattic	e dynan	nics ar
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	CO4	To in s	explain olids	the basi	c transp	ort theo	ry for u	nderstan	ding the	e transpo	ort phen	omeno
	CO5	Usi	ng vari perties o	ous mo of insula	dels of tors.	molec	ular po	larizabil	lity, un	derstand	the di	electri
		M	apping	of cour	rse outc	omes w	ith the	progran	n outco	mes		
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Crystal binding and Elastic constants: Binding in solids; Cohesive energy, Crystals of Inert gases, ionic crystal, Covalent Crystals, Analysis of elastic strains: dilation, stress components; Elastic Compliance and Stiffness: elastic constants, elastic waves in cubic crystals.

(Lectures 6)

- 2. Lattice Dynamics and Thermal Properties: Vibrations of crystal with monatomic and two atom per primitive Basis; Quantization of Elastic waves, Phonon momentum; Inelastic scattering by phonons, Phonon Heat Capacity, Planck Distribution, normal modes; Density of states, Debye T2 model; Einstein Model; anharmonic crystal interactions; thermal conductivity expansion. (Lectures 9)
- Energy Band Theory: Electrons in a periodic potential: Bloch theorem, Nearly free electron model; Kronig Penney Model; Electron in a periodic potential; tight binding method; Wigner-Seitz Method Semiconductor Crystals, Band theory of pure and doped semiconductors; effective mass elementary idea of semiconductor superlattices.
- (Lectures 9) Transport Theory: Electronic transport from classical kinetic theory; Introduction to Boltzmann transport equation; electrical and thermal conductivity of metals; thermoelectric effects; Hall effect and magneto resistance.

(Lectures 8)

5. Dielectrics and Ferro Electrics: Polarization mechanisms, Dielectric function from oscillator strength, Clausius-Mosotti relation; piezo, pyro- and ferro-electricity; Dipole theory of ferroelectricity; thermodynamics of ferroelectric transition.

(Lectures 8)

Text Books:

- Introduction to Solid State Physics: C. Kittel (Wiley, New York), 8th ed. 2005.
- Quantum Theory of Solids: C. Kittel (Wiley, New York) 1987.

- Principles of the Theory of Solids: J. Ziman (Cambridge University Press) 1971
- Solid State Theory: Walter A. Harrison (Tata McGraw-Hill, New Delhi) 1970.
- Liquid Crystals: S. Chandrasekhar (Cambridge University), Ind ed. 1991.

I. R. Gujral Punjab Technical University, Kapurthala

IVIS	SPH532	2-18		Nuclei	ar Physi	ics		L-3, T-	1, P-0		4 Cree	dits
Pre	-requis	ite: Un	derstand	ing of g	raduate	level ph	ysics			1		
radio	oactive	decays,	s: The a class to nuclear used in	forces	nucleor	sudals	course Juclear and nu	on Nucl Physics clear rea	ear Ph	vies is the prop so that the	to famil perties c hey are	iarize of nuc equipp
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- Nuclear Models: Liquid drop model, Binding energy; fission and fusion, Experimental
 evidence for shell effects, Shell Model, Spin-Orbit coupling, Magic numbers, Application of
 Shell Model like Angular momenta and parities of nuclear ground states, Collective modelnuclear vibrations spectra and rotational spectra. (Lectures 8)
- 2. Static properties of nucleus: Nuclear radii and measurements, nuclear binding energy (review), nuclear moments and systematic, wave-mechanical properties of nuclei, hyperfine structure.

 (Lectures 5)
- 3. Nuclear decay: Review of barrier penetration of alpha decay & Geiger-Nuttal law. Beta decays, Fermi theory, Kurie plots and comparative half-lives, Allowed and forbidden transitions, Experimental evidence for Parity-violation in beta decay, Electron capture probabilities, Neutrino, detection of neutrinos, Multipolarity of gamma transitions, internal conversion process.

 (Lectures 10)
- 4. Nuclear forces: Evidence for saturation of nuclear density and binding energies (review), types of nuclear potential, Ground and excited states of deuteron, dipole and quadrupole moment of deuteron, single and triplet potentials, meson theory of nuclear forces.

(Lectures 10)

5. Nuclear reactions: Nuclear reactions and cross-sections, Resonance, Breit- Wigner dispersion formula for l=0 and higher values, compound nucleus, Direct reactions, Transfer reactions.

(Lectures 7)

Text Books:

- 1. Nuclear Physics: Irving Kaplan (Narosa), 2001.
- 2. Theory of Nuclear Structure: R.R. Roy and B.P. Nigam (New Age, New Delhi) 2005.

Reference Books:

- 1. Basic Ideas and Concepts in Nuclear Physics: K. Hyde (Institute of Physics) 2004.
- 2. Nuclear physics: Experimental and Theoretical, H.S. Hans (New Academic Science) Ind ed (2011).
- 3. Nuclear Physics and its applications: John Lile
- 4. Nuclear Physics: V. Devnathan

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L.C. Gujral Punjab Technical University

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- 1. **Introduction:** Fermions and bosons, particles and antiparticles, quarks and leptons, interactions and fields in particle physics, classical and quantum pictures, Yukawa picture, types of interactions electromagnetic, weak, strong and gravitational, units.
- 2. Invariance Principles and Conservation Laws: Invariance in classical mechanics and quantum mechanics, Parity, Pion parity, Charge conjugation, Positronium decay, Time reversal invariance, CPT theorem.

 (Lectures 7)
- 3. Hadron-Hadron Interactions: Cross section and decay rates, Pion spin, Isospin, Two nucleon system, Pion-nucleon system, Strangeness and Isospin, G-parity, Total and Elastic cross section, Particle production at high energy.

 (Lectures 7)
- Static Quark Model of Hadrons: The Baryon decuplet, quark spin and color, baryon octer, quark-antiquark combination. (Lectures 7)
- 6. Weak Interactions: Classification of weak interactions, Fermi theory, Parity non conservation in β-decay, experimental determination of parity violation, helicity of neutrino, K-decay, CP violation in K- decay and its experimental determination.

(Lectures 7)

Text Books:

- 1. Introduction to High Energy Physics: D.H. Perkins (Cambridge University Press), 2000.
- 2. Gauge Theory of Elementary Particle Physics: T.P Cheng & L.F. Li (Oxford).
- 3. An Introductory Course of Particle Physics: Palash Pal (CRC Press).

Reference Books:

- 1. Elementary Particles: I.S. Hughes (Cambridge University Press), 2rded. 1991.
- 2. Introduction to Quarks and Partons: F.E. CLose (Academic Press, London), 1979.
- 3. Introduction to Particle Physics: M.P. Khanna (Prentice Hall of India, New Delhi), 2004.
- 4. Dynamics of the Standard Model: J.F. Donoghue (Cambridge University Press).
- 5. First Book of Quantum Field Theory: A. Lahiri & P. Pal, Narosa, New Delhi.
- 6. Introduction to Quantum Field Theory: M. Peskin & D.V. Schroeder. (Levant Books).

Department of Physical Sciences

I.K. Gujral Punjab Technical University

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Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

Elective Subject -1

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- Optical fibre and its properties: Introduction, basic fibre construction, propagation of light, modes and the fibre, refractive index profile, types of fibre, dispersion, data rate and band width, attenuation, leaky modes, bending losses, cut-off wavelength, mode field diameter, other fibre types.
 (Lectures 7)
- 3. Optics of anisotropic media: Introduction, the dielectric tensor, stored electromagnetic energy in anisotropic media, propagation of monochromatic plane waves in anisotropic media, directions of D for a given wave vector, angular relationships between D, E, H, k and Poynting vector S, the indicatrix, uniaxial crystals, index surfaces, other surfaces related to the uniaxial indicatrix, Huygenian constructions, retardation, biaxial crystals, intensity through polarizer/waveplate/ polarizer combinations.

 (Lectures 10)
- 4. Electro-optic and acousto-otpic effects and modulation of light beams: Introduction to the electro-optic effects, linear electro-optic effect, quadratic electro-optic effects, longitudinal electro-optic modulation, transverse electro optic modulation, electro-optic amplitude modulation, electro-optic phase modulation, high frequency wave guide, electro-optic modulator, strain optic tensor, calculation of LM for a logitudinal acoustic wave in isotropic medium, Raman-Nath diffraction, Raman-Nath acousto-optic modulator.

(Lectures 10)

5. Non-linear optics/processes: Introduction, anharmonic potentials and nonlinear polarization, non-linear susceptibilities and mixing coefficients, parametric and other nonlinear processes, macroscopic and microscopic susceptibilities. (Lectures 8)

Text Books:

1. The Elements of Fibre Optics: S.L. Wymer and Meardon (Regents/Prentice Hall), 1992.

Reference Books:

- 1. Lasers and Electro-Optics: C.C. Davis (Cambridge University Press), 1996.
- 2. Optical Electronics: Gathak & Thyagarajan (Cambridge Univ. Press), 1989.
- 3. The Elements of Non-linear Optics: P.N. Butcher & D. Cotter (Cambridge University Press). 1991.

Page 7 of

MC	PH535-	10								Electi	ve Subj	ect -I
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 Interaction of electromagnetic radiations with Matter: Different photon interaction processes viz. photoelectric effect, Compton scattering and pair production. Minor interaction processes, Energy and Z dependence of partial photon interaction processes. Attenuation coefficients, Broad and narrow beam geometries. Multiple scattering.

(Lectures 8)

- Interaction of charged particles with Matter: Elastic and inelastic collisions with electrons and atomic nucleus. Energy loss of heavy charged particles. Range-energy relationships, Straggling. Radiative collisions of electrons with atomic nucleus.
- 3. Nuclear Detectors and Spectroscopy: General characteristics of detectors, Gas filled detectors, Organic and inorganic scintillation detectors, Semi-conductor detectors [Si(Li), Ge(Li) HPGe]. Room temperature detectors, Gamma ray spectrometers. Gamma ray spectrometery with NaI(Tl) scintillation and semiconductor detectors.
- 4. Nuclear spectrometry and applications: Analysis of nuclear spectrometric data, Measurements of nuclear energy levels, spins, parities, moments, internal conversion coefficients, Angular correlation, Perturbed angular correlation, Measurement of g-factors and hyperfine fields.

 (Lectures 8)
- 5. Analytical Techniques: Principle, instrumentation and spectrum analysis of XRF, PIXE and neutron activation analysis (NAA) techniques. Theory, instrumentation and applications of electron spin resonance spectroscopy (ESR). Experimental techniques and applications of Mossbauer effect, Rutherford backscattering. Applications of elemental analysis, Diagnostic nuclear medicine, Therapeutic nuclear medicine.

(Lectures 8)

Text Books:

- 1. The Atomic Nucleus: R.D. Evans, Tata Mc Graw Hill, New Delhi.
- 2. Nuclear Radiation Detectors: S. S. Kapoor and V. S. Ramamurthy, New Age, International, New Delhi.

Reference Books:

- 1. Radiation Detection and Measurements: G. F. Knoll, Wiley & Sons, New Delhi.
- 2. Introductory Nuclear Physics: K. S. Krane, Wiley & Sons, New Delhi.
- 3. An Introduction to X-ray Spectrometry: Ron Jenkin, Wiley.
- Techniques for Nuclear and Particle Physics Experiments: W. R. Leo, Narosa Publishing House, New Delhi.
- 5. Introduction to experimental Nuclear Physics: R.M. Singru, Wiley & Sons, New Delhi.

Campus An iechnical University

Elective Subject -I

MS	PH536-	18	Ne	onlinear	Dynan	nics		L-3, T-1	, P-0		4 Cred	its
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- Phenomenology of Chaos: Linear and nonlinear systems, A nonlinear electrical system, Biological population growth model, Lorenz model; determinism, unpredictability and divergence of trajectories, Feigenbaum numbers and size scaling, self similarity, models and universality of chaos. (Lectures 8)
- 2. Dynamics in State Space: State space, autonomous and nonautonomous systems, dissipative systems, one dimensional state space, Linearization near fixed points, two dimensional state space, dissipation and divergence theorem. Limit cycles and their stability, Bifurcation theory, Heuristics, Routes to chaos. Three-dimensional dynamical systems, fixed points and limit cycles in three dimensions, Lyapunov exponents and chaos. Three dimensional iterated maps, U-sequence. (Lectures 10)
- Hamiltonian System: Non-integrable systems, KAM theorem and period doubling, standard map. Applications of Hamiltonian Dynamics, chaos and stochasticity.

(Lectures 8)

- Quantifying Chaos: Time series, Lyapunov exponents. Invariant measure, Kolmogorov -Sinai entropy. Fractal dimension, Statistical mechanics and thermodynamic formalism.
- Quantum Chaos: Quantum Mechanical analogies of chaotic behaviour, Distribution of energy eigenvalue spacing, chaos and semi-classical approach to quantum mechanics.

(Lectures 7)

Text Books:

1. Chaos and Non Linear Dynamics: R.C. Hilborn (Oxford Univ. Press), 2001.

Reference Books:

- 1. Chaos in Dynamical Systems: E. Ott (Cambridge Univ. Press), 2001.
- Applied Nonlinear Dynamics: A.H. Nayfeh and B. Balachandran (Wiley), 1995.
- 3. Chaos in Classical and Quantum Mechanics: M.C. Gutzwiller (Springer-Verlag), 1990.

Department of Physical Sciences

I.K. Gujral Punish Technical University

Elective Subject -II

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- 1. **Introduction:** Plasma State, elementary concepts and definitions of temperature and other parameters, occurrence and importance of plasma for various applications, Production of Plasma in the laboratory, Physics of glow discharge, electron emission, ionization, breakdown of gases, Paschen's laws and different regimes of E/p in a discharge, Townsend discharge and the evolution of discharge.

 (Lectures 8)
- 2. Plasma diagnostics: Probes, energy analyzers, magnetic probes and optical diagnostics, preliminary concepts. (Lectures 5)
- 3. Single particle orbit theory: Drifts of charged particles under the effect of different combinations of electric and magnetic fields, Crossed electric and magnetic fields, Homogenous electric and magnetic fields, spatially varying electric and magnetic fields, time varying electric and magnetic fields, particle motion in large amplitude waves.

(Lectures 8)

- 4. Fluid description of plasmas: distribution functions and Liouville's equation, macroscopic parameters of plasma, two and one fluid equations for plasma, MHD approximations commonly used in one fluid equations and simplified one fluid and MHD equations. dielectric constant of field free plasma, plasma oscillations, space charge waves of warm plasma, dielectric constant of a cold magnetized plasma, ion- acoustic waves, Alfven waves. Magnetosonic waves.

 (Lectures 10)
- 5. Stability of fluid plasma: The equilibrium of plasma, plasma instabilities, stability analysis, two stream instability, instability of Alfven waves, plasma supported against gravity by magnetic field, energy principle. microscopic equations for my body system: Statistical equations for many body systems, Vlasov equation and its properties, drift kinetic equation and its properties.

 (Lectures 7)

Text Books:

1. Introduction to Plasma Physics, F.F. Chen

- 1. Principles of Plasma Physics, Krall and Trievelpice
- 2. Introduction to Plasma Theory, D.R. Nicholson
- 3. The Plasma State, J.L. Shohet
- 4. Introduction to Plasma Physics, M. Uman
- 5. Principles of Plasma Diagnostic, I.H. Hutchinson



I. K. Gujral Punjah Technical University, Kapurthala

Elective Subject-II

MS	PH538-		ructure Biomo	es, Spec lecutes	tra and	Proper	ties	L-3, T-	1, P-0		4 Cred	its
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- Structure Aspects of Biomolecule: Conformational Principles, Conformation and Configuration Isomers and Derivatives, Structure of Polynucleotides, Structure of Polypeptides, Primary, Secondary, Tertiary and Quaternary Structure of Proteins, Structure of Polysaccharides. (Lectures 10)
- Theoretical Techniques and Their Application to Biomolecules: Hard Sphere Approximation, Ramachandran Plot, Potential Energy Surface, Outline of Molecular Mechanics Method, Brief ideas about Semi-empirical and Ab initio Quantum Theoretical Methods, Molecular Charge Distribution, Molecular Electrostatic Potential and Field and their uses. (Lectures 10)
- 3. Spectroscopic Techniques and their Application to Biomolecules: Use of NMR in Elucidation of Molecular Structure, Absorption and Fluorescence Spectroscopy, Circular Dichroism, Laser Raman Spectroscopy, IR spectroscopy, Photo-biological Aspects of Nucleic Acids.

 (Lectures 10)
- Structure-Function Relationship and Modeling: Molecular Recognition, Hydrogen Bonding, Lipophilic Pockets on Receptors, Drugs and Their Principles of Action, Lock and Key Model and Induced fit Model. (Lectures 10)

Text Books:

1. Srinivasan & Pattabhi: Structure Aspects of Biomolecules.

Reference Books:

- 1. Govil & Hosur: Conformations of Biological Molecules
- 2. Price: Basic Molecular Biology
- 3. Pullman: Quantum Mechanics of Molecular Conformations
- 4. Lehninger: Biochemistry
- 5. Mehler & Cordes: Biological Chemistry
- 6. Smith and Hanawait: molecular Photobiology, Inactivation and Recovery

Department of Physical Sciences

Main Campus

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- 1. **Introduction**: Production and reserves of energy sources in the world and in India, need for alternatives, renewable energy sources. (Lectures 8)
- 2. Solar Energy: Thermal applications, solar radiation outside the earth's atmosphere and at the earth's surface, Principal of working of solar cell, Performance characteristics of solar cell. Types of solar cell, crystalline silicon solar cell, Thin film solar cell, multijunction solar cell, Elementary ideas of perovskite solar cell, dye synthesized solar cell and Tandem solar cell, PV solar cell, module, array, and panel, Applications.

(Lectures 11)

3. Hydrogen Energy: Environmental considerations, solar hydrogen through photo electrolysis and photocatalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells.

(Lectures 10)

4. Other sources: Nature of wind, classification and descriptions of wind machines, power coefficient, energy in the wind, wave energy, ocean thermal energy conversion (OTEC), system designs for OTEC, basic idea about biogas, biofuel, and biodiesel.

(Lectures 8)

Text Books:

1. Solar Energy: S.P. Sukhatme (Tata McGraw-Hill, New Delhi), 2008.

- 1. Solar Cell Devices: Fonash (Academic Press, New York), 2010.
- 2. Fundamentals of Solar Cells, Photovoltaic Solar Energy: Fahrenbruch and Bube (Springer, Berlin), 1982.
- 3. Photoelectrochemical Solar Cells: Chandra (New Age, New Delhi).



MS	PH540-	18	Conden	seci Ma	tter Ph	vsies La	b	L-3, T-	1, P-0		4 Cred	its
Pre-	requisit	e: Unde	erstandi	ng of gr	aduate l	ovel soli	d state j	ohysics	experin	nents		
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Gujral Punjab Technical University

Note: Students are expected to perform atleast ten experiments out of following list.

- 1. To study temperature dependence of conductivity of a given semiconductor crystal using four probe method.
- 2. Verification of curie-weiss law for the electrical susceptibility of a ferroelectric material.
- 3. To determine charge carrier density and Hall coefficient by Hall effect.
- 4. To determine magnetic susceptibility of material using Quink 's tube method.
- 5. To determine energy gap and resistivity of the semiconductor using four probe method.
- To study the B-H loop characteristics.
- 7. To determine dielectric constant of a material with Microwave set up.
- 8. To measure the Curie temperature of a given PZT sample.
- 9. To measure the velocity of ultrasonic wave in liquids.
- 10. To study dispersion relation for Mono-atomic and Diatomic lattices using Lattice dynamic kit.
- 11. To study the properties of crystals using X-Ray Apparatus.

Text Books:

- 1. Introduction to Solid State Physics: C. Kittel (Wiley, New York), 8th ed. 2005.
- 2. Quantum Theory of Solids: C. Kittel (Wiley, New York) 1987.

- 1. Principles of the Theory of Solids: J. Ziman (Cambridge University Press) 1971
- 2. Solid State Theory: Walter A. Harrison (Tata McGraw-Hill, New Delhi) 1970.
- 3. Liquid Crystals: S. Chandrasekhar (Cambridge University), Ind ed. 1991.



Elective Subject -III

MS	PH541-	18 PI	rysics of	Nanou	nsteria	ls		L-3, T-1	, P-0	-	4 Credi	its
Pre-	requisit	e: Con	densed	matter	physics				******		10 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 + 1 +	
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(CO2	Ac	quire kn	owledge	e of bas	c appro	aches to	synthes	ize the i	norgani	c nanop	article
(CO3	De:		e use o	f unique	optical	propert	ies of na				
(CO4	Und	derstand ostructu	the pl	hysical operous	and ch	emical	properti	es of	carbon	nanotub	es an
(CO5	Det	ermine, cepts, n	the stru	cture-p	operty larger le	relation	ships in ales.	nanom	aterials	as well	as th
		[M	apping	of cour	se oute	omes w	ith the p	rogran	ourcor	nes		
	POI	PO2	PO3	PO4	POS	PO6	PO7	PO8	PO9	PO10	POII	PO1:
01	1	2	2	3	3	1	2	1	1	2	2	3
O2	1	2	2	3	3	2	2	1	1	2	2	3
03	1	2	2	3	3	2	2	1	i	2	2	3
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Scheme & Syllabus (M.Sc. Physics) Beach 2018 & Onwards

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- Introductory Aspects: Free electron theory and its features, Idea of band structure metals, insulators and semiconductors. Density of state in one, two, and three dimensional bands and its variation with energy, Effect of crystal size on density of states and band gap. Examples of nanomaterials.
 (Lectures 8)
- Preparation of Nanomaterials: Bottom up: Cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques and Top down: Ball Milling.

(Lectures 8)

- 4. Quantum Dots: Electron confinement in infinitely deep square well, confinement in one and two-dimensional wells, idea of quantum well structure, Examples of quantum dots, spectroscopy of quantum dots.

 (Lectures 8)
- 5. Other Nanomaterials: Properties and applications of carbon nanotubes and nanofibres. Nanosized metal particles, Nanostructured polymers, Nanostructured films and Nano structured semiconductors.

 (Lectures 8)

Text Books:

- 1. Nanotechnology-Molecularly Designed Materials: G.M. Chow & K.E. Gonsalves (American Chemical Society), 1996.
- Nanotechnology Molecular Speculations on Global Abundance: B.C. Crandall (MIT Press), 1996.

- 1. Quantum Dot Heterostructures: D. Bimerg, M. Grundmann and N.N. Ledentsov (Wiley), 1998.
- Nanoparticles and Nanostructured Films-Preparation, Characterization and Application: J.H.Fendler (Wiley), 1998.
- 3. Nanofabrication and Bio-system: H.C. Hoch, H.G. Craighead and L. Jelinski (Cambridge Univ. Press), 1996.
- 4. Physics of Semiconductor Nanostructures: K.P. Jain (Narosa), 1997.
- 5. Physics of Low-Dimension Semiconductors: J.H. Davies (Cambridge Univ. Press) 1998.
- 6. Advances in Solid State Physics (Vo.41): B. Kramer (Ed.) (Springer), 2001.

Elective Subject -III

8.50	TENT TO 40									Licelly	Subje	Ct -111
IVES	SPH542	-18	Ex _I	periment: clear and	al Techi Particle	riques in Physic	n s	L-3, T-	1, P-0		4 Cred	lits
Pre	-requis	ite: C	ourse or	ı Nuclear	Physics	and Par	ticle Ph	ysics		J		
Nuc of di	irse Ol lear an ifferent	ojecti d Pa equip	ves: The rticle Planent an	e aim ar nysics is t d method	d object o expose s i sec i	tive of the stu the fiel	the co idents o	urse on f M.Sc. :	students ysics ar	imental to expe nd partic	Techn rimenta le physi	iques l'aspec es.
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	CO2		Use vari	ous statis	tical met	hods for	rexperi	mental d	ata.			
	CO3			ige abou						n detec	tors ar	d the
	CO4	1	ntroduce	ed to neur	ron phys	sics, met	thods to	detector	slow a	nd fast n	eutrons	
•	CO5	I	Equipped	d with the aboratorie	basic kr	owledg	e about	the expe	rimenta	method	ds used	in the
			Mappi	ng of cou	rse outc	omes w	ith the	progran	outco	mes		
	PO1	PC	02 PO	3 PO4	P()5	PO6	PO7	PO8	PO9	POIO	PO11	POI
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03	-	-	1	2	13	-	1	3		2	2	
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05			1						2	2	2	2
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- 2. Detectors: Gas-filled detectors, Proportional counters, space charge effects, energy resolution, time characteristics of signal pulse, position-sensitive proportional counters, Multiwire proportional chambers, Drift chamber, Time projection chamber. Organic and inorganic scintillators and their characteristics, light collection and coupling to photomultiplier tubes and photodiodes, Semiconductor detectors, Ge and Si(Li) detectors, Charge production and collection processes, Pulse height spectrum, General background and detector shielding.

(Lectures 16)

3. Applications of Detectors: Description of electron and gamma ray spectrum from detector, semiconductor detectors in X- and gamma-ray spectroscopy, Compton-suppressed, Semiconductor detectors for charged particle spectroscopy and particle identification.

(Lectures 8)

 Experimental methods: Large gamma and charge particle detector arrays, heavy-ion reaction analysers, production of radioactive ion beams. Detector systems for high energy experiments: Collider physics (brief account), Particle Accelerators (brief account), Modern Hybrid experiments- CMS. (Lectures 8)

Text Books:

1. Techniques in Nuclear and particle Experiments by W.R. Leo (Springer), 1994.

Reference Books:

- 1. Radiation detection and measurement by Glenn F. Knoll (Wiley), 2010.
- Introduction to Experimental Particle Physics by Richard Fernow (Cambridge University Press), 2001.
- 3. Detectors for particle radiation by Konrad Kleinknecht (Cambridge University Press), 1999.

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Elective Subject -III

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MSPH543	6 7 30 1 4			ALCOHOLD STATE OF THE PARTY OF	Elective Subject -III											
		Supercor Tempera	ductivit ture Phy	y and I sies	-09V		L-3, T-	1, P-0		4 Cred	lits					
Pre-requis	ite: cou	rse in Co	ondensed	Matter	Physics											
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Course Out																
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CO2	Co		observed							with o	rigin c					
CO3		escribe	appropri	ate th	eoretica	ıl mo	del fo	r des	cribing	behav	ior o					
CO4	Pro	vide exp	osure to	High T	c class o	of super	conduct	ors and	theoreti	cal						
CO4	Рто	ovide exp derstandi	ng of low	tempe	rature te	chriqu	es.									
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CO5 PO1 01 1 03 1	Pro sup	vide exp derstandi vide exp erconduc tapping PO3	oosure to ng of low osure abo etivity. of course PO4 2	put the coutco	mes wit	h the p	es. chnique rogram	PO9 2	nes PO10	POII	3					
CO5 POI 1	Pro sup	derstandi vide exp erconduc lapping PO3 2	oosure to ng of low osure abo etivity. of course PO4 2 2	POS 2	mes wit	h the p	es. chnique rogram	outcor PO9	nes PO10	ent of						

Scheme & Syllabus (M.Sc. Physics) Barch 2618 & Onwards

- Superconductivity: Introduction, Thermodynamics, The London Equations, penetration depth, Superconductors in magnetic field, Ginzberg-Landau Theory, Type I and II superconductors, BCS theory, second quantization, Cooper Pairing, energy gap Tunnelling, Josephson effects and SIS tunneling. (Lectures 10)
- Preparation and measurement techniques: Single crystal growth: Optical image furnace, seeded melt growth, Thin film deposition: Pulsed laser deposition, sputtering, Resistivity measurements, magnetic measurements, Point contact spectroscopy, scanning tunneling microscopy and spectroscopy.
 (Lectures 10)
- Cryogenics: Thermal and electrical properties of different materials at low temperatures, Cooling methods above 1K, Joule-ThomPOn, Gifford-McMohan, Evaporation cooling, Liquefication of Helium, Cooling methods below 1K, dilution refrigeration, adiabatic demagnetisation. (Lectures 10)
- Introduction to high-Tc superconductors: Discovery of high-Tc superconductors, Mechanisms of superconductivity in high-Tc superconductors, Introduction to high-Tc superconducting compound like YBCO, Synthesis, Structure and properties, Electronics and applications. (Lectures 10)

Text Books:

1. Introduction to superconductivity: Michael Tinkham, Courier Corporation, 2004.

- 1. Introduction to superconductivity: A.C. Rose-Innes and E.H. Rhoderick, Pergamon Press, 2004.
- 2. Experimental techniques in low temperature physics: G.K. White and P.J. Meeson, Oxford Univ. Press, 2001.
- 3. Experimental low temperature physics: A. Kent, MacMillan Press, 1992.
- 4. The theory of superconductivity in high-TC Cuprates: P.W. Anderson, Princeton Series Publications.



Elective Subject -IV

			Advance Physics	d Cond	ensed N	latter		L-3, T-	1, P-0		4 Cred	lits	
Pre-	requisi	te: co	irse on C	ondense	ed Matte	r Physic	ès .			1	7		
supe	rconduc	ctivity,	es: The o Sc. stude magneti techniqu	e resona	nce teci	ery advi							
Cou	rse Out	comes	: At the	end of th	ne cours	e, the st	udent w	il! be ab	le to			112-2:11	
CO1 Comprehend and describe the Optical properties of solids employmacroscopic theories.												nployin	
1	CO2	E	Explain various types of regnetic phenomenon in solids, underlying physics, a correlation with the applications.										
(CO3	U	nderstand	d and rea	alize the	use of	NMR m	ethods f	or descr	ibing so	lids	**************************************	
(CO4		terpret th										
(CO5	Fi	gure our lids									avior o	
			Mapping	of cour	'se outc	omes w	ith the	progran	outco	mes		-	
	POI	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	POI0	POII	PO12	
01	2	1	2	2	2	2	1	1	2	2	2	13	
O2	2	2	2	2	1	2	1	2	2	1	2	3	
03	3	2	12	1 2	12	i	2	2	2	2		2	
04	2	2	2	2	2	2	2	1	2	2	2	2	
05	3	2	2	2	1	2	2	2	2	1	2	3	
			j				with any				-	3	

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- Optical Properties: Macroscopic theory; Reflectance and Transmittance of a slab; generalized susceptibility, Kramers- Kronig relations, Brillouin scattering, Raman effect in crystals; interband transitions. (Lectures 8)
- 2. Magnetism: Dia and para-magnetism in materials; Langevin theory of diamagnetism, quantum theory of diamagnetism and paramagnetism, Exchange interaction. Heisenberg Hamiltonian; Hubbard model; mean field theory; Ferro-, ferri- and antiferromagnetism; Magnons: spin waves, thermal excitation of magnons; Bloch T2/1 law. (Lectures 8)
- 3. Nuclear Magnetic Resonance in Solids: Origin of NMR in solids- equations of motion, line width, motional narrowing, Knight shift. (Lectures 8)
- 4. Superconductivity: Experimental Survey; Basic phenomenology; Vortex state of a Type II superconductors; BCS pairing mechanism and nature of BCS ground state; Flux quantization; Tunneling Experiments; High Tc superconductors; Ginzburg-Landau theory; Greens functions at zero temperature; Applications of Greens functions to superconductivity. (Lectures 8)
- Disordered Solids: Basic concepts in point defects and dislocations; Noncrystalline solids: diffraction pattern, Glasses, Amorphous semiconductors and Ferromagnets, Heat capacity and Thermal conductivity of amorphous solids; Quasicrystals. (Lectures 8)

Text Books:

- 1. Introduction to Solid State Physics: C. Kittel (Wiley, New York) 2005.
- 2. Quantum Theory of Solids: C. Kittel (Wiley, New York) 1987.

Reference Books:

- 1. Principles of the Theory of Solids: J. Ziman (Cambridge University Press) 1971.
- 2. Solid State Physics: H. Ibach and H. Luth (Springer, Berlin), 2rd. ed. 2001.
- 3. A Quantum Approach to Solids: P.L. Taylor (Prentice-Hall, Englewood Cliffs), 1970.
- 4. Intermediate Quantum Theory of Solids: A.O.E. Animalu (East-West Press, New Delhi), 1991.
- 5. Solid State Physics: Ashcroft and Mermin (Reinhert & Winston, Berlin), 1976.

Denarment of Physical Sciences

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Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

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Elective Subject -IV

MS	PH545-	18	Adva	nced Pa	irticle P	hysics		L-3, T-1	, P-0		4 Credi	ts
Pre-	requisi	te: Knov	wledge o	of partic	le physi	cs						
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	CO1	Un	derstand	variou	s global	and los	cal gaug	ll be able	etries o	f systen	ı, invari	ance o
	CO2	Ned of (ed for st QCD.	andard	model o	° particl	e physic	es and it	s !imita	tions and	the pro	opertie
CO3 D		Define the problem of divergencies in quantum field theories and the renormalisation methods.										
(CO4	Asy	mptone	freedor gauge	n and in theory o	frared s	lavery o	of the run	ming co	upling c	onstant	in
(CO5	Giv	en expo	sure abo	out the p	nysics b	eyond t	he Stand	lard Mo	del.		
		M	apping	of cour	se outc	omes w	ith the p	program	outcor	nes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	POI:
01	2	2	2	2	2	2	2	-	2	1	2	2
02	2	1	1	2	2	2	2	-	2	1	2	2
03	1	2	1	2	2	2	2	-	2	3	1	2
04	1	1	2	1	2	2	2	-	1	2	1	2
		1			1							

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- 1. Symmetries and Symmetry Breaking in QFT: Continuous groups: Lorentz group SO(1,2) and its representations, Unitary groups and Orthogonal groups and their representations, Discrete symmetries: Parity, Charge Conjugation and Time reversal Invariance, CP, CPT. (Lectures 10)
- Global and Local invariances of the Action: Approximate symmetries, Noethers theorem, Spontaneous breaking of symmetry and Goldstone theorem, Higgs mechanism, Abelian and Non-Abelian gauge fields, Lagrangian and gauge invariant coupling to matter fields. (Lectures 10)
- 3. Standard Model of Particle Physics: SU(2) x SU(1) x U(1) gauge theory, Coupling to Higgs and Matter fields of 2 generations, Gauge boson and fermion mass generation via spontaneous symmetry breaking, CKM matrix, Low energy Electroweak effective theory and Decoupling, Elementary electroweak scattering processes. (Lectures 10)
- 4. QCD and quark model: Asymptotic freedom and Infrared slavery, confinement hypothesis, Approximate flavor symmetries of the QCD lagrangian, Classification of hadrons by flavor symmetry: SU(1) and SU(2) multiplets of Mesons and Baryons, Chiral symmetry and chiral symmetry breaking, Sigma model, Parton model and Deep inelastic scattering structure functions. (Lectures 10)

Text Books:

- 1. Gauge Theory of Elementary Particle Physics: T.P Cheng & L.F. Li (Oxford).
- 2. An Introductory Course of Particle Physics: Palash Pal (CRC Press).

Reference Books:

- 1. First Book of Quantum Field Theory: A. Lahiri & P. Pal, Narosa, New Delhi.
- 2. Introduction to Quantum Field Theory: M. Peskin & D.V. Schroeder. (Levant Books).
- 3. Dynamics of the Standard Model: J.F. Donoghue (Cambridge University Press).

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Elective Subject -IV

MSPH546-18			Env	ironme	ntal Phy	vsics	1	3, T-1	, P-0	-	4 Credi	ts
Pre-r	equisit	e: Knov	vledge o	f classic	cal phys	ics						
of M	Sc phy	sics to	the reci	ent adva	ancemer	us in th	is field	so that	they un	pose the nderstan	d these	aspects
Cour	se Outo	omes:	At the er	nd of the	e course	, the stu	dent wil	l be able	e to			
(COI	Une	derstand	the diff	ferent ty	pes of p	ollution	that occ	cur in th	e Earth'	s enviro	nment
CO1 Understand the different types of pollution that occur in the Earth's environ CO2 Apply the laws of radiation to Solar and Terrestrial Radiation												
(CO3	Des	scribe th	e main i	reservoi ges invo	rs and e	xchange	s in the CO2 e	global c	arbon c	ycle and	
(CO4	App	olication	in the I	Renewal	ole sour	ces of er	nergy		***************************************		
(005	Des	cribe ho	ow poll	ution ar	d clima to the g	ate are lobal Ea	modelle arth syst	d on di em.	fferent	scales,	ranging
		M	apping	of cour	se outc	omes w	th the p	orogran	outco	mes		
	POI	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	POIO	POII	PO12
COI	2	2	2	2	2	2	2	2	2	1	2	3
CO2	2	1	2	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	1	2	2
CO4	1	2	1	2	2	2	2	2	2	2	-	3
	1	2	2	2	2	2	2	2	2	2	2	2

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Scheme & Syllabus (M.Sc. Physics) Batch 2018 & Onwards

- 1. Essentials of Environmental Physics: Structure and thermodynamics of the atmosphere. Composition of air, Greenhouse effect, Transport of matter, energy and momentum in nature, Stratification and stability of atmosphere, Lass of motion, hydrostatic equilibrium, General circulation of the topics, Elements of weather and climate of India.
- Solar and Terrestrial Radiation: Physics of radiation, Interaction of light with matter, tayleigh and Mie scattering, Laws of radiation (Kirchoffs law, Planck's law, Beer's law, Wien's displacement law, etc.), Solar and terrestrial spectra, UV radiation, Ozone depletion problem, IR absorption energy balance of the earth atmosphere system.
- 3. Environmental Pollution and degradation: Elementary fluid dynamics, Diffusion, Turbulence and turbulent diffusion, Factors governing air, Water and noise pollution, Air and water quality standards, Waste disposal, Heat island effect, Land and sea breeze, Puffs and plumes, Gaseous and particulate matters, Wet and dry deposition.
- Environmental Changes and remote sensing: Energy sources and combustion processes, Renewable sources of energy, Solar energy, Wind energy, bioenergy, hydropower, fuel cells, nuclear energy, Forestry and bioenergy.
- Global and Regional Climate: Elements of weather and climate, Stability and vertical
 motion of air, Horizontal motion of air and water, Pressure gradient forces, Viscous forces,
 Reynolds number, Enhanced Greenhouse Effect, Energy balance-a Zero-dimensional
 Greenhouse model, Global climate models.

Suggested Readings/Books:

- 1. Egbert Boeker & Rienk Van Groundelle: Environmental Physics (John Wiley).
- 2. J. T Hougtion: The Physics of atmosphere (Cambrige University Press, 1977).
- 3. J Twidell and J Weir: Renewable energy Resources (Elbs, 1988).
- Sol Wieder: An introduction t solar energy for scientists and Engineers (John Wiley, 1982)
- 5. R. N. Keshavamurthy and M. Shanker Rao: The Physics of Monsoons (Allied Publishers, 1992).
- 6. G.J. Haltiner and R.T. Williams: Numerical Weather Prediction (John Wiley, 1980).

MSI	PH547-	18		Disse	rtation		1	L-0, T-1	2, P-0	1	2 Cred	its
Pre-	requisit	e: Kno	wledge o	of specif	fic branc	h of ph	ysics		******			
Physi devel	nts to pics. Stu	orelimir idents (of a lal	naries an get the poratory	opporti experin	odology inity to nent	of rese	earch in pate in	Theore	tical Ph ongoing	ertation ysics an researc	d Expe	riment
Course Outcomes: At the end of the course, the student will be able to CO1 Explain the significance and value of problem in physics, both so in the wider community.									ientific	ally an		
CO2 Design and carry out scientific experiments as well as accurately recoresults of experiments.										ord th		
•	CO3 Critically analyse and evaluate experimental strategies, and decide which is appropriate for answering specific questions.										is mos	
(CO4	Research and communicate scientific knowledge in the context of a topic relation condensed matter physics/Nuclear/High Energy Physics, in oral, written an electronic formats to both scientists and the public at large.									related and	
(005	Exp	olore ne nnology.	w area	s of re	search .	in phys	ics and	allied	fields o	of scien	ice and
		M	lapping	of cour	se outc	omes w	ith the j	progran	n outco	mes		
	POI	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	POIO	POH	PO12
CO1	2	2	1	3	1	2	2	2	2	3	2	3
CO2	3	3	3	2	2	2	1	2	2	2	2	2
CO3	2	2	2	2	2	Ž		2	2	1 2	1	3
201	1	1	-	i	-	2	2	2	2	3	1	3
CO4		1		1	1			P.	1			10

Guidelines for the Dissertation:

The aim of project work in M.Sc. 4th semesters is to expose the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiments, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data, etc.. Project work can be in Experimental Physics, Theoretical Physics, or Simulation(quantum based softwares, HPCC, etc.) based in the thrust as well as non-thrust research areas of the Department.

A student opting for this course will be attached to one teacher of the Department before the end of the 3rd semester. A report about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the Head of Department.

Assessment of the work done under the project will be carried out by a committee on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva-voce/seminar, etc. as per course guidelines.

Head
Department of Physical Sciences
LK Guiral Punjab Technical University

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Annexure-B

Draft Syllabus of Personality Development

UNIT I

Building up and enrichment of Vocabulary

Learning Derivatives, Prefixes and Suffixes; Homonyms & Homophones; Pairs/Group of words; Synonyms & Antonyms; One word substitution; Foreign words & Phrases

UNIT II

Application of Business Communication

(a) Speaking Module

- Oral communication-Everyday Interactions, Group Discussions, Public speaking;
- Conversation Skills; Business Etiquette;
- Presentation Skills- combating stage fright, preparing power point presentations
- Non- Verbal Communication in Oral & Power Point Presentations; Telephonic Skills;
- Preparation for job interview- practice through mock interview

(b) Mechanics of Writing

- · Descriptive and argumentative essays,
- Scientific & Technical Writing- writing abstracts & summaries, research papers;
- Writing business letters, emails; memos;
- Drafting Reports- training reports, project reports, varied business reports;
- Career Documents: Preparing a selling resume, covering letters, CVs, Preparing Portfolio etc.

Suggested Readings:

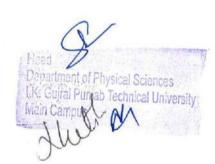
- 1. Practical English Usage. Michael Swan. OUP. 1995.
- 2. On Writing Well. William Zinsser. Harper Resource Book. 2001
- 3. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
- 4. Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.
- 5. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
- 6. English Language Skills. Aruna Koneru. McGraw Hill Education (India) by Privatences
 Limited. 2015.

 Limited. 2015.

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B.Sc. (Hons.) Physics

Course Structure and Syllabus
(Based on Choice Based Credit System)
2019 onwards



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SEMESTER FIRST

Course Code	Course Title	Load Allocation				ırks bution	Total Marks	Credits
		L	T	P	Internal	External		
BSHPXXX- 19	Optics	3	1	-	40	60	100	4
BSHPXXX- 19	Mechanics	3	1	-	40	60	100	4
BSHPXXX- 19	Mathematics-I	3	1	-	40	60	100	4
BSHPXXX- 19	Chemistry-I	3	1	-	40	60	100	4
BSHPXXX- 19	Communicative English -I	3	1	-	20	30	50	2
BSHPXXX- 19	Punjabi Compulsory-I or Mudhli Punjabi-I	2	-	-	20	30	50	2
BSHPXXX- 19	Physics Lab-I	-	-	6	50	25	75	3
BSHPXXX- 19	Chemistry Lab-I	-	-	4	30	20	50	2
	TOTAL	16	4	10	280	345	625	25

L: Lectures T: Tutorial P: Practical



SEMESTER SECOND

Course Code	Course Title	Allocation			1	arks ibution	Total Marks	Credit	
		1.	. 1	T	P	Internal	External		
BSHPXXX- 19	Waves and Vibrations	3		1	-	40	60	100	4
BSHPXXX- 19	Electricity and Magnetism	3		1	-	40	60	100	4
BSHPXXX- 19	Mathematics-II	3	1	ı	-	40	60	100	4
BSHPXXX- 19	Chemistry-II	3	1	+	-	40	60	100	4
BSHPXXX- 19	Communicative English -II	2	-	+	-	20	30	50	2
BSHPXXX- 19	Punjabi Compulsory-I or Mudhli Punjabi-II	2	-	-	-	20	30	50	2
BSHPXXX- 19	Physics Lab-II	-			5	50	25	75	3
BSHPXXX- 19	Chemistry Lab-II	-	-	4	1	30	20	50	2
	TOTAL	16	4	10	0	280	345	625	25

L: Lectures T: Tutorial P: Practical

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BSHPXXX- 19	Optics	L-3, T-1, P-0	4 Credits
Pre-requisite: U	Inderstanding of senior seco	ondary level Physics and Mathematics	

Course Objectives: The objective of the course is to develop basic understanding of Interference, Diffraction and Polarization among students. The Students also learn about the LASER and its applications. Students will be equipped with knowledge to measure wave length, refractive index and other related parameters, which will act as a strong background if he/she chooses to pursue research in physics as a career.

Detailed Syllabus:

PART-A

UNIT I

Interference: Definition and properties of wave front, Temporal and Spatial Coherence, Young's double slit experiment, Lloyd's single mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films, Fringes of equal inclination (Haidinger Fringes), Newton's Rings: Measurement of wavelength and refractive index. Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, Fabry-Perot interferometer. (12 Lectures)

UNIT-II

Diffraction: Huygens Principle, Huygens-Fresnel Diffraction theory, Fraunhofer diffraction: Single slit. Circular aperture, Rayleigh criterion of resolution, Resolving Power of a telescope, Double slit, Multiple slits, Diffraction grating, Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions, Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light, Theory of a Zone Plate: Multiple Foci of a Zone Plate, Fresnel diffraction pattern of a straight edge and circular aperture. (11 Lectures)

PART-B

UNIT-III

Polarization: Plane polarized light, Representation of Unpolarized and Polarized light, Polarization by Reflection, Brewster's law, Malus Law, Polarization by Selective absorption by Crystals. Polarization by Scattering, Polarization by Double Refraction, Nicol Prisp, Huygen's theory of Double Refraction, Polaroid, Elliptically and Circularly polarized Fights Quarter and Half wave partment of Physical Sciences Lectures) plates. F.K. Gujral Punjab Technical University Main Campus ,

UNIT-IV

Laser and Application: Lasers, Spontaneous emission, Stimulated absorption, Stimulated emission, Einstein coefficients, Einstein relations, Conditions for Laser actions, Population inversion, Different types of Laser Pumping mechanism: Optical Pumping, Electric Discharge and Electrical pumping, Resonators, Two, Three and Four level laser systems, Ruby laser, He-Ne gas Laser, Semiconductor laser, CO2 laser, applications of laser: Holography, Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

Text and Reference Books:

- 1. Optics: A.K. Ghatak (Tata-McGraw Hill). 1992.
- 2. Fundamentals of Optics: F.A. Jenkins and H.E. White (McGraw Hill), 1981.

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BSHPXXX- 19	Mechanics	L-3, T-1, P-0	4 Credits
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	unding of conjor accordant loss		

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The aim and objective of the course on Mechanics is to introduce the students to the formal structure of vector mechanics, harmonic oscillators, and mechanics of solids so that they can use these in Engineering as per their requirement. This will act as a strong background if he/she chooses to pursue higher studies in physics.

Detailed Syllabus:

UNIT I:

Fundamentals of Dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket.

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Force as gradient of potential energy. Work done by non-conservative forces. Law of conservation of Energy. (12 Lectures)

UNIT-II

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems. Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frame of refrences.

UNIT-III

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and fields due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).

UNIT-IV:

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Mintowski space time, Relativisitic Kinematics. Energy-Momentum Four Vector.

(12 Lectures)

Text and Reference Books:

- 1. Mechanics, Berkeley Physics, Vol.1, C. Kittel, W. Knight, et.al. 2007. Tata McGraw-Hill.
- 2. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- 3. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- 4. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons
- 5. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Physics for scientists and Engineers with Modern Phys., J.W.Jewett, R.A.Serway, 2010. Cengage Learning
- 7. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.



Vibrations and Waves L-3, T-1, P-0 4 Credits BSHP121-19

Pre-requisite: Understanding of senior secondary level physics and Mathematics

Course Objectives: The objective of the course provides an exposure about simple harmonic motions, damped harmonic motions and forced oscillations. Students learns about the different waves, propagation of waves in various mediums and reflection/transmission of waves at the interface of mediums.

Detailed Syllabus:

PART-A

UNIT-I

Simple and Damped Harmonic Motion: Simple harmonic motion, energy of a SHO, Compound pendulum, Torsional pendulum, Electrical Oscillations, Lattice Vibrations, Transverse Vibrations of a mass on a string, Anharmonic Oscillations. Damped simple harmonic motion, Decay of free Vibrations due to damping, types of damping, Determination of damping coefficients Logarithmic decrement, relaxation time and Q-factor. Electromagnetic damping. (12 Lectures)

UNIT-II

Forced Vibrations and Resonance: Forced mechanical and electrical oscillator, Transient and Steady State Oscillations, Displacement and velocity variation with driving force frequency, Variation of phase with frequency resonance, Power supplied to forced oscillator by the driving force. O-factor and band width of a forced oscillator, Electrical and nuclear magnetic resonances. (1 2 lectures)

PART-B

UNIT-III

Coupled Oscillations: Stiffness coupled oscillators, Normal coordinates and modes of vibrations. Inductance coupling of electrical oscillators, Normal frequencies, Forced vibrations and resonance for coupled oscillators, Masses on string-coupled oscillators.

Waves in Physical Media: Types of waves, wave equation (transverse) and its solution characteristics impedance of a string, Impedance matching, Reflection and Transmission of waves at boundary, Energy of vibrating string, wave and group velocity. (12 Lectures)

UNIT-IV

Electromagnetic waves: Physical interpretation of Maxwell's equations, E.M waves and wave equation in a medium having finite permeability and permittivity but with conductivity $\sigma = 0$. Poynting vector, Impedance of a dielectric to EM waves, EM waves in a conducting medium and skin depth, EM wave velocity in a conductor and anomalous dispersion, Response of a conducting medium to EM waves. Reflection and transmission of EM waves at a boundary of two dielectric media for normal and oblique incidence, Reflection of EM waves from surface of a conductor at normal incidence.

Text and Reference Books:

- 1. Text Book of Vibrations and Waves: S.P. Puri (Macmillan India), 2004.
- 2. The Physics of Vibrations and Waves: H.J. Pain (Wiley and ELBS), 1976.

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BSHP12	2-19 Electricity and Magnetism	L-3, T-1, P-0	4 Credits
Pre-requi	site: Basic knowledge of Electricity and M	fagnetism at high school lev	el.
	bjectives: The objective of the course is to and magnetism so that they can use these a		formal structure of
	utcomes: At the end of the course, the stud		
CO ₁	Understand and describe the different conc	epts of electrostatics and magn	etostsics
CO2	Apply the knowledge of Maxwell's equa- problems.	ation and flow of electromag	gnetic waves in real
CO3	Analyze the wave propagation in different	media	
CO4	Compare the different types of polarization	1	
CO5	have a solid foundation in electromagnet also to pursue higher studies.	ism fundamentals required to	solve problems and

Detailed Syllabus:

PART-A

UNIT I Review of Vector Analysis and Electrostatics: scalar and vector product; gradient, divergence and curl and their significance; Gauss-divergence theorem and Stoke's theorem (statement only); Electrostatic field; electric flux; Gauss's law of electrostatics; Applications of Gauss law-Electric filed due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charge sheet; Electric potential as line integral of electric field, potential due to point charge and electric dipole; calculation of electric field from potential; Poisson's equation and Laplace's equation(Cartesian coordinate); Capacitance; capacitance of a spherical conductor and cylindrical capacitor, Energy per unit volume in electrostatic field, Dielectric medium, dielectric polarization and its types, Displacement vector, Boundary conditions (12 Lectures)

UNIT-II Magnetostatics: Magnetic flux; magnetic flux density; Faraday s law; magnetomotive force; Biot-Savart's law and its applications-straight conductor, circular coil, divergence and curl of magnetic field; Ampere's work law in differential form; Magnetic vector patential; ampere's force law; magnetic vector potential; Energy stored in a magnetic field, boundary conditions on magnetic fields.

(10 Lectures)

PART-B

UNIT-III Maxwell's Equations and Poynting Vector: Equation of continuity for time varying fields; Inconsistency of ampere's law; concept of sinusoidal time variations (Phasor notation); Maxwell's equations with physical significance; Maxwell equations in free space, static field and in Phasor notation; Difference between displacement current and conduction current; Concept of Poynting vector; Poynting Theorem.

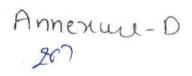
(11 Lectures)

UNIT-IV Electromagnetic Waves: Wave equation in free space or non-conducting or lossless medium; wave equation for conducting medium; wave propagation in lossless and conducting medium (phasor form); Propagation characteristics of EM waves in free space, lossless and in conducting medium; Uniform plane waves and solution; relation between electric and magnetic fields of an electromagnetic wave; Linear, circular and elliptical polarization; depth of penetration, Reflection of waves by a perfect conductor: normal incidence and oblique incidence: Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

Reference Books:

- David Griffiths, Introduction to Electrodynamics, Pearson Education India Learning Private Limited; 4 edition.
- (ii) Edward C Jordan and Keith G Balmain, Electromagnetic waves and radiating systems,
 Prentice Hall
- (iii) Kraus John D, Electromagnetics, McGraw-Hill Publisher
- (iv) W. Saslow, Electricity, magnetism and light, Academic Press

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4 Credits

Pre-requisite:	: Knowledge of particle physics		5
students of Ph theory, standar	etives: The objective of the course on and and the relatively advanced topics related model of particle physics, QCD and questand these aspects properly and are well.	lated to symmetry brea juark model, and variou	king in quantum field as unification schemes
Course Outco	omes: At the end of the course, the stude	ent will have	
	120 (27)	in will have	
CO1	Understanding of various global and	local gauge symmetries	s of system, invariance
		local gauge symmetries iggs mechanism.	
CO1	Understanding of various global and of action, symmetry breaking, and H Need for standard model of particle	local gauge symmetries iggs mechanism. physics and its limitation	ons and the properties
CO1	Understanding of various global and of action, symmetry breaking, and H Need for standard model of particle of QCD. The problem of divergencies in quantitations are considered as a constant of the problem of divergencies in quantitations.	local gauge symmetries iggs mechanism. physics and its limitation turn field theories and twery of the running cou	ons and the properties

L-3, T-1, P-0

Advanced Particle Physics

Detailed Syllabus:

PHSS906-18

- Symmetries and Symmetry Breaking in QFT: Continuous groups: Lorentz group SO(1,2) and its representations, Dirac, Weyl and Majorana fermions, Unitary groups and Orthogonal groups and their representations, Discrete symmetries: Parity, Charge Conjugation and Time reversal Invariance, CP, CPT. (Lectures 10)
- Global and Local invariances of the Action: Approximate symmetries, Noethers theorem, Spontaneous breaking of symmetry and Goldstone theorem, Higgs mechanism, Abelian and Non-Abelian gauge fields, Lagrangian and gauge invariant coupling to matter fields. (Lectures 10)
- 3. Standard Model of Particle Physics: SU(2) x SU(1) x U(1) gauge theory, Coupling to Higgs and Matter fields of 2 generations, Gauge boson and fermion mass generation via spontaneous symmetry breaking, CKM matrix, Lowenergy Physical Science (Lectures 10) and Decoupling, Elementary electroweak scattering processes Physical Science (Lectures 10)
- 4. QCD and quark model: Asymptotic freedom and Infrared slavely, confinement hypothesis, Approximate flavor symmetries of the QCD lagrangian, Classification of hadrons by flavor symmetry: SU(1) and SU(2) multiplets of Mesons and Baryons, Chiral symmetry and chiral symmetry breaking, Parton model and Deep inelastic scattering structure functions.

(Lectures 10)

Hoth

Text Books:

1. Gauge Theory of Elementary Particle Physics: T.P Cheng & L.F. Li (Oxford).

2. An Introductory Course of Particle Physics: Palash Pal (CRC Press).

Reference Books:

1. First Book of Quantum Field Theory: A. Lahiri & P. Pal, Narosa, New Delhi.

2. Introduction to Quantum Field Theory: M. Peskin & D.V. Schroeder. (Levant Books).

3. Dynamics of the Standard Model: J.F. Donoghue (Cambridge University Press).

PHS907-18	Renewable Energy Resources	L-3, T-1, P-0	4 Credits
Pre-requisite	: Understanding of semiconductor phys	ics	
Course Objective expose the Philenergy, etc.	ctives: The aim and objective of the co D. students to the basics of the alternati	ourse on Renewable ve energy sources like	Energy Resources is to te solar energy, hydrogen
	omes: At the end of the course, the stude	ent will be able to	
	Understand the energy demand of		between traditional and
Course Outed	Understand the energy demand of alternative form of energy.	world & distinguish	
Course Outed	Understand the energy demand of alternative form of energy. Describe the concept of solar energy	world & distinguish radiation and therma	
Course Outed CO1 CO2	Understand the energy demand of alternative form of energy.	world & distinguish radiation and thermatypes.	al applications.

Detailed Syllabus:

- Introduction: Production and reserves of energy sources in the world and in India, need for alternatives, renewable energy sources. (Lectures 8)
- 2. Solar Energy: Thermal applications, solar radiation outside the earth's atmosphere and at the earth's surface, Principal of working of solar cell, Performance characteristics of solar cell. Types of solar cell, crystalline silicon solar cell, Thin film solar cell, multijunction solar cell, Elementary ideas of perovskite solar cell, dye synthesized solar cell and Tandem solar cell, PV solar cell, module array, and panel, Applications. (Lectures 11)
- 3. Hydrogen Energy: Environmental considerations, solar hydrogen through photo electrolysis and photocatalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells. (Lectures 10)
- 4. Other sources: Nature of wind, classification and descriptions of wind machines, power coefficient, energy in the wind, wave energy, ocean thermal energy conversion (OTEC), system designs for OTEC, basic idea about biogas, biofuel, and biodiesel.

Text Books:

1. Solar Energy; S.P. Sukhatme (Tata McGraw-Hill, New Delhi), 2008.

(Lectures 8)

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Reference Books:

- 1. Solar Cell Devices: Fonash (Academic Press, New York), 2010.
- 2. Fundamentals of Solar Cells, Photovoltaic Solar Energy: Fahrenbruch and Bube (Springer, Berlin), 1982.
- 3. Photoelectrochemical Solar Cells: Chandra (New Age, New Delhi).

First Semester

Course type	Course Code	Course Title	A	Load			rks bution	Total Marks	C
PHYSICS-C-	BSHP-111-21	0-4:	L	T	Р	Internal	External	ridiks	+
1		Optics	3	1	-	40	60	100	14
PHYSICS-C- 2	BSHP-112-21	Mechanics	3	1	-	40	60	100	4
PHYSICS-C	BSHP-113-21	Physics Lab-I	+-	+-	4	20	20		
GE-1	BSHM-104-21	Calculus	4		4	30	20	50	2
GE-2	BHCL-103-21			1	7	40	60	100	4
02 2		Inorganic Chemistry	3	1	-	40	60	100	4
	BHC 109-21	Chemistry Lab-I	-	-	4	30	20		_
AEC-1	BHHL-105-21	Communicative	2		+ -			50	2
		English-I	2	-	-	20	30	50	2
	BHHL-106B-21	Punjabi Compulsory-I or Mudhli Punjabi-I	2	-	-	20	30	50	2
	PHYSICS-Core	OTAL	17	4	8	260	340	600	24

L:Lecture T: Tutorial

P:Practical Cr: Credit

Ability Enhancement Compulsory: AEC

Second Semester

Course type	Course Code	Course Title		d Allo	cation	The state of the s	rks bution	Total Marks	Cr
PHYSICS-	DCHD 121 21		L	T	P	Internal	External		1
C-3		Waves and Vibrations	3	1	-	40	60	100	4
PHYSICS- C-4	BSHP-122-21	Electricity and Magnetism	3	1	-	40	60	100	4
PHYSICS- C	BSHP-123-21	Physics Lab-II	-	-	4	30	20	50	2
GE-3	BSHM-204-21	Vector Algebra & Vector Analysis	4	1	-	40	60	100	4
GE-4	BHCL-114-21	Organic Chemistry	3	1	-	40	60	100	4
	BHCP-116-21	Chemistry Lab-II	-	-	4	30	20	50	3
AEC-3	BHHL-115-21	Communicative English-II	2	-	-	20	30	50	2
AEC-4	BHHL-116A-21 BHHL-116A-21	Punjabi Compulsory-II or Mudhli Punjabi-II	2	-	-	20	30	50	2
		OTAL	17	4	8	260	340	600	24

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C	/SICS-	21	P-113-	1	ysics L		L-0,	T-0, P	-4	2	Credits	
Pre-	-requis	ite (If	anv): H	igh-sch	ool adu	cation						
Cou	rse Ob	jective:	s: The a	im and	objecti	ive of th	ne lab c	ourse is	to intr	oduce t	he stuc	ente
						and ph	enome	non of	wave o	ptics so	that th	iev c
~		P	an icqui	CHICKLE.								,
CO1	rse ou	tcomes	: At the	end of	the cou	irse, the	studer	nt will be	able t	0		
		ADIE	o verify	the the	eoretica	concer	ts/laws	learnt	in theor	V COURS	es.	
CO2		equip	ea in	carrying	g out	precise	meas	suremer	nts and	hand	lling se	ensitiv
CO3		Under	stand t	he met and sys	hods u	sed for	estima	ting an	d deali	ng with	experi	ment
CO4			to draw					ovolop	ما دالندا			
CO5		Docum	nent a t	ecnnica	1-report	which o	commu	nicates :	scientifi	experin c inforn	nental d nation ir	esign n a
			ing of			nes wi	th the	progra	m outo	omes		<u> </u>
	PO1	PO2	PO3	PO4	PO5	P06	P07	P08	PO9	PO1	PO1	PO
204	-									0	1	2
01	3	3	2	2	2	1	2	1	2	3	2	3
02	3	3	1	-	2	2	1	1	1	3	2	3
03	3	3	2	-	2	1	2	1	1	3	2	3
04	3	2	2	2	-	2	2	1	1	3	2	3
-04					1		-	-	4			

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Head of Deportment Department of Physics I.K.Gujrti Punjab fechnical University Jalandhar, Kapurthala, Punjab-144603 Note: Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab.

List of experiments:

- Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
- To study the laser beam characteristics like; wavelength, aperture, spot size, etc. using diffraction grating.
- 3. To study the diffraction using laser beam and thus to determine the grating element.
- 4. To study wavelength and laser interference using Michelson's Interferometer.
- 5. To find the refractive index of a material/glass using spectrometer.
- 6. To find the refractive index of a liquid using spectrometer.
- 7. To determine the angle of prism and resolving power of a prism.
- 8. To study the magnetic field of a circular coil carrying current using a Steward and Gees Tangent Galvanometer.
- 9. Determine the radius of circular coil using the Circular coil.
- 10. To study B-H curve using CRO.
- 11. To find out polarizability of a dielectric substance.
- 12. To find out the horizontal component of earth's magnetic field (B_h) .

Text and Reference Books:

- 1. A Textbook of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.
- Engineering Practical Physics, S. Panigrahi& B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- 3. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
- 4. Practical Physics, C L Arora. S. Chand & Company Ltd.
- 5. http://www.vlab.co.in

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Head of Department Department of Physics I.K.Gujn/Punjab Technical University Jalandhar, Kapurthala, Punjab-144603 General BHCL-102-21 INORGANIC L-3, T-1, P-0 4 Credits
(GE)-2 CHEMISTRY

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: To teach the fundamental concepts of Inorganic chemistry and their applications,

CO1 Understand the fundamental concepts and postulates of various theories regarding the structure of atom.

CO2 Learn the periodicity of the s & p block elements

CO3 Understand the various types of bonding present in the different inorganic compounds

CO4 Learn about the various theories pertaining to the different types of boding

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	1	2	2	2	3	2	3
CO2	2	3	1	-	2	2	1	2	2	3	2	3
CO3	2	3	2	-	2	1	2	1	2	3	2	3
CO4	3	2	2	2	-	2	2	1	2	3	2	3
CO5	2	2	2	2	-	2	2	1	1	3	2	3

Detailed Syllabus:

PART-A

UNIT-I

Atomic Structure:

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: deBroglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2 . Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, dand f orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number

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Department of Physics
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Kapurthala, Punjab-144603

UNIT-II

Chemical Bonding-I:Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

UNIT-III

Chemical Bonding-II:Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2 , O_2 , C_2 , B_2 , F_2 , CO, NO, and their ions; HCl, BeF_2 , CO_2 , (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and σ bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

UNIT-IV

Chemistry of s and p Block Elements:

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate. Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

Reference Books :-

- 1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- 2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
- 3. Greenwood, N.N. & Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
- 4. Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
- 5. Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry 4th Ed., Pearson, 2010.
- 6. Shriver & Atkins, Inorganic Chemistry 5th Ed.

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Head of Department Department of Physics I.K.Gujnd Punjab Tathnical University Jalandhar, Kapurthala, Punjab-144603

Gen (GE)		lective	BHCP	102-21	CHI	EMISTR	Y LAB-	L-0,	T-0, P-	-4	2 Cre	dits
Pre-	requis	ite: Und	erstandi	ng of se	nior sec	ondary	evel Ch	emistry				
comp	ounds		arious ty	pes or i	norgani	c titratic	ns and i	prepara	tion of s	wledge a	and illus organic	trative
Cour	se Ou	tcomes:	At the e	end of th	ne cours	e, the s	tudent v	vill be a	ble to			
C	01	Underst	and to d	alibrate	and rur	the ins	trument	s for ar	alvsis			
C	02	Learn to	the qui	antitativ	e analys	sis of va	rious me	etal ions	/cations	and ani	one	
C)3	Underst	and the	various	principl	es of dif	ferent to	echniqu	es involv	ed in th	e quant	itative
CC)4	Learn to	prepare	e various	s inorga	nic com	pounds					5 7 5 5 5 5 5
								progra	m outc	omes		
	PO1	1	PO3	PO4	PO5	P06	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	1	2	1	2	3	2	3
	2	3	1	3	2	2	1	1		2	2	3
CO2	1070		1	1		1	-	-		-		
CO2	2	3	2	3	2	1	2	1	1	2	2	3

List of Experiments:

(A) Titrimetric Analysis

- (i) Calibration and use of apparatus
- (ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

- (i) Estimation of carbonate and hydroxide present together in mixture.
- (ii) Estimation of carbonate and bicarbonate present together in a mixture.
- (iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

- (i) Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.
- (ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
- (iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

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Head of Department Department of Physics I.K.Gujiki Punjab Technical University Jalandhar, Kapurthala, Punjab-144603

Enhancement 105-21 English -I Compulsory (AEC)-1	L-2, T-0, P-0	2 Credits
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Course Objectives: The main objective of this course is:

- To help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills
- To help the students become the independent users of English language
- To develop in them vital communication skills, integral to their personal, social and professional interactions
- To teach them the appropriate language of professional communication
- To prepare them for job market

Course Out-			
Course Outcomes:	At the end	of the course.	the student will

CO1	acquire basic proficiency in reading &istening, writing and speaking skills
CO2	be able to understand spoken and written English language, particularly the language of their chosen technical field.
CO3	be able to converse fluently.
CO4	be able to produce on their own clear and coherent texts.
CO1	become proficient in professional communication, such as, interviews, group discussions, office environments, important reading skills as well as writing skills and thereby will have better job prospects.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4 -	PO5	P06	PO7	PO8	P09	PO10	PO11	PO12
CO1	2	2	2	2	3	2	2	3	2	3	2	2
CO2	2	2	2	1	1	2	2	3	2	3	2	2
CO3	1	-	2	1	2	2	2	3	2	3	2	2
CO4	1	-	-	1	1	2	2	3	2	3	2	2
CO5	2	-	-	1	1	2	2	3	2	3	2	2

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Head of Department Department of Physics IK.Guji I Punjab Technical University Jalandhar, Kapurthala, Punjab-144603

Detailed Syllabus:

Part -A

UNIT I-(Literature)

(A) The Poetic Palette (Orient Black Swan, Second Edition, 2016)

The following poems from this anthology are prescribed:

- 1. Pippa's Song: Robert Browning
- 2. Apparently With No Surprise: Emily Dickinson
- 3. Fool and Flea: Jeet Thayii

(B) Prose Parables (Orient Black Swan, 2013)

The following stories from the above volume are prescribed:

- a. The Kabuliwallah: Rabindranath Tagore
- b. The Eyes Are Not Here: Ruskin Bond
- c. Grief: Anton Chekov

UNIT-II

Vocabulary: Word Formation Processes; Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives; Synonyms, antonyms

Grammar: Subject-verb agreement; Noun-pronoun agreement; Misplaced modifiers; Articles Determiners; Modals; Prepositions;

PART-B

UNIT-III

Reading and Understanding: Close Reading; Comprehension;

UNIT-IV

Mechanics of Writing & Speaking Skills

Essay Writing (Descriptive/Narrative/Argumentative); Business letters; Précis Writing; Self Introductions; Group Discussion

TEXT AND REFERENCE BOOK

- 1. John Eastwood, Oxford Practice Grammar, Oxford University Press, 2014
- 2. Michael Swan, Practical English Usage, OUP. 1995.
- 3. F.T. Wood, Remedial English Grammar, Macmillan. 2007.
- 4. William Zinsser, On Writing Well, Harper Resource Book 2001.
- 5. Sanjay Kumar and Pushp Lata, Oxford University Press. 2011.
- 6. Communication Skills, Oxford University Press. 2011.
- 7. Liz Hamp-Lyons and Ben Heasly, Study Writing, Cambridge University Press. 2006.

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Department of Physics

PHY:	SICS	BSHP-1	23-21	Phys	ics Lab	-II	L-0, T-	0, P-4		2 Cr	edits					
Pre-	requis	ites (if a	ny): High	n-school	educati	on with	Physics I	ab as on	e of the	subject						
Cour	se Ob	jectives:	The aim	and obj	ective o	f the Phy	vsics Lat	COURSE	is to inte	oduce th	a studo	ntc of [
Sc. (H	Hons.)	Physics to	the form	nal struc	ture of	wave ar	nd vibrat	ions and	l mechai	nics so th	nat they	can u				
these	as per	r their requ	uirement		1				· ····cciiai	1100 00 01	iac circy	carr us				
Cour	se Ou	tcomes: A	At the en	d of the	course,	the stuc	lent will	be	_							
CO1		Able to u	nderstan	d the the	eoretica	concep	ts learne	ed in the	theory o	course.						
CO2																
CO3		Learn to	rained in carrying out precise measurements and handling equipment. earn to draw conclusions from data and develop skills in experimental design.													
CO4		Able to understand the principles of error analysis and develop skills in experimental design.														
CO5		Able to do	ocument se mann	a techni ier.	cal repo	rt which	commu	nicates s	scientific	informat	ion in a	clear				
		Ма	pping o	of cours	e outco	mes w	ith the	progran	n outco	mes	***************************************	-				
	PO:	1 PO2	PO3	PO4	PO5	P06	PO7	P08	PO9	PO10	PO11	PO12				
01	3	3	2	2	2	1	2	1	2	3	2	3				
202	3	3	1		2	2	1	1	1	3	2	3				
.02	-	3	2	-	2	1	2	1	1	3	2					
	3	3	-						1			3				
CO2 CO3 CO4	3	2	2	2	-	2	2	1	1	3	2	3				

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Head of Department Department of Physics I.K.Gujrkl Punjob Technical University Jalandhar, Kapurthala, Punjab-144600 Note: Students are expected to perform about 8-10 experiments from the following list, selecting minimum of 6-7 from the Physical Lab and 2-3 from the Virtual lab.

List of experiments:

- 1. Measurements of length (or diameter) using vernier caliper and screw gauge.
- 2. Measurement of volume using travelling microscope. Use of Plumb line and Spirit level.
- 3. To determine the frequency of an electrically maintained tuning fork in a) Transverse mode of vibration b) Longitudinal mode of vibration.
- 4. To verify the law of vibrating string Using Melde's experiment.
- 5. To compare mass per unit length of two strings by Melde's experiment.
- 6. To find out the frequency of AC mains using electric-vibrator/sonometer.
- 7. To determine the horizontal and vertical distance between two points using a Sextant.
- 8. To determine the height of an inaccessible object using a Sextant.
- 9. To determine the angular diameter of the sun using the sextant.
- 10. To determine the angular acceleration a, torque T, and Moment of Inertia of flywheel.
- 11. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of **g** and (c)
- 12. To determine the time-period of a simple pendulum for different length and acceleration due to
- 13. To study the variation of time-period with distance between centre of suspension and centre of gravity for a compound pendulum and to determine: (i) Radius of gyration of the bar about an axis through its C.G. and perpendicular to its length. (ii) The value of g in the laboratory.
- 14. To find the moment of inertia of an irregular body about an axis through its C.G with the

Reference book and suggested readings:

- 1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing
- 2. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- 3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11thEdn, 2011, Kitab Mahal.
- 4. Engineering Practical Physics, S. Panigrahi& B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- 5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
- 6. Practical Physics, C L Arora. S. Chand & Company Ltd.
- 7. http://www.vlab.co.in

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	Genera Electiv (GE)-4	ve 4	BSHC-1 21		ORGAN CHEMI	STRY			3, T-1, I			edits				
			derstand	ling of	senior se	econdary	level P	hysics a	nd Math	ematics						
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Cou	rse Ou	tcomes	At the	end of	the cour	se, the	student	will be a	able to							
	01	Unders	Omes: At the end of the course, the student will be able to Understand the fundamental concepts of organic chemistry i.e. structure, bonding and various effects in organic compounds.													
C	02	10 lear	To learn the stereochemistry viz. optical isomerism, stereoisomerism and conformational isomerism of organic compounds.													
C	03	To stud	y the va	rious k	known rea	active in	termedi	iate in oi	rganic sy	Inthesis						
C	04	To learr the stud	the fur	idame ction r	ntal and a	advance	d conce	inte of re	anction w			ng with				
CC)5	To pred	ict the re	elation	ships bet	ween or	ganic cl	hemical	ctructur	20 20 4 4	L _ '					
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02	2	2	2	1	1	3	2	3	2	2	2	2				
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03	3	2	2	1		10000	-	-	-)	2	2				

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Department of Physics
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Kapurthala, Punjab-144603

Detailed Syllabus:

PART-A

Unit-I

Basics of Organic Chemistry

Organic Compounds: Classification, and Nomenclature, Hybridization, molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit-II

Stereochemistry:

Fischer Projection, Newmann and Sawhorse Projection formulae interconversions; Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations with

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemicmixture and resolution. Relative and absolute configuration: D/L and R/S designations.

A. Carbon-Carbon sigma bonds formation:-

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

PART-B

Unit-III

Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ AntiMarkownikoff addition), mechanism of oxymercuration-demercuration, hydroboration oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation(oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to formcarbonyl compounds, Alkylation of terminal alkynes.

Unit-IV

Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Aromatic Hydrocarbons

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and

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Head of Department Department of Physics I.K.Guji & Punich Technical University Jalandhar, Kapurihala, Punjab-144603 heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Text and Reference Books:

- 1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).
- 2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
- 3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- 4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
- 5. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

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I.K.Gujn, Punjab Technical University Jalandhar,
Kapurthala, Punjab-144603

	Genera tive (G	-	BSHC 119-2		HEMIS	TRY LA	B-II	L-0,	T-0, P	-2	2 Cree	dits
Pre-r	equisit	te: Unde	erstandi	ng of se	nior sec	ondary	level Ch	emistry	1000		No. of the second secon	TO THE RESIDENCE
Cour	se Obje eer.	ectives	which	will act	as a stro	ong back	kground	if he/sh	e choos	ses to pu	irsue ph	ysics as
Cour	se Outo	omes:	At the e	end of the	ne cours	e, the s	tudent v	vill be al	ole to			
CC)1											
CC)2		-	10.71734700000						- Address		
CC)3											
CO)4		West of the second seco	7799040								
CO	5											
		Мар	ping of	cours	e outco	mes w	ith the	progra	m outc	omes		
7 187 d Labour	PO1	PO2	PO3	P04	PO5	P06	P07	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	2	2	3	2	3	2	2
CO2	2	2	2	1	1	2	2	3	2	2	2	2
CO3	3	3	2	1	2	2	2	3	2	2	2	2
CO4	2	3	-	1	1	2	2	3	2	3	2	2
CO5	2	1	1	1	1	2	2	3	2	3	2	2

List of Experiments:

- 1. Checking the calibration of the thermometer
- 2. Purification of organic compounds by crystallization using the following solvents: a) Water b) Alcohol, and c) Alcohol-Water.
- 3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
- 4. Effect of impurities on the melting point mixed melting point of two unknown organic compounds
- 5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100°C by distillation and capillary method)
- 6. Chromatography a) Separation of a mixture of two amino acids by ascending and horizontal paper chromatography b) Separation of a mixture of two sugars by ascending paper chromatography, c) Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books

- 1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
- 2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry*, *5th Ed.*, Pearson (2012).

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Department of Physics
I.K.Guj N Punich fechnical University Jelandhar,
Kapurthala, Punjab-144603

Ability Enhancement Compulsory (AEC)-3	BHHL- 115-21	Communicative English-II	L-2, T-0, P-0	2 Credits
Pre-requisite:Bas	sic proficiency	in communicative Englis	h	W/W 1997 1997 1997 1997 1997 1997 1997 199

ves: This course is designed to

- help the students become proficient in LSRW-Listening, Speaking, Reading & Writing skills
- help the students become the independent users of English language
- develop in them vital communication skills, integral to their personal, social and professional interactions
- teach them the appropriate language of professional communication

Cour	se ou	tcomes:	at the e	end of th	ne cours	se, the s	tudent v	vill be a	ble to			
C	01	Student skills.	s will a	cquire b	pasic pr	oficiency	y in rea	ding &l	istening	, writing	and s	peaking
CC)2	Students the lang	s will be uage of	able to their ch	unders osen te	tand spo	oken and	d writte	n Englis	h langua	ge, par	ticularly
CC)3	They wi	The second secon	And the second s	Ohn a comment of the							***************************************
CC)4	They wi	l be abl	e to pro	duce on	their or	wn clear	and co	herent t	exts.		
****		Students group di skills and Map	scussior d thereb	ns, office by will ha	e enviro ave bett	nments, er job p	importa	ant read 5.	ing skill	s as well		
	PO1	PO2	PO3	PO4	PO5	P06	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	1	1	2	2	3	2	3	2	2
CO2	1	-	-	1	1	2	2	3	2	3	2	2
СОЗ	1	-	-	1	1	2	2	3	2	3	2	2
CO4	1	-	-	1	1	2	2	3	2	3	2	2
CO5	2		-	1	-	2	2	3	2	3	2	2

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Detailed Syllabus:

Part -A

UNIT I-(Literature)

(A) The Poetic Palette (Orient Black Swan, Second Edition, 2016)

The following poems from this anthology are prescribed:

- 1. The Soul's Prayer: Sarojini Naidu
- 2. I Sit and Look Out: Walt Whitman
- 3. Women's Rights: Annie Louise Walker

(B) Prose Parables (Orient Black Swan, 2013)

The following stories from the above volume are prescribed:

- 1. The Doctor's Word: R.K. Narayan
- 2. The Doll's House: Katherine Mansfield
- 3. Dusk: H.H. Munroe (Saki)

UNIT-II

Vocabulary: Standard abbreviations; Oneword substitution; Word Pairs(Homophones/Homonyms) **Grammar:** Sentence Structures; Use of phrases and clauses in sentences; Transformation of Sentences; Importance of proper punctuation

PART-B

UNIT-III

Reading and Understanding: Summary Paraphrasing; Analysis and Interpretation; Translation (from Hindi/Punjabi to English and vice-versa)

UNIT-IV

Mechanics of Writing & Speaking Skills: Report writing, Career Documents- Job applications, Resume/CV writing, Common Everyday Situations: Conversations & Dialogues, Formal Presentations

TEXT AND REFERENCE BOOK

- 1. John Eastwood, Oxford Practice Grammar, Oxford University Press, 2014
- 2. Michael Swan, Practical English Usage, OUP. 1995.
- 3. F.T. Wood, Remedial English Grammar, Macmillan. 2007.
- 4. William Zinsser, On Writing Well, Harper Resource Book 2001.
- 5. Sanjay Kumar and Pushp Lata, Oxford University Press. 2011.
- 6. Communication Skills, Oxford University Press. 2011.
- 7. Liz Hamp-Lyons and Ben Heasly, Study Writing, Cambridge University Press, 2006.

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Third Semester

Coursetype	Course Code	Course Title		Load	d tion	Ma Distri	Total Marks	Cr	
			L	Т	Р	Internal	External		
PHYSICS-C-5	BSHP-211-21	Mathematical Physics-I	5	1	-	40	60	100	6
PHYSICS-C-6	BSHP-212-21	Elements of Modern Physics	3	1	-	40	60	100	4
	BSHP-213-21	Physics Lab-III	-	-	4	30	20	50	2
PHYSICS-C-7	BSHP-214-21	Analog Systems and Application	3	1	-	40	60	100	4
	BSHP-215-21	Physics Lab-IV	-	-	4	30	20	50	2
GE-5	BHCL-204-21	Physical Chemistry	3	1	-	40	60	100	4
	BHCP-208-21	Chemistry Lab-III	-	-	4	30	20	50	2
PHYSICS- SEC-1	BSHP-216-21	Workshop Skill Enhancement	-	1	2	30	20	50	2
	BSHP-217-21	Computational Physics							
	BSHP-218-21	Weather Forecasting							
		TOTAL	14	5	14	280	320	600	26

PHYSICS-SEC:PHYSICS-Skill Enhancement Elective Course

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PH	YSICS-	С	BSHP-	213-21	. PH	YSICS I	AB-III		L-0, T-0), P-4	2	Credits
Pre	-requis	site: Und	derstand	ling of s	enior se	condary	level Pl	nysics a	nd Math	ematics		
Cou	rse O	bjectiv	es: The	lahorai	tory ov	marima	ata C-					echanics ion, and
Cou	rse Ou	tcomes	At the	end of t	he cour	se, the s	student	will be a	able to			
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Head of Department Department of Physics IKGuja Purjo febriod University Jalandhar, Kapurthara, Punjob-144603

Detailed Syllabus:

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

List of experiment:

- 1. Measurement of Planck's constant using black body radiation and photo-detector.
- 2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photoelectrons versus frequency oflight.
- 3. To determine work function of material of filament of directly heated vacuumdiode.
- 4. To determine the Planck's constant using LEDs of at least 4 different colours.
- 5. To determine the wavelength of H-alpha emission line of Hydrogenatom.
- **6.** To determine the ionization potential ofmercury.
- 7. To determine the absorption lines in the rotational spectrum of Iodinevapour.
- 8. To determine the value of e/m by (a) Magnetic focusing or (b) Barmagnet.
- 9. To setup the Millikan oil drop apparatus and determine the charge of anelectron.
- 10. To show the tunneling effect in tunnel diode using I-Vcharacteristics.
- 11. To determine (i) wavelength and (ii) angular spread of a laser using plane diffraction grating.
- 12. Dependence of scattering angle on kinetic energy and impact parameter in Rutherford scattering (mechanicalanalogue).
- **13.** Measurement of the electrical and thermal conductivity of copper to determine its Lorentz number.
- 14. To determine energy band gap of a givensemiconductor.

Reference Books:

- **1.** Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia PublishingHouse.
- 2. AdvancedlevelPhysicsPracticals,MichaelNelsonandJonM.Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- 3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11thEdn, 2011, KitabMahal.

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PHYSICS-C-7 BSHP-214-21 ANALOG L-3, T-1, P-0 4 Credits **ELECTRONICS** Pre-requisite: Understanding of senior secondary level Physics and Mathematics Course Objectives: The course content covers basic semiconductor physics and devices, diodes, bipolar junction transistors, amplifiers, feedback concepts, Operation amplifiers and applications. Course Outcomes: At the end of the course, the student will be able to Illustrate working principle of different electronic circuit and their applications in real CO1 Understand the working of semiconductor device and different operating condition CO₂ and their performanceparameter. Design and analyse the different types of amplifiers and understand the feedback **CO3** mechanism. CO4 Design and analyse the different types of oscillators. Recognize different signal processing circuit and the use in industrial, real life, **CO5** modern control system application. Mapping of course outcomes with the program outcomes PO1 PO₂ PO3 PO4 PO5 PO6 PO7 **PO8** PO9 PO10 PO11 PO12 CO1 2 1 2 1 1 2 2 1 3 2 2 CO2 2 2 2 1 1 1 1 1 3 1 1 CO3 3 2 2 2 1 2 1 1 3 1 1 CO4 2 2 2 2 1 1 2 1 1 3 1 1 CO5 2 2 2 2 1 1 2 1 1 3 1 1

Detailed Syllabus:

PART-A

UNIT-I

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and Reverse Biased Diode. (10 Lectures)

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Kapurthala, Punjab-144603

UNIT-II

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3)Solar Cell.

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β . Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff andSaturationRegions.(12 Lectures)

PART-B

UNIT-III

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B &CAmplifiers. Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response. (10 Lectures)

UNIT-IV

Oscillators: Introduction, Types of oscillators, Fundamental principle of oscillators, Feedback oscillators, Tunes collector oscillator, Hartley and Colpitts Oscillator, Phase shift oscillator, Wein bridge oscillator, crystal oscillators. (9 Lectures)

Reference Books:

- 1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- 2. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- 3. Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, 6th Edn.,2009, PHI Learning Electronic Devices & circuits, S. Salivahanan& N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- 5. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- 6. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn, Oxford
- 7. Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk, 2008, Springer
- 8. Semiconductor Devices: Physics and Technology, S.M. Sze, 2ndEdn., 2002, Wiley India
- 9. Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
- 10. Electronic Devices, 7thedn. Thomas L. Floyd, 2008, Pearson India

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PHY	SICS-	С	BSHP-	215-21	PHY	SICS L	AB-IV	L	0, T-0), P-4	2 0	redits
Pre-	requis	site: Und	erstand	ing of se	enior sec	condary	level Ph	ysics ar	nd Math	ematics		
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Cour	se Ou	tcomes:	At the	end of the	ne cours	se, the s	student v	will be a	ble to			
C	01	Illustrat	e worki	ng princ	iple of d	lifferent	electror	nic circu	it and th	neir appl	ications	in real
CC	02	Underst	and the	working mancep	of sem	niconduc	tor devi	ce and	differen	t operati	ng cond	ition
CC		Design mechan	and and ism.	alyse th	e differe	ent type			and ur	nderstand	d the fe	edback
CC)4	Design a	and ana	lyse the	differen	t types	of oscill	ators				
CC)5	Recogni modern	ze diffe	erent sic	inal pro	cessina	circuit	and th	ie use	in indus	strial, re	al life,
		Мар	ping o	fcourse	outco	mes w	ith the	progra	m outo	omes		-
	PO1	PO2	PO3	PO4	PO5	P06	PO7	PO8	PO9	PO10	PO11	PO12
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CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
	2	2	2	2	1	1					-	-

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Kapurthala, Punjab-144603

Detailed Syllabus:

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

- 1. To study I-V characteristics of different diodes Ge, Si, LED and Zener.
- 2. To study voltage regulation and ripple factor for a half-wave and a full-wave rectifier without and with different filters. Use of Zener diode and ICregulators.
- **3.** To study common emitter characteristics of a given transistor and to determine various parameters.
- 4. Study of I-V & power curves of solar cells and find maximum power point &efficiency.
- **5.** To design a CE transistor amplifier of a given gain (mid-gain) using voltage dividerbias.
- **6.** To study the frequency response of voltage gain of a RC-coupled transistoramplifier.
- 7. To design a Wien bridge oscillator for given frequency using anop-amp.
- **8.** To design a phase shift oscillator of given specifications using BJT.
- 9. To study the Colpitts'soscillator.
- 10. To design a digital to analog converter (DAC) of givenspecifications.
- 11. To study the analog to digital convertor (ADC)IC.
- **12.** To design an inverting amplifier using Op-amp (741,351) for dc voltage of givengain and study its frequencyresponse.
- 13. To draw the characteristics of a given triode and to determine the tubeparameters.
- 14. Calibration of a Si diode, a thermistor, and thermocouple for temperaturemeasurements.
- 15. To measure low resistance by Kelvin's double bridge/Carey Foster'sbridge.

Reference Books:

- 1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc- GrawHill.
- 2. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, PrenticeHall.
- 3. Electronic Principle, Albert Malvino, 2008, Tata Mc-GrawHill.
- 4. Electronic Devices & circuit Theory, R.L. Boylestad& L.D. Nashelsky, 2009, Pearson.

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(GE)-5 C	Elective hemistry	BHCP-2 21		stry Lab-III	L-0, T-0, P-4	2 Credits
Pre-requ	isite: Unde	rstanding o	f senior seconda	ary level Physics	s and Mathematics	
Course O	biectives	To provide	ptudo-t-	,	- and mathematics	
in theory of skills.	class of phy	sical chemis	stry, which in tu	al knowledge a rn will enhance	and skills about vari their problem solv	ous topics taugling and analytic
Course O	utcomes:	At the end o	of the course, th	e student will b	pe able to	
CO1	Understa	and the basi	c procedures for	carning out a	physical chemistry p ng the equipment ar	ractical like nd measuring
CO2	Correlate				know about the lim	
CO3	Determin	e the variou	is physical paran	neters for the va	arious problems unc	lor considerati
CO4	Verify va	rious laws s	tudied in the th	2021 224	arious problems und	lei consideration
apping o	of course o	utcomes	with the progr	am outcomes		
		PSO1	PSO2	PSO3	PSO4	
CO1		-	3	-	P304	PSO5
CO2		-	3			3
CO3		-	3		-	3
CO4		-	3	-	-	3
C04	The same of the sa			~	-	3

Detailed Syllabus

UNIT-I

Preparation and Standardization of Solutions.

UNIT-II

Surface tension measurements.

a)Determine the surface tension by (i) drop number (ii) drop weight method.

b) Study the variation of surface tension of detergent solutions with concentration.

UNIT-III

Viscosity measurement using Ostwald's viscometer.

a) Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room

b) Study the variation of viscosity of sucrose solution with the concentration of solute.

UNIT-IV

pH metry

a) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and

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Head of Department Department of Physics I.K.Guj. V Punici, fechnical University Jalandhar, Kapurihala, Punjab-144603 their mixtures.

- b) Preparation of buffer solutions of different pH;
- (i) Sodium acetate-acetic acid
- (ii) Ammonium chloride-ammonium hydroxide
- c) pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
- d) Determination of dissociation constant of a weak acid.

Recommended Books

- 1. J.B. Yadav, Practical Physical Chemistry, Krishna
- 2. Findlay, Practical Physical Chemistry, Longman, New York

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-1	YSICS			216-21	1	YSICS			L-0, T-	1. P-2	"5)	Sity, Kapu Credits
Pre	-requi	site: Un	derstand	ding of c	VVC	KKSH(OP SKI	LL		***		CICUITS
		site: Un	a ci stail	allig of S	enior se	econdary	/ level P	hysics a	nd Math	nematics		
Cor	irse O	bjective Is mecha	s: Tho	vim of H								
with	variou	is mecha	pical a	WIN OF EF	is cours	se is to	enable	the stud	dents to	familia	r and a	
of t	he stud	is mecha lents to fi	rama -	a electri	cal tool	s through	gh hand	s-on mo	ode, and	to imp	rovo th	kperience
	io ocac	ents to fi	arrie an	a tackle	problen	ns in Ph	ysics.			· co mp	TOVE LITE	a adilitie.
		itcomes	. At the	end of t	he cour	se, the	student	will be a	able to			
C	01											
C	02	Introdu	caria the	concept	it types	of unit	s systen	n and th	eir conv	ersion		
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Detailed Syllabus:

PART-A

Unit-I

Introduction: Measuring units. conversion to SI and CGS unit system. Familiarization with meter scale, Vernier caliper, Screw gauge and their utilities. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc. (4 Lectures)

Unit-II

Introduction to prime movers: Gear and gear mechanism, lever and lever mechanism, Brakes and braking mechanism, Pulley and pulley mechanism, power generator system. **(6 Lectures)**

PART-B

Unit-III

Mechanical Skills: Concept of workshop practice. Overview of manufacturing methods: foundry, machining, forming, and welding. Types of welding joints and welding defects. Common materials used for manufacturing like, metals, alloys, and composites. Concept of machine processing, introduction to common machine tools like athe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Introduction to sheet metal, operations, and job of funnel fabrication. (5 Lectures)

Unit-IV

Electrical and Electronic Skill: Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, electronic switch using transistor and relay. (5 Lectures)

Reference Books:

- 1. A textbook in Electrical Technology B L Theraja S. Chand and Company.
- 2. Performance and design of AC machines M.G. Say, ELBS Edn.
- 3. Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.
- 4. Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes [ISBN: 0750660732]
- 5. New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN: 0861674480]

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UNIT-II

Scientific Programming using C++/Python: Introduction to the Concept of Object-Oriented Programming; Advantages of C++; Structure of a C++ program, concepts of compiling and linking, IDE and its features; Basic terminology - Character set, tokens, identifiers, keywords, fundamental data types, literal and symbolic constants, declaring variables, initializing variables, type modifiers. Operators in C++, Input/output using extraction and insertion operators, writing simple C++ programs, comments in C++, stages of program execution. (5 Lectures)

PART-B

UNIT-III

Control Statements: Types of Logic, CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO), Subscripted Variables (Arrays: Types of and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, reading from a file. Examples from physics problems. (5 Lectures)

UNIT-IV

Programming:

- 1. Exercises on syntax on usage of C++/Python
- 2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in C++/Python.
- 3. To print out all natural even/ odd numbers between given limits.
- 4. To find maximum, minimum and range of a given set of numbers.
- **5.** Calculating Euler number using exp(x) series evaluated at x=1.

Reference Books:

- 1. Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt. Ltd.
- 2. Computer Programming in Fortran 77". V Rajaraman (Publisher: PHI).
- 3. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- 4. Computational Physics: An Introduction, R. C. Verma et al., New Age International Publishers, New Delhi (1999)
- 5. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning
- 6. Elementary Numerical Analysis, K.E. Atkinson, 3rdEdn. 2007, Wiley India Edition.

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PHYSICS-SEC BSHP-217-21 COMPUTATIONAL L-0, T-1, P-2 2 Credits -2 PHYSICS Pre-requisite: Understanding of senior secondary level Physics and Mathematics Course Objectives: The aim of this course is to Highlights the use of computational methods to solve physical problems Course will consist of hands-on training on the Problem solving on Computers. Course Outcomes: At the end of the course, the student will be able to CO1 Introduced the concept of using the computers in Physics. analyze practical and theoretical aspects of physics problems with the help of CO₂ asuitable mathematical model. CO₃ describe and evaluate sources of error for the modeling and calculation for a given problem. CO4 mathematical modeling and numerical analysis of problems in science and technology. how scientific knowledge is achieved by an interplay between theory, modeling and **CO5** simulation. Mapping of course outcomes with the program outcomes PO1 PO₂ PO₃ PO4 PO5 P06 PO7 **PO8** PO9 PO10 PO11 PO12 CO1 2 1 2 1 1 2 1 2 3 2 2 CO₂ 2 2 1 2 1 1 1 3 1 1 1 CO3 3 2 2 2 1 1 1 3 1 1 1 CO4 2 2 2 2 1 1 2 1 1 3 1 1 **CO5** 2 2 2

Detailed Syllabus:

UNIT-I

PART-A

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2

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1

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution. Operating system, Usage of Linux as an editor, Algorithms and Flowcharts. Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal. (5 Lectures)

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2

1

Fourth Semester

Coursetype	Course Code	Course Title	е		oa ocat	d tion	The second second	rks bution	Total Marks	Cr
				L	Т	P	Internal	External		
PHYSICS-C-8	BSHP-221-21	Mathematical Phys	ics-II	5	1	-	40	60	100	6
PHYSICS-C-9	BSHP-221-21	Thermal Physics		3	1	-	40	60	100	4
	BSHP-223-21	Physics Lab-V		-	-	4	30	20	50	2
PHYSICS-C-	BSHP-224-21	Digital Electronics		3	1	-	40	60	100	4
10	BSHP-225-21	Physics Lab-VI		-	-	4	30	20	50	2
GE-6	BSHM-408- 21	Matrices & Ordinar Differential Equation	,	4	1	-	40	60	100	4
AEC-5	EVS-101A	Environmental Stud		2	-	-	20	30	50	2
PHYSICS- SEC-2	BSHP-226-21	Electrical Circuits a Network Skills	nd	-	1	2	30	20	50	2
	BSHP-227-21	Basic Instrumentat Skills	ion							
	BSHP-228-21	Scientific Word Processing								
		TOTAL		17	5	10	270	330	600	26

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PHY	SICS-(C	BSHP-2	223-21	РНҮ	SICS L	AB-V	L	-0, T-0	, P-4	2 0	redits
Pre-	requis	ite: Und	erstandi	ng of se	nior sec	condary	level Ph	vsics an	d Mathe	ematics		
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Cour	se Out	comes:										
CC		Able to	verify th	ne theore	etical co	ncepts/	laws lea	rnt in th	eory co	urses.		
CC		Trained	in carry	ing out p	orecise	measure	ements	and han	idlina se	nsitive e	auipme	nt.
CC	03	Underst	and th	e meth	ods us	ed for	estima	ting an	d deali	ng with	exper	imenta
		uncertai	nties ar	id systen	natic "e	rrors".						
CC		Learn to	draw c	onclusio	ns from	data ar	nd devel	op skills	in expe	erimenta	design	
CO)5	Docume .	nt a tec	hnical re	port w	nich com	nmunica	tes scier	ntific inf	ormation	in a cle	ar and
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03	3	2	2	2	1	1	2	1	1	3	1	1
04	2	2	2	2	1	1	2	1	1	3	1	1
	2	2	2	2								

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Detailed Syllabus:

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

- 1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow
- 2. To measure the coefficient of linear expansion for different metals and alloys.
- 3. To determine the value of Stefan's Constant of radiation.
- 4. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
- 5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
- 6. To measure the thermal conductivity and thermal diffusivity of aconductor.
- 7. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's discmethod.
- 8. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer(PRT).
- 9. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions. To calibrate a thermocouple to measure temperature in a specified Range using (i) Null Method, (ii) Direct measurement using Op-Amp difference amplifier and to determine NeutralTemperature.
- 10. To determine thermal conductivity of a bad conductor disc using Advance kit involving constant current source for heating and thermocouples for temperaturemeasurements.
- 11. Calibration of Si diode and Copper -Constantan thermocouple as temperature sensor.
- 12. Measurement of Planck's constant using black body radiation.
- 13. To determine Stefan's Constant.
- 14. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
- 15. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
- 16. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

Reference Books

- 1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia PublishingHouse
- 2. A Textbook of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, KitabMahal
- 3. Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- 4. A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.

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10	D					ITAL CTRON:	ICS	L-3, T-1, P-0 4 Cre					
Pre-	requis	ite: Und	erstandi	ng of ba	sics of	electron	ics.		all defends	***************************************		F.O. 100a.	
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CC)1	Underst	and the	fundam	entals o	of codes	and nur	mber sv	stem				
CC)2	Underst								ς			
CC)3	Underst	and the	function	s and w	vorking	of flipflo	p circuit	s regist	er s and	counter	'C	
CC)4	Underst	and the	applicat	ions into	o memo	rv circui	ts.	.0 109/00	Cr 5 drid	counter	J,	
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CO2	2	2	1	2	1	1	1	1	1	3	1	1	
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05	2	2	2	2									

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Detailed Syllabus:

UNIT-I

PART-A

Digital Circuits: Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. (11 Lectures)

UNIT-II

Data Processing Circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. (9 Lectures)

PART-B

UNIT-III

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). Lectures) (10

UNIT-IV

Counters and Converters: Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Digital to analogue converter, analogue to digital converter using counter. Lectures)

Reference Books:

- 1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata
- 2. Fundamentals of Digital Circuits, Anand Kumar, Edn, 2009, PHI Learning Pvt. Ltd.
- 3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- 4. Digital Electronics G K Kharate ,2010, Oxford University Press
- 5. Digital Systems: Principles & Applications, R.J.Tocci, N.S. Widmer, 2001, PHI Learning
- 6. Logic circuit design, Shimon P. Vingron, 2012, Springer.
- 7. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- 8. Digital Electronics, S.K. Mandal, 2010, edition, McGraw Hill

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PHY	SICS-	223 21				SICS L	AB-VI	L	0, T-0	, P-4	2 0	redits
Pre-	requi	site: Und	erstand	ng of se	nior sec	condary	level Ph	ysics ar	nd Mathe	ematics		
traini count	ing or ters.	pjectives e of the basic I	Logic ga	s iearnt ates, fli _l	In the l p-flops,	theory (sequen	course o ntial and	f digita d comb	l electro inationa	mica T+	0011040	
		tcomes:	At the	end of th	e cours	se, the s	tudent v	vill be a	ble to	***************************************	700	
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CC)2	Irained	in carry	ing out	precise	measure	ements.	and han	dlina se	nsitive e	auinma	nt
CO)3	Underst	and th	e meth	ods us	ed for	estimat	ing an	d deali	ng with	evner	imental
		uncerta	inues ar	ia syster	natic "e	rrors".						
CO	-	Learn to	draw c	onclusio	ns from	data ar	nd devel	op skills	in expe	rimenta	design	-
СО)5	Docume concise	ent a tec	nnical re	port wh	nich con	nmunica	tes scie	ntific inf	ormation	n in a cl	ear and
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	PO1	PO2	PO3	PO4	PO5	P06	PO7	PO8	PO9	PO10	PO11	PO12
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02	2	2	1	2	1	1	1	1	1	3	2	1
03	3	2	2	2	2	1	2	1	1	3	2	1
04	2	2	2	2	1	1	2	1	1	3	2	1

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Detailed Syllabus:

Note: Students are expected to perform 8-10 experiments from the list taking at least

List of Experiments:

- 1. To measure (a) Voltage, and (b) Time period of a periodic waveform usingCRO.
- 2. To test a Diode and Transistor using aMultimeter.
- 3. To design a switch (NOT gate) using atransistor.
- 4. To verify and design AND, OR, NOT and XOR gates using NANDgates.
- 5. To design a combinational logic system for a specified TruthTable.
- 6. To convert a Boolean expression into logic circuit and design it is using logic gateICs.
- 7. To minimize a given logiccircuit.
- 8. Half Adder, Full Adder, and 4-bit binaryAdder.
- 9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full AdderI.C.
- 10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NANDgates.
- 11. To build JK Master-slave flip-flop using Flip-FlopICs
- 12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timingdiagram.
- 13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-FlopICs.
- 14. To design an astable multivibrator of given specifications using 555Timer.
- 15. To design a monostable multivibrator of given specifications using 555Timer.

Reference Books:

- 1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGrawHill.
- 2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-GrawHill.

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-4	SICS-			226-21	CIR	CTRIC/ CUITS	AND		0, T-1		2 (Credits
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CC)3	Underst impedar	and the	DC Pov	ver soul	ces, AC	DC ger	nerators	, Induct	ance, ca	pacitan	ce, and
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	PO1	PO2	PO3	PO4	PO5	P06	PO7	P08	PO9	PO10	PO11	PO12
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02	2	2	1	2	1	1	1	1	1	3	1	1
:03	3	2	2	2	1	1	2	1	1	3	1	1
04	2	2	2	2	1	1	2	1	1	3	1	1
:05	2	2	2	2	1	1	2	1	1	3	1	1

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Detailed Syllabus:

PAHT-A

UNITI

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter, and ammeter.

Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary, and complex power components of AC source. Power factor. Saving energy and money.

(6 Lectures)

UNIT-II

Generators and Transformers: DC Power and impedance. Operation of transformers.

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. (5 Lectures)

PART-B

UNIT-III

Solid-State Devices: Resistors, inductors, and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources.

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device) (6 Lectures)

UNIT-IV

Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drops and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.

(5 Lectures)

Reference Books:

- 1. A textbook in Electrical Technology B L Theraja and A K Theraja S Chand & Co.
- 2. Performance and design of AC machines M G Say, CBS Publisher.
- 3. Electronic Principles (SIE)- Albert Malvino and David J. Bates 7th Edition, McGraw Hill Education.

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-5				-227-2	IF	ASIC NSTRUM	ENTATIO	NC		T-1, P-2	1	? Credit
Pr	e-requ	isite: U	nderstar	nding o	feening	KILLS	ary level P				ĺ	
	-			rang o	3011101	second	ary level P	hysics	and Mat	hematic	S	
usa	age thro pics.	ough ha	es: This Inds-on	course mode.	is to g Experii	net expos ments lis	sure with sted below	various vare t	s aspect. To be do	s of insti		and the
Co	urse O	utcome	s: At the	e end o	f the co	ourse, th	e student	will be	able to			ON OF th
(CO1	Apply	the fun	dament	als of i	nstrume	ntation in	measu	rements	and cal	ibration	of
	02	Make range	use of ir	nstrume ent.	ent with	approp	riate speci	fication	ns and d	esign of	extensi	on of
C	03	Experi	ment wi tance) r	th diffe	rent br	idge circi	uits for un	known	parame	eter (Res	istance,	
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C	05	Select of reco	the digit	al instr	ument	for the n	for electrine	ical pa	rameter given pa	measure rameter	ement.	ke use
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			, , ,	, cour	se out	comes i	with the	progra	am outo	comes		
	PO1	PO2	PO3	PO4	PO5			PO 8	PO9	PO10	PO11	PO12
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02	2	2	1	2	1		2	1	2	3	2	2
03	3	2	2	2		1	1	1	1	3	1	1
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05	2	2	2	2	1	1	2	1	1	3	1	1
	ed Syll			2	1	1	2	1	1	3	1	1
-carre	eu Syll	abus:										

UNIT-I

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their

PART-A

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Head of Department Department of Physics I.K.Guji Al Punish fe, hnical University Jalandhar, Kapurthala, Punjab-144603 **Electronic Voltmeter:** Advantage over respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic willivoltmeter. Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance. (6 Lectures)

UNIT-II

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only-no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

Use of CRO for the measurement of voltage (dc and ac frequency, time-period, Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

(6 Lectures)

PARTB

UNIT-III

Signal Generators and Analysis Instruments: Block diagram, explanation, and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

(6 Lectures)

UNIT-IV

Digital Instruments: Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time-base stability, accuracy, and resolution.

(5 Lectures)

The test of lab skills will be of the following test items:

- 1. Use of an oscilloscope.
- 2. CRO as a versatile measuring device.
- 3. Circuit tracing of Laboratory electronic equipment,
- 4. Use of Digital multimeter/VTVM for measuring voltages
- 5. Circuit tracing of Laboratory electronic equipment
- 6. Winding a coil / transformer
- 7. Study the layout of receiver circuit.
- 8. Trouble shooting a circuit
- 9. Balancing of bridges

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Laboratory Exercises:

- 1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
- 2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
- 3. To measure Q of a coil and its dependence on frequency, using a Q-meter.
- 4. Measurement of voltage, frequency, time period and phase angle using CRO.
- 5. Measurement of time period, frequency, average period using universal counter/ frequency
- 6. Measurement of rise, fall and delay times using a CRO.
- 7. Measurement of distortion of a RF signal generator using distortion factor meter.
- 8. Measurement of R, L and C using a LCR bridge/ universal bridge.
- 9. Using a Dual Trace Oscilloscope
- **10.**Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

- 1. A Textbook in Electrical Technology B L Theraja S Chand and Co.
- 2. Performance and design of AC machines M G Say ELBS Edn.
- 3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- 4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
- 5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- 6. Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, Ed., 2012, Tata Mc Graw Hill.
- 7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
- 8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

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PHYSICS-SEC BSHP-228-21 SCIENTIFIC L-0, T-1, P-2 -6 2 Credits WORD PROCESSING Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The aim of this course is not just to teach scientific documentation methods and numerical analysis but to emphasize its role in solving problems in Physics.

- Use of latex as a tool in writing scientific document in physics applications.
- Course will consist of hands-on training on the latex on Computers.

CO1	Explain, install, and use of TeX and LaTeX.
CO2	Describes the development process of TeX and LaTeX.
CO3	Explains the difference between TeX and LaTeX.
CO4	Tells the advantages of LaTeX over other more traditional software's.
CO5	Lists LaTeX compatible operating systems and use latex for scientific documentation purpose.

Mapping of course outcomes with the program outcomes

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	PO1	PO2	PO3	PO4	PO5	P06	P07	P08	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	7 012
CO2	2	2	1	2	1	1	1	1	1	3	2	2
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1
			2	2	1	1	2	1	1	3	1	1

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Detailed Syllabus:

UNIT-I

PART-A

Introduction to LaTeX:TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type of style, Symbols from other languages. (6 Lectures)

UNIT-II

Equation representation: Formulae and equations, Figures and other floating bodies, lining in columns- Tabbing and tabular environment, generating table of contents, bibliography, and citation, making an index and glossary, List making environments, Fonts, Picture environment and (8 Lectures)

PART-B

UNIT-III

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving, and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding (8 Lectures)

UNIT-IV

Exercises:

- 1. Write a 20 pages report in latex on any topic of your interest in Physics.
- 2. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an .eps file and as a .pdf file.

Reference Books:

- 1. LaTeX-A Document Preparation System", Leslie Lamport (Second Edition, Addison- Wesley,
- 2. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- 3. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe,
- 4. Computational Physics: An Introduction, R. C. Verma et al. New Age International Publishers,

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Fifth Semester

Coursetype	Course Code	Course Title	Load Allocation			Ma Distri	Total Marks	Cr	
			L	T	Р	Internal	External		
PHYSICS-C- 11	BSHP-311-21	Quantum Mechanics	5	1	-	40	60	100	6
PHYSICS-C- 12	BSHP-312-21	Solid State Physics	3	1	-	40	60	100	4
PHYSICS-C	BSHP-313-21	Physics Lab-VII	-	-	4	30	20	50	2
PHYSICS-C-	BSHP-314-21	Computational Physics Lab-I	-	-	4	30	20	50	2
DSE-1 DSE-2	BSHP-315-21 BSHP-316-21	Department Specific Elective (DSE)-1	5	1	-	40	60	100	6
DSE-3 DSE-4 DSE-5	BSHP-317-21 BSHP-318-21 BSHP-319-21	Department Specific Elective (DSE)-2	5	1	-	40	60	100	6
		TOTAL	18	4	8	220	280	500	26

Department Specific Electives -1 and 2 (Any two from the following list)

S. No.	Name of the Subject	Code
1	Atomic and Molecular Physics	BSHP-315-21
2	Nuclear Physics	BSHP-316-21
3	Dissertation	BSHP-317-21
4	Communication Electronics	BSHP-318-21
5	Renewable Energy and Energy Harvesting	BSHP-319-21

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Kapurthala, Punjab-14460.

PHYSICS-DSE BSHP-316-21 Nuclear Physics L-5, T-1, P-0 6 Credits -2

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The course contents cover general properties of nuclei, nuclear models, radioactive decays, nuclear reactions, fission and fusion processes and applications, interaction of gamma ray, charged particles and neutrons radiation with matter and respective detectors.

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

CO1	Understand the ideas of basics of nucleus and their energy.
CO2	Understand the procedures for nuclear fission and fusion.
CO3	Understand the relationship between various types of couplings.
CO4	Ability to have insight into the interplay between theory, models, and data from modernexperiments and into how the major open questions are being addressed.
CO5	A basic understanding of nuclear properties and models that describe the quantum structure, decay, and reactions of nuclei.

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Detailed Syllabus

PART A

UNIT-I

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

Radioactivity decay: (a) Alpha decay: basics of α -decay processes, radioactive series, tunnel theory of α emission, Gamow factor, Geiger Nuttall law, α -decay spectroscopy. (b) β -decay: β -, β +, EC decays, beta energy spectrum, end point energy, Gamma decay: Gamma rays' emission & kinematics, internal conversion. (16 Lectures)

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UNIT-II

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force, Meson theory of nuclear forces. **(14 Lectures)**

PART B

UNIT-III

Nuclear Reactions: Types of Reactions, Coulomb scattering (Rutherford scattering), Coulomb barrier, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction.

Fission and Fusion: Nuclear reactors, Breeder reactors, nuclear fusion in stars, formation of heavier elements, nuclear reactor accidents – Chernobyl and Fukushima, nuclear weapons, Fusion reactors, International thermonuclear experimental reactor (ITER). (15 Lectures)

UNIT-IV

Interaction of radiation and charged particles with matter: Interaction of gamma rays with matter - photoelectric effect, Compton scattering, pair production, Energy loss of electrons and positrons, Positron annihilation in condensed media, Stopping power and range of heavier charged particles, derivation of Bethe-Bloch formula, neutron interaction with matter.

Nuclear Detectors: Gas-filled detectors: ionization chamber, proportional counter and GM Counter. Basic principle of Organic and Inorganic scintillation detectors for gamma and electron radiation, photo-multiplier tube, Semiconductor detectors, Solid state nuclear track detectors, Neutron detector, Cherenkov detector, radiation monitoring devices. (15 Lectures)

Reference Books:

- 1. Introductory Nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- 2. Concepts of Nuclear Physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- **3.** Concepts of Modern Physics by Arthur Beiser, Shobit Mahajan and S. Rai Choudhury (Tata Mcgraw Hill, 2006).
- 4. Modern Physics by J. Bernstein, Paul M. Fishbane, S. G. Gasiorowicz (Pearson, 2000).
- 5. Introduction to the physics of Nuclei & Particles, R.A. Dunlap. (Thomson Asia, 2004).
- **6.** Basic ideas and concepts in Nuclear Physics An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
- 7. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- **8.** Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
- 9. Theoretical Nuclear Physics, J.M. Blatt &V.F.Weisskopf (Dover Pub.Inc., 1991).

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PHYS -3	ICS-I	DSE B	SHP-3:	L7-21	DISS	ERTAT:	ION	L-	5, T-1,	P-0	6 Cr	edits
Pre-re	equis	ite: Unde	rstandin	g of Ph	ysics an	d Mathe	matics					
Cours	se Obj	jectives:										
Cours	se Out	tcomes:	At the e	nd of th	e course	e, the st	udent w	vill be ab	ole to			
СО	1	Explain to			and val	ue of pr	oblem ir	n physics	s, both s	scientific	ally and	in the
СО	2	Design experime		rry out	experir	nents a	is well	as acci	urately	record	the res	ults o
СО	3	Critically appropri						strategi	es and	decide	which is	s mos
СО	4	Research physics.	n and co	ommuni	cate sci	entific k	nowledg	ge in the	e conte	ct of a t	opic rela	ated to
CO	5	Explore	new are	as of re	search i	n physic	s and a	llied field	ds of sci	ence an	d techno	ology.
		Мар	ping of	course	e outco	mes w	ith the	progra	m outc	omes		
	PO1	PO2	PO3	PO4	PO5	P06	P07	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
СОЗ	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

Guidelines:

- The aim of project work in B.Sc. (H.S.) 5th semester is to expose the students to Instrumentation, Power Electronics, Microcontroller, Digital communication.
- It may include development of pulse processing electronic modules, power supplies, softwarecontrolled equipment in a research laboratory, or fabrication of a device. Project work based on participation in some ongoing research activity or analysis of data or review of some research papers is included.
- A student will work under the guidance of a faculty member from the department before the end of the 5th semester.
- A report of nearly 40 pages about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the Department.
- Assessment of the work done under the project will be carried out by a committee based on grasp of the problem assigned, efforts put in the execution of the project, degree of interest shown in learning the methodology, report prepared, and viva-voce/seminar, etc., as per guidelines.

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PHYS DSE-4		В	SHP-3:	18-21		MUNIC		L-	5, T-1,	P-0	Cre	edits
Pre-re	equisi	i te: Unde	rstandin	g of ser	nior seco	ondary l	evel Phy	sics and	Mather	matics		
interpo and be	stand ret an e able	pjectives and use d analyze to design	the basi the ch the sim	ic conce naracteri nplest de	epts of t istics of evices ar	the circu the ma nd trans	its four ain comp mitting	nd in rac ponents the sign	diocomn of com als.	nunicatio nmunicat	ons, be	able to
Cours	e Out	comes:	At the (end of t	the cou	ırse, stı	udents	will be	able to)		
СО	1	Introduc	ed to th	e comm	unicatio	nmetho	ds mear	ns and r	nodes.			
СО	2	Compare	the pe	rforman	ce of AN	۸, FM ar	nd PM so	chemes	with ref	erence t	o SNR	
CO	3	Understa										
СО		Evaluate	the per	formand	ce of PC	M, DPCI	M and D	Minac	digital co	mmunic	cation sy	/stem
СО	5	Identify									ınicatior	link
		Мар	ping of	course	outco	mes wi	th the	prograi	m outc	omes		
	PO1	PO2	PO3	PO4	PO5	P06	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1

PART A

UNIT-I

CO3

CO4

CO5

Electronic communication: Introduction to communication – means and modes. Need for modulation. Block diagram of an electronic communication system. Basic principles of propagation of e. m. waves through atmosphere and ionosphere, Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to- noise (S/N) ratio. (10 Lectures)

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UNIT-II

AM Transmission and Reception: Mathematical analysis of AM, Power content of sidebands and carrier, Generation of AM signals, switching modulator, square law modulation, double sideband suppressed carrier modulation, Ring modulator, Coherent detection, Costas receiver, Receiver Parameters; Selectivity, Sensitivity, Fidelity, Super heterodyne Receiver. Generation of SSB signals; Filter method, Phase-shift Method, Demodulation of SSB-SC signals. Transmission and reception of vestigial side band signals.

FM Transmission and Reception: Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, FM allocation standards, generation of FM signals, Direct and Indirect FM, Diode reactance modulator, Phase-Locked-Loop, Armstrong method, RC phase shift method, Frequency stabilized reactance FM transmitter. Frequency demodulators tuned circuit frequency discriminators; FM stereo multiplexing, FM detection using PLL. **(16 Lectures)**

PART B

UNIT-III

Analog Pulse Modulation: Channel capacity, Sampling theorem, Basic Principles-PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing.

Digital transmission – Need for digital transmission, Pulse code modulation, Sampling, Aliasing, quatisation error, Digital carrier modulation and demodulation techniques: Information capacity, Shannon limit of information capacity, ASK, FSK, PSK, Differential encoder and decoder, Differential PSK, modulators and detectors, Scrambling and descrambling.

Advanced communication: Overview of picture and sound transmission and reception, channel band width, television standards, Block diagram of T.V. receivers, Concept of colour picture transmission. (15 Lectures)

UNIT-IV

Satellite Communication: Introduction, need, Geosynchronous satellite orbits, geostationary satellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and downlink. FDMA, TDMA, CDMA, SDMA.

Mobile Telephony System – Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, simplified block diagram of mobile phone handset, 2G, 3G 4G and 5G concepts (qualitative only).

GPS navigation system (qualitative idea only)

(14 Lectures)

TUTORIALS: Relevant problems on the topics covered in the course.

Reference Books:

- 1. Communication Systems: B.P. Lathi, Wiley Eastern Limited.
- 2. Communication Systems, S. Haykin, 2006, Wiley India
- 3. Principles of Communication Systems: Taub and Schilling, John Wiley and Sons.

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- 4. Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
- 5. Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
- 6. Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGraw Hill.
- 7. Principles of Electronic communication systems Frenzel, 3rd edition, McGraw Hill
- 8. Electronic Communication system, Blake, Cengage, 5th edition.
- 9. Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press
- 10. Digital Computer Electronics: Albert P. Malvino, Jerald A Brown Tata-McGraw Hill.
- 11. Digital signal Transmission: C.C. Bissell and D.A. Chapman, Cambridge University Press.

-5	SICS-I				AND	ENERG VESTIN	IG			-1, P-0	6 C	redits
Pre-r	equis	i te: Unde	erstandir	ng of ser	nior seco	ondary	evel Phy	sics an	d Mathe	matics	-	
stuae.	nts but	jectives:	ae tnem	with ex	posure	and har	nds-on le	earning	whereve	etical kno er possib	owledge le	to the
Cours	se Out	comes:	At the e	nd of th	e cours	e, the st	tudent w	vill be al	ole to			
CO)1	Understa alternati	and the	energy of	demand gy.	of wor	d & dist	inguish	betweer	n traditio	nal and	
CO)2	Describe	the cor	ncept of	solar er	nergy ra	diation a	and the	rmal apr	olications		
CO	3	Analyze	making	of solar	cell and	its typ	es.					
CO	4	Identify						and tra	nsporta	tion met	hods	
СО	5	Compare										
	-			course							,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
	PO1	PO2	PO3	PO4	PO5	P06	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	1	3	1	1

PART A

UNIT-I

Introduction to alternate sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. Renewable energy source, Types of

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Head of Department Department of Physics I.K.Gujt, Punich fechnical University Jalandhar, Kapurthala, Punjab-144603 renewable energy, zero-carbon or low-carbon energy, Working of renewable energy sources: Solar energy, Wind energy, Hydro energy, Tidal energy, Geothermal energy, Biomass energy, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. Scope and future of renewable energy.

(11 Lectures)

Unit II

Solar energy and solar cell: Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

(13 Lectures)

PART B

UNIT-III

Hydrogen Energy: Solar hydrogen through photo electrolysis and photocatalytic process, Physics of material characteristics for production of solar hydrogen.

Production storage and transportation: Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells, hydride batteries. **(15 Lectures)**

UNIT-IV

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices, Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass, Geothermal Energy: Geothermal Resources, Geothermal Technologies. Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials, and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications.

(15 Lectures)

Demonstrations and Experiments

- 1. Demonstration of Training modules on Solar energy, wind energy, etc.
- 2. Conversion of vibration to voltage using piezoelectric materials
- 3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books:

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I.K.Gujin Punjab fechnical University Jalandhar

Kapurthala, Punjab-144600

PHYSI	CS-C	B	SHP-31	3-21	PHYS	ICS LA	B-VII	L-(), T-0, I	P-4	2 Cre	edits
Pre-re	quisi	te: Under	standin	g of sen	ior seco	ndary le	evel Phys	sics and	Mathen	natics		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
Cours formal	e Obj struct	ectives: ure of so	The aim lid state	and ob physics	jective so that	of the la	ab cours n use th	se is to ese as p	introduc per their	ce the st	tudents ment.	to the
Cours	e Out	comes:	At the er	nd of th	e course	, the st	udent w	ill be ab	le to			
СО	1	Able to v	erify the	e theore	etical cor	ncepts/la	aws lear	nt in the	eory cou	rses.		
СО		Trained in carrying out precise measurements and handling sensitive equipment.										
СО	3	Understa					estimati	ng and	d dealir	ng with	experi	menta
СО	4	Learn to	draw co	nclusio	ns from	data an	d develo	p skills	in expe	rimental	design.	
СО	5	Docume	nt a tech	nnical re	eport wh	ich com	municat	es scier	itific info	ormation	in a cle	ar and
		concise manner.										
		Мар	ping of	course	e outco	mes wi	ith the	prograi	m outc	omes		
	PO1	PO2	PO3	PO4	PO5	P06	P07	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
	0.00%									3	1	1

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Detailed Syllabus:

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

List of Experiments:

- 1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
- 2. To measure the Magnetic susceptibility of Solids.
- 3. To determine the Coupling Coefficient of a Piezoelectric crystal.
- 4. To measure the Dielectric Constant of a dielectric Materials with frequency
- 5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
- 6. To determine the refractive index of a dielectric layer using SPR
- 7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
- 8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
- 9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 oC) and to determine its band gap.
- 10. To determine the Hall coefficient of a semiconductor sample.
- 11. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
- 12. To study of Zeeman effect: with external magnetic field; Hyperfine splitting
- 13. To show the tunneling effect in tunnel diode using I-V characteristics.
- 14. Quantum efficiency of CCDs

Reference Books

- 1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing
- 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.

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PHYS	ICS-C					PUTATI		L-(O, T-O,	P-4	2 Credits	
Pre-re	equisit	e: Under	rstandin	g of ser	nior seco	ndary le	evel Phys	sics and	Mather	natics		
Cours formal proble	struct	ectives: ure of co	The aim mputati	and ob onal phy	ojective ysics so	of the lather	ab cours ey can u	se is to se these	introdu e essent	ce the s ial to sol	tudents Ive the p	to the
Cours	e Out	comes:	At the e	nd of th	e course	e, the st	udent w	ill be ab	le to			
СО	1	Able to v	erify the	e theore	etical cor	ncepts/la	aws lear	nt in the	eory cou	ırses.		
СО	2	Trained	in carryi	ng out	orecise r	neasure	ments a	nd hand	dling ser	nsitive e	quipmer	nt.
СО	3	Understa uncertair	and the	meth	ods use	ed for	estimat	ing and	d dealir	ng with	experi	menta
CO	4	Learn to	draw co	onclusio	ns from	data an	d develo	op skills	in expe	rimental	design.	
СО	5	Docume concise i	manner.								in a cle	ar and
		Мар	ping of	course	e outco	mes wi	th the	prograi	m outc	omes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	-	1	2	1	2	3	2	2
CO2	2	2	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
004	2	2	2	2	1	1	2	1	1	3	1	1
CO4						1	2	1	1	3	1	1

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Note: Students are expected to perform atleast 10 experiments out of following list using C++ and Gnuplot.

List of experiments:

- 1. To find the standard deviation, mean, variance, moments etc. of at least 15 entries.
- 2. To compile a frequency distribution and evaluate mean, standard deviation etc.
- 3. To evaluate sum of finite series and the area under a curve.
- 4. To find the product of two matrices
- 5. To find a set of prime numbers and Fibonacci series.
- 6. To write program to open a file and generate data for plotting using Gnuplot.
- 7. To choose a set of 10 values and find the least squared fitted curve.
- 8. Plotting trajectory of a projectile projected horizontally.
- 9. Plotting trajectory of a projectile projected making an angle with the horizontally.
- 10. To find the roots of a quadratic equation.
- 11. Motion of a projectile using simulation and plot the output for visualization.
- 12. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
- 13. Motion of particle in a central force field and plot the output for visualization.
- 14. To find the determinant of a matrix and its eigenvalues and eigenvectors.
- 15. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.

Text and Reference Books:

- 1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford & IBH Book Co.) 6th ed., 1979.
- 2. A first course in Computational Physics: P.L. DeVries (Wiley) 2nd edition, 2011.
- 3. Computer Applications in Physics: S. Chandra (Narosa) 2nd edition, 2005.
- 4. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 2000.
- 5. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 4th edition 2008.

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- 1. Non-conventional energy sources G.D Rai Khanna Publishers, New Delhi
- 2. Solar energy M P Agarwal S Chand and Co. Ltd.
- 3. Solar energy Suhas P Sukhative Tata McGraw Hill Publishing Company Ltd.
- **4.** Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.
- 5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
- 6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

SEMESTER-VI

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Sixth Semester

Coursetype	Course Code	Course Title		Loa	d ti on	The second of the second	rks bution	Total Marks	Cr
DI IVCICO O			L	T	P	Internal	External		1
PHYSICS-C- 13	BSHP-321-21	Electromagnetic Theory	5	1	-	40	60	100	6
PHYSICS-C- 14	BSHP-322-21	Statistical Mechanics	3	1	-	40	60	100	4
PHYSICS-C-	BSHP-323-21	Physics Lab -VIII	-	-	4	30	20	50	2
	BSHP-324-21 BSHP-325-21	Department Specific Elective (DSE)-3	5	1	-	40	60	100	6
DSE-9	BSHP-326-21 BSHP-327-21 BSHP-328-21	Department Specific Elective (DSE)-4	5	1	-	40	60	100	6
		TOTAL	18	4	4	190	260	450	24

Department Specific Electives- 3 and 4 (Any two from the following list)

S. No.	Name of the Subject	Code
1	Particle Physics	BSHP-324-21
2	Advanced Mathematical Physics	BSHP-325-21
3	Advanced Condensed Matter Physics	BSHP-326-21
4	Experimental Techniques	BSHP-327-21
5	Radiation Safety	BSHP-328-21

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	ICS-C			23-21			B-VIII		0, T-0,	P-4	2 Cı	redits	
Pre-r	equisi	i te: Unde	rstandir	ng of ser					Mathe	matics			
Cours and to	se Obj	jectives: experime	The lab ental phy	oratory sics and	should d data a	help the nalysis.	e studen	t devel	op a bro	oad arra	y of bas	sic skills	
Cours	e Out	comes:	At the e	nd of th	e cours	e, the s	tudent w	rill be at	ole to				
CO	1	Able to verify the theoretical concepts/laws learnt in theory courses.											
CO	2	Trained	in carryi	ng out p	precise i	measure	ements a	nd han	dlina se	nsitive e	auipmei	nt.	
СО	3	Understa uncertain	and the	e metho	ods use	ed for	estimati	ing and	d deali	ng with	exper	imental	
СО	4	Learn to		100000000000000000000000000000000000000	The second secon		nd develo	op skills	in expe	rimental	design		
СО	5	Documer concise r	nt a tecl	nnical re	port wh	nich com	nmunicat	es scier	ntific info	ormation	in a cle	ear and	
				course	outco	mes w	ith the	progra	m outc	omes			
	PO1	PO2	PO3	PO4	PO5	P06	PO7	PO8	PO9	PO10	PO11	PO12	
CO1	2	1	2	1		1	2	1	2	3	2	2	
CO2	2	2	1	2	1	1	1	1	1	3	1	1	
CO3	3	2	2	2	1	1	2	1	1	3	1	1	
CO4	2	2	2	2	1	1	2	1	1	3	1	1	
CO5	2	2	2	2	1	1	2	1	1	3	1	1	

Note: Students are expected to perform 8-10 experiments from the list taking at least 2-3 from the virtual lab.

List of Experiments:

- 1. To verify the law of Malus for plane polarized light.
- 2. To determine the specific rotation of sugar solution using Polarimeter.
- 3. To analyze elliptically polarized Light by using a Babinet's compensator.
- 4. To study dependence of radiation on angle for a simple Dipole antenna.
- **5.** To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
- **6.** To study the reflection, refraction of microwaves.

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- 7. To study Polarization and double slit interference in microwaves.
- 8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
- **9.** To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
- **10.** To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
- 11. To verify the Stefan's law of radiation and to determine Stefan's constant.
- 12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

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. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

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PHYSICS-DSE -9		EXPERIMENTAL TECHNIQUES	L-5, T-1, P-0	6 Credits
Pre-requisite: U	nderstanding of sen	incr secondary lavel by		

Pre-requisite: Understanding of senior secondary level Physics and Mathematics

Course Objectives: The aim of course is to introduce students to basic experimental techniques, measurement theory and experiment design. The primary goal is to develop an appreciation of the role and significance of experimentation in the field of science. Students will be exposed to some widely employed experimental techniques and be introduced to some of the instrumentation that is used in experimental physics research.

	Course Outcomes: At the end of the course, the student will be able to
ĺ	CO1

CO1	mastered the use of digital multimeters and oscilloscopes to measure DC and AC voltages and currents.									
CO2	mastered the assessment of reasonable experimental uncertainty in a variety of different measurements and understood how to minimize that uncertainty.									
CO3	rigorously analyzed experimental data using accepted error analysis methodologies to verify theoretical predictions.									
CO4	Use the tools, methodologies, language and conventions of physics to test									
CO5	learned to efficiently search the scientific literature and critically assess the scientific merit of what they read.									
	Mapping of course outcomes and the									

Mapping of course outcomes with the program outcomes

	PO1	PO2	PO3	PO4	PO5	P06	PO7	PO8	POG	PO10	DO11	0013
CO1	2	1	2	1	-	1	2	1	103	7010	PUII	PU12
CO2	2	2	1	2	- 1	1	_	1	2	3	2	2
	-	-	1	2	1	1	1	1	1	3	1	1
CO3	3	2	2	2	1	1	2	1	1	3	1	1
CO4	2	2	2	2	1	1	2	1	1	3	1	1
CO5	2	2	2	2	1	1	2	1	-1			.l.
				N	_	1		T	1	3	1	1.

PARTA

UNIT-I

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Gaussian distribution. (10 Lectures)

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UNIT-II

Signals and Systems: Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise.

Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference. (14 Lectures)

PART B

UNIT-III

Transducers & industrial instrumentation (working principle, efficiency, applications): Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.

(16 Lectures)

UNIT-IV

Digital Multimeter: Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy, and resolution of measurement.

Impedance Bridges and Q-meter: Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge.

Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization). (12 Lectures)

Reference Books:

- 1. Measurement, Instrumentation and Experiment Design in Physics and Engineering,
- 2. M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
- 3. Experimental Methods for Engineers, J.P. Holman, McGraw Hill
- 4. Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt.
- 5. Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
- 6. Instrumentation Devices and Systems, C.S. Rangan, G.R. Sharma, V.S.V. Mani, Tata McGraw
- 7. Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
- 8. Electronic circuits: Handbook of design & applications, U.Tietze, Ch.Schenk, Springer

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PHYSICS- DSE-10			HP-32		RADIA SAFET	Υ			, T-1, F			
Pre-re	quisit	e: Under	standing	of sen	ior secor	ndary le	vel Phys	ics and	Mathem	natics		
hazard: done ir	s and s conti	ctives: safety. Ti nuation o	he list of of the top	f labora pics.	itory skil	lls and e	experime	ents liste	ea belov	ing regai v the co	rding rad urse are	diation to be
Course		omes: A							e to			
CO1 Understand the basics of nuclear and particle physics.												
CO2 Students will demonstrate kn					te know	ledge of	radiatio	n safety	/.	d a u a t a	nd tho	impac
CO3 Students will use critical the of radiation hazardous.												
CO4		Compare the effects of radiation has on a variety of biological and non-biological materials. account for the role of radiation physics in a societal context, including climate and										
CO	5	onvironn	nontal ch	hallenge	25						ig ciiria	
		Мар	ping of	course	e outco	mes wi	th the	prograi	n outc	omes		
	PO1	PO2	PO3	PO4	PO5	P06	PO7	PO8	PO9	PO10	PO11	PO1
CO1	2	1	2	1	† -	3	2	1	2	3	2	2
CO2	2	2	1	2	1	3	1	1	1	3	3	2
CO3	3	2	2	2	1	3	2	1	1	3	3	1
CO4	2	2	2	2	1	3	2	1	1	3	3	1
CO5	2	2	2	2	1	3	2	1	1	3	2.	1
		llabus:	1						1		Assessment of the same of	

PART A

Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half-life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, (15 Lectures) fission.

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UNIT-II

Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, Interaction of Photons - Photo- electric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, Interaction of Charged Particles: Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), Interaction of Neutrons- Collision, slowing down and Moderation.

(15 Lectures)

PART B

UNIT-III

Radiation detection and monitoring devices: Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). Radiation detection: Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry. (15 lectures)

UNIT-IV

Radiation safety management: Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management.

Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses: Tracing, Gauging, Material Modification, and Food preservation. (15 Lectures)

Reference Books:

- 1. W.E. Burcham and M. Jobes Nuclear and Particle Physics Longman (1995)
- 2. G.F. Knoll, Radiation detection and measurements
- 3. Thermoluninescense Dosimetry, Mcknlay A.F., Bristol, Adam Hilger (Medical Physics Handbook)
- 4. W.J. Meredith and J.B. Massey, "Fundamental Physics of Radiology". John Wright and Sons, UK, 1989.
- **5.** J.R. Greening, "Fundamentals of Radiation Dosimetry", Medical Physics Hand-Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
- Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
- A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.
- 8. W.R. Hendee, "Medical Radiation Physics", Year Book Medical Publishers Inc. London, 1981.

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