STUDENT'S HAND BOOK

Programmes Ph. D.(Physics), Ph.D. (Electronics)
M. Sc. (Physics) / M. Sc. (Electronics)
B.Sc.(Hons.) Physics & B.Sc.(Hons.) Electronics

Academic Session (2022 – 2023)

Department of Pure & Applied Physics

Guru Ghasidas Vishwavidyalaya
(A Central University Established by the Central University Act, 2009 No. 25 of 2009)

Bilaspur (C.G.) – 495 009

For office use only

Personal Details
(Office copy)

Photograph

Name :………………………………..

Course :……………………………….

Father's Name :………………………………

Mother's Name : ………………………………

Date of Birth : ………………………………

Blood Group : ………………………………

Address
Permanent : ………………………………

: ………………………………

: ………………………………

Local : ………………………………

: ………………………………

Telephone……………………

Mobile……………………….

E-mail………………………..

Local Guardian : ………………………………

Person to contact : ………………………………(in case of emergency)

Telephone/ mobile : ………………………………

Other information : ………………………………

Signature of Local Guardian Student's Signature

*Note: To be filled by the student and submitted in the office.

Personal Details
(Student's copy)

Name :………………………………..

Course :……………………………….

Father's Name :………………………………

Mother's Name : ……………………………..

Date of Birth : ……………………………..

Blood Group : ……………………………..

Photograph

Address

Permanent : ……………………………..

: ……………………………..

: ……………………………..

Local : ……………………………..

: ……………………………..

Telephone……………………

Mobile……………………….

E-mail………………………..

Local Guardian : ……………………………..

Person to contact : ……………………………..(in case of emergency)

Telephone/ mobile : ……………………………..

Other information : ……………………………..

Signature of Local Guardian Student's Signature

Message from Vice – Chancellor

Prof. Alok Kumar Chakrawal
Vice - Chancellor
Guru Ghasidas Vishwavidyalaya
Bilaspur (C.G.)-495009, India
Email- alochak69@gmail.com

Imparting quality education, transfer and upgradation of knowledge, pursuing researches in emerging areas for generating new ideas and concepts, are the well defined objectives of any university system.

Guru Ghasidas Vishwavidyalaya, a Central University established under the Central Universities Act, 2009 on January 15, 2009, provides immense scope, not only for excellence in academic achievements, but also in the development of human values and ethics with contemporary requirements. The university aims to inculcate a blend of resources for academic, cultural and intellectual development. It has posed challenges of pursuing and achieving the objectives of quality education and excellence in research. With this perspective, **Department of Pure & Applied Physics** has a major responsibility of imparting training for achieving these objectives in the specialized areas of Physics and Electronics.

Department of Pure & Applied Physics has established and maintained good ambience and infrastructure for research and training in different areas of Physics. Department has developed competitive laboratory facilities for training and research. It has already taken a major initiative of establishing 3.0 MV particle accelerator. Once established, this will provide facilities for goal oriented material development and modifications using ion beam analysis for high end applications in critical technology areas and also be useful for inter-disciplinary research. I am sure that the **Department of Pure and Applied Physics** will fulfill the interests and aspirations of the incoming students of the university through its various courses and programs.

I wish for the best academic environment and enlightened learning opportunities for both the students and faculty of the university. I am wishing them good luck for the forthcoming academic session.

Prof. Alok Kumar Chakrawal

Message from Head of the Department

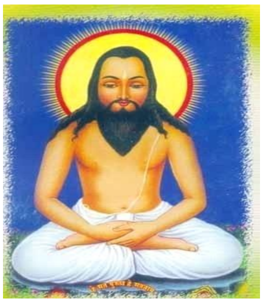
Prof. M. N. Tripathi
Professor & Head
Department of Pure & Applied Physics
Guru Ghasidas Vishwavidyalaya
Bilaspur (C.G.), India
E- mail: ommadhav27@gmail.com
Phone: 099814-01993

Dear Student,

Congratulations, for being the part of tradition that is committed for nurturing scientific values and inculcate zeal for development. We welcome you in the department that possess congenial academic atmosphere and has all possible ingredients for your bright future. The quality education and state of art training that we always attempt to impart and imbibe within you is only possible with your commitment, diligence, dynamism and enthusiasm. We hope your stay here will certainly enhance the knowledge as well as creativity within you. Your fellow seniors have put their best in building the image of this department and it is up to you to carry forward this image further. This handbook is designed to acquaint you regarding the details of academic program chosen by you. It also covers information about the department in particular and University in general. I am sure this will be of immense help for you all. Wishing you all success in your future endeavors,

Prof. M.N. Tripathi

About the University



Guru Ghasidas Vishwavidyalaya, is a Central University of India, located in Bilaspur C.G. State, established under Central Universities Act 2009, No. 25 of 2009. Formerly called Guru Ghasidas University (GGU), established by an Act of the State Legislative Assembly, was formally inaugurated on June 16, 1983. GGU is an active member of the Association of Indian Universities and Association of Commonwealth Universities. The National Assessment & Accreditation Council (NAAC) has accredited the University as B+. Situated in a socially and economically challenged area, the university is appropriately named to honor the great Satnami Saint Guru Ghasidas (born in 17th century), who championed the cause of the downtrodden and waged a relentless struggle against all forms of social evils and injustice prevailing in the society. The lush green sprawling campus of the university spread over an area of 875 acres is located 5 K.M. away from the main Bilaspur town, the city of Bilasa. The river Arpa, the lifeline of Bilaspur runs parallel to the university campus. Bilaspur is a fast industrializing city, already having large number of industrial units coming up in the region.

The city is well connected with all parts of country by road and rail. Being a railway Zone, Bilaspur facilitates travel by train to and from any part of country 120 K.M. away, at Raipur, the capital of Chattisgarh is the nearest airport.

The University is a residential cum affiliating institution, having its jurisdiction spread over Bilaspur Revenue Division of the state of Chhattisgarh. The university covers almost the total spectrum of higher education, University teaching department and about 125 affiliated colleges offering various courses in area of Arts, Commerce, Education, Engineering and Technology, Law, Humanities, Life Sciences, Management, Pharmacy, Physical Sciences and Social Sciences.

Department Profile

Department of Pure and Applied Physics, one of the premier departments of University, was established in 1995. Since its inception, it has been actively involved in teaching and research activities. The department has grown by itself and emerged as the leader of the science education in this region of central India.

The department is having 20 teaching faculty, including two professors. The image of any teaching institute is framed through the quality of its faculty, the department is proud to have highly qualified and acclaimed faculty members. The diversity of the research areas of our faculty makes this department unique in itself. The department offers teaching and research programs in Experimental & Theoretical Condensed Matter Physics, Experimental Materials Science, Experimental Nuclear Physics, Spectroscopy and Plasma Physics.

The department offers wide ranging courses, such as UG/PG program in Physics & Electroincs, two years M. Sc. in Physics & Electronics, Ph. D. (Physics & Electronics). New specializations Nuclear Physics, Astophysics, and Accelerator Physics are going to be offered in coming sessions at Masters level along with the presently offered Material Science.

Department is proud to share the information about the lab facilities offered to the both UG/PG students. Department is having well equipped laboratories for general physics, mechanics, heat and thermodynamics, optics, electronics, and computational techniques. Advanced material characterization facilities such as, Scanning Electron Microscopy, Atomic Force Microscopy, Fourier Transform–Infrared spectroscopy, UV–Vis spectrophotometer, and X–ray diffractometer are available for the M. Sc. students & research scholars of the department as central facility. Department has its own library which provides rich resources for both students and researchers.

Department had established a 3 MV high current pelletron accelerator facility. This facility make us to stand in the national science picture as one of the emerging research department of the country. The Installed facility provides an opportunities to carry out interdisciplinary research work in various branches of science.

The department is having dynamic academic activity by coordinating regular seminars of eminent science personalities, workshops, and symposia which provide excellent opportunities particularly to the UG/PG students of the department.

The department is having its own training and placement cell, which trains students for national level entrance examinations, looks after their placement at various research institutes and industry. Students from the department are encouraged to appear in national level examinations like, NET, GATE, JEST etc.

Department is striving very hard to improve the quality of Physics education to stand as one of the leading science education centers in the country. We express our deep desire to work with the new students to make their lives brighter.

WE WELCOME YOU TO OUR DEPARTMENT

Faculty Profile

Dr. P. K. Bajpai
Professor and Dean
Mail:bajpai.pk1@gmail.com
Mobile: +91-9424154024

Research Interests: Experimental Condensed Matter Physics/ Material Science, Vibrational spectroscopy of structural phase transitions, Bio-spectroscopy, Electronic ceramic materials and Bio-photons

Prof. H. S. Tewari
Professor
E-mail:tewari.hs@gmail.com
Mobile: 91-9424140587
Research Interests: Dielectric, Ferroelectric ceramics, Glass ceramics, Nanomaterials and Oxide based sensor materials,

Prof. Madhvendra Nath Tripathi
Professor
Email:ommadhav27@gmail.com
Mobile: +91-9981401993

Research Interests: Density Functional Theory, Thermoelectric materials, transport properties of solids and computational material science, Optoelectronic materials.

Prof. Parijat Thakur
Professor
Email: parijatthakur@yahoo.com
Contact No.- 075870-96051

Research Interest: Astronomy & Astrophysics, Investigating Transiting Exoplanets, Stellar Photometry, X-Ray Studies of Galactic Binaries, Galactic Structure and Dynamics, Galaxy Surface Photometry, Structure and Evolution of Barred Galaxies, NBODY PMSPH & TREESPH Simulations, Astronomical Image Processing.

Dr. R. P. Patel
Associate Professor
Email- dr_rppatel@rediffmail.com
Contact No.- 70009-89789
Resarch Interest: Optoelectronic Properties of Materials , Synthesis and characterization of Nanophosphors & Nano Materials, Electroluminescence, Mechnoluminescence, Photoluminescence, Thermoluminescence, While LED materials, Solar cell materials

Arun Kumar Singh
Associate Professor
Email - arunsingh.itbhu@gmail.com
Contact No.- 094540-60837

Resarch Interest: Electronic and Optoelectronic Properties of Materials, Charge transport in Nanomaterials and Organic Semiconductors ,Applications of Materials in Electronic Devices, Metal-Semiconductor Interfaces and Physics of Electronic Devices, Conducting Polymers, Organic/Molecular Electronics & Energy Materials

Dr. Jai Singh
Associate Professor
Email - jai.bhu@gmail.com
Contact No.- 94244-59805

Resarch Interest: Two Dimensional Materials, Graphene Oxide, Nano Material, Energy Materials, Nano phosphors and Bio-imaging , Thermoelectric Materials, Multiferroic

Dr. Rajesh Sharma:

Associate Professor
Email- sharma_rajesh1234@yahoo.com
Contact No.- +918894118606

Resarch Interest:
Terahertz radiations, ultrafast optics, Condensed matter physics, Nanomaterials

Dr. R.K.Pandey
Assistant Professor
Email - rkpandey_ggu@yahoo.com
Contact No.- 098265-60597

Research Interest: Material Science, Thin films, Optoelectronics Devices Optical Communication, Nano-materials and Devices

Dr. M.P.Sharma
Assistant Professor
Email - mps.phy@gmail.com
Contact No.- 094790-39965

Research Interest: Materials Science, Multiferroics and Magnetic Oxide materials

Dr. Goverdhan Reddy Turpu

Assistant Professor
E-mail:dr.tgreddy@gmail.com
Mobile No: +91-8963901321
Research Interests: Experimental condensed matter physics and low temperature physics

Mr. Pachineela Rambabu
Assistant Professor
E-mail: rams.hcu@gmail.com
Mobile No: +91-9074508220

Rsearch Interest: Magnetic Materials, Density functional Theory

Dr. Pradip Das

Assistant Professor
Email - pradipd.iitb@gmail.com
Contact No.- 094077-34453

Research Interest: Quantum transport properties of three dimensional topological insulators · Topological Phases in Weyl semimetals (WSM) and Dirac semimetals (DSM) · Topological Hall Effect · Crystal growth and low temperature properties of strongly correlated electron systems

Dr. Shiv Poojan Patel
Assistant Professor
Email - shivpoojanbhola@gmail.com
Contact No.- 094792-46120
Research Interest: Accelerator Physics, Nuclear Materials, Ion Induced Materials Modification, Ion Beam Analysis, Thermoelectric Materials, Perovskite Solar Cell, Experimental Condensed Matter Physics/Materials Science

Dr. Dinesh Uthra
Assistant Professor
Email - dkuthra@rediffmail.com, dkuthra45@gmail.com
Contact No.- 94063-54309 ,+91-91319-02773
Research Interest: Material Science ,Manganites Materials , GMR, CMR materials, Nano Material, Energy Materials, Nano phosphors and Multiferroic Materials

Dr. Alka Singh
Assistant Professor
Email - singh.alka18@gmail.com
Contact No.- 088390-47690
Research Interest: Advance material, Signal Processing, semiconductor materials , Acoustic signal processing

Dr. Shalinta Tigga
Assistant Professor
Email - shalintatigga@gmail.com
Contact No.- 79991-89306
Research Interest: Luminescence

Dr. Vijaya Kumar
Assistant Professor
Email - kumar.mrc.iisc@gmail.com
Contact No.- 82960-20436.
Research Interest: Materials Science

Dr. Awadesh Kumar Dubey
Assistant Professor
Email- awadhesh1234@gmail.com, awadeshdubey16@gmail.com
Contact No.: 9305331599, 7380553791
Research Interest: Theoretical and soft condensed matter physics, non-equilibrium statistical physics, phenomena far from equilibrium, Cooling of granular gases, mechanical properties of glasses, Silicon Nanowires; Front Propagation in disordered media; theory and simulation of active matter, avalanche phase transaction.

Dr. Devendra Singh
Assistant Professor
Email- devinderbhu@yahoo.com
Contact No:9455222876
Research Interest: bulk metallic glasses, quasicrystal, nanomaterials, metastable phases, Heusler alloy, high entropy alloys, electron microscopy. X-ray diffraction, phase transformation, rapid solidification, micro- and nanoindentation, structure (microstructure) property correlation etc.

Technical and Support Staff

Shri Khem Kumar Kurre	UDC
Mr. Jai Dev Dewangan	Technical Officier
Sri Sandeep Ram	Senior Technical Assistant
Shri Rajendra Pandey	Senior Technical Assistant
Shri Santosh Tiwari	Library & Office Assistant
Shri Chandra Nath Mishra	Office Assistant
Shri Ram Gopal Sao	MTS
Shir Salik Ram Sahu	MTS
Sri Yashwant Manhar	Farrash

MAJOR DEPARTMENTAL FACILITIES

COMPUTATIONAL FACILITY

A nodal centre for Computer Application has been established in the Department of Pure and Applied Physics sponsored by University Grants Commission. The centre provides practical training to the post graduate students.

LIBRARY

Departmental library is very rich in specialized text books, reference books and journals particularly in the area of Physical Sciences. It has about 2600 books related to different branches of Physical Sciences. Many International, National Journals and Magazines have been subscribed.

AWARDS AND SCHOLARSHIPS

- The topper of each batch is awarded a Gold Medal and Merit Certificate during the convocation of the University

OTHER SCHOLARSHIPS / AWARDS

1. Merit scholarship of Rs. 10,000/- per year may be extended to any one student from each school of studies, who secures highest score in the examination of respective course at the end of each year. Such scholarship will continue till the student maintains first position alongwith attendance record of 75% in classes and all clear status in semester examination and on the recommendation of the Director/ Dean. In case of otherwise the benefit will be shifted to the other highest score.

2. An amount of Rs. 5,000/- may be extended to students for the particular session, who have participated in any national level sports or games/ events as recommended by Director/ Dean.

3. An amount of Rs. One lac. may be awarded to students for the particular session, who have participated in any international sports/ games/ events as recommended by Director/ Dean.

4. Full free ship of tution fee may be extended to any one student in each department belonging to poor family background, subject to condition that the student maintains attendance record of 75% in classes, all clear status, secures minimum 60% marks in semester examinations (Who is not a recipient of scholarship or financial aid from any other source) as recommended by Director/ Dean.

5. Free meal facility may be extended to all blind students (total blindness) residing in hostels of the University. Their actual mess bill will be reimbursed under the Students Welfare Scheme. The amount will be paid by drawing the bill in Favor of Warden of the concerned hostel.

6. A sum of Rs. 5000/- per year per student in the form of cash may be provided to all blind students (total blindness) of the University as financial assistance to purchase " Teaching Aid" every year, as recommended by the Dean/ Director of concerned school of studies.

7. Hand driven tricycle may be provided to physically handicapped students for movement in the campus and only once during their entire tenure of education in the University. Further, students should have attendance record of 75% in classes and on the recommendation of Dean/ Director of concerned school of studies.

8. An amount of Rs.11,000/- may be awarded to students who have set an example in the campus by their extrordinary task as recommended by DSW/ Chief Proctor/ Chief Warden.

RESEARCH FACILITIES

Scanning Electron Microscope

FT-IR Spectrometer RX-1

Rigaku Miniflex X-ray diffractometer

UV- VIS Spectrophotometer

Single Dip Coating system

HP-4263B LCR meter with external bias Supply, HiokiLCR tester

Automatic PE Loop Tracer system

Atomic Force Microscopy

Dielectric Setup & Spin Coating Units

Dielectric Measurement setup

Thermal evaporation Unit

Differential Scanning Calorimetry

3 MV PARTICLE ACCELERATORS FOR INTER-DISCIPLANIRY RESEARCH

Beam Hall of 3.0 MV Accelerator of Department of Pure & Applied Physics, GGV, Bilaspur

POST GRADUATE
&
UNDER GRADUATE LABORATORIES

GENERAL & OPTICS LABORATORY

- **UV- VIS Spectrophotometer**
- **B-H Hysteresis loop tracer ES-320**
- **Measurement of high resistance by substitution method using digital nanometer ES-287**

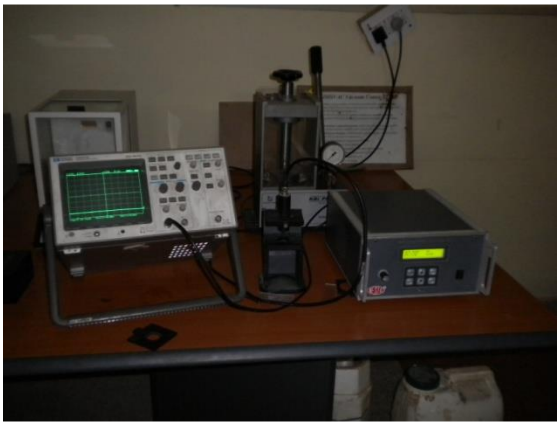
- **Measurement of electron mobility Es-306**
- **Ultrasonic interferometer**
- **Michelson Interferoemeter**

MATERIAL SCIENCE LABORATORY

- Electronic Balance Capacity 200G. Modal N0.- AA2200
- Measurement of Magneto-resistance of Semiconductors
- Four probe arrangement
- Magneto resistance set up DMR-10
- Electromagnet EMU-50
- Constant current power supply DPS-50
- Digital Gauss meter DGM-102
- Temperature Dependent Hall Effect
- Hall effect setup DHE-22
- ESR Spectrometer
- Techno Search Instruments
- Hydraulic press with die set
- KBr Press -15 Ton
- KBr Die-13mm
- Agate Mortar & Pestle 2” Dia
- Spectroscopic grade KBr
- Dry Box
- Nujol Bottle 500 ml
- Microprocessor based PH Analyzer (PHAN) Lab India Instruments Pvt. Ltd.
- High Temp. Furnaces Rated Max. Temp. 1400C
- Electric Agate Mortar Pastle 100 mm dia

NUCLEAR PHYSICS LABORATORY

- Gieger Muller counter
- Scintillation counter
- γ-ray spectrometer
- β - reference sources (^{60}Co, ^{90}Sr, in μCi range)
- γ - reference sources (^{133}Ba,^{137}Cs, in μCi range)
- Lead Shielding
- Gamma Reference Standard Set



MICROWAVE AND COMMUNICATION LABORATORY

X-Band Microwave Bench with Dielectric measurements for solids & liquids

X-Band Microwave Bench for different types of antenna characterization and radiation distribution measurements.

- Klystron power supply KPS-151 (2Nos.)
- Gunn Power supply X111
- VSWR meter (Solid State) VS-411DX
- Tri-pot stand for antenna for polar pattern X-5145
- Microwave power meter with digital readout AT-211B

BASIC ELECTRONICS LABORATORY

- Function generators
- Dual trace oscilloscope
- Digital storage oscilloscope
- IC testers
- Design facilities for Op-Amp, SCR, Gating circuits, counters, resistors, FET, MOSFET based experiments.
- Training kits for analog/ digital communication

OPTICAL FIBER COMMUNICATION LABORATORY

- Advance Fiber Optic Communication Kit (Link-B)
- Physics of Fiber Optic Training Kit (Link-D)
- Laser Diode and Glass Fiber Based Fiber Optic Kit (Link-E)
- He-Ne Laser
- Fiber Optic Power meter

DIGITAL COMMUNICATION LABORATORY

- BPSK/DPSK/DEPSK Modulation/ Demodulation Kit (ADCL-01)
- QPSK/DQPSK Modulation/Demodulation Kit (ADCL-02 / ADCL-03)
- DPCM/ADPCM modulation/Demodulation Kit (ADCL-07)
- Interactive computer based training manuals and software for each kit (05)

MICROPROCESSOR & MICROCONTROLLER LABORATORY

- 8086 Dyna Microprocessors
- Dyna 52 Microcontrollers
- Interfacing Cards
- SMPS and PC interface

Facilities on the campus

Hostel: Hostel facility for boys and girls are available in the campus.

Computer Centre: The University has a sophisticated computer centre equipped with latest versions of hardware and software. The centre has appropriate statistical, scientific and simulation packages to cater to the educational needs. The Centre has installed one VSNL based leased line with 64 Kbps capacity. Students of the Department are eligible to avail the centralized computer facility. The Department has fully air-conditioned computer lab with Wi-Fi facilities well connected with LAN networking and necessary software for management students.

Library: The University has a well stocked up-to-date library containing about 86,000 books, 1650 back volumes of journals and five thousand projects / Ph.D. thesis. Presently, it subscribes about 150 Indian and foreign journals in various disciplines. The reprographic facility on subsidized rate is provided to the users along with other library services. The library has internet facility and library automation with INFLIBNET link. Besides the central library, students can also use the departmental library.

National Service Scheme: The University has a unit of National Service Scheme (NSS) having a total strength of 100 students from the University Teaching Departments. The aim of NSS is to provide an opportunity and working experience for social services. The students participate in various activities like plantation, blood donation, seminar, essay writing, quiz, debate etc..

Post Office and Bank: The residents and students on the Campus are provided with Banking & Communication facilities. Punjab National Bank, Extension Counter (PNB) and Post Office are rendering their services in the campus. ATM (24 hours) facilities as well as online banking have been recently introduced by the PNB. Also ATM (24 hours) facilities by State Bank Of India is available in the campus. A new electronic telephone exchange is also established in the campus.

Health Centre: Health and ambulance facilities to the students and residents are available in the Health Centre located near the University Computer Centre.

SC/ST Cell: University has a separate SC/ST cell. The cell processes and provides assistance to the SC/ST students to get scholarships as per the Government rules and deals with all the problems of the SC/ST students.

Seminar Hall: The Department has a conference hall equipped with modern audio visual gadgets including facility for power-point presentations.

Courses Offered

- B.Sc. (Honors) in Physics & Electronics
- 2 Years (4 Semester) Course
    - M. Sc. Physics
      Presently offered speicializations are material Science, Nuclear Physics……… will be offered from coming sessions
    - M. Sc. Electronics
- Ph. D. in Physics & Electronics

DEPARTMENT OF PURE AND APPLIED PHYSICS
B. Sc. (Physics) Course structure under CBCS/LOCF
Academic year 2022 – 2023

Sem.	Course	Course Code	Course Name	Credits	Credits (L+T+P)	Internal Marks/	ESE Max. Marks	Total Marks
I	Core 1	PPUAT T1	Mathematical Physics-I	5	4+1+0	30	70	100
	Core 2	PPUAT T2	Mechanics	3	3+0+0	30	70	100
		PPUAL T2	Mechanics Lab	2	0+0+2	30	70	100
	GE-1		Opted from the pool Course and offered by Sister Departments	5		30	70	100
	AEC-1		Opted from the Pool Course offered by University	2		30	70	100
	SEC-1		Opted from the Pool Course offered by University	2		30	70	100
			Total	**19**				**600**
II	Core 3	PPUBT T1	Electricity and Magnetism	3	3+0+0	30	70	100
		PPUBL T1	Electricity and Magnetism Lab	2	0+0+2	30	70	100
	Core 4	PPUBT T2	Waves and Optics	3	3+0+0	30	70	100
		PPUBL T2	Waves and Optics Lab	2	0+0+2	30	70	100
	GE-2		Opted from the pool Course and offered by Sister Departments	5		30	70	100
	AEC-2		Opted from the Pool Course offered by University	2		30	70	100
	SEC 2		Opted from the Pool Course offered by University	2		30	70	100
			Total	**19**				**600**
III	Core 5	PPUCT T1	Mathematical Physics-II	5	4+1+0	30	70	100
	Core 6	PPUCT T2	Thermal Physics	3	3+0+0	30	70	100
		PPUCL T2	Thermal Physics Lab	2	0+0+2	30	70	100
	Core 7	PPUCT T3	Analog Systems and Applications	3	3+0+0	30	70	100
		PPUCL T3	Analog Systems & Applications Lab	2	0+0+2	30	70	100
	GE-3		Opted from the pool Course and offered by Sister Departments	5		30	70	100
	AEC-3		Opted from the Pool Course	2		30	70	100

			offered by University					
	Additional Credit Courses					30	70	100
			Total	**22**				**800**
IV	Core 8	PPUDT T1	Mathematical Physics-III	5	4+1+0	30	70	100
	Core 9	PPUDT T2	Elements of Modern Physics	3	3+0+0	30	70	100
		PPUDL T2	Elements of Modern Physics Lab	2	0+0+2	30	70	100
	Core 10	PPUDT T3	Digital Systems and Applications	3	3+0+0	30	70	100
		PPUDL T3	Digital Systems and Applications Lab	2	0+0+2	30	70	100
	GE 4		Opted from the pool Course and offered by Sister Departments	5		30	70	100
	AEC - 4		Opted from the Pool Course offered by University	2		30	70	100
	Internship*			6**		30	70	100
	Additional Credit Course					30	70	100
			Total	**22+6****				**900**
V	Core 11	PPUET T1	Quantum Mechanics & Applications	5	4+1+0	30	70	100
	Core 12	PPUET T2	Statistical Mechanics	5	4+1+0	30	70	100
	DSE - 1	PPUET D1	Fundamentals of Nano Materials	3	3+0+0	30	70	100
		PPUEL D1	Basic Nano Materials Lab	2	0+0+2	30	70	100
	DSE - 2	PPUET D2	Experimental Techniques	3	3+0+0	30	70	100
		PPUEL D3	Experimental Techniques Lab	2	0+0+2	30	70	100
	AEC-5		Opted from the Pool Course offered by University	2		30	70	100
	Additional Credit Course					30	70	100

	s							
	Total			**22**				**800**
VI	Core 13	PPUFTT1	Electromagnetic Theory	5	4+1+0	30	70	100
	Core 14	PPUFTT2	Solid State Physics	3	3+0+0	30	70	100
		PPUFLT2	Solid State Physics Lab	2	0+0+2	30	70	100
	DSE 3	PPUFTD1	Basics Nuclear Physics	3	3+0+0	30	70	100
		PPUFLD2	Basics Nuclear Physics Lab	2	0+0+2	30	70	100
	Seminar	PPUFS01#	Seminar	2		30	70	100
	Dissertation	PPUFD01#	Dissertation/ project work followed by seminar	7		30	70	100
	Total			**23**				**600**
Ability Enhancement Course (AEC) offered by Department								
1	AEC	AECPP01	Indian Contribution to Physics	2	2+0+0	30	70	100
2	AEC	AECPP02	Physics for Sustainable Future	2	2+0+0	30	70	100
Skill Enhancement Course offered by Department								
1	SEC	SECPP01	Analytical Techniques in Physics	2	1+0+1	30	70	100
2	SEC	SECPP02	Renewable Energy and Energy harvesting	2	1+0+1	30	70	100
Generic Elective offered by Department								
1	GE	PPUATG1	Mechanics	3	3+0+0	30	70	100
		PPUALG1	Mechanics Lab	2	0+0+2	30	70	100
2	GE	PPUBTG2	Electricity and Magnetism	3	3+0+0	30	70	100
		PPUBLG2	Electricity and Magnetism Lab	2	0+0+2	30	70	100
3	GE	PPUCTG3	Thermal Physics	3	3+0+0	30	70	100
		PPUCLG3	Thermal Physics Lab	2	0+0+2	30	70	100
4	GE	PPUDTG4	Elements of Modern Physics	3	03+0+0	30	70	100
		PPUDLG4	Elements of Modern Physics Lab	2	0+0+2	30	70	100

#The Code generated by the Department.

PHY- Physics, T- Theory, P- Practical, S- Seminars

Semester - I

Core - 1: Mathematical Physics-I
Course Code: PPUATT1 **Credits = 5 (4+1+0)**
Course Objectives

- The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Unit – I: Calculus: First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients.Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral.

Unit – II: Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration.Constrained Maximization using Lagrange Multipliers. **Vector Calculus**: Vector Differentiation: Directional derivatives and normal derivative.Gradient of a scalar field and its geometrical interpretation.Divergence and curl of a vector field.Del and Laplacian operators.Vector identities.

Unit – III: Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian.Notion of infinitesimal line, surface and volume elements.Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).

Unit – IV: Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.
Dirac Delta function and its properties: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

Reference Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
6. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
7. Mathematical Physics, Goswami, 1st edition, Cengage Learning
8. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
9. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
10. Essential Mathematical Methods, K.F.Riley&M.P.Hobson, 2011, Cambridge Univ. Press.
11. Mathematical Physics, H.K. Dass and R. Verma, S. Chand & Company.

Core - 2: Mechanics **Credits = 3 (3+0+0)**
Course Code: PPUATT2

Course Objectives

- This course would empower the student to acquire theoretical concept and practical knowledge regarding mechanical motions. This syllabus will cater the basic requirements for their higher studies. This course will provide a theoretical basis for doing experiments in related areas

Learning Outcomes

- Upon successful completion of this course, students will be able to understand basic concept about Newtonian mechanics and Special theory of relativity, which is very fundamental for further higher studies in physics.

Unit – I: Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket.Motion of a projectile in uniform gravitational field Dynamics of a system of particles.Centre of Mass. Principle of conservation of momentum.

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces.PotentialEnergy.Energy diagram.Stable and unstable equilibrium.Elastic potential energy. Force as gradient of potential energy. Work & Potential energy.Work done by non-conservative forces.Law of conservation of Energy

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit – II: Rotational Dynamics: Angular momentum of a particle and system of particles. Torque.Principle of conservation of angular momentum.Rotation about a fixed axis.Moment of Inertia.Calculation of moment of inertia for rectangular, cylindrical and spherical bodies.Kinetic energy of rotation.Motion involving both translation and rotation. **Fluid Motion:** Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube**.**

Unit – III: Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy.Inertial and gravitational mass.Potential and field 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'sLaws.Satellite in circular orbit and applications.

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

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. Mass-energy Equivalence (only problems)

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
8. Additional References:
9. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000

10. University Physics. F.W Sears, M.WZemansky, H.D Young 13/e, 1986, Addison Wesley
11. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
12. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Core - 2: Mechanics Lab **Credits = 2 (0+0+2)**
Course Code: PPUALT2
Name of the experiments

1. Measurements of length (or diameter) using verniercalliper, screw gauge and travelling microscope.
2. To study the Motion of Spring and calculate (a) Spring constant, (b) g
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
5. To determine the elastic Constants of a wire by Searle's method.
6. To determine the value of g using Kater's Pendulum.
7. To determine coefficient ofviscosity of Glycerine by stoke's method

GE -1: Mechanics **Credits = 3 (3+0+0)**
Course Code: PPUATG1

Course Objectives

- This course would empower the student to acquire theoretical concept and practical knowledge regarding mechanical motions. This syllabus will cater the basic requirements for their higher studies. This course will provide a theoretical basis for doing experiments in related areas

Learning Outcomes

- Upon successful completion of this course, students will be able to understand basic concept about Newtonian mechanics and Special theory of relativity, which is very fundamental for further higher studies in physics.

Unit – I: Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum.
Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy
Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit – II: Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.
Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube**.**

Unit – III: Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field 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.

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

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. Mass-energy Equivalence (only problems)

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
8. Additional References:
9. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
10. University Physics. F.W Sears, M.WZemansky, H.D Young 13/e, 1986, Addison Wesley
11. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
12. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

GE -1: Mechanics Lab
Course Code: PPUALG1 **Credits = 2 (0+0+2)**
Name of Experiments

1. Measurements of length (or diameter) using verniercalliper, screw gauge and travelling microscope.
2. To study the Motion of Spring and calculate (a) Spring constant, (b) g
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
5. To determine the elastic Constants of a wire by Searle's method.
6. To determine the value of g using Kater's Pendulum.
7. To determine coefficient ofviscosity of Glycerine by stoke'smethod

AEC -1: Indian Contribution to Physics **Credits = 2 (2+0+0)**
Course Code: AECPP01

Course Objectives

- This course would empower the student to understand the ancient contribution of India towards Classical Physics.
- It will also enable the students to analysis Vaiseshika Darshan originated by Kanada with the principles of Classical Physics.
- The students will also be able to understand the great contribution of Indian Physicists towards the growth of Science and Technology

Learning Outcomes

- Upon successful completion of this course, students will be able to understand understand the ancient contribution of India towards Classical Physics.
- It will also enable the students to analysis Vaiseshika Darshan given by Kanada with the principles of Classical Physics.

- The students will also be able to understand the great contribution of Indian Physicists towards the growth of Science and Technology

Unit -1

- ❖ Need to understand the ancient contribution of India towards Classical Physics.
- ❖ Devlopment of Classical Physics in Western civilization, Ancient Engineering, temples, Dam, Monastery etc.
- ❖ Basic framework of Classical Physics of ancient indian origin.
- ❖ vaisheshika darshan- introductioncommentries on important vaisheshika sutras
- ❖ Dharma of physical world, Kanada atomic theory of universe, importance of ancient thoughts in this context.

Unit -2

- ❖ Contributions of contemporary indian physicists towards the growth of science and technology:
  a) Dr. C.V. Raman (1888-1970), and discovery of Raman effect.
  b) Satyendranath Bose (1894-1974), Bose-Einstein condensate.
  c) Dr. Chandrashekhar (1910-1995) and Chandrashekhar limit in Astrology.
  d) Dr. Meghnad Saha (1893-1956) and Saha Ionization equation.
  e) Dr. H.J.Bhabha (1909-1966)
  f) Vikram Sarabhai (1919-1971)
  g) G.N. Ramachandran (1922-2001)
  h) Jayant Narlikar (1938)

SEC -1: Analytical Techniques in Physics **Credits = 1 (1+0+0)**
Course Code: SECPP01

Course Objective

- The course focuses on the properties, functions of the internal structure, and arrangement of atoms in a crystalline material. It offers an insight into how x-ray diffraction, can solve crystallographic issues related to single and poly-crystalline material, right from the base. This course will also cover the basic principles and techniques of scanning electron microscopy and Atomic Force microscopies along with demonstrations on the instrument details and imaging experiments. The sample preparation techniques for the microstructural analysis and surface Morphology analysis will be discussed. Structural studies by Fourier transform IR (FTIR) and Raman spectroscopies will be discussed.

Course learning outcomes:

- Students will have achieved the ability to: 1. apply appropriate characterization techniques for microstructure examination at different magnification level and use them to understand the microstructure of various materials 3. Determine crystal structure of specimen and estimate its crystallite size by X-ray Diffraction technique 4. Use appropriate spectroscopic technique to measure vibrational / electronic transitions.

Unit – I: Structure and Microstructure analysis by X-ray and electron diffraction: The geometry of crystals and reciprocal lattice, Basics of x-rays and their production and detection, X-ray diffraction, Determination of crystal structure: Qualitative and quantitative analysis, Particle size determination by x-rays, X-rays and stress analysis,

Unit – II: Scanning electron microscopy techniques and Composition analysis by Energy dispersive X-ray (EDX): Introduction to Scanning electron microscopy, Basic principles and components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast,Instrumental details and image formation, Energy-dispersive x-ray spectroscopy (paired with scanning electron microscopy) analysis to gain elemental information about samples.

Unit – III: Structural studies by Fourier transform IR (FTIR) and Raman spectroscopies: Basics of Fourier Transform Infrared (FT-IR) spectrometry,Different regions in infrared radiations, Modes of vibrations in diatomic molecule. characteristic absorption bands, Instrumental details, Qualitative treatment of Rotational Raman effect, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, Instrumental details& data accusation process.

Unit – IV: Ultra-violet and Visible Absorption Spectroscopy: Principle of UV Spectroscopy, Beer's Law and Quantitation, Deviations and limitations to Beer's Law, Instrumentation for UV-VIS spectroscopy i) Components and design ii) Actual commercial instruments, Methods and applications of absorption spectroscopy

Reference Books:

1. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).
2. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction", Prentice-Hall, (2001).
3. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, (2001).

SEC -1: Analytical Techniques in Physics Lab **Credits = 1 (0+0+1)**
Course Code: SECPP01

1. Study X-ray diffraction for the purpose of (a) identifying (cubic) crystal systems, (b) determining the lattice constant, a,
2. Study scanning electron microscopy (SEM) technique to obtain real space atomic resolution images of conductive surfaces, Energy-dispersive x-ray spectroscopy (paired with scanning electron microscopy) analysis to gain elemental information about samples.
3. Observation and analysis of a given Spectra to understand IR & Raman spectroscopy. .
4. StudyUltra-violet and Visible Absorption Spectroscopy for finding the bandgap of a given sample. (Only Data Analysis)

Ability Enhancement Course (AEC) offered by Department for the Pool AEC courses of the University

AEC -1: Physics for Sustainable Future **Credits = 2 (2+0+0)**
Course Code: AECPP02

Course Objectives

- The students will explore the physics of energy, learning to calculate the energy content of a wide variety of systems such as speeding cars, toasty houses and hot tubs, wind, solar illumination, nuclear powerplants
- To study the basic concepts to the various energy production schemes and usages found in our lives.
- This course is meant to provide a scientific foundation for understanding the energy issues facing our country and world so that students will be able to make informed decisions regarding and participate in the ongoing debate surrounding this important global issue.
- The course goals are for each student to learn how to understand and analyze issues related to energy production and usage and its influence on the environment around us (both local and global).

Learning Outcome:
By the end of the course, the student will be able to:

- Discuss the side–effects of energy production and use, and estimate energy content and conversion.
- Explain the physical concept of energy and identify it in the world around us.
- Analyze the energy usage in our lives and be well informed on the topic of energy, its use in our society, and the impacton our environment.
- Participate in the ongoing global debate and make smart decisions.

Unit – I: Fundamental laws of Nature
Basic laws of Nature that govern all energy transformations like: statisticsand data, the second law of thermodynamics, exponential grow depletion time of a non–renewable resource, principles of relativity and anti–matter.

Unit – II: Need of energy and power losses
Power transmission and power loss.The status and current developments of energy in third–world countries.Power requirements and basics of related terminologies.

Unit – III: Nuclear Energy
Radiation and human health, radioactive wastes, history and future of nuclear power technologies, nuclear fuel resources, processing, use, and disposal. Fission and fusion power, three key issues related to reprocessing, storage and disposal.

Unit – IV: Renewable Energy
Types of renewable energies. Fundamentals of solar and wind energies and their environmental advantages/disadvantages. General characteristics of passive and active solar thermal energy, power generation with thermal solar energy, and solar photovoltaic systems. Wind tower and turbine design and their sustainability attributes.

Books Recommended:

1. University Physics with Modern Physics, Fourtheenth Edition, By Pearson.
2. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
3. Sustainable Energy Si Edition by Dunlap R A, Cengage Learning.
4. Textbook of Renewable Energy by S. C. Bhatia, R. K. Gupta, Woodhead Publishing India PVT.

Skill Enhancement Course (SEC) offered by Department for the Pool SEC courses of the University

SEC : Renewable Energy and Energy Harvesting **Credits = 2 (2+0+0)**
Course Code: SECPP02

Course Outcomes:

- To understand the Energy policies and to know some of the renewable energy sources such as solar energy, off-shore wind energy, tidal energy, biogas energy and hydroelectricity.
- Illustrate Photovoltaic conversion mechanism.
- Appraise wind energy conversion and ocean energy
- Conversion of vibration into voltage using piezoelectric materials,
- Conversion of thermal energy into voltage using thermoelectric modules.
- The students are expected to learn not only the theories of the renewable sources of energy, but also to have hands-on experiences on them wherever possible.

Unit – I: Introduction to Energy Policy:
Overview of world energy scenario; Energy Demand- present and future energy requirements; Review of conventional energy resources, Global warming; Green House Gas emissions, impacts, mitigation; sustainability; Clean Development Mechanism (CDM); Prototype Carbon Fund (PCF). Need and characteristics of photovoltaic (PV) systems, PV modules and sun tracking systems (6)

Unit – II: Renewable Energy Sources & Instruments: Solar, wind, small hydro, biomass, geothermal and ocean energy, energy flow in ecosystem, Solar Energy Resources, Solar radiation: Spectrum of EM radiation, sun structure and characteristics.
Sunshine recorder, Pyranometer, Pyrheliometer, Albedometer, Radiation measurement stations, solar radiation data. (8)

Unit – III: Photovoltaic Materials and Devices:
Bulk and thin film forms of materials, single crystal and polycrystalline, amorphous and nano-crystalline semiconductor materials, Intrinsic, extrinsic and compound semiconductor, Electrical and optical properties of photovoltaic / semiconductor materials, p-n junction: homo and hetero junctions; solar cell design, Dark and illumination characteristics; Principle of photovoltaic conversion of solar energy, various parameters of solar cell. (8)

Unit – IV: Solar Thermal Conversion:
Solar radiation, its measurements and prediction; Solar thermal collectors- flat plate collectors, concentrating collectors; solar heating of buildings; solar still; solar water heaters; solar driers; conversion of heat energy in to mechanical energy, solar thermal power generation systems.
Introduction to Geothermal Energy, Hydro Energy and Piezoelectric Energy harvesting (8)

Reference Books

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
5. University Press, in association with The Open University. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. on- conventional energy resources, B H Khan, Tata McGraw-Hill Publication 2006, ISBN 0-07-060654-42
8. Renewable Energy Resources Paperback John Twidell and Tony Weir ,Routledge, Taylor& Francis, 2015
9. Solar Photovoltaic's: Fundamentals, Technologies And Applications, CHETAN SINGH SOLANKI, PHI Learning Pvt. Ltd., Third Edition 2015
10. Non – Conventional Energy Resources: G. D. Rai, KhannaPublishers,2008.
11. Solar Energy Fundamentals, Technology, and Systems, Klaus JägerOlindoIsabella Arno H.M. SmetsRenéA.C.M.M. van SwaaijMiroZeman Delft University of Technology, 2014

Semester - II

Core - 3: Electricity and Magnetism **Credits = 3 (3+0+0)**

Course Code: PPUBTT1

Course Objective

The course aims to develop an understanding of:

- Electric field, Magnetic field, and Electromagnetic theory.
- To learn how to apply Gauss's law to problems.
- Describe how static charge produces electricity and list examples where its effects are observed. Explain various phenomenon's like polarization.
- Describe how dynamic/moving charge produces magnetic field and list examples where its effects are observed. Explain various phenomenon's like magnetization in materials.
- Identify the connection between electricity and magnetism & to understand what is meant by electromotive force (emf).
- To learn different electrical networks theorems.

Learning Outcome

Upon successful completion of this course, students will be able to address following points:

- The use of Coulomb's law and Gauss' law for the electrostatic force.
- The use of the Lorentz force law for the magnetic force
- Ampere's law and how to apply Ampere's law to problems.
- Explain various phenomenon like polarization, dielectrics, magnetization, diamagnetic, paramagnetic and Ferromagnetism, etc.
- What is meant by electromotive, motional emf and learn the formula for induced emf.
- Understand the relation in between Electromagnetic theory.
- The basic laws that underlie the properties of electric circuit elements.

Unit – I: Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux.Gauss' Law with applications to chargedistributions with spherical, cylindrical and planar symmetry.

Divergence and Curl of Electric Field, Conservative nature of electric field, Electrostatic Potential.Electrostatic energy of system of charges, Electrostatic energy of a charged sphere.Conductors in an electrostatic Field.Laplace's and Poissonequations,Capacitance of a system of charged conductors. Parallel-plate capacitor.Capacitance ofan isolated conductor.

Method of Images and its application to: (1) Plane Infinite Sheetand (2) Sphere.

Unit – II: Dielectric Properties of Matter: Electric Field in matter. Force and Torque on a dipole. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant, Displacement vector **D**. Relations between**E**, **P** and **D**, Gauss' Law in dielectrics and its application.

Unit – III: Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Biot-Savart's Law and its simple applications: straight wire current, plane current and circular loop current. Ampere's Circuital Law and its application to straight wire and Solenoid. Curl and divergence B, Vector Potential. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole).Torque on a current loop in a uniform Magnetic Field.

Unit – IV: Magnetic Properties of Matter: Magnetization vector (**M).** Magnetic Intensity (**H).**Magnetic Susceptibility and permeability. Relation between **B, H, M**. B-H curve and hysteresis loop.

Electromagnetic Induction: Faraday's Law. Lenz'sLaw. Self-Inductance and MutualInductance.Reciprocity Theorem. Introduction toMaxwell's Equations. Charge Conservation and Displacement current.

Reference Books:

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
2. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
3. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
4. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
5. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
6. Electricity and Magnetism, J.H.Fewkes&J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

Core - 3: Electricity and Magnetism Lab **Credits = 2 (0+0+2)**

Course Code: PPUBLT1

Name of Experiments

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To verify the Thevenin theorems.
3. To verify the Norton theorems.
4. To verify the Superposition, and Maximum Power Transfer Theorems.
5. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
6. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
7. To determine the frequency of AC mains using Sonometer.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, AsiaPublishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,reprinted 1985, Heinemann Educational Publishers
4. Engineering Practical Physics, S. Panigrahi and B. Mallick, 2015, Cengage Learning.
5. A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.

Core - 4: Waves and Optics **Credits = 3 (3+0+0)**

Course Code: PPUBTT2

Course Objectives:

The course aims to develop an understanding of:

- The type of waves and various phenomenon of optics.
- The superposition of waves, progressive and stationary waves, optical phenomenon based on superposition of waves such as Interference and Diffraction.

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- The physics behind various phenomenon in wave and optics.
- The significance of superposition of waves and optical phenomenon based on principle of superposition of waves.

Unit – I: Superposition of Harmonic oscillations:

Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

Superposition of two perpendicular Harmonic Oscillations, Graphical and Analytical Methods of Lissajous Figures with equal and unequal frequency and their uses.

Unit – II: Wave Motion and Velocity:

Plane Wave. Longitudinal and Transverse Waves. Plane Progressive (Traveling) Waves. Wave Equation. Particle and Wave Velocities. Group Velocity, Graphical Relation between Wave and Group Velocity, Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave.

Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Unit – III: Interference:

Division of amplitude and wavefront. Young's double slit experiment. Lloyd's 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); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. (9 Lectures)

Unit – IV: Fraunhofer and Fresnel Diffraction:

Fraunhofer Diffraction: Single slit. Circular aperture, 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's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

Reference Books:

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

Core - 4: Waves and Optics Lab **Credits = 2 (0+0+2)**

Course Code: PPUBLT2

Name of Experiments

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda 2$ –T law.
2. To investigate the motion of coupled oscillators.
3. Familiarization with: Schuster`s focusing; determination of angle of prism.
4. To determine refractive index of the Material of a prism using sodium source.
5. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
6. To determine wavelength of sodium light using Fresnel Biprism.
7. To determine wavelength of sodium light using Newton's Rings.
8. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
9. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
10. To determine dispersive power and resolving power of a plane diffraction grating.

Semester - III

Core - 5: Mathematical Physics-II **Credits = 5 (4+1+0)**
Course Code: PPUCTT1
Course Objectives:
The course aims to develop an understanding of:

- Student will learn to solve different types of periodic functions using Fourier series.
- In physics, generally we encounter different types differential equations. Ordinary differential equations and series solution methods with special functions are taught here in this course to solve various types of differential equations.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- To analyse the periodic functions by Fourier series methods.
- To solve differential equations using special functions and other differential equation methods.

Unit – I: Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only).Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period.Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite series.

Unit – II: Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Bessel Functions of the First Kind: Generating Function, simple recurrence relations.

Unit – III: Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

Unit – IV: Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry.

References:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
2. Fourier analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
4. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
5. Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
6. Mathematical methods for Scientists & Engineers, D.A. Mc-Quarrie, 2003, Viva Books

Core - 6: Thermal Physics **Credits = 3 (0+0+0)**
Course Code: PPUCTT2
Course Objectives:
The course aims to develop:

- To learn how to apply thermodynamic principles in order to interpret thermodynamic systems and predict their behaviors.
- To make familiar with laws of thermodynamics
- The understanding of the biggest natural force ‘Heat’ and its manifestations in natural phenomenon

- To become familiar with the thermodynamic potentials and statistics of gas theory.

Learning Outcomes:
Upon successful completion of this course, students will be able to:
- Understand the thermodynamic systems in nature.
- Understand the law of thermodynamics, concept of efficiency of heat engines and Carnot engine.
- Understand different thermo dynamical processes and explanation of various natural phenomena.
- Understand of the various thermodynamical relations and heat transport
- Understand the different behavior of the gases under temperature and their distribution laws

Unit – I: Introduction to Thermodynamics Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Unit – II: Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Second Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics. Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy.Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

Unit – III: Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, ClausiusClapeyron Equation and Ehrenfest equations. Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) Tds Equations.

Unit – IV: Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy. Specific heats of Gases. Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. Van der Waal's Equation of State for Real Gases, P-V Diagrams. Joule's Experiment, Free Adiabatic Expansion of a Perfect Gas. Temperature of Inversion,

Reference Books:
1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
3. Thermal Physics, Charles Kittel, H. Kroemer, Publisher: W. H. Freeman, 1980
4. Concepts in thermal Physics by B. Stephen, 2nd Edition, Oxford University Press, 2010.

Core - 6: Thermal Physics Lab **Credits = 2 (0+0+2)**
Course Code: PPUCLT2
Name of the experiments

1. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
4. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
5. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.
6. Coefficient of linear expansion using Gumber method.
7. Specific heat determination by calorimeter method.

Core - 7: Analog Systems and Applications **Credits = 3 (3+0+0)**
Course Code: PPUCTT3

Course Objectives:

- To understand basic analog circuit and their applications using active devices.
- To understand electronic system (oscillators) with a continuously variable signal.
- To learn use of active component in linear circuit.
- To understand component symbol, working principle, classification and specification of amplifiers.
- To learn different theorems for simplification of basic linear electronic circuits

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- Basic of semiconductors like energy level, drift velocity, fabrication process, Barrier Potential, Barrier Width
- Fundamentals of N-P-N and P-N-P Transistors and use of transistor as Amplifier
- Working of different oscillators
- Basic of Op-AMP

Unit – I: Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity.PN Junction Fabrication (Simple Idea). 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.(10 Lectures)
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, (2) Zener Diode and Voltage Regulation.(4 Lectures)

Unit – II: 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, Cut-off and Saturation Regions. (6 Lectures) Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network.h-parameter Equivalent Circuit. Analysis of 29 a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. (10 Lectures)

Unit – III: Coupled Amplifier: RC-coupled amplifier and its frequency response. (4 Lectures) Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability (4 Lectures)

Unit – IV: Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley &Colpitts oscillators. (4 Lectures) Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response.CMRR. Slew Rate and concept of Virtual ground. (4 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
4. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
5. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India 8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Core - 7: Analog Systems and Applications Lab **Credits = 2 (0+0+2)**
Course Code: PPUCLT3
Name of the experiments

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
6. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
7. To design a phase shift oscillator of given specifications using BJT.
8. To study the Colpitt`s oscillator.

Semester - IV

Core - 8 : Mathematical Physics-III
Course Code: PPUDTT1 **Credits: 5 (4+1+0)**
Course Objectives:
The course aims to develop an understanding of:
• The concept of Laplace transforms and inverse Laplace transforms.
• The concept of complex analysis and Fourier transform

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
• Apply Laplace and inverse Laplace transform to different applications
• Apply Fourier transform to different applications.
• Use the complex analysis for finding singularity, residues and integral value of a given complex function.

Unit – I: Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable.Cauchy'sInequality.Cauchy’s Integral formula.Simply and multiply connected region.Laurent and Taylor’sexpansion.Residues and Residue Theorem.Application in solving Definite Integrals.

Unit – II: Integrals Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral.

Unit – III: Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

Unit – IV: Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of ScaleTheorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals ofLTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT, Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Reference Books:
1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence,3rd ed.,2006, Cambridge University Press
2. Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
3. Complex Variables, A.S. Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
4. Complex Variables and Applications, J.W. Brown &R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
5. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett

Core - 9: Elements of Modern Physics
Course Code: PPUDTT2 **Credit: 3 (3+0+0)**

Course Objectives:

This course covers certain conceptual courses of physics by virtue of which the students will be able to understand some concepts of Quantum Mechanics and Nuclear Physics.

It also imparts the basic principles of Quantum mechanics, Schrodinger equation and its applications

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

Understand and explain the differences between classical and quantum mechanics.

Solve Schrodinger equation for simple potentials.

Assess whether a solution to a given problem is physically reasonable.

Identify properties of the nucleus and other sub-atomic particles.

Unit – I: Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.

Unit – II: Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.

Unit – III: One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; tunneling in one dimension-across a step potential & rectangular potential barrier, Position measurement- gamma ray microscope thought experiment; Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- range of an interaction.

Unit – IV: Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers, Introduction to fission and fusion.

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission.

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
4. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
5. Quantum Mechanics: Theory & Applications, A. K. Ghatak & S.Lokanathan, 2004, Macmillan
6. Quantum Mechanics: Concepts and Applications, Wiley Publisher , Nouredine *Zettili*

Core - 9: Elements of Modern Physics Lab
Course Code: PPUDLT2 **Credit: 2 (0+0+2)**
Name of the experiments

1. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
2. To determine the wavelength of laser source using diffraction of single slit.
3. To determine the wavelength of laser source using diffraction of double slits.
4. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. Determination of Planks constant by Photo electric effect.
7. Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).

Core - 10 : Digital Systems and Applications
Course Code: PPUDTT3 **Credit: 3 (3+0+0)**

Course Objectives:

- To make the student understand the digital system.
- To understand the Boolean algebra and data processing circuit.
- Understanding the arithmetic and sequential circuit

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- Gain both theoretical and experimental knowledge about digital electronics..
- Verify and design various logic gates.
- Use combinational logic circuit in various applications.
- Test various asynchronous sequential circuits.
- Build the sequential circuits based on algorithmic state machines (ASM) chart.

Unit – I: Digital Circuits: Difference between Analog and Digital Circuits**.** Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal, and Hexadecimal numbers. AND, OR, and NOT Gates ,NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application.

Unit – II: Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of LogicCircuit using Boolean algebra. Fundamental Products. The idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and and (2) Karnaugh Map.

Unit – III: Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. Data processing circuits: Basic idea of Multiplexers, Demultiplexers, Decoders, Encoders.

Unit – IV: 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. Shift Registers: SISO, SIPO, PISO,PIPO. Counters: Asynchronous Counters and Synchronous Counters.

Reference Books:

1. Fundamentals of Digital Circuits, Anand Kumar, 2ndEdn, 2009, PHI Learning Pvt. Ltd.
2. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
3. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning

4. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
5. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill

Core - 10 : Digital Systems and Applications Lab

Course Code: PPUDLT3 **Credit: 2 (0+0+2)**

Name of the experiments
1. To design a switch (NOT gate) using a transistor.
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. To design a combinational logic system for a specified Truth Table.
4. To convert a Boolean expression into the logic circuit and design it using logic gate ICs.
5. To minimize a given logic circuit..
6. Half Adder, Full Adder and 4-bit binary Adder.
7. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder
8. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
9. To build JK Master- Slave Flip-Flop circuits using Flip-Flop ICs.
10. **To build a 4-bit Counter using D-type /JK** Flip-Flop ICs.

Semester - V

Core 11 : Quantum Mechanics & Applications **Credit: 5 (4+1+0)**

Course Code: PPUETT1

Course Objectives:

- To introduce the modern concepts of quantum mechanics in a stimulating, elegant, exhaustive and explanatory manner.
- To explore the nature of the microscopic world into substantial depth in terms of meaning and interpretation so as to acquaint the learners to initiate thinking and analysing the physically observable phenomena quantum mechanically without exceeding the mathematical level of complexity.
- To lay down the foundation and enhance capabilities of students to pursue various aspects of modern physics and interdisciplinary fields confidently.

Course Outcomes:

After the completion of course, students should be able to understand and grasp

- The basic concepts of quantum mechanics including the solution of wave equation, interpretation of dynamical variables and applying wave mechanics to various situations in terms of boundary value problems so as to understand the quantum well, barriers and particle motion in different types of force field (potentials). Its basic applications in modelling Quantum dots Quantum wires and wells in nanotechnology, understanding and implication of quantum tunnelling.
- Applying special functions as the solutions of differential equation as the wave function/state functions and understanding the physical situations where these can be applied.
- Calculating states of electrons in hydrogen atom and harmonic oscillators and the interpretation of quantum states.
- Applying the stationary perturbation problems to various problems including particle states splitting in electric and magnetic field.
- Introduction of Algebraic method (Heisenberg matrix mechanics) to learners
- Application of Commutator algebra and operators in finding the states and properties of various quantum systems

Unit – I: Introduction to Schrodinger equation; probability interpretation, probability current, Admissible wave functions; Stationary states, Schrodinger equation in one dimensional problems, wells and barriers; Extension to three dimensional problems, Applications in Quantum dots Quantum wires and wells in nanotechnology, understanding and implication of quantum tunnelling, Harmonic oscillator solution by Schrodinger Equation

Unit – II: General Formalism of wave mechanics; Commutation Relations; Representation of states and dynamical variables; Completeness of eigen functions; Dirac delta function; Bra and ket Notation; Matrix representation of an operator; Unitary transformation. Solution of Harmonic oscillator by operator method.

Unit – III: Angular momentum in QM; Central force problems: Spherically symmetric potential, Schrodinger equation in spherical polar coordinates, Solution of Schrodinger equation for spherically symmetric potentials; Hydrogen atom problem. Interpretation of hydrogenic states.

Unit – IV: Need for approximation methods, Time independent perturbation theory, its validity/conditions for applications; non-degenerate and degenerate cases; calculating corrections in state functions and energy up to first order, Applications such as Stark effect, Zeeman effect, etc.

Core 12 : Statistical Mechanics
Course Code: PPUETT2 **Credit: 5 (4+1+0)**
Course Objectives:
- To understand connection between Thermodynamics and Statistical Mechanics.
- To understand Ensemble and Phase space.
- To learn use of Partition function.
- To understand different distribution law
- To learn the use of different distribution function

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Difference of Macro state & Microstate and limitation of Thermodynamics and quantum mechanical calculations
- Fundamental difference of classical and quantum statistical distribution
- Application of Fermi distribution function to understand electronic contribution of Heat capacity, behaviour of metal
- Application of B-E distribution function to understand lattice contribution of Heat capacity, Blackbody Radiation, Bose Einstein condensation

Unit – I: Classical Statistics: Thermodynamic potentials, Macrostate& Microstate, Concept of Ensemble, Phase Space, Dynamical variable, Entropy, Partition Function, relation of partition function with Thermodynamic Functions, application of partition function. Thermodynamic Probability, Law of Equipartition of Energy (with proof) (15 Lectures)

Unit – II: Maxwell-Boltzmann Distribution Law, B-E distribution law, Fermi-Dirac Distribution Law (10 Lectures)

Unit – III: Fermi-Dirac Statistics: Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Fermi sphere, Electron gas in a Metal, Specific Heat of Metals. (15 Lectures)

Unit – IV: Bose-Einstein Statistics: Heat capacity, Bose Einstein condensation, Radiation as a photon gas, Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law. (13 Lectures)

Reference Books:

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Statistical mechanics by Kerson Huang (2Ed, Wiley, 1987)
3. Statistical Physics: Volume 5: EvgenyLifshitz and Lev Landau
4. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
5. *Statistical Mechanics by D. A. McQuarrie.*

DSE - 1 : Fundamentals of Nano Materials
Course Code: PPUETD1 **Credit: 3 (3+0+0)**
Course Objectives:
The course aims to develop an understanding of:
- To develop basic understanding of nanomaterials.
- To provide the knowledge on synthesis of various nanomaterials.
- To acquire the knowledge on characterization of nanomaterials.

- To able to understand the charge transport in nanoscale materials.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Learn the basic physics of materials at nanoscale.
- Learn the various experimental techniques for synthesis of nanomaterials.
- Learn about structural and morphological characterizations of nanomaterials.
- Knowledge of the charge transport in nanomaterials.

Unit – I: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

Unit – II: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition.

Unit – III: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.

Unit – IV: Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.

Reference books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).

DSE - 1 : Basic Nano Materials Lab
Course Code: PPUELD1 **Credit: 2 (0+0+2)**
Name of the experiments
1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of ZnO nanoparticles
3. Study UV-Visible spectroscopy of nanomaterials.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To prepare composite of CNTs with other materials.
6. Growth of quantum dots by thermal evaporation.
7. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.

DSE - 2 : Experimental Techniques
Course Code: PPUETD2 **Credit: 3 (3+0+0)**
Course Objectives:
The course aims to develop an understanding of:

- Various measurement parameters like precession, accuracy and variety of signals, frequency response of systems and noise measurements
- Working and construction of digital multimeter
- Working and construction of transducers and sensors
- The working, construction of variety of vacuum pumps and techniques of vacuum level measurement

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- Knowledge of accuracy, precession, types of errors and variety of noise
- The course intends to impart knowledge of basic instrumentation tools and techniques to physics
- Course intends to impart knowledge of variety of transducers/sensors required for industrial instrumentation
- Knowledge about variety of vacuum pumps and vacuum measurement techniques

Unit – I: 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) and curve fitting. Gaussian distribution.

Unit – II: 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.
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.

Unit – III: Electrical, Thermal and Mechanical system. Calibration. Characteristics of Transducers. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35) and signal conditioning. Linear position transducers: 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.

Unit – IV: 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).

Reference Books:

1. Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer.
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Grew Hill.
3. Measurements, Instrumentation and Experimental Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHI Learning.
4. Electrical and Electronic Measurements and Instrumentation, A. K. Sawhney.
5. Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.

DSE - 2 : Experimental Techniques Lab
Course Code: PPUELD2 **Credit: 2 (0+0+2)**
Name of the experiments

1. Determine output characteristics of a LVDT & measure displacement using LVDT.
2. To study the characteristics of a Thermostat and determine its parameters.
3. Study of distance measurement using ultrasonic transducer.

4. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75).
5. To measure the change in temperature of ambient using Resistance Temperature Device (RTD).
6. Create vacuum in a small chamber using a mechanical (rotary) pump and measure the chamber pressure using a pressure gauge.
7. Design and analyze the clippers and Clampers circuits using junction diode.
8. Measurement of Strain using Strain Gauge.
9. Measurement of level using capacitive transducer.

Semester - VI

Core 13: Electromagnetic Theory **Credit: 5 (4+1+0)**
Course Code: PPUFTT1
Course Objectives:

The course aims to develop

- An understanding of Electromagnetic Waves and their fundamentals.
- Ability to understand the concept of Gauge and invariance of fields.
- Understanding of the propagation of waves in different media such as dielectric, metallic, anisotropic and plasma.
- Ability to interpret optical phenomenon by using Electromagnetic Waves theories
- Understanding of polarization phenomenon

Learning Outcomes:

At the end of this course student will demonstrate the ability to:

- Understand Maxwell's equations for electromagnetic waves using Gauge concept
- Understand the propagation of electromagnetic waves in different media and related characteristics
- Calculate reflection and transmission of waves at media interface
- Understand the aspects related to Polarized lights and its generation as superposition of different waves

Unit – I: Maxwell Equations: Review of Maxwell's equations. Vector and Scalar Potentials. Maxwells equations in terms of scalar and vector potentials. Concept of Gauge. Gauge Transformations: Lorentz and Coulomb Gauge. Propagation of electromagnetic plane waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density and Momentum Density. Radiation Pressure.

Unit – II: EM Wave Propagation in Unbounded Media: Transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, skin depth. Propagation of E.M. Waves in Anisotropic Dielectrics. Fresnel's law of normal velocities. Propagation of plane electromagnetic waves in ionized gases.

Unit – III: EM Wave in Bounded Media: Boundary Conditions at Interface between two Media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Total internal reflection, Metallic reflection (normal Incidence).

Unit – IV: Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Optical Rotation. Fresnel's Theory of optical rotation. Specific rotation. Laurent's half-shade polarimeter.

Reference Books:

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
3. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
4. Electromagnetic Theory, Chopra & Agrawal, K. Nath Publishing
5. Optics, Ajoy Ghatak, Tata Mc-Graw Hill Publishing
6. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.

7. Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press

Core 14: Solid State Physics
Course Code: PPUFTT2

Credit: 3 (3+0+0)

Course Objectives:
The course provides
- An overview of solid state physics and students how to apply classical and quantum mechanical theories needed to understand the properties of solids.
- The emphasis is on developing models that can describe a variety of solid-state phenomena.
- The fundamental knowledge in solid state physics and then study their physical properties

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Students will be able to calculate the Braggs conditions for X-ray diffraction in crystals and will calculate the conditions for allowed and forbidden reflections in crystals.
- Know the concept of Lattice Vibrations and Phonons, and how the dispersion relationship appears for different lattice structures.
- Know the concept Depolarization Field, Electric Susceptibility, Polarizability.
- Classify solid state matter according to their band gaps.
- Know the basic physics behind dia, para and ferromagnetism**.**

Unit – I: Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law.

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

Unit – III: Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials.Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Unit – IV: Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion.

Elementary band theory and Superconductivity: Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators, P and N type Semiconductors, Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient.
Superconductivity: Experimental Results. Critical Temperature, Critical magnetic field, Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth, Isotope effect.

Reference Books:
1. Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
4. Solid State Physics, Neil W. Ashcroft and N. David Mermin, 1976, Cengage Learning

5. Solid State Physics, A J Dekkar Macmillan India Ltd., New Delhi, 2004.
6. Solid State Physics, Rita John, 2014, McGraw Hill
7. Solid-state Physics, H. Ibach and H Luth, 2009, Springer
8. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
9. Solid State Physics, M.A. Wahab, 2011, Narosa Publications

Core 14: Solid State Physics Lab

Credit: 2 (0+0+2)

Course Code: PPUFLT2

Name of the experiments

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solution (Gouy's Method).
3. To measurement of the Dielectric Constant.
4. To study of V-I characteristics curves of optoelectronics devices and verification of inverse square law.
5. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four-probe method (from room temperature to 150 C) and to determine its band gap.
6. To determine the Hall coefficient of a semiconductor sample.

DSE 3: Basics Nuclear Physics

Credit: 3 (3+0+0)

Course Code: PPUFTD1

Course Objectives:

The course aims to develop an understanding of:

- To get an idea about the structure of atomic nucleus.
- To impart knowledge about basic nuclear properties
- To introduce nuclear models for understanding its structure
- To understand the basics of nuclear decay and reaction mechanism
- To import the knowledge of basics nuclear detectors and accelerators.

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- explain the constituents of the nucleus, ground state properties of the nucleus
- describe the structure of the atom in terms basic nuclear structure models
- Understand the various types of radiations and its decay mechanism
- Understand the basic of interaction of radiations with matter and different types of detectors used for detecting the radiations.
- Basics of particle accelerators.

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, nuclear fission and fusion N/A plot, angular momentum, parity, magnetic moment, electric moments.

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, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field.

Unit – III: Nuclear decay and Reactions: Alpha, beta, gamma decay, energy spectrum, Geiger-Nuttel law, disintegration energy, quantum theory of alpha decay, types of beta decay and energy spectrum, Pauli's prediction of neutrino.
Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

Unit – IV: Nuclear Detector and Particle Accelerators: Interaction of charge particle through matter, Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation, Detectors and construction of photo-multiplier tube (PMT), Semiconductor Detectors. Accelerator facility available in India: Van-de Graaff generator, Pelletron accelerator, Linear accelerator, Cyclotron accelerator.

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 Mc-Graw Hill, 1998).
3 Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
4 Nuclear Physics An Introduction S. B. Patel New Age International Publishers.
5 Introduction to Nuclear and Particle Physics V.K. Mittal, R. C. Verma, S. C. Gupta, Eastern Economy Edition.
6 Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).

DSE 3: Basics Nuclear Physics Lab
Course Code: PPUFLD2 **Credit: 2 (0+0+2)**

1. To study the variation of count rate with applied voltage of Geiger-Müller counter and their by determine its plateau, operating voltage and slope of plateau.
2. Verify the inverse square law for γ-ray using Geiger-Müller counter.
3. To estimate the efficiency of GM detector for beta and gamma source.
4. To determine the different reaction channels for a given reaction using PACE4 software and draw the excitation function.
5. To perform energy calibration of NaI detector and determine the energy resolution of known decay transition.
6. To perform spectrum analysis of ^{60}Co and ^{137}Cs with NaI detector using single channel analyzer.
7. To determining the efficiency of a given unknown alpha emitting radio isotope

DEPARTMENT OF PURE AND APPLIED PHYSICS
B. Sc. (Electronics) Course structure under CBCS/LOCF
Academic Year 2022 – 23

Sem	Course	Course Code	Course Name	Credits	Credits (T+L+P)	Internal Marks/	ESE Max. Marks	Total Marks
I	Core 1	PLUATT1	Mathematical Foundation for Electronics	5	4+1+0	30	70	100
	Core 2	PLUATT2	Basic Circuit Theory and Network Analysis	3	3+0+0	30	70	100
		PLUALT2	Basic Circuit Theory and Network Analysis Lab	2	0+0+2	30	70	100
	GE-1		Opted from the pool course and offered by sister Departments	5		30	70	100
	AEC-1		Opted from the pool course and offered by University	2		30	70	100
	SEC-1		Opted from the pool course and offered by University	2		30	70	100
	Total			**19**				**600**
II	Core 3	PLUBTT1	Semiconductor Devices	3	3+0+0	30	70	100
		PLUBLT1	Semiconductor Devices Lab	2	0+0+2	30	70	100
	Core 4	PLUBTT2	Applied Physics	3	3+0+0	30	70	100
		PLUBLT2	Applied Physics Lab	2	0+0+2	30	70	100
	GE-2		Opted from the pool course and offered by sister Departments	5		30	70	100
	AEC-2		Opted from the pool course and offered by University	2		30	70	100
	SEC 2		Opted from the pool course and offered by University	2		30	70	100
	Total			**19**				**700**
III	Core 5	PLUCTT1	Electronic Circuits	3	3+0+0	30	70	100
		PLUCLT1	Electronic Circuits Lab	2	0+0+2	30	70	100
	Core 6	PLUCTT2	Digital Electronics and VHDL	3	3+0+0	30	70	100
		PLUCLT2	Digital Electronics Lab	2	0+0+2	30	70	100
	Core 7	PLUCTT3	C/ C^{++} Programming and Data Structures	3	3+0+0	30	70	100
		PLUCLT3	C/ C^{++} Programming and	2	0+0+2	30	70	100

			Data Structures Lab					
	GE-3		Opted from the pool course and offered by sister Departments	5		30	70	100
	AEC-3		Opted from the pool course and offered by University	2		30	70	100
	Additional Credit Courses							
Total				**22**				**800**
IV	Core 8	PLUDTT1	Signals and Systems	5	4+1+0	30	70	100
	Core 9	PLUDTT2	Operational Amplifiers and Applications	3	3+0+0	30	30	100
		PLUDLT2	Operational Amplifiers and Applications Lab	2	0+0+2	30	70	100
	Core 10	PLUDTT3	Electronics Instrumentations	3	3+0+0	30	70	100
		PLUDLT3	Electronics Instrumentations Lab	2	0+0+2	30	70	100
	GE - 4		Opted from the pool course and offered by sister Departments	5		30	70	100
	AEC -4		Opted from the pool course and offered by University	2		30	70	100
	Internship *			6**		30	70	100
	Additional Credit Course							
		Total		**22+6****				**800**
V	Core 11	PLUETT1	ElectromagneticTheory	5	4+1+0	30	70	100
	Core 12	PLUETT2	Microprocessors and Microcontrollers	3	3+0+0	30	70	100
		PLUELT2	Microprocessors and Microcontrollers Lab	2	0+0+2	30	70	100
	DSE - 1	PLUETD1	Nano Electronics	3	3+0+0	30	70	100
		PLUELD1	Nano Electronics Lab	2	0+0+2	30	70	100
	DSE - 2	PLUETD2	Numerical Techniques	3	3+0+0	30	70	100
		PLUELD2	Numerical Techniques Lab	2	0+0+2	30	70	100
	AEC-5		Opted from the pool department and offered by pool departments	2		30	70	100
	Additional Credit Courses							

VI	Core 13	PLUFTT1	Semiconductor Fabrication & Characterization	3	3+0+0	30	70	100
		PLUFLT1	Semiconductor Materials Lab	2	0+0+2	30	70	100
	Core 14	PLUFTT2	Communication Electronics	3	3+0+0	30	70	100
		PLUFLT2	Communication Electronics Lab	2	0+0+2	30	70	100
	DSE 3	PLUFTD1	Photonic Devices and Power Electronics	3	3+0+0	30	70	100
		PLUFLD1	Photonics Devices and Power Electronics Lab	2	0+0+2	30	70	100
	Seminar	PLUFS01#	Seminar	2		30	70	100
	Dissertation	PLUFD01 #	Dissertation/ project work followed by seminar	7		30	70	100
	Total			**23**				**800**
Ability Enhancement Course (AEC) offered by Department								
1	AEC	AECPL01	Electronics in daily life	2	2+0+0	30	70	100
2	AEC	AECPL02	Organic Electronics	2	2+0+0	30	70	100
Skill Enhancement Courseoffered by Department								
1	SEC	SECPL01	Network Circuit Analysis	2	1+0+1	30	70	100
2	SEC	SECPL02	Simulation and Design of Digital Circuit Components	2	1+0+1	30	70	100
Generic Elective offered by Department								
1	GE	PLUATG1	Basic Circuit Theory and Network Analysis	3	3+0+0	30	70	100
		PLUALG1	Basic Circuit Theory and Network Analysis Lab	2	0+0+2	30	70	100
2	GE	PLUBTG2	Applied Physics	3	3+0+0	30	70	100
		PLUBLG2	Applied Physics Lab	2	0+0+2	30	70	100
3	GE	PLUCTG3	Electronic Circuits	3	3+0+0	30	70	100
		PLUCLG3	Electronic Circuits Lab	2	0+0+2	30	70	100
4	GE	PLUDTG4	Operational Amplifiers and Applications	3	3+0+0	30	70	100
		PLUDLG4	Operational Amplifiers and Applications Lab	2	0+0+2	30	70	100

#The Code generated by the Department.

PHY- Physics, T- Theory, P- Practical, S- Seminars

Semester - I

Core -1: Mathematical Foundation for Electronics
Course Code: PLUATT1 **Credits = 5 (4+1+0)**

Course Objective:

- To build the strong foundation in Mathematics of students needed for the field of electronics and Telecommunication production
- Solve higher order linear differential equation and matrix using appropriate techniques for modeling and analyzing electrical circuits.

Course Outcome:

- Demonstrate basic knowledge of solving differential equations, introduction to special functions like Bessel and Legendre.
- Demonstrate basic knowledge of Matrix Theory, convergence and divergence of a series and Complex Integration

Unit – I:
Ordinary Differential Equations: First Order Ordinary Differential Equations, Basic Concepts, Separable Ordinary Differential Equations, Exact Ordinary Differential Equations, Linear Ordinary Differential Equations. Second Order homogeneous and non-homogeneous Differential Equations.
Series solution of differential equations and special functions: Power series method, Legendre Polynomials, Frobenius Method ,Bessel' s equations and Bessel's functions of first and second kind.

Unit – II:
Matrices: Introduction to Matrices, System of Linear Algebraic Equations ,Gaussian Elimination Method, Eigen Values and Eigen Vectors, Linear Transformation, Properties of Eigen Values and Eigen Vectors, Cayley-Hamilton Theorem, Diagonalization, Powers of a Matrix. Real and Complex Matrices, Symmetric, Skew Symmetric, Orthogonal Quadratic Form, Hermitian, Skew Hermitian, Unitary Matrices.

Unit- III:
Sequences and series: Sequences,Limitofasequence,Convergence,DivergenceandOscillationofa sequence ,Infinite series, Necessary condition for Convergence, Cauchy's Integral Test, D'Alembert's Ratio Test, Cauchy's nth Root Test, Alternating Series, Leibnitz's Theorem, Absolute Convergence and Conditional Convergence, Power Series.

Unit – IV:
Complex Variables and Functions: Complex Variable, Complex Function, Continuity, Differentiability, Analyticity. Cauchy-Riemann (C- R) Equations, Harmonic and Conjugate Harmonic Functions, Exponential Function, Line Integral in Complex Plane, Cauchy's Integral Theorem, Cauchy's Integral Formula, Derivative of Analytic Functions. Sequences, Series and Power Series, Taylor's Series, Laurent Series, Zeroes and Poles. Residue integration method, Residue integration of real Integrals.

Reference Books:

1. E. Kreyszig, advanced engineering mathematics, Wiley India (2008)
2. MurraySpiegel,SeymourLipschutz,JohnSchiller,OutlineofComplexVariables,SchaumOutlineS eries, Tata McGraw Hill (2007)
3. R.K. Jain andS.R.K.Iyengar,AdvancedEngineeringMathematics,NarosaPublishingHouse(2007)
4. C .R. Wylie and L. C. Barrett, Advanced Engineering Mathematics, Tata McGraw-Hill (2004)
5. B.V.Ramana,HigherEngineeringMathematics,TataMcGrawHillPublishingCompanyLimited(2 007)

Core -2: Basic Circuit Theory and Network Analysis
Course Code: PLUATT2 **Credits = 3 (3+0+0)**

Course Objectives:

- The objective of the course is that the student acquires the knowledge of basics of electrical network.
- To gain the knowledge and critical analysis of electrical circuit using network theorem.

Course Outcomes:

- Understand the basic concepts, basic laws and methods of analysis of DC and AC networks and reduce the complexity of network using different network theorems.
- Student will understand the resonance in series and parallel circuits and also the importance of initial conditions and their evaluation.

Unit – I: Circuit Analysis: Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Star-Delta Conversion.

Unit – II: DC Transient Analysis: RC Circuit- Charging and discharging with initial charge, RL Circuit with Initial Current, Time Constant, RL and RC Circuits, DC Response of Series RLC Circuits.

Unit – III: AC Circuit Analysis: Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Power in AC Circuits &Power Factor.Sinusoidal Circuit Analysis for RL, RC and RLC Circuits.Resonance in Series and Parallel RLC Circuits, Frequency Response of Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth. Passive Filters: Low Pass, High Pass, Band Pass and Band Stop.

Unit – IV: Network Theorems:Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem.
Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission (ABCD) Parameters.

Reference Books:

1. S. A. Nasar, Electric Circuits, Schaum's outline series, Tata McGraw Hill (2004).
2. Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill.(2005).
3. Robert L. Boylestad, Essentials of Circuit Analysis, Pearson Education (2004)
4. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata McGraw Hill(2005).
5. Alexander and M. Sadiku, Fundamentals of Electric Circuits , McGraw Hill (2008)
6. Grob's Basic Electronics, 11^{th} ed., Mitchel E. Schultz, McGraw Hill.

Core - 2: Basic Circuit Theory and Network Analysis Lab
Course Code: PLUALT2 **Credits = 2 (0+0+2)**
Name of Experiments

8. Verification of Kirchhoff's Law.
9. Verification of Norton's theorem.
10. Verification of Thevenin's Theorem.
11. Verification of Superposition Theorem.
12. Verification of the Maximum Power Transfer Theorem.
13. Charging and discharging of Capacitor
14. Designing of a Low Pass RC Filter and study of its Frequency Response.

15. Designing of a High Pass RC Filter and study of its Frequency Response.
16. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.
17. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.

GE - 1: Basic Circuit Theory and Network Analysis
Course Code: PLUATG1 **Credits = 3 (3+0+0)**

Course Objectives:
- The objective of the course is that the student acquires the knowledge of basics of electrical network.
- To gain the knowledge and critical analysis of electrical circuit using network theorem.

Course Outcomes:
- Understand the basic concepts, basic laws and methods of analysis of DC and AC networks and reduce the complexity of network using different network theorems.
- Student will understand the resonance in series and parallel circuits and also the importance of initial conditions and their evaluation.

Unit – I: Circuit Analysis: Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis, Star-Delta Conversion.

Unit – II: DC Transient Analysis: RC Circuit- Charging and discharging with initial charge, RL Circuit with Initial Current, Time Constant, RL and RC Circuits, DC Response of Series RLC Circuits.

Unit – III: AC Circuit Analysis: Sinusoidal Voltage and Current, Definition of Instantaneous, Peak, Peak to Peak, Root Mean Square and Average Values. Power in AC Circuits &Power Factor.Sinusoidal Circuit Analysis for RL, RC and RLC Circuits.Resonance in Series and Parallel RLC Circuits, Frequency Response of Series and Parallel RLC Circuits, Quality (Q) Factor and Bandwidth. Passive Filters: Low Pass, High Pass, Band Pass and Band Stop.

Unit – IV: Network Theorems:Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem.
Two Port Networks: Impedance (Z) Parameters, Admittance (Y) Parameters, Transmission (ABCD) Parameters.

Reference Books:

7. S. A. Nasar, Electric Circuits, Schaum's outline series, Tata McGraw Hill (2004).
8. Electrical Circuits, M. Nahvi and J. Edminister, Schaum's Outline Series, Tata McGraw-Hill.(2005).
9. Robert L. Boylestad, Essentials of Circuit Analysis, Pearson Education (2004)
10. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata McGraw Hill(2005).
11. Alexander and M. Sadiku, Fundamentals of Electric Circuits , McGraw Hill (2008)
12. Grob's Basic Electronics, 11th ed., Mitchel E. Schultz, McGraw Hill.

GE - 1: Basic Circuit Theory and Network Analysis Lab
Course Code: PLUALG1 **Credits = 2 (0+0+2)**
Name of Experiments

1. Verification of Kirchhoff's Law.
2. Verification of Norton's theorem.
3. Verification of Thevenin's Theorem.
4. Verification of Superposition Theorem.
5. Verification of the Maximum Power Transfer Theorem.
6. Charging and discharging of Capacitor
7. Designing of a Low Pass RC Filter and study of its Frequency Response.
8. Designing of a High Pass RC Filter and study of its Frequency Response.
9. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.
10. Study of the Frequency Response of a Series LCR Circuit and determination of its (a) Resonant Frequency (b) Impedance at Resonance (c) Quality Factor Q (d) Band Width.

AEC - 1: Electronics in daily life
Course Code: AECPL01 **Credits = 2 (2+0+0)**

Unit – I: History of Electronics: The vacuum tube era, The semiconductor revolution, Integrated circuits, Compound Semiconductor, Digital electronics Materials, Optoelectronics, Superconducting electronics, Flat-panel displays

Unit – II: Different Electronic Components / Semiconductor Components, Passive Components- Resistors: specifications and colour coding. Capacitors: Principle, specifications and colour coding. Inductors: Principle, specifications and classification, Battery, Battery holders and connectors ,Fuses ,Transistors, Oscillation, thyristors ,Light-emitting diodes (LEDs) AC fundamentals: Generation of alternating voltages, Basic electronic functions Rectification, Amplification Using n-p-n transistor, Multimeters, MOSFETs.

Unit – III: Application of Electronics: Consumer Electronics Office Gadgets like calculators, Personal computers, Digital Camera, FAX machines, Printers, Scanners, Front Projector, etc. Home appliances Robot Vacuum Cleaner, Electric Deep Fryer Refrigerator, AC, Coffee Maker Machine, Hair dryer Water Purifier/Dispenser, Storage Devices
Advanced Consumer Electronic Devices: Smart Phones, iPod and Tablets, Wi-Fi and the Internet, barcode scanners, ATM, Dishwasher and POS terminals.

Medical Electronics: Stethoscope, Respiration Monitors Glucose meter, The Pacemaker, MRI, CT scan
Unit – IV: Industrial and Automotive Electronics: Power Windows, Electronic Control Unit (ECU),Airbag control , all vehicles etc. Meteorological and Oceanographic Electronics: Barometer: .Anemometer: Anemometer Hygrometer ,Data logger Smart Grid Systems Image Processing, Entertainment and Communication Electronics:Smart TVs, Set Top Boxes, Speakers , receivers etc.
Defence Application: RADAR technology, Electronic Warfare Systems, Military electronic equipments etc.

Reference Books:

1. Getting Started in Electronics by Forrest, M.Mims, Master Publishing, Inc
2. Make Electronics – Learning by Discovery by Charles Platt ,Maker Media Publishers
3. Practical Electronics for Inventors , Paul Scherz, McGraw-Hill Education

4. Everyday Electronics and You: A Guide to Maintaining and Getting the Best Out of Your Everyday Electronics Devon A. Smith Kindle Edition ,
5. Complete Guide to Home Appliance Repair – Evan Powel, Better Homes & Garden Books Publication.
6. A Text book of Electrical Technology Vol. 1 and 2,.B.L.Thereja S. Chand & Company
7. Domestic appliances servicing, K.P.Anwer,Scholar Institute Publications.
8. Basic Electrical Engineering, M.L. Anwani,DhanpatRai Publication.

SEC - 1: Simulation and Design of Digital Circuit Components
Course Code: SECPL02 **Credits = 1 (1+0+0)**

Course Objectives

- To acquaint students with various basic digital gates used in digital system and develop logical circuits using Boolean gates, construction of various logic circuits using basic gates.
- To impart practical working knowledge of Simulation and Analysis of digital circuits using MATLAB and/or SCILAB.

Learning Outcomes:

On successful Completion of the course, students will be able to:

- Understand the main features and importance of the MATLAB/SCI LAB mathematical programming environment.
- Apply working knowledge of MATLAB/SCI LAB package to simulate and solve Digital Electronics circuits and Applications.

Basics of the circuit components

Basics of Voltage, Current, Resistance and Power, Ohm's law, Series and parallel combinations of electrical components.Basics of electrical instruments such as multimeter, voltmeter and ammeter.

Basics and Applications of the MATLAB

Fundamentals of the MATLAB software. Logic Circuits,Equivalent circuits of an NOT Gate, Exclusive OR Gate, , NOR Gate as Universal Gate, NAND Gate, NAND Gate as Universal Gate, XNOR Gate,Half Adder, Full Adder, Half Adder using NAND Gate, Full Adder using NAND Gate, Comparator.

Reference Books:

1. Electrical Circuits, K.A. Smith and R.E. Alley
2. Modern Digital Electronics by R.P. Jain
3. Digital Electronics by Malvino and Leech
4. Digital Signal Processing with Examples in MATLAB by Samuel D. Strearns and Don R. Hush
5. Digital Signal Processing using MATLAB by Vinay K. Ingle and Johan G. Proakis

SEC - 1: Simulation and Design of Digital Circuits Components Lab
Course Code: SECPL02 **Credits = 1 (0+0+1)**
Name of Experiments

1. Design the OR, AND &NOT Gate circuits using software and Verify with experiments
2. Design the NANDGate circuits using software and Verify with experiments.
3. Design the NOR Gate circuits using software and Verify with experiments.
4. Design the Half Adderusing NAND Gate using software and Verify with experiments.
5. Design the Full Adderusing NAND Gate using software and Verify with experiments.
6. Design the Comparator circuit using software and Verify with experiments.

Semester - II

Core 3: Semiconductor Devices **Credit: 3 (3+0+0)**

Course Code: PLUBTT1

Course Objective:

- This module introduces to the students some of the important semiconductor devices along with the underlying semiconductor physics. The module makes the students familiar with the working principles of major semiconductor diode, bipolar transistor, field-effect transistor devices, negative-resistance and power devices and photonic devices.
- Understand the fundamental principles and applications of modern electronic and optoelectronic semiconductor device.
- Understanding the connection between theory and practical as well as to make familiar with Experiments.

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

- Get an understanding about the working principles and characteristics of different types of semiconductor devices — p-n junction diodes, bi-polar transistors, MOSFETs, MESFETs, tunnel diodes, photo-detectors, LEDs and solar cells

Unit – I: Semiconductor Basics: Carrier Concentration at Normal Equilibrium in Intrinsic Semiconductors, Fermi Level for Intrinsic & Extrinsic Semiconductors, Donors, Acceptors, Dependence of Fermi Level on Temperature and Doping Concentration, Carrier Transport Phenomena: Carrier Drift, Mobility, Resistivity, Hall Effect, Diffusion Process, Einstein Relation, Current Density Equation, Continuity Equation.

Unit – II: P-N Junction Diode: Formation of Depletion Layer, Space Charge at a Junction, Derivation of Electrostatic Potential Difference at Thermal Equilibrium, Concept of Linearly Graded and an abrupt Junction, Depletion Width and Depletion Capacitance of an Abrupt Junction. Derivation of Diode Equation and I-V characteristics, Zener and Avalanche Junction Breakdown Mechanism. Tunnel diode, varactor diode, solar cell: circuit symbol, characteristics, applications.

Unit – III: Bipolar Junction Transistors (BJT): PNP and NPN Transistors, Basic Transistor Action, Emitter Efficiency, Current Gain, Energy Band Diagram of Transisto rin Thermal Equilibrium, Quantitative Modes of operation, Input and Output Characteristics of CB, CE and CC Configurations. Metal Semiconductor Junctions:

Unit – IV: Field Effect Transistors: JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage OutputCharacteristics. MOSFET, types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N-channel and P-Channel) and Enhancement type MOSFET (both N channel and P channel). Power Devices: UJT, Basic construction and working, Equivalent circuit, Characteristics and relaxation oscillator-expression. SCR, Construction, Working and Characteristics, MESFET, Circuit symbols, Basic constructional features, Operation and Applications.

Reference Books:

1) S. M. Sze, Semiconductor Devices: Physics and Technology, 2nd Edition, Wiley India edition (2002).
2) Ben G Streetman and S. Banerjee, Solid State Electronic Devices, Pearson Education (2006)
3) Dennis Le Croissette, Transistors, Pearson Education (1989)
4) Jasprit Singh, Semiconductor Devices: Basic Principles, John Wiley and Sons (2001)
5) Kanaan Kano, Semiconductor Devices, Pearson Education (2004)
6) Robert F. Pierret, Semiconductor Device Fundamentals, Pearson Education (2006)

Core 3: Semiconductor Devices Lab **Credit: 2 (0+0+2)**
Course Code: PLUBLT1
List of Experiments:
1. Study of the I-V Characteristics of Diode – Ordinary and Zener Diode.
2. Study of the I-V Characteristics of the CE configuration of BJT and obtain r_i,r_o,β.
3. Study of the I-V Characteristics of the Common Base Configuration of BJT and obtain r_i, r_o,α.
4. Study of the I-V CharacteristicsoftheCommonCollectorConfigurationofBJTandobtainvoltagegain, r_i, r_o.
5. Study of the I-V Characteristics of the UJT.
6. Study of the I-V Characteristics of the SCR.
7. Study of the I-V Characteristics of JFET.
8. Study of the I-V Characteristics of MOSFET.
9. Study of Characteristics of Solar Cell

Core 4: Applied Physics **Credit: 3 (3+0+0)**

Course Code: PLUBTT2
Course Objectives:
Understand the fundamental principles and applications of modern physics.
This course covers certain conceptual courses of physics by virtue of which the students will be able to understand some concepts of Quantum Mechanics and solid state behavior.
It also imparts the basic principles of Quantum mechanics, Thermal Properties, Debye's Law and its applications
Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
Understand and explain the differences between classical and quantum mechanics.
Identify behavior of the solid Materials.
Unit – I: Quantum Physics: Inadequacies of Classical physics, Compton's effect, Photo-electric Effect, Wave-particle duality, de-Broglie waves, Basic postulates and formalism of quantum mechanics: probabilistic interpretation of waves, conditions for physical acceptability of wave functions, Schrodinger wave equation for a free particle and in a force-field (1dimension),Boundary and continuity conditions, Operators in Quantum Mechanics, Conservation of probability, Time-dependent form, Linearity and superposition, Operators, Time- independent one dimensional Schrodinger wave equation, Eigen-values and Eigen functions.

Unit – II: Mechanical Properties of Materials: Elastic and Plastic Deformations, Hooke's Law, Elastic Moduli, Brittle and Ductile Materials, Tensile Strength, Theoretical and Critical Shear Stress of Crystals. Strengthening Mechanisms, Hardness, Creep, Fatigue, Fracture.

Unit – III: Thermal Properties, Brief Introduction to Laws of Thermodynamics, Concept of Entropy, Concept of Phonons, Heat Capacity, Debye's Law, Lattice Specific Heat, Electronic Specific Heat, Specific Heat Capacity for Si and GaAs, Thermal Conductivity, Thermoelectricity, Seebeck Effect, Thomson Effect, Peltier Effect.

Unit – IV: Electric and Magnetic Properties: Conductivity of metals, Ohm's Law, relaxation time, collision time and mean free path, electron scattering and resistivity of metals, heat developed in current carrying conductor, Superconductivity, Concepts of Giant Magnetic Resistance (GMR), Magnetic recording.

Reference Books:
1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.

2. Quantum Mechanics: Theory & Applications, A. K. Ghatak & S.Lokanathan, 2004, Macmillan
3. Quantum Mechanics: Concepts and Applications, Wiley Publisher , Nouredine *Zettili*
4. Introduction to Solid State Physics, Charles Kittel, John Wiley & Sons, Inc
5. Material Science and Engineering ,5th Edition , V. Raghavan,

Core 4: Applied Physics Lab **Credit: 2 (0+0+2)**
Course Code: PLUBLT2
Name of the Experiments

1. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
2. To determine the Young's modulus of material of cantilever.
3. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
4. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
5. Determination of Planks constant by Photo electric effect.
6. To determine work function of material of filament of directly heated vacuum diode.
7. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.

Semester – III

Core - 5: Electronic Circuits **Credit: 3 (3+0+0)**
Course Code: PLUCTT1
Course objective:
The course aims to develop an understanding of:

- How to analyze electrical filters, applications of diode diodes, and principle of power supply.
- To learn basic of different transistor biasing.
- To understand basic construction of feedback circuits and their application in Oscillators.
- To understand basic amplifier and oscillator circuits and their application.

Learning outcome:
Upon successful completion of this course, students will be able to address following points:

- Students will the working principle of power supply and it component such as half as well as full wave rectifiers, of regulated power supply.
- Learn the principle of common Emitter based amplifier, class A, Class B
- Students learn the concept of feedback and oscillators such as Phase shift, Colpitt, and Hartley.
- To learn the Biasing of MOSFET and characteristics of FET in common source mode,

Unit – I: Diode Circuits: Ideal diode, dc load line analysis, Quiescent (Q) point. Clipping and clamping circuits. Rectifiers: HWR, FWR (center tapped and bridge). Circuit diagrams, working and waveforms ripple factor & efficiency, comparison. Filters: types, circuit diagram and explanation of shunt capacitor filter with waveforms. Zener diode, regulator circuit diagram, and explanation for load and line regulation.

Unit – II: Bipolar Junction Transistor: Review of CE, CB Characteristics and regions of operation. Hybrid parameters, Transistor biasing, DC load line, operating point, thermal runaway, stability and stability factor, Fixed bias without and with R_E, collector to base bias, voltage divider bias and emitter bias (+VCC and –VEE bias), circuit diagrams and their working. Transistor as a switch, circuit and working, Darlington pair and its applications BJT amplifier (CE), dc and ac load line analysis, hybrid model of CE configuration.

Unit – III: Feedback Amplifiers: Concept of feedback, negative and positive feedback, advantages and disadvantages of negative feedback, voltage (series and shunt), current (series and shunt) feedback amplifiers, gain, input and output impedances . Barkhausen criteria for oscillations, Study of phase shift oscillator, Colpitts oscillator and Hartley oscillator.

Unit – IV: MOSFET Circuits: Review of Depletion and Enhancement MOSFET, Biasing of MOSFETs, Common Source amplifier circuit analysis, CMOS circuits.
Power Amplifiers: Classification of power amplifiers, Class A, Class B, Class C and their comparisons. Operation of a Class A single ended and transformer coupled power amplifier. Circuit operation of complementary symmetry Class B push pulls power amplifier, crossover distortion.

Reference Books:

1. Electronic Devices and circuit theory, Robert Boylstead and Louis Nashelsky, 9th Edition, 2013, PHI.
2. Electronic devices, David A Bell, Reston Publishing Company
3. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill (2002)
4. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill (2002)

5. J. Millman and C. C. Halkias, Integrated Electronics, Tata McGraw Hill(2001)J. R. C. Jaegar and T. N. Blalock, Microelectronic Circuit Design, Tata McGraw Hill(2010)
6. J. J. Cathey, 2000 Solved Problems in Electronics, Schaum's outline Series, Tata McGraw Hill (1991)

Core 5: Electronic Circuits Lab **Credit: 2 (0+0+2)**

Course Code: PLUCLT1
Name of Experiments
1. Study of the half wave rectifier and Full wave rectifier.
2. Study of power supply using C filter and Zener diode.
3. Designing and testing of 5V/9V DC regulated power supply and find its load-regulation
4. Study of clipping and clamping circuits.
5. Study of Fixed Bias, Voltage divider bias Feedback configuration for transistors.
6. Designing of a Single Stage CE amplifier.
7. Study of the Colpitt's Oscillator.
8. Study of the Hartley's Oscillator.
9. Study of the Phase Shift Oscillator
10. Study of the frequency response of Common Source FET/MOSFET

Core 6: Digital Electronics and VHDL **Credit: 3 (3+0+0)**
Course Code: PLUCLT2
Course Objectives:
- To understand the different number systems and their conversion.
- Design and realization of the basic and universal logic gates and simplification of the Boolean algebra.
- Construction of sequential logic circuits and understanding various design of flip flops.
- To study hardware description languages HDL and describe their role in the electronic design automation environment.
- This course also focuses on basics of VHDL simulation

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Design and verification of different logic gates (AND, OR, XOR)
- Design of multiplexer, encoder, and decoder circuit using VHDL Design
- Design of arithmetic circuits (half adder, full adder, half subtractor, full subtractor)
- Design of 4 Bit Binary to Grey code Converter using VHDL
- Write simple programs in VHDL in different styles.
- Design and verify the functionality of digital circuit/system using test benches.

Unit – I: Number System: Binary number system, Binary to decimal conversion, Decimal to binary conversion , Binary operations: addition, subtraction, complement of a number - 1's complementary subtraction, 2's complementary subtraction , binary multiplication, binary division, Representation of binary number as electrical signals, octal number system, octal to decimal conversion – decimal to octal conversion, binary to octal conversion, octal to binary conversion, advantages of octal number system, hexadecimal number system, binary to hexadecimal conversion, hexadecimal to binary conversion.

Unit – II: Boolean Algebra: Introduction, Laws of Boolean Algebra, Equivalent switching circuits, De Morgan's theorem, Logic circuits, Definition, Positive and Negative Logic, OR Gate, Equivalent circuit of an OR Gate, AND Gate, Equivalent circuit of an AND Gate, NOT Gate, Equivalent circuit of a NOT Gate, Exclusive OR Gate, Diode OR Gate, Diode AND Gate, Transistor OR Gate, Transistor AND circuit.

Unit – III: Implementation of Combinational Logic Circuits: NOR Gate, NOR Gate as a Universal Gate, NAND Gate, NAND Gate as a Universal Gate, XNOR Gate, Adders and Substractor, Half Adder, Full Adder, Half Substractor, Full Substractor, Half Adder using NAND Gate, Full Adder using NAND Gate, Flip Flop, Master Slave Flip Flop, R-S Flip Flop, Master Slave J-K Flip Flop, Counters, The 7493 A four Bit Binary Counter Shift Register, Serial in – Serial out shift Register

Unit – IV: Introduction to VHDL: A Brief History of HDL, Structure of HDL Module, Operators, Data types, Types of Descriptions, simulation and synthesis, Highlights of Data-Flow Descriptions, Structure of Data-Flow Description, Data Type – Vectors, Behavioral Description highlights, structure of HDL behavioral Description, The VHDL variable –Assignment Statement, sequential statements. Highlights of structural Description, Organization of the structural Descriptions, Binding, state Machines, Generate, Generic, and Parameter statements.

Reference Books:

6. Modern Digital Electronics by R.P.Jain
7. Principles of Electronics. V. K. Mehta, Rohit Mehta
8. Digital Computer Electronics: Malvino and Brown
9. Digital Electronics by Malvino and Leech
10. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis", Pearson Education, Second Edition.
11. Kevin Skahill, VHDL for Programmable Logic‖, PHI/Pearson education, 2006.

Core 6: Digital Electronics Lab **Credit: 2 (0+0+2)**

Course Code: PLUCLT2
Name of the experiments
1. Realization of Basic logic gates AND, OR, XOR and verify their truth table.
2. Configuring NAND and NOR logic gates as universal gates.
3. Implementation of Boolean Logic Functions using logic gates and combinational circuits.
4. Measure digital logic gate specifications such as propagation delay, noise margin, fan in and fan out.
5. Study and configure of digital circuits such as adder, subtractor,
6. Study and configure of decoder, encoder and code converters.
7. Study and configurations of multiplexer and demultiplexer circuits.
8. Study and configure of flip-flop, registers and counters using digital ICs.
9. Design digital system using these circuits.
10. Perform an experiment which demonstrates function of 4 bit or 8 bit ALU.

Core 7: C/ C++ Programming and Data Structures **Credit: 3 (3+0+0)**
Course Code: PLUCTT3
Course Objectives:
The course aims to develop an understanding of:
- The concept of a program.
- The concept of a loop – that is, a series of statements which is written once but executed repeatedly- and how to use it in a programming language.
- The abstract properties of various data structures such as stacks, queues, lists, and trees.
- Various sorting algorithms, including bubble sort, insertion sort, selection sort, merge sort.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- To demonstrate an understanding of primitive data types, values, operators and expressions in C.
- Be able to develop logics which will help them to create programs.
- Be able to break a large problem into smaller parts, writing each part as a module or function
- Compare different implementations of data structures and to recognize the advantages and disadvantages of the different implementations.

Unit – I: C Programming Language: Introduction, Importance of C, Character set, Tokens, keywords, identifier, constants, basic data types, variables: declaration & assigning values. Arithmetic operators, relational operators, logical operators, assignment operators, increment and decrement operators, conditional operators, expressions and evaluation of expressions, type cast operator, implicit conversions, precedence of operators, Structure of C program. Arrays-concepts, declaration, accessing elements, storing elements, two-dimensional and multi-dimensional arrays. Input output statement and library functions.

Unit – II: Decision making, branching & looping: Decision making, branching and looping: if, if-else, else-if, switch statement, break, for loop, while loop and do loop. Functions: Defining functions, function arguments and passing, returning values from functions. Structures: defining and declaring a structure variable, accessing structure members, initializing a structure, copying and comparing structure variables, array of structures, arrays within structures, structures within structures, structures and functions, Pointers.

Unit – III: Data Structures: Definition of stack, array implementation of stack, conversion of infix expression to prefix, postfix expressions, evaluation of postfix expression. Definition of Queue, Circular queues, Array implementation of queues. Linked List and its implementation.

Unit – IV: Searching and sorting: Insertion sort, selection sort, bubble sort, merge sort, linear Search, binary search. Trees: Introduction to trees, Binary search tree, Insertion and searching in a BST.

Reference Books:

1. Yashavant Kanetkar, Let Us C, BPB Publications.
2. Programming in ANSI C, Balagurusamy, 2nd edition,TMH.
3. Byron S Gottfried, Programming with C, Schaum Series.
4. Brian W. Kernighan, Dennis M. Ritchie, The C Programming Language, Prentice Hall.
5. Yashavant Kanetkar, Pointers in C, BPB Publications.
6. S. Sahni and E. Horowitz, "Data Structures", Galgotia Publications.
7. Tanenbaum: "Data Structures using C",Pearson/PHI.
8. Ellis Horowitz and Sartaz Sahani "Fundamentals of Computer Algorithms", Computer Science Press.

Core 7: C/ C++ Programming and Data Structures Lab **Credit: 2 (0+0+2)**
Course Code: PLUCLT3
Name of the experiments

1. Find minimum and maximum of N numbers.
2. Calculate the value of sin (x) and cos (x) using the series. Also print sin (x) and cos (x) value using library function.
3. Generate and print prime numbers up to an integer N.

4. Calculate the subject wise and student wise totals and store them as a part of the structure.
5. Create a stack and perform Pop, Push, Traverse operations on the stack using Linear Linked list.
6. Create circular linked list having information about a college and perform Insertion at front, Deletion at end.
7. Create a Linear Queue using Linked List and implement different operations such as Insert, Delete, and Display the queue elements.
8. Implement Insertion sort and Merge sort.
9. Implementation of Bubble sort and Selection sort.

Semester - IV

Core 8: Signals and Systems **Credit: 5 (4+1+0)**

Course Code: PLUDTT1

Course Objectives :

The course will provide strong foundation on

- Learn basic continuous time and discrete time signals and systems.
- Understand application of various transforms for analysis of signals and systems both continuous time and discrete time.
- Also explore to power and energy signals and spectrum

Learning Outcomes

After learning the course the students should be able:

- To Understand about various types of signals, classify them, analyze them, and perform various operations on them.
- To Understand about various types of systems, classify them, analyze them and understand their response behaviour.
- To illustrate of transforms in analysis of signals and system.

Unit – I: Basic definitions, Classification of signals and systems. Signal operations and properties. Basic continuous time signalsand discrete time signals. Basic system properties, Representation for systems Power and energy signals, Energy and power Spectral densities.

Unit – II: Stability of Linear system, Impulse response of Continuous Time Linear Time Invariant system (CT- LTI system, signal responses to CT-LTI system, properties of convolution

Unit – III: Causal signal response to DT-LTI systems. Properties of convolution summation, Impulse response of DT-LTI system. DT-LTI system properties from Impulse response. System analysis from difference equation model, examples.

Unit – IV: Representation of periodic functions, Fourier series& its properties , Frequency spectrum of a periodic signals, Fourier Transform, Relation between Laplace Transform and Fourier Transform and its properties. Fourier Series Sampling theorem and applications, Fast Fourier transform (FFT), Introduction to DTFT and DFT , The z-Transform, Convergence of z-Transform, Basic z-Transform, Properties of z-Transform, Inverse z-Transform .

Reference Books:

1. Signals and Systems by Alan V. Oppenheim, Alan S. Wilsky and Nawab, Prentice Hall.
2. Signals and Systems by K. Gopalan, Cengage Learning (India Edition).
3. Signals & Systems : Continuous and Discrete by Rodger E. Ziemer , William H.Tranter, D.Ronald Fannin , Pearson Education Asia.
4. Signals and Systems by Michal J. Roberts and Govind Sharma, Tata Mc-Graw Hill Publications.
5. Signals and Systems by Simon Haykin and Bary Van Veen, Wiley- India Publications.
6. Linear Systems and Signals by B.P.Lathi, Oxford University Press.
7. Signal, Systems and Transforms by Charles L. Philips, J. M. Parr and E. A. Riskin, Pearson Education.
8. Digital Signal Processing Fundamentals and Applications by Li Tan, Elsevier, Academic Press.
9. Signal and Systems by Anand Kumar, 3rd Edition, PHI.

Core 9: Operational Amplifiers and Applications **Credit: 3 (3+0+0)**
Course Code: PLUDTT2
Course Objective:

- To study the characteristics and applications of operational amplifiers (opamps).
- To study op-amp amplifiers, comparators, voltage, and current regulators, summers, integrators, and differentiators as well as a signal generator.
- To study and design multivibrators and their applications.
- To study and design various types of filter and their applications.

Course outcome:

- The student will be able to use mathematical and problem-solving approaches for design and Operational amplifiers.
- Be able to define the significance of Op-Amps and their important applications and build circuits using analog ICs.
- Be able to apply depth knowledge of real-time applications such as comparator and trigger circuits.
- Be able to design various types of filers and their applications based on Op Amp.

Unit – I: Basic Operational Amplifier: Concept of differential amplifiers (Dual input balanced and unbalanced output), constant current bias, current mirror, cascaded differential amplifier stages with the concept of the level translator, block diagram of an operational amplifier (IC 741).

Op-Amp parameters: input offset voltage, input offset current, input bias current, differential input resistance, input capacitance, offset voltage adjustment range, input voltage range, common mode rejection ratio, slew rate, supply voltage rejection ratio.

Unit – II: Op-Amp Circuits: Open and closed loop configuration, Frequency response of an op-amp in open loop and closed loop configurations, Inverting, Non-inverting, Summing and difference amplifier, Integrator, Differentiator, Voltage to current converter, Current to voltage converter.
Comparators: Basic comparator, Level detector, Voltage limiters, Schmitt Trigger.

Unit – III: Multivibrators (IC 555): Block diagram, Astable and monostablemultivibrator circuit, Applications of Monostable and Astablemultivibrators, IC565.

Unit – IV: Signal Conditioning circuits: Active filters: First order low pass and high pass Butterworth filter, Second order filters, Band pass filter, Band reject filter, All pass filter.

Reference Books:

1. R. A. Gayakwad, Op-Amps and Linear IC’s, Pearson Education(2003)
2. George Clayton and Steve Winder, Operational Amplifiers, ELSEVIER, Fifth edition
3. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, Pearson Education(2001)
4. J. Millman and C.C. Halkias, Integrated Electronics, TataMcGraw-Hill,(2001)
5. A.P.Malvino, Electronic Principals,6th Edition, TataMcGraw-Hill,(2003)
6. K.L.Kishore, OP-AMP and Linear Integrated Circuits, Pearson(2011)

Credit: 2 (0+0+2)

Core 9: Operational Amplifiers and Applications Lab
Course Code: PLUDLT2
Name of the experiments

1. Study of op-amp characteristics: CMRR and Slew rate.
2. Designing of an amplifier of given gain for an inverting and non-inverting configuration using an op amp.
3. Designing analog adder and subtractor circuits.
4. Designing an integrator using op-amp for a given specification and studying its frequency response.
5. Designing a differentiator using op-amp for a given specification and studying its frequency response.
6. Designing of a First Order Low-pass filter using op-amp.
7. Designing of a First Order High-pass filter using op-amp.
8. Designing a band-pass filter using op-amp.
9. Study of IC 555 as an astable multivibrator.
10. Study of IC 555 as a mono stable multivibrator.

Core - 10: Electronics Instrumentations **Credit: 3 (3+0+0)**
Course Code: PLUDTT3
Course Objectives:

- In-depth understanding of Measurements and errors.
- Students can able to develop topology of the various instruments and apply the knowledge in taking the measurements with better accuracy.
- Students can get knowledge on practice in testing of various instruments and able to take the measurements with better accuracy and precision.
- Students can identify which parameters are involved, in taking the measurement using an instrument and also gain the knowledge to compare the results and the performance of various instruments.

Course outcome:

- The student will be able to use instruments accurately taking care of errors.
- Be able to use sophisticated electronic instruments and knowledge of their basics.
- Be able to compare the results of various instruments.
- Be able to understand the working of Transducers and sensors.

Unit – I: Qualities of Measurement: Specifications of instruments, their static and dynamic characteristics, Error (Gross error, systematic error, absolute error and relative error) and uncertainty analysis. Statistical analysis of data and curve fitting.

Unit – II: Basic Measurement Instruments: PMMC instrument, galvanometer, DC measurement - ammeter, voltmeter, **ohm** meter, AC measurement, Digital voltmeter systems (integrating and non-integrating types), digital multimeters, digital frequency meter system (different modes and universal counter).
Connectors and Probes: low capacitance probes, high voltage probes, current probes, identifying electronicconnectors - audio and video, RF/Coaxial, USB etc.

Unit – III: Measurement of Resistance and Impedance: Low Resistance: Kelvin's double bridge method, Medium Resistance by Voltmeter Ammeter method, Wheatstone bridge method, High Resistance by Megger. A.C. bridges, Measurement of Self Inductance, Maxwell's bridge, Hay's bridge, and Anderson's bridge, Measurement of Capacitance, Schering's bridge, DeSauty's bridge, Measurement of frequency, Wien's bridge. **A-D and D-A Conversion:** 4 bit binary weighted resistor type D-A conversion, circuit and working. Circuit of R-2R ladder. A-D conversion characteristics, successive approximation ADC. (Mention of relevant ICs forall).

Unit – IV: Transducers and sensors: Classification of transducers, Basic requirement/characteristics of transducers, active & passive transducers, Resistive (Potentiometer, Strain gauge - Theory, types, temperature compensation and applications), Capacitive (Variable Area Type - Variable Air Gap type - Variable Permittivity type), Inductive (LVDT) and piezoelectric transducers. Measurement of temperature (RTD, thermistor, thermocouple, semiconductor IC sensors), Light transducers (photoresistors, photovoltaic cells, photodiodes).

Reference Books:

1. H. S. Kalsi, Electronic Instrurnentaion, TMH(2006)
2. W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice-Hall (2005).
3. Instrumentation Measurement and analysis: Nakra BC, Chaudry K, TMH
4. E.O.Doebelin, Measurement Systems: Application and Design, McGraw Hill Book - fifth Edition(2003).
5. Joseph J Carr, Elements of Electronic Instrumentation and Measurement, Pearson Education (2005)
6. David A. Bell, Electronic Instrumentation and Measurements, Prentice Hall (2013).
7. Oliver and Cage, "Electronic Measurements and Instrumentation", TMH (2009).
8. Alan S. Morris, "Measurement and Instrumentation Principles", Elsevier (Buterworth Heinmann-2008).
9. A. K Sawhney, Electrical and Electronics Measurements and Instrumentation, DhanpatRai and Sons(2007).
10. C. S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata Mcgraw Hill(1998).

Core 10: Electronics Instrumentations Lab **Credit: 2 (0+0+2)**
Course Code: PLUDLT3
Name of the experiments

1. Design of multi range ammeter and voltmeter using galvanometer.
2. Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity.
3. Measure of low resistance by Kelvin's double bridge.
4. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement of Strain usinghalf and full bridge.)
5. To determine the Characteristics of LVDT.
6. To determine the Characteristics of Thermistors and RTD.
7. Measurement of temperature by Thermocouples and study of transducers like AD590 (two terminaltemperature sensor), PT-100, J- type, K-type.
8. To study the Characteristics of LDR, Photodiode, and Phototransistor:
9. Variable Illumination (ii) Linear Displacement.
10. Characteristics of one Solid State sensor/ Fiber optic sensor

Semester - V

Core 11: Electromagnetic Theory **Credit: 5 (4+1+0)**

Course Code: PLUETT1

Course Objectives:

The course aims to develop an understanding of:

- The basic mathematical concepts related to electromagnetic vector fields
- Knowledge on the concepts of electrostatics and its applications
- Knowledge on the concepts of magneto-statistics
- The concept of Electromagnetic Waves and fundamentals.
- To enhance the ability to Solve Electromagnetic Relation using Maxwell relations

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- Understand the basic mathematical concepts related to electromagnetic vector fields.
- Apply the principles of electrostatics to solve the problems related to electric field and electric potential.
- Apply the principles of magneto-statics to the solutions of problems relating to magnetic field and magnetic potential
- Understand the concepts related to Faraday‘s law, induced emf and Maxwell‘s equations.
- Apply Maxwell‘s equations to solve the problems of boundary conditions, plane wave propagation

Unit – I: Vector Analysis: Scalars and Vectors, Vector Algebra, Vector Components and Unit Vector, Cartesian, Cylindrical and Spherical Coordinates, Line, Surface and Volume integrals, Del Operator, Gradient of a Scalar, Divergence and Curl of a Vector, the Laplacian. Derivation of Poisson's and Laplace's equation, Examples of Solution of Laplace's Equation.

Unit – II: Electrostatic Fields: Coulomb's Law and Electric Field, Field due to Discrete and Continuous Charge Distributions, Electric Flux Density, Gauss's Law and Applications, Divergence Theorem and Maxwell's First Equation. Electric Potential, Potential due to a Charge and Charge distribution, Electric dipole. Electric Fields in Conductors, Current and Current Density, Dielectric materials, Dielectric Constant, Capacitance and Capacitors, Electrostatic Energy.

Unit – III: Magnetostatics and Time-Varying Fields: BiotSavert's law and Applications, Magnetic dipole, Ampere's Circuital Law, Curl and Stoke's Theorem, Maxwell's Equation, Magnetic Flux and Magnetic Flux Density, Magnetization in Materials and Permeability, Magnetic Energy.Faraday's Law of Electromagnetic Induction,Inductors and Inductances,Transformer and Motional EMF, Stationary Circuit in Time-Varying Magnetic Field.

Unit – IV: Maxwell's Equations and its Applications:, Maxwell's Equations in differential and integral form and Constitutive Relations. Displacement Current, Electromagnetic Boundary Conditions. Scaler and vector magnetic potential, Flow of Electromagnetic Power and Poynting Theorem, Poynting Vector, Wave Equation in a source free isotropic homogeneous media.

Reference Books:

1. Murray. R. Spiegel, Vector Analysis, Schaum series, Tata McGraw Hill (2006)
2. M. N. O. Sadiku, Elements of Electromagnetics, Oxford University Press (2001)
3. D. C. Cheng, Field and Wave Electromagnetics, Pearson Education (2001)
4. J. A. Edminster, Electromagnetics, Schaum Series, Tata McGraw Hill (2006)
5. N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
6. Introduction to Electrodynamics, D.J. Griffiths, Pearson Education (2012)

Core 12: Microprocessors and Microcontrollers **Credit: 3 (3+0+0)**
Course Code: PLUETT2
Course Objectives:

- Be able to understand the evaluation of microprocessors and microcontrollers and their difference, uses, applications in day to day life.
- Understand the architecture of microprocessor & microcontroller, their internal mechanism how each block is functioning.
- The writing programs in assembly language and able to run by using the microprocessor.
- Learn how to interface the peripheral devices to this microprocessor and microcontrollers.

Unit – I: Introduction to Microprocessor: Introduction, Applications, Basic block diagram, Speed, Word size, Memory capacity, Classification of microprocessors (mention of different microprocessors being used)
Microprocessor 8085: Features, Architecture -block diagram, General purpose registers, register pairs, flags, stack pointer, program counter, types of buses. Multiplexed address and data bus, generation of control signals, pin description of microprocessor 8085. Basic interfacing concepts, Memory mapped I/O and I/O mapped I/O.

Unit – II: 8085 Instructions: Operation code, Operand & Mnemonics. Instruction set of 8085, instruction classification, addressing modes, instruction format. Data transfer instructions, arithmetic instructions, increment & decrement instructions, logical instructions, branch instructions and machine control instructions. Assembly language programming examples.
Stack operations, subroutine, call and return instructions. Delay loops, use of counters, timing diagrams-instructioncycle, machine cycle, T- states, time delay.
Interrupt structure of 8085A mic roprocessor, processing of vectored and non-vectored interrupts, latency time and response time; Handling multiple interrupts

Unit – III: Microcontrollers: Introduction, different types of microcontrollers, embedded microcontrollers, processor architectures. Harvard vs. Princeton, CISC vs. RISC architectures, microcontroller memory types, microcontroller features, clocking, I/O pins, interrupts, timers, peripherals.

Unit – IV: PIC16F887 Microcontroller: Core features, Architecture, pin diagram, memory organization- Program and data memory organization, I/O Ports, oscillator module, Timer modules (Timer 0, Timer 1 and Timer 2), comparator module, analog-to-digital converter (ADC) module, data EEPROM. 16x2 LCD display, 4x4 Matrix Keyboard, Digital to Analog Converter, Stepper Motor and DC Motor. Interfacing program examples using C language.

Reference Books:

1. Microprocessor Architecture, Programming and Applications with 8085, Ramesh S.Gaonkar - WileyEastern Limited- IV Edition.
2. Fundamentals of Microprocessor & Microcomputer: B. Ram-Danpat Rai Publications.
3. Microchip PIC16F87X datasheet
4. PIC Microcontrollers, Milan Verle, Mikro Elektronika, 1st edition (2008)
5. Muhammad Ali Mazidi, "Microprocessors and Microcontrollers", Pearson, 2006

Core 12: Microprocessors and Microcontrollers Lab **Credit: 2 (0+0+2)**
Course Code: PEUELT2
Name of the experiments
1. Program to transfer a block of data.
2. Program for multibyte addition and subtraction
3. Program to multiply and division two 16-bit numbers.
4. Program to generate terms of Fibonacci series.
5. Program to find minimum and maximum among N numbers
6. Program to find the square root of an integer.
7. Program to find GCD of two numbers.
8. Program to verify the truth table of logic gates.

DSE - 1: Nano Electronics **Credit: 3 (3+0+0)**
Course Code: PLUETD1
Course Objectives:
The course aims to develop an understanding of:
- Explain the various aspects of nano-technology and the processes involved in making nanomaterials.
- Explain confinement of charge carrier on properties of materials
- To provide the knowledge on various nanomaterials synthesis processes.
- To gain the knowledge on characterization of nanomaterials.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Learn the basic physics of nanomaterials.
- Learn the various experimental techniques for synthesis of nanomaterials.
- Learn various characterization techniques of nanomaterials.
- Knowledge of the various nanostructure of carbon materials and their applications

Unit – I: Definition of Nano-Science and Nano Technology, Applications of NanoTechnology. Introduction to Physics of Solid State: Size dependence of properties, bonding in atoms and giant molecular solids, Systems confined to one, two or three dimension and their effect on property, Quantum Theory for Nano Science: Time dependent and time independent Schrodinger wave equations. Particle in a box, Potential step: Reflection and tunneling (Quantum leak). Penetration of Barrier, Electron trapped in 2D plane (Nano sheet), Quantum confinement effect in nano materials.

Unit – II: Growth Techniques of Nanomaterials: Synthetic aspects: bottom up and top down approaches, Lithograpahic and Nonlithograpahic techniques, Sputtering and film deposition in glow discharge, DC sputtering technique. Thermal evaporation technique, E-beam evaporation, Chemical Vapour deposition (CVD), Pulsed Laser Deposition, Molecular beam Epitaxy, Sol-Gel Technique (No chemistry required).

Unit – III: Methods of Measuring Properties and Characterization techniques: Microscopy:Scanning Probe Microscopy (SPM), Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Infra-red and Raman Spectroscopy, X-ray Spectroscopy, Optical and Vibrational Spectroscopy, Characterization and application like biopolymer tagging and light emitting semiconductor quantum dots.

Unit – IV: Carbon nanotubes, nano cuboids, graphene, carbon quantum dots: Fabrication, structure, electrical, mechanical, and vibrational properties and applications. Use of nano particles for biological application, drug delivery and bio-imaging, Impact of nanotechnology on the environment.

Reference Books:

1. Nanoscale Science and Technology, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005.
2. Nanomaterials: synthesis, properties and applications, Institute of Physics, 1998.
3. Introduction to Nanotechnology, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, 2003.
4. Introduction to Nanoscience and Technology K.K. Chattopadhyay and A. N. Banerjee,. (PHI Learning Private Limited)
5. Nano: The Essentials: Understanding Nanoscience and Nanotecnology, T.Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
6. Nanobiotechnology, concepts, applications and perspectives, Wiley-VCH, 2004.

DSE - 1: Nano Electronics Lab **Credit: 2 (0+0+2)**
Course Code: PLUELD1
Name of the experiments

1. Synthesis of at least two different sizes of Nickel Oxide/ Copper Oxide/ Zinc Oxide Nano Particles Using Sol- Gel Method.
2. Particle size determination by X-ray diffraction (XRD) and XRD analysis of the given XRD spectra
3. Determination of the particle size of the given materials using He-Ne LASER.
4. Spectroscopic characterization of metallic, semiconducting and insulating nanoparticles
5. Growth of quantum dots by thermal evaporation.
6. To prepare nanocomposite materials and its characterizations.

DSE - 2: Numerical Techniques **Credit: 3 (3+0+0)**
Course Code: PEUETD2

Course Objectives:
The course aims to develop an understanding of:

- Learning basic methods, tools and techniques of computational physics.
- Developing practical computational problem solving skills in basic computer programming

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- Identify and describe the characteristics of various numerical methods.
- Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.

Unit – I: Numerical Methods: Round-off error, Programming errors, Solution of Transcendental and Polynomial Equations using Bisection method, Secant, Regula Falsi Methods, Newton Raphson method, Iteration Methods, Newton's Method for Systems.

Unit – II: Interpolation: Langrange Interpolation, Newton Divided Difference Interpolation (forward and backward difference formulae). **Curve Fitting**: Least square fitting, Curve fitting.

Unit – III: Numerical Integration: Trapezoidal Rule, Simpson's Rule and Gauss Integration formula.
Numerical methods for first order differential equations: Taylor's Series, Euler's Method and Runge Kutta method.

Unit – IV: Numerical Methods in Linear Algebra: Linear systems $Ax = B$, Gauss Elimination, Partial Pivoting, Matrix Inversion by Gauss-Jordon, Iterative Methods: Gauss-Seidel Iteration, Jacobian Iteration.

Reference books:

1. V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall India, Third Edition.
2. S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall India (2008).
3. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods: Problems and Solutions, New Age International (2007).
4. B.S. Grewal, Numerical Methods in Engineering and Science with Programs in C and C++, Khanna Publishers (2012).
5. R.V. Dukkipati, Numerical methods, New Age International.

DSE - 2: Numerical Techniques Lab **Credit: 2 (0+0+2)**
Course Code: PEUELD2
Name of the experiments

1. Program to implement Bisection Method
2. Program to implement Secant Method
3. Program to implement Regulafalsi method
4. Program to implement Newton Raphson Method
5. Program to implement Trapezoidal rule
6. Program to implement Simpson's rule
7. Program to implement Runge Kutta Method
8. Program to implement Gauss-Jordon Method
9. Program to implement Gauss-Seidel Iteration

Semester - VI

Core 13: Semiconductor Fabrication & Characterization **Credit: 3 (3+0+0)**
Course Code: PLUFTT1
Course Objectives:
The course aims to develop an understanding of:
- To introduce the fundamental properties and fabrication methods of semiconductor materials used for technology development
- To know the state-of-the-art fabrication techniques of different materials,
- To know the various properties of semiconductor materials used for device fabrication.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Understand and discuss the basic fabrication principals of semiconductor materials;
- Apply and select appropriate techniques for characterizing semiconductor materials;
- Demonstrate the basic aspects of advanced engineering of semiconductor materials and their applications in device and system fabrication.

Unit – I: Introduction of Semiconductor Process Technology: Introduction of Semiconductor materials and Devices, single crystal, polycrystalline and amorphous, Crystal growth techniques: Silicon Crystal Growth from the melt, The Czochralski technique, Silicon Float Zone Process, GaAs from Brigdman techniques. Wafer preparation.

Unit – II: Film Deposition: Epitaxial Growth Techniques, Chemical Vapour Deposition, CVD for GaAs, Metalorganic CVD, Molecular Beam Epitaxy, Defect in Epitaxial layers. Dielectric Deposition
Characterization: Crystal characterization, Crystal defects**,** Characterization methods for structural, optical properties. Basic idea of X-ray diffractometer, and UV-VIS-NIR spectrophotometer.

Unit – III: Silicon Oxidation: Thermal Oxidation Process:Kinetics of Growth for thick and thin Oxide, Dry and Wet oxidation. Effects of high pressure and impurity Redistribution during Oxidation, Masking property of Silicon Dioxide, Oxide Quality.

Unit – IV: Etching: Wet Chemical Etching-basic process and few examples of etchants for semiconductors, insulators and conductors; Dry etching using plasma etching technique. **Metallization:** Uses of Physical Vapor Deposition and Chemical Vapor Deposition technique for Aluminum and Copper Metallization. **Lithographic Processes:** Basic idea about lithography process

Reference books:

1. Gary S. May and S. M. Sze, Fundamentals of Semiconductor Fabrication, John Wiley& Sons (2004)
2. Ludmila Eckeno va, Physics of Thin films, Second Edition, Plenum Press (1986).

Core 13: Semiconductor Materials Lab **Credit: 2 (0+0+2)**
Course Code: PLUFLT1
Name of the experiments
1. To measure the resistivity of semiconductor crystal with temperature by four -probe method.
2. To determine the type (n or p) and mobility of semiconductor material using Hall-Effect System

3. To determine the thickness of Thin films using Ellipsometer
4. To determine the Energy Band gap (Eg) of silicon Crystal using energy band gap measurement setup
5. To Characterize the optical characteristics using UV-VIS Spectrometer
6. To find out the chemical bond present in deposited thin films using FTIR
7. To Synthesize the Thin Films using Sol-Gel Spin Coating system
8. To Synthesize the Thin Films using Chemical Route Synthesis method
9. To Deposit the Thin Films of Conductors using CVD System
10. To Determine the Optical Bandgap through transmission spectra.

Core 14: Communication Electronics **Credit: 3 (3+0+0)**
Course Code: PLUFTT2
Course Objectives: The course aims to develop an understanding of:
- The objective of this syllabus is to impart primitive to advance theoretical and practical knowledge of communication technology,
- To understand special emphasis on modulation techniques to learners.
- This includes both analog and digital modulation and this knowledge will serve as building block in understanding advance communication system.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Basic concept of communication technology.
- Processes involved in communication..
- Then they will be accustomed to both analog and digital modulation techniques in both theoretical and practical aspects.

Unit – I: Electronic communication: Block diagram of an electronic communication system, need for modulation, concept of channels and base-band signals. Concept of Noise,Types of Noise, Signal to noise ratio, Noise Figure, Noise Temperature.

Unit – II: Amplitude Modulation: Amplitude Modulation, modulation index and frequency spectrum. Generation of AM, Amplitude Demodulation (diode detector), Concept of Double side band suppressed carrier, Single side band suppressed carrier, other forms of AM
Angle modulation: Frequency and Phase modulation, modulation index and frequency spectrum, Block diagram of FM Transmitter and Receiver .Comparison between AM, FM and PM.

Unit – III: Pulse Analog Modulation: Sampling theorem, Multiplexing, TDM and FDM.
Pulse Code Modulation: Need for digital transmission, Quantizing, Uniform and Non-uniform Quantization , Quantization Noise, Companding.

Unit – IV: Digital Carrier Modulation Techniques: Bit Rate, Baud Rate and M-ary coding. Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Binary Phase Shift Keying (BPSK) and Quadrature Phase Shift Keying (QPSK)

Reference Books:
1. Electronic communication systems-Kennedy,3rd edition,Mc Graw international publications
2. Principles of Electronic communication systems–Frenzel,3rd edition, Mc Graw Hill
3. Communication Systems, S. Haykin, Wiley India(2006)

4. Advanced electronic communications systems–Tomasi, 6th edition, PHI.
5. Communication Systems, S. Haykin,Wiley India(2006)

Core 14: Communication Electronics Lab **Credit: 2 (0+0+2)**
Course Code: PLUFLT2

Name of the experiments
1. Study of Amplitude Modulation and Demodulation
2. Study of Frequency Modulation and Demodulation
3. Study of Pulse Amplitude Modulation
4. AM Transmitter/Receiver
5. FM Transmitter/Receiver
6. Study of TDM, FDM
7. Study of Pulse Width Modulation
8. Study of Pulse Position Modulation
9. Study of Pulse Code Modulation
10. Study of Amplitude Shift Keying
11.Study of Phase Shift Keying,
12.Study of Frequency Shift Keying.

DSE 3: Photonic Devices and Power Electronics **Credit: 3 (3+0+0)**
Course Code: PLUFTD1

Course Objectives:
The course aims to develop an understanding of:
- Wide variety of different semiconductor optoelectronic devices employed in light wave systems and networks
- The basic physics behind optoelectronic devices
- The basic theory of power semiconductor devices and passive components and their practical applications in power electronics
- The structure of power electronic devices such as diode, SCR, IGBT, MOSFET

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Relate basic semiconductor physics to properties of power devices
- Develop basic understanding of optoelectronic integrated circuits
- Describe basic operation and compare performance of various power semiconductor devices, passive components and switching circuits

Unit – I: Classification of photonic devices. Interaction of radiation and matter, Radiative transition and optical absorption. Light Emitting Diodes- Construction, materials and operation. Semiconductor Laser- Condition for amplification, laser cavity. Charge carrier and photon confinement, line shape function.
Photodetectors: Photoconductor. Photodiodes (p-i-n) and Photo transistors, Photomultiplier tube, Solar Cell: Construction, working and characteristics.

Unit – II: LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, advantages over LED displays. Introduction to Fiber Optics: Evolution of fiber optic system- Element of an Optical Fiber Transmission link, Optical Fiber Modes and Configurations - Mode theory of Circular Wave guides, Single Mode Fibers, Graded Index fiber structure.

Unit – III: Introduction to family of thyristors. Silicon Controlled Rectifier (SCR)- structure, I-V characteristics, Turn-On and Turn-Off characteristics, Diac Basic structure, working and V-I characteristics, Triac- Basic structure, working and V-I characteristics, MOSFET.
Insulated Gate Bipolar Transistors (IGBT): Basic structure, I-V Characteristics, switching characteristics, device limitations and safe operating area (SOA).

Unit – IV: Applications of SCR: Phase controlled rectification, AC voltage control using SCR and Triac as a switch. Power Invertors- Need for commutating circuits and their various types, Parallel capacitor commutated invertors, Series Invertor.

Reference Books:

1. J. Wilson & J.F.B. Hawkes, Optoelectronics: An Introduct ion, Prentice Hall India (1996).
2. S.O. Kasap, Optoelectronics & Photonics, Pearson Education (2009).
3. A K Ghatak & K Thyagarajan, Introduction to fiber optics, Cambridge Univ. Press (1998).
4. Power Electronics, P.C. Sen, Tata McGraw Hill.
5. Power Electronics, M.D. Singh & K.B. Khanchandani, Tata McGraw Hill.
6. Power Electronics Circuits, Devices & Applications, 3rd Edn., M.H. Rashid, Pearson Education.
7. Optoelectronic Devices and Systems, Gupta, 2nd edn., PHI learning.
8. Electronic Devices and Circuits, David A. Bell, 2015, Oxford University Press.

DSE 3: Photonics Devices and Power Electronics Lab **Credit: 2 (0+0+2)**
Course Code: PLUFLD1
Name of the experiments

1. Diffraction experiments using a laser.
2. To determine characteristics of (a) LED and (b) Photo diode.
3. To study the Characteristics of LDR and Photodiode with (i) Variable Illumination intensity, and (ii) Linear Displacement of source.
4. To measure the numerical aperture of an optical Fibre.
5. Output and transfer characteristics of a power MOSFET.
6. Study of I-V characteristics of SCR.
7. SCR as a half wave R and R_L loads.
8. SCR as full wave rectifiers with R and R_L loads.
9. Study of solar cell characteristics.
10. Study of DIAC characteristics.

DEPARTMENT OF PURE AND APPLIED PHYSICS
M.Sc. (Physics) Course structure under CBCS/LOCF
Academic year 2022 – 2023

Sem	Course Opted	Course Code	Name of the course	Credit	L:T:P	Internal	External	Total
I	Core-1	PPPATT1	Classical Mechanics	5	4+1+0	30	70	100
	Core -2	PPPATT2	Quantum Mechanics	4	3+1+0	30	70	100
		PPPALT2	Quantum Mechanics Lab	1	0+0+1	30	70	100
	Core -3	PPPATT3	Electronic and Experimental Methods	3	3+0+0	30	70	100
		PPPALT3	Electronic and Experimental Methods Lab	2	0+0+2	30	70	100
	Open Elective		Opted from the pool and offered by other departments	5		30	70	100
	Other if any							
			TOTAL	**20**				**500**
		Open Elective offered by department						
	Open Elective	OPNPPT1	Nanomaterials and its Applications	3	3+0+0	30	70	100
		OPNPPL1	Nanomaterials and its Applications Lab	2	0+0+2	30	70	100
	Open Elective	OPNPPT2	Advanced characterization and computational techniques in Physics	3	3+0+0	30	70	100
		OPNPPL2	Advanced Characterization and Computational Techniques in Physics Lab	2	0+0+2	30	70	100
II	Core-4	PPPBTT1	Concepts of Mathematical Physics	5	4+1+0	30	70	100
	Core -5	PPPBTT2	Advanced Quantum Mechanics	4	3+1+0	30	70	100
		PPPBLT2	Advanced Quantum Mechanics Lab	1	0+0+1	30	70	100
	Core -6	PPPBTT3	Statistical Mechanics	5	4+1+0	30	70	100
	Discipline Specific elective 1	PPPBTD1	Computational Physics and Programming	3	3+0+0	30	70	100
		PPPBLD1	Computational Physics and Programming Lab	2	0+0+2	30	70	100
	Other if any							
			TOTAL	**20**				**1000**
III	Core-7	PPPCTT1	Nuclear and Particle Physics	5	4+1+0	30	70	100
	Core-8	PPPCTT2	Condensed Matter Physics	3	3+0+0	30	70	100
		PPPCLT2	Condensed Matter Physics Lab	2	0+0+2	30	70	100
	Research Methodology	PPPCTR1[#]	Research Methodology in Physics	2	2+0+0	30	70	100
	Discipline Specific elective 2	PPPCTD1	Molecular Physics and Group Theory	5	4+1+0	30	70	100
	Discipline	PPPCTD2	i. Advanced Condensed	3	3+0+0	30	70	100

	Specific elective - 3		Matter Physics-I					
			ii. Advanced Nuclear Physics –I		3+0+0	30	70	100
			iii. Astronomy and Astrophysics-I		3+0+0	30	70	100
			iv. Molecular Spectroscopy-I		3+0+0	30	70	100
			v. Material Science –I		3+0+0	30	70	100
			vi. Accelerator Physics-I		3+0+0	30	70	100
		PPPCLD2	Respective Discipline Specific elective Lab - 3	2	0+0+2	30	70	100
	*Certificate/ FC/UEC			2		30	70	100
	Other if any							
			TOTAL	**22+2 ***				**1300**

IV	Core-9	PPPDTT1	Atomic and Molecular Physics	5	4+1+0	30	70	100
	Core-10	PPPDTT2	Electrodynamics	5	4+1+0	30	70	100
	Discipline Specific elective 4	PPPDTD1	i. Advanced Condensed Matter Physics-II	3	3+0+0	30	70	100
			ii. Advanced Nuclear Physics –II		3+0+0	30	70	100
			iii. Astronomy and Astrophysics-II		3+0+0	30	70	100
			iv. Molecular Spectroscopy-II		3+0+0	30	70	100
			v. Material Science –II		3+0+0	30	70	100
			vi. Accelerator Physics-II		3+0+0	30	70	100
		PPPDLD1	Respective Discipline Specific elective Lab - 4	2	0+0+2	30	70	100
	**Dissertation /Project	PPPDD01#	Major Project Work With Dissertation	8		30	70	100
	Other if any							
			TOTAL	**23**				**1000**

#The Code generated by the Department.

L = Lecture, T = Tutorial, P = Practical (Lab)

* Additional Credit courses (not mandatory in nature)

The Discipline specific courses will be treated as special paper of old pattern as and when needed.

Semester – I

Core –1: Classical Mechanics
Course Code: PPPATT1 **Credits = 5 (4+1+0)**

Course Objectives:
The course aims to develop an understanding of:
- To solve advanced problems involving the dynamic motion of classical mechanical systems.
- To use conservation of energy, linear and angular momentum to solve dynamics problems.
- To constructing the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.
- The motion under central force and inverse square force.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- The significance of conservation of various physical quantities to discuss the motion of dynamical system.
- The constraints and their significance to solve the equations of motion of the dynamical system.
- The necessity of Lagrangian and Hamiltonian formulations for simplified treatments of many complex problems in classical mechanics.
- This course enables the students to model dynamical systems, both in inertial and rotating frames, using Lagrange and Hamilton equations.
- The essential features of a problem (like motion under central force and rigid body dynamics), use them to set up and able to solve the appropriate mathematical equations under central force and inverse force
- The theory of small oscillations and its importance in several areas of physics.

Unit–I Elementary Principles:
Mechanics of a Particle, Mechanics of a System of Particles, Conservation Laws, Work Energy Theorem, Constraints, Classification of Constraints, Degree of Freedom, Generalized Coordinates,Virtual displacement and virtual work, Principle of Virtual Work, D'Alembert's Principle, Lagrange's Equation from D'Alembert's Principle, Properties of Kinetic Energy Function.

Unit–II Lagrangian Formulation:
Lagrangian equation of motion from D'Alembert's Principle, Lagrangian equation of motion from Calculus of Variations, Properties of Kinetic Energy Function and Kinetic energy in terms of generalized coordinates. Gyroscopic Forces, Dissipative Forces, Rayleigh's Dissipation Function, Lagrangian equation of motion for Dissipative System, Linear Generalized Potential, Generalized Momenta and Energy, Jacobi Integral, Gauge Function for Lagrangian, Cyclic Coordinates, Integrals of Motion, Symmetry of Space and Time with Conservation Laws – Homogeneity and Isotropy, Invariance of Lagrangian equation of motion under Galilean Transformation.

Unit–III Rotating Frames, Central Force and Rigid Dynamics:
Inertial and Rotating Frames, Inertial Forces in Rotating Frame, Pseudo forces – centrifugal, Coriolis and Euler forces and their derivation from Newtonian and Lagrangian Formulation,Definition and Properties of Central Force, Two–body Central Force Problem, General Featuresof Central Force Motion and its Orbits, Stability of Orbits and Conditions for Closure, Motion under Inverse Square Force (Kepler's Problem) and Shapes of Orbits, Unbound Motion - Rutherford Scattering. Euler's angles, Inertial forces, Angular momentum of rigid body, Euler's equation of rigid body, free motion of rigid body.

Unit–IV Hamiltonian Formulation and Small Oscillations:

Hamilton's Variational Principle Hamilton's Variational Principle from Lagrangian equation of motiom, Hamilton's Canonical Equations of Motion, Hamilton's Canonical Equations from Hamilton's Variational Principle, Principle of Least Action, Canonical Transformations and Generating Functions, Example of Canonical Transformations, Condition for Canonical Transformations, Hamilton – Jaccobi Equation, Hamilton's Principal and Characteristic Functions, Poison Bracket, Invariance of Poisson Brackets with Respect to Canonical Transformations, Equations of Motion in Poisson Bracket Form, Poisson's Theorem, Angular Momentum in Poisson Bracket, Small Oscillations, Normal Modes and Normal Coordinates.

References:

12. Classical Mechanics, N.C. Rana and P.S. Joag, (TATA McGraw-Hill, 1991).
13. Classical Mechanics, H. Goldstein, (Addition Wesley, 1980).
14. Classical Mechanics, H. Goldstein, C. Poole, and J. Safko, (Pearson Education, Inc, 2002).
15. Classical Mechanics, J.C. Upadhaya (Himalaya Publishing House)
16. Classical Mechanics, Gupta, Kumar and Sharma (PragatiPrakashan)
17. Classical Mechanics by P.V. Panat, (Narosa Book Distributors Private Ltd)

Core –2: Quantum Mechanics
Course Code: PPPATT2 **Credits = 4 (3+1+0)**

Course Objectives:
- To introduce the modern concepts of quantum mechanics in a stimulating, elegant, exhaustive and explanatory manner.
- To explore the nature of the microscopic world into substantial depth in terms of meaning and interpretation so as to acquaint the learners to initiate thinking and analyzing the physically observable phenomena quantum mechanically without exceeding the mathematical level of complexity.
- To lay down the foundation and enhance capabilities of students to pursue various aspects of modern physics and interdisciplinary fields confidently.

Course Outcomes:
After the completion of course, students should be able to understand and grasp.
- The basic concepts of quantum mechanics including the solution of wave equation, interpretation of dynamical variables and applying wave mechanics to various situations in terms of boundary value problems so as to understand the quantum well, barriers and particle motion in different types of force field (potentials).
- Applying special functions as the solutions of differential equation as the wave function/state functions and understanding the physical situations where these can be applied.
- Calculating states of electrons in hydrogen atom and harmonic oscillators and the interpretation of quantum states.
- Applying the stationary perturbation problems to various problems including particle states splitting in electric and magnetic field.

Unit – I: Introduction to Schrodinger equation; probability interpretation, probability current, continuity equation; Ehrenfest theorem; Admissible wave functions; Stationary states, Schrodinger equation in one dimensional problems, wells and barriers; Harmonic oscillators by Schrodinger Equation

Unit – II: Uncertainty relation of x and p, States with minimum uncertainty product; General Formalism of wave mechanics; Commutation Relations; Representation of states and dynamical variables; Completeness of eigen functions; Dirac delta function; Bra and ket Notation; Matrix representation of an operator; Unitary transformation. Solution of Harmonic oscillator by operator method.

Unit – III: Angular momentum in QM, Central force problems: Solution of Schrodinger equation for spherically symmetric potentials; Hydrogen atom problem.

Unit – IV: Time independent perturbation theory; Non-degenerate and degenerate cases; Applications such as Stark effect etc.

Reference Books:

1. Quantum mechanics, by L I Schiff
2. Quantum physics by S Gasiorowicz
3. Quantum mechanics by B Craseman and J D Powell
4. Quantum mechanics by A P Messiah
5. Modern Quantum mechanics by J J Sakurai.
6. Qunatum mechanics by Mathews and Venkatesan

Core –2: Quantum Mechanics Lab
Course Code: PPPALT2 **Credits = 1 (0+0+1)**

1. To determine the Planck Constant and work function
2. Measurement of wavelength of He-Ne LASER (Grating)
3. To determine the wavelengths of Hydrogen spectrum and determine the value of Rydberg's constant.

Core –3: Electronics and Experimental Methods
Course Code: PPPATT3 **Credits = 3 (3+0+0)**

Course Objectives:

- The course mainly focuses on developing the Electronics, experimental and instrumentation skills of the students.
- To develop the understanding of physics of semiconductor, semiconductor junctions, metal-semiconductor, homo-junction, and hetero-junction and metal-oxide semiconductor contacts.
- Semiconductor photonic devices and hetero-structures for detection and production of optical radiation.
- To understand the concept of Data Interpretation and Analysis of results.

Course Outcomes:

- Students understand the basic of semiconductor and electronics devices.
- Students understand the current voltage characteristics of semiconductor devices, metal-semiconductor, homo-junction, and hetero-junction and metal-oxide semiconductor contacts.
- Student understands the basic mechanism involves in optoelectronics devices.
- Understanding of sensors and transducers for temperature, vacuum, optical and vibration measurements

Unit – I: Energy band in semiconductors, Carrier concentration in intrinsic and extrinsic semiconductors, Fermi levels in intrinsic and doped semiconductors, Concept of degenerate and non-degenerate semiconductors, temperature and doping dependent energy band gap of semiconductors.

Unit – II: Carrier mobility and drift velocity, Resistivity and conductivity, diffusion current, Einstein's relationship, Generation and recombination of carriers, Continuity equation, Carrier Injection and excess carriers, Decay of carriers.

Unit – III: P-N junction; device structure, energy band diagram, depletion region (abrupt junctions), depletion capacitance and C-V characteristics, I-V characteristics, Varactor diode, Tunnel diode principle of operation and I-V characteristics, Semiconductor hetero-junctions, Metal-semiconductor junction, Ohmic contacts. Solar cells, Photo-detectors, LEDs.

Unit – IV: Precision and Accuracy, Error Analysis, Types of errors,Propagation of errors, Curve fitting: Least square fitting, chi-square test. Measurement techniques: Sensors and Transducers (Temperature, vacuum, optical, particle and radiation detectors etc.), Signal and Noise.

References:

1. Semiconductor devices- Physics and Technology by S.M.Sze
2. Electronic Devices and Circuit Theory by Boylestad and Nashelky
3. Integrated Electronics : Milliman and Halkias
4. Measurement, Instrumentation, and Experimental design in Physics and Engineering: Michael Sayer, AbhaiMansingh
5. Transducers and Instrumentation:DVSMurty

Core –3: Electronics and Experimental Methods Lab
Course Code: PPPALT3 **Credits = 2 (0+0+2)**

1. Study the operational Amplifier as inverting and non-inverting amplifier
2. Study the operational Amplifier as a summing amplifier (Voltage adder and voltage subtraction).
3. Study the operational Amplifier as a differentiator and integrator.
4. A study of V-I characteristics of light emitting diode (LED).
5. A study of V-I characteristics of Tunnel diode.
6. Study of Solar Cell characteristics
7. Photoconductivity (Photocurrent as a function of irradiance at constant voltage)
8. Design of regulated Power Supply
9. Verification of De Morgan's Theorem
10. To design a digital to analog converter (DAC) of given specifications

Open Elective: Nanomaterials and Its Applications
Course Code: OPNPPT1 **Credits = 3 (3+0+0)**

Course Objectives:
The objective of the subject is that the student acquires knowledge

- To foundational knowledge of the Nanomaterials and related fields.
- To understand the influence of dimensionality of the object at nanoscale on their properties
- To make the students acquire an understanding the basic Nanoscience/Nanotechnology and their Applications .
- Students gain knowledge about the principles of various synthesis techniques**.**

Learning Outcomes:
After completing this course students will be able to:

- Learn about the background on Nanoscience
- Understand the various synthesis methods of Nanomaterials and their application and the impact of Nanomaterials on environment
- Apply their learned knowledge to develop new Nanomaterial's.

Unit – I: History of nano- materials, Ancient Indian Culture and Nanotechnology, Role of Feynman in development of Present Nano-sciences, what are Nanoscience and Nanotechnology?Atomic structure and atom size and their effects, Types of 1D, 2D, 3D Nano-structured materials, Influence of nano over micro/macro.

Unit – II: Properties of Nano materials: Physical, Magnetic, Optical, Thermal, Mechanical, Electrical for nano materials and Chemical Properties, Size effects, Surface Effects and Surface to Volume ratio.

Unit – III : Type of Nanomaterials: different type of nano materials,Carbon nanotube, Fullerene, Type of CNT: SWNT (Single wall nano tube), Multi wall nano tubes. 2D nano material, Graphite and Graphene, metal nano particle silver and gold, ZnO and TiO_2 metal oxides, Semiconductors, Nano-composites,Creating nanoparticles by using software.

Unit – IV: Synthesis of nano materials**:** Top- down or bottom up approach, Physical Methods, PLD, Sputtering, Thermal evaporation, Chemical Methods – CVD, Sol-gel, Hydrothermal, Biological Methods – Green Synthesis, mechanical milling, sputtering and microwave plasma, chemical reduction and oxidation, hydrothermal, micelles, sol-gel processes, photolysis, and metal organic chemical vapor deposition

Reference Books:

1. Introduction to Nano Science and Nano Technology – K.K. Chattopadhyay & A. N. Banerjee PHI Pvt. Ltd., 2009.
2. Nano technology: Principles and practices - Sulabha K. Kulkarni, Capital Publisher Co., 2015.
3. Introduction to nano technology: Charles P. Poole, Jr. Frank J. Owen, Wiley, Interscience Pub., May, 2003.
4. Nanostructures & Nanomaterials Synthesis Properties & Applications. Guozhong Cao, Imperials College Press London. 2004
5. Textbook of Nanoscience and Nanotechnology-B.S.Murty, P.Shankar, BaldevRaj, B.B. Rath and James Murday Universities press, IIM, Metallurgy and Materials Science
6. Principles of Nanoscience & amp; Nanotechnology M.A. Shah, Tokeer Ahmad, Narosa Publishing House
7. Nanocrystals: Synthesis, Properties and Applications C.N. Rao, P.J. Thomas, G.U. Kulkarni
8. Nano materials Handbook – Yury Gogotsi
9. Introduction to Nano science and Nano technology – K K Chatopadhayya & Banerjee, PHI
10. Introduction of Nano Technology - Cahrles P. Poole Jr and Franks J. Qwens

Open Elective: Nanomaterials and Its Applications Lab
Course Code: OPNPPL1 **Credits = 2 (0+2+0)**

1. To determine the crystallite size of given sample and observe the influence of do-pants through given XRD data.
2. To analyze the particle size Scanning Electron Microscopy and Transmission Electron Microscopy images of given samples.
3. To determine the crystallinity and phase composition of the given sample through selective area electron diffraction.
4. To determine the electronic band-gap of given sample through Tauc plots derived from UV-Vis diffused reflectance spectroscopy.
5. To identify Hydrogen bond through FTIR spectroscopy.
6. To analyze the elemental species present in the given sample through X-ray Photoelectron Spectroscopy.

Semester - II

Core-4: Concepts of Mathematical Physics **Credit: 5 (4+1+0)**
Course Code: PPPBTT1

Course Objectives:
The course aims to develop an understanding of:
- Vectors and Matrices are applied in the Quantum Mechanics, Solid state physics, atomic and molecular spectroscopy and Nuclear Physics etc.
- Complex variables is very important tool to handle complex integrations in different brances of physics.
- In physics, generally we encounter different types differential equations. Ordinary differential equations and series solution methods with special functions are taught here in this course to solve various types of differential equations.
- Students will learn Integral transforms and their applications to solve and understand different types of signals and their characteristics.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Vector space and eigen value problems
- Students are able to solve difficult integrations in complex plane.
- Students are able to solve differential equations using special functions.
- Students are able to solve differential equations by Integral transforms.

Unit – I: Vector algebra and vector calculus, linear independence, basis expansion, Schmidt orthogonalisation. Matrices: Representation of linear transformations and change of basis; Eigen values and eigenvectors; Functions of a matrix; Cayley-Hamilton theorem; Commuting matrices with degenerate eigenvalues; Orthonormality of eigenvectors, Concepts of tensors.

Unit – II: Complex variables: Recapitulation: Complex numbers, triangular inequalities, Schwarz inequality. Function of a complex variable : single and multiple-valued function, limit and continuity; Differentiation; Cauchy-Riemann equations and their applications; Analytic and harmonic function; Complex integrals ,Cauchy's theorem (elementary proof only), converse of Cauchy's theorem, Cauchy’s Integral Formula and its corollaries; Series - Taylor and Laurent expansion; Classification of singularities; Branch point and branch cut; Residue theorem and evaluation of some typical real integrals using this theorem.

Unit – III: Theory of second order linear homogeneous differential equations Singular points: regular and irregular singular points; Frobenius method; Fuch's theorem; Linear independence of solutions: Wronskian, second solution. Sturm-Liouville theory; Hermitian operators, Special functions: Basic properties (recurrence and orthogonality relations, series expansion) of Bessel, Legendre, Hermite and Laguerre functions and its generating functions.

Unit – IV: Integral transforms: Fourier and Laplace transforms and their inverse transforms, Bromwich integral [use of partial fractions in calculating inverse Laplace transforms]; Transform of derivative and integral of a function; Solution of differential equations using integral transforms, Delta function.

Reference Books:
1. Mathematical methods for physics, by G ARFEKEN
2. Advanced engineering mathematics, by E KREYSZIG
3. Complex Variables with an introduction to CONFORMAL MAPPING and its applications,

Second Edition Murray R. Spiegel, Seymour Lipschutz, John J. Schiller, Dennis Spellman.
4. Mathematical Physics by Dass H. K.
5. Special functions, by E D RAINVILLE
6. Special functions by W W BELL
7. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence,3rded., 2006, Cambridge University Press
8. Mathematics for physicists, by MARY L BOAS

Core –5: Advanced Quantum Mechanics **Credit: 4 (3+1+0)**
Course Code: PPPBTT2

Course Objectives:
- To introduce the advanced concepts of quantum mechanics and the applications of quantum mechanical methods in problems of many electron systems, scattering problems.
- To explore the nature of the microscopic world into substantial depth in terms of meaning and interpretation so as to acquaint the learners to initiate thinking and analysing the physically observable phenomena quantum mechanically without exceeding the mathematical level of complexity.
- To lay down the foundation and enhance capabilities of students to pursue various aspects of modern physics and interdisciplinary fields confidently.

Course Outcomes:
After the completion of course, students should be able to understand:
- The basic concepts of quantum mechanics including the solution of wave equation, interpretation of dynamical variables and applying wave mechanics to various situations in terms of boundary value problems so as to understand the quantum well, barriers and particle motion in different types of force field (potentials).
- Applying special functions as the solutions of differential equation as the wave function/state functions and understanding the physical situations where these can be applied.
- Calculating states of electrons in hydrogen atom and harmonic oscillators and the interpretation of quantum states.
- Applying the stationary perturbation problems to various problems including particle states splitting in electric and magnetic field.
- The case studies and problem-solving exercises will be given as assignments and group activities in both the courses so as to enhance the experiential learning and induce group learning.

Unit – I: Approximation methods, higher order time independent perturbation, Variational method, WKB approximation, turning points and applications.

Unit – II: Time dependent perturbation theory, harmonic perturbation, Fermi’s golden rule, Adiabatic and sudden approximation. Semi-classical theory of radiation, transition probability for absorption and induced emission, electric dipole and forbidden transitions, selection rules.

Unit – III: Collision in 3-D and scattering, laboratory and CM reference frames, scattering amplitude, differential scattering cross section and total scattering cross section, scattering by spherically symmetric potential, partial waves and phase shifts, scattering by perfectly rigid sphere and by square well potential

Unit – IV: Identical particles, symmetric and anti-symmetric wave functions, collision of identical particles, spin angular momentum, spin function for a many electrons system.
Relativistic Quantum Mechanics: Klein-Gordon and Dirac equations; Properties of Dirac

matrices. Plane wave solutions of Dirac equation; Spin and magnetic moment of the electron. Nonrelativistic reduction of the Dirac equation. Spin-orbit coupling. Energy levels in a Coulomb field.

Reference Books:

1. L I Schiff, Quantum Mechanics (McGraw- Hill).
2. J.J. Sakurai, Modern Quantum Mechanics
3. Griffiths, Introduction to Quantum Mechanics
4. A.P. Messiah, Quantum Mechanics Vol 2, (North-Holland, 1962).
5. R. Shankar, Principles of Quantum Mechanics (Plenum 1994)
6. James D. Bjorken and Sidney D. Drell, Relativistic Quantum Mechanics (McGraw-Hill 1964)
7. B.K. Agarwal and Hari Prakash, Quantum Mechanics (Prentice-Hall 2007)

Core –5: Advanced Quantum Mechanics Lab **Credit: 1 (0+0+1)**

Course Code: PPPBLT2

1. By analyse the Zeeman Effect in mercury vapour, determine the fine structure constant by Fabry-Perot Interferometry. (Experiment)
2. Calculate the energy difference between the singlet and triplet state of He Atom. (Mathematical solutions only)
3. Two identical particles of spin 1/2 are enclosed in a one-dimensional box potential of length L with walls at x=0 and x=L. Find the Ground state energy. (You can use any programming language)

Reference Books:

1. Modern*Quantum Mechanics*, by J. J. *Sakurai*&Jim Napolitano, 2nd Edition. Addison-Wesley.
2. *Quantum Mechanics*. Concepts and Applications. Second Edition. Nouredine *Zettili*.

Core –6: Statistical Mechanics **Credit: 5 (4+1+0)**

Course Code: PPPBTT3

Course Objectives:

- To understand connection between Thermodynamics and Statistical Mechanics.
- To understand different Ensemble and their applications.
- To understand different distribution law
- To learn the Application of different distribution function
- To understand phase transition

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- Concept of ensemble theory
- Fundamental difference of classical and quantum statistical distribution
- Application of Fermi distribution function and B-E distribution function to calculate various physical parameters
- Concept of different Phase

Unit – I: Review of Thermodynamic potentials and Macrostate& Microstate, Concept of distribution function of Microcanonical Ensemble, Canonical ensemble, Grand Canonical ensemble, Phase Space, Dynamical variable, Relation of partition function with thermodynamic Functions, application of partition function, Motion of the point in phase space (Liouville equation), fluctuations of energy in canonical ensemble and no. of particles in grand canonical ensemble (15 Lectures)

Unit – II: Maxwell-Boltzmann Distribution Law, B-E distribution law, Fermi-Dirac Distribution Law, Derivation of Ideal Quantum gas equation, adiabatic quantum gas relations. (10 Lectures)

Unit – III: Application of Fermi-Dirac Statistics: Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Fermi sphere, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit. Application of B-E statistics: Bose Einstein condensation, properties of liquid He (qualitative description), Blackbody Radiation, heat capacity (20Lectures)

Unit – IV: Phase transition, (P, T), (V, T) and (P. V) Phase diagram, Real gas equation, tie line, order parameter, Landau theory with example. Ising Model(15 Lectures)

Reference Books:

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
3. Statistical Mechanics, By K Huang.
4. Statistical Physics, By Landau and Lifshitz.
5. *Statistical Mechanics* by *Donald* A. *Mc Quarrie* (Harper & Row, New York, 1976)

DSE – 1: Computational Physics and Programming **Credit: 3 (3+0+0)**
Course Code: PPPBTD1

Course Objectives:
The course aims to develop an understanding of:

- Basic methods, tools and techniques of computational physics with Fortran 90/95.
- Developing practical computational problem solving skills.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- identify modern programming methods and describe the extent and limitations of computational methods in physics,
- independently program computers using leading-edge tools,
- formulate and computationally solve a selection of problems in physics,

Unit – I: Basic in computer programming, programming preliminaries, Fortran 90 programming: Constants and Variables, Arithmetic expression, I/O statements, Conditional statements

Unit – II: Loops and Logical expressions, Functions and Subroutines, Arrays, Format specifications, Files Processing in Fortran 90

Unit – III: Numerical methods: solution of linear and nonlinear algebraic equations and transcendental equations, bisection method, false position method, Newton Raphson method, Solution of simultaneous linear equations, Matrix inversion, Gaussian elimination, iterative Method.

Unit – IV: Interpolation (with equally spaced and unevenly spaced point), Curve fitting, Numerical integration, Trapezoidal rule, Simpson's method, Numerical solution of ordinary differential equation by Runga-Kutta method.

Reference Books:

1. Sastry: Introductory methods of Numerical Analysis.
2. Rajaraman: Numerical Analysis and Fortran Programming
3. *Numerical Recipes in FORTRAN: The Art of Scientific Computing*, Press, et al. (Cambridge

University Press)
4. *Fortran 90 Programming*, Ellis, Philips and Lahey (Addison-Wesley)
5. *Fortran 90/95 Explained*, Metcalf and Reid (Oxford)
6. *Fortran 90/95 for Scientists and Engineers*, Chapman (McGraw-Hill Higher Education)

DSE – 1: Computational Physics and Programming Lab Credit: 2 (0+0+2)
Course Code: PPPBLD1

Name of the experiments

1. Implementation of solving the non algebraic equation using Fortran 90
2. Implementation of Numerical Integration using Fortran 90
3. Implementation of Solving Differential equation using Fortran 90
4. Implementation of Solving linear equations using Fortran 90

Semester – III

Core–7: Nuclear and Particle Physics **Credit: 5 (4+1+0)**
Course Code: PPPCTT1
Course Objectives:
The course aims:

- To develop the basic concepts and knowledge of nuclear properties to understand structure of nucleus.
- To understand various theories of nuclear force
- To understand various nuclear models to explain its shapes
- To impart knowledge about nuclear physics properties and nuclear models for understanding of related reaction dynamics
- To get preliminary knowledge of particle physics and quark structure.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- Explain the ground state properties of the nucleus for study of the nuclear structure behavior.
- Explain the deuteron behavior at ground and excited states.
- Apply Nucleon-Nucleon scattering to understand the nuclear forces.
- Demonstration of the shell model and collective model descriptions.
- Apply various aspects of nuclear reactions in view of compound nuclear dynamics.
- Basic understanding of particle physics and quark structure of hadrons.

Unit – I: Static properties of Nuclei: Nuclear size determination from electron scattering, nuclear charge distribution. Angular momentum, spin and moments of nuclei. Binding energy, semi-empirical mass formula, Liquid drop model, fission and fusion
Two Nucleon Systems & Nuclear Forces: Dipole and quadrupole moments of the deuteron, Central and tensor forces, Evidence for saturation property, Neutron-proton scattering, Protonproton scattering, S-wave effective range theory, charge independence and charge symmetry, exchange character, spin dependence. General form of the nucleon-nucleon force. Yukawa interaction

Unit – II: Nuclear Models: Liquid drop model, nuclear shapes. Experimental evidence for shell effects, shell model, spin Orbit coupling, Magic numbers, angular momenta and parities of nuclear ground states,Magnetic moments and Schmidt lines, failure of shell model,Collective model of Bohr and Mottelson, rotational model, Qualitative discussion and estimates of transition rates.

Unit – III: Nuclear decay and Reactions: Alpha decay: Geiger-Nuttall law, Electromagnetic decays: selection rules,Fermi theory of beta decay. Kurie plot. Fermi and Gamow-Teller transitions, Parity violation in beta-decay.
Direct and compound nuclear reaction mechanism, reaction cross section, cross sections in terms of partial wave amplitudes, compound nucleus -scattering matrix, Reciprocity theorem, Breit-Wigner one Level formula-Resonance scattering.

Unit – IV: Elementary Particles (quarks, baryons, mesons, leptons). Classification: spin and parity assignments; isospin, strangeness. Elementary ideas of SU(2) & SU(3). Gell-Mann-Nishijima scheme. C, P and T invariance and application of symmetry arguments to particle reaction. Properties of quarks and their classification. Introduction to the standard model, Hicks bosons, Parity non-conservation in weak interactions,

Reference books:
1. Nuclear Physics by S.N. Ghoshal, S. Chand & Company Ltd,2004

2. Introducing Nuclear Physics by K. S. Krane (Wiley India., 2008) .
3. Nuclear Physics - Theory & Experiments by R.R. Roy &B.P.Nigarn (New Age lnternational, 2005)
4. Nuclear & Particle Physics: An Introduction by B. Martin (Willey,2006)
5. Introduction to Elementary Particles by D. J. Griffiths (Academic Press 2nd Ed.2008)
6. Concept of Nuclear Physics by B. L. Cohen (McGraw-Hill,2003)

Core–8: Condensed Matter Physics **Credit: 3 (3+0+0)**
Course Code: PPPCTT2

Course Objectives:
The course aims to develop an understanding of:
- Crystal structure and determination through diffraction techniques
- Phonon dynamics
- Energy band in solids
- Magnetism in solids
- Superconductivity in solids

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- To determine the crystal classes and crystal structures
- To study the electronic and magnetic properties.

Unit – I: The crystal lattice. Basis vectors. Unit cell. Symmetry operations. Point groups and space groups. Plane lattices and their symmetries. Three dimensional crystal systems. Miller indices. Directions and planes in crystals. Bravais lattices, crystal structure, reciprocal lattice, Brillouin zones.Diffraction: Theory and experimental methods (X – ray and Neutron)

Unit – II: Lattice dynamics: Phonons, density of states, specific heat, thermal conductivity. Electron theory: Free electron model, elementary band theory, metals, semiconductors, electrical conductivity.

Unit – III: Energy bands in solids. The Bloch theorem. Bloch functions. Review of the Kroning-penney model. Brillouin zones. Number of states in the band. Band gap in the nearly free electron model. The tight binding model. The fermi surface. Electron dynamics in an electric field. The effective mass. Concept of hole. (elementary treatment)

Unit – IV: Origins of magnetism in condensed matter: localized moments (from atoms to solids, delocalized electrons, diamagnetism), Paramagnetism of localized moments, Interacting moments: origin of the exchange interaction, Heisenberg Hamiltonian , Mean field treatment of interacting magnetic systems: ferro-, antiferro-, and ferrimagnetism

Reference books:
1. John Singleton: Band theory and Electronic properties of Solids (Oxford University Press; Oxford Master Series in Condensed Matter Physics).
2. Ibach & Luth: Solid State Physics
3. M. Ali Omar: Elementary solid state physics (Addison-wesley)
4. C. Kittel: Solid-state physics (Wiley eastern)(5th edition).

Credit: 2 (0+0+2)

Core–8: Condensed Matter Physics Lab
Course Code: PPPCLT2

Name of the experiments
18. Hall effect experiment
19. Four probe measurement for electrical resistivity
20. Magnetic susceptibility measurement
21. Band gap estimation through UV – Vis spectroscopy
22. Raman spectra of a known system
23. FT – IR spectra of a known system
24. Determination of crystal structure through XRD
25. Lande-g factor by ESR method.

Credit: 2 (2+0+0)

Research Methodology: Research Methodology in Physics
Course Code: PPPCTR1
Objective:
To introspect the fundamentals of research methodology and its association in diverse areas of science**.**

Course Outcomes: After completion of this course, post graduate will be able to
- Identify the research gap and various methodologies to solve the problems
- Analyze the data by using different methods and develop presentation skills
- Engage in research in the field of pure and applied physics and involve in lifelong learning

Unit – I: Research and Research Design: Introduction to Research, Types of research: exploratory, conclusive, modeling and algorithmic, , Tools used for review, journals, conferences, books, magazines and their quality and authenticity, effective searches, find relevant papers related to your area of research, capture critical information, understand and identify the bias, theoretical position and evidence produced, compare ideas and concepts from different papers, distinguishing own work from others work and acknowledging such references.

Unit – II: Problem identification and its solution: Identification of research problems, Identify key areas in research field, Identification of a problem and literature survey. Collection of data and analysis, Determine the nature and extension of papers that should be read, Identify the research gaps, Formulate the Problem Statement, Examples of effective and ineffective titles.

Unit – III: Data Analysis: Identify problem and experimental/theoretical data for comparison with proposed model, extrapolate/scale data for validation, Error Analysis and Numerical Methods, editing and coding of data, tabulation, graphic presentation of data, cross tabulation, testing of hypotheses.

Unit – IV: Presentation: Scientific Writing: Goals and Objectives, Structure of documents, importance of clear title, abstract or summary, Main message of presentation, highlight review points, structure of presentation key components of an oral presentation, show support material, feedback on oral presentation, prepare a set of questions.

Reference Books:

1. R L Dominowski: Research Methods (Prentice Hall of India, N J 1980)
2. John R Rice: Numerical Methods, Software and Analysis (Mc Graw Hill ISE, 1985)
3. Gaur R. R., Sangal R., & Bagaria G. P. (2010). A foundation course in human values and professional ethics. New Delhi: Excel Publishers.
4. Naagarazan R. S. (2006). A textbook on professional ethics and human values. New Delhi:

New Age International Pvt Ltd.
5. Verma R. (2003). Modern trends in teaching technology. New Delhi: Anmol publishers Pvt. Ltd.
6. Rao U. (2001). Educational teaching. New Delhi: Himalaya publishing house.

DSE– 2: Molecular Physics and Group Theory **Credit: 5 (4+1+0)**
Course Code: PPPCTD1

Course Objectives:
The course aims to develop an understanding of:
- The basic principles, theory and experimental details for understanding the structure, properties and applications of materials.
- Defects, diffusion and phase transitions in solids and how these affect the properties.
- Also gives an overview of various methods for the synthesis of single crystals, thin films and nanomaterials.

Course Outcome:
At the end of the course, students will be able to understand:
- The symmetry properties and vibrational intensities of molecules.
- Learned about group theory to molecular vibrations.

Unit – I: Vibration in polyatomic molecules; Normal Coordinates and Normal Modes; Overtone and Combination Bands Normal Coordination Analysis; Symmetry properties of Normal coordinates; Vibrational Intensities: Interpretation and Use for Diagnostics Purposes

Unit – II: Group Theory: Definition and theorem of group theory, Properties of groups, sub-groups and classes; Molecular symmetry elements and operations; Symmetry planes and reflections, proper and improper rotations; product of symmetry operations; Effect of symmetry lowering on vibrational Spectra.

Unit – III: Representation of point group; Matrix representation of the symmetry elements of point group, Great Orthogonality Theorem; Character tables; Reducible and irreducible representations; Symmetry species; Character tables for point groups.

Unit – IV: Applications of group theory to molecular vibrations, Analysis of reducible representation; characters for the reducible representation of molecular motions; number of normal modes of various symmetry types.

Reference Books:
1. Chemical Application of Group Theory: F.A. Cotton.
2. Introduction to Molecular Spectroscopy: G.M. Barrow.

DSE – 3: i. Advanced Condensed Matter Physics–I **Credit: 3 (3+0+0)**
Course Code: PPPCTD2
Course Objectives:
The aim of the proposed course is to introduce the basic notion of the condensed matter physics and to familiarise the students with the various aspects of the interactions effects. This course will be bridging the gap between basic solid state physics and quantum theory of solids. The course is proposed for postgraduate students. The courses begins with the review of some of the basic concepts of introductory condensed matter physics and then sequentially explore the interaction effects of electron-electron/phonon, optical properties of solids, interaction of light with matter and

finally the Magnetism behaviour in solids.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- Advanced concepts condensed matter physics be cleared
- Advanced device applications may be derived

UNIT – I: Reconstruction and relaxation phenomena, work function, thermionic emission, electronic surface states, magnetoresistence. Disorder in condensed matter, substitutional, positional and topographical disorder, short and long range order.

UNIT – II: Atomic correlation function, Anderson model for random systems and electron localization, mobility edge, qualitative application of the idea to amorphous semiconductors and hopping conduction.

UNIT – III: Magnetic properties of solids : Quantum theory of magnetic susceptibility, Pauli paramagnetism, magnetic properties of two-electron system, spin Hamiltonian and Heisenberg model, magnetic interaction in free electron gas, mean field theory, Exchange interaction, one-and two-dimensional ising model, spin waves, magnons.

UNIT – IV : Optical properties of solids: band to band absorption, excitions, Polarons, Colour centres, Luminescence. Photoconductivity,: Optical reflectance, Excitons, Kramers-kronig relations, Electronic inter-band transitions.

Reference Books:

1. Introduction to Condensed Matter Physics – K.C. Barua (Alpha Science International Ltd.)
2. A Basic Course in Crystallography – JAK. Tareen & TRN Kutly. (Universities Press, India Pvt.)
3. An Introduction to Crystallography, F.C. Phillips, Longman Higher Education.
4. Crystallography Applied to Solid State Physics – A.R. Verma and O. N. Srivastava, New Age International limt., 2nd Ed. Reprint 2005.
5. Elements of Solid state Physics, M. Ali omor Peasson Education 3rd Indian reprint, 2002
6. Solid state Physics, C. Kittel, Wiley. 5th Edition.
7. Solid state Physics, A.J. Dekkar, Macmillan.
8. Elementary Solid state Physics: Principles and Applications, M. Ali Omar, Addison-Wesley.
9. Introduction to Solids, L.V. Azaroff, Tata Mc-Graw Hill.
10. Solid state Physics: An introduction to Principles of Materials Science, H. Ibach and H. Luth, Springer.
11. Solid state Physics, S.O. Pillai, New Age International.
12. Condensed matter Physics, M.P. Mardar,Wiley.
13. Physics of solids, C.A. Wert and R. M. Thomson, McGraw-Hill.
14. Fundamentals of Solid state Physics, J. R. Christmaan, Wiley.
15. Solid State Physics- Structure and Properties of materials, M.A. Wahab, Narosa *Publishing* House

DSE – 3: ii. Advanced Nuclear Physics –I **Credit: 3 (3+0+0)**
Course Code: PPPCTD2
Course Objectives:
The course aims to develop an understanding of:

- To develop the knowledge of nuclear structure through various from simple shell model to mean field theory.

- To understand many exotic features of exotic nuclei

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- Explain the shell model, collective model, mean field theory of atomic nucleus.
- Explain the many recent observed features of nucleus

Unit – I: Nuclear Shell Model:

Shell model: Review of the Shell Model, magic numbers, single particle shell model, wave function, quantum numbers, Residual interaction and configuration mixing, effective interaction and operators, Description of two or more particles outside a closed core. Classification of shells, Seniority, Pairing force, Energy level calculations. Spectra of closed shell nuclei, lp-lh excitations.

Unit – II: Collective models: Nuclear vibrations and excited states, isoscalar vibrations, sum rule in vibration model, Collective model of Bohr and Mottelson, Energy levels and electromagnetic properties of even-even and odd-A deformed nuclei, Permanent deformation, Nuclear shapes, super deformed and hyper deformed shapes. Particle states in nonspherical nuclei-Nilsson's model, Coupling of particle states and collective motion in unified model.

Unit – III: Mean Field models and behavior at high spin physics: Nuclear mean field, Hartree-Fock theory, Hartree-fockBogolieubov, Pairing plus quadrupole interactions. Production of high spin states, level structure, behavior of nuclei at high spin state, Qualitative discussion and estimates of transit ion rates, Nuclear moment of inertia, Back bending.

Unit – IV: Exotic Nuclei: Nuclear landscape: proton and neutron drip lines, nuclear structure at the extremes of stability, nuclear halos, neutron skins, proton rich nuclei and beyond, decay modes of exotic nuclei, Production of exotic nuclei – RIB and ISOL facility (an overview)

Reference books:

1. Introducing Nuclear Physics by K. S. Krane (Wiley India., 2008) .
2. Introductory Nuclear Physics S. M. Wong (Wiley-VCH Verlag GmbH & Co. KGaA)
3. Nuclear Structure from a Simple Perspective: R. F. Caston (Oxford Studies in Nuclear Physics)
4. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004)
5. Nuclear Physics - Theory & Experiments by R.R. Roy &B.P.Nigarn (New Age lnternational, 2005)
6. Nuclear structure – Bohr and Mottelson (World Scintific)
7. Kaplan Irving, Nuclear Physics, Narosa Publishing House, (2000).
8. Theoretical Nuclear Physics, J.M. Blatt &V.F.Weisskopf (Dover Pub.Inc., 1991)

DSE – 3: iii. Astronomy and Astrophysics–I **Credit: (3+0+0)**

Course Code: PPPCTD2

Course Objectives:

The course aims to develop an understanding of:

- The basic idea of stellar astrophysics
- The formation of evolution of stars the binary stars and star clusters
- And their classifications.

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- The basic quantities used in astronomy such as coordinates, Stellar Distance, magnitude, and Stellar Luminosity etc. and measurement techniques of astrophysical quantities as well as spectral classification of stars.

- Formation and Evolution of Star, and the fate of low and high mass stars, as well as the physics of white dwarfs, neutron starts, pulsars and black holes.
- Binary Stars and Star Clusters, as well as their Classifications. the workings of astronomical instruments as well as their use.

Unit – I: Basic Stellar Astrophysics: Celestial Sphere, Stellar Parallax, Units of stellar distance, stellar magnitude sequence, Apparent and Absolute magnitudes, distance modulus, stellar distances, bolometric magnitude, color index, luminosities of stars, spectral classification, Henry-Draper and modern M_K classification scheme, H-R diagram of stars, empirical mass – luminosity relation.

Stellar interiors: The basic equation of stellar structure, hydrostatic equilibrium, thermal equilibrium, virial theorem, energy Eourse, energy transport by radiation and convection, equation of state.

Unit – II: Formation and evolution of stars: Inter stellar Dust and Gas, Formation of Pro-stars, Pre-main sequences evolution, Evolution on the Main sequence for Low and High Mass Stars, Post Main Sequence evolution, End States of Stars, Degenerate States, White Dwarf and Chandrashekhar Limit, Fate of Massive Stars, Neutron Stars, Pulsars and Black holes, Suprenovae and its Characteristics

Unit – III: Binary Stars and Star Clusters: Binary Stars: Binary Stars and their classification, Close Binaries, Roche Lobes, Evolution of Semidetached systems: Algols, Cataclysmic variables and X-ray Binaries. Star Clusters: Galactic Clusters, Globular Clusters, H-R diagram of star clusters

Unit – IV: Astronomical Instrumentation: Telescope- Basic Optics, Focal Plane, Plate Scale, Resolution and Rayleigh Criterion, Seeing Aberrations, Brightness of an Image, Refracting Telescope, Reflecting Telescope, Telescope mounts, Large aperture telescope, Adaptive optics, Space-based observatories, Telescope for Infrared, Ultraviolet, X-ray, Gamma-ray and Radio Astronomy, Stellar Photometry using CCD.

Reference Books:

1. An Introduction to Astrophysics, Baidyanath Basu, Prentice Hall of India.
2. Textbook of Astronomy and Astrophysics with Elements of Cosmology, V.B. Bhatia, New Delhi, Narosa Publishing House.
3. Theoretical Astrophysics, Vol. I: Astrophysical processes T. Padmanabhan, Cambridge University Press.
4. Theoretical Astrophysics, Vol. II: Stars and Stellar Systems, T. Padmanabhan, Cambridge University Press.
5. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th edition, Saunders College Publishing.
6. The New Cosmos, A. Unsold and B. Baschek, Newyork, Springer Velas.
7. Astronomical Photometry, A.A. Henden, and R.H. Kaitchuk, Willmann-Bell.
8. Handbook of CCD Astronomy, S.B. Howell, Cambridge University Press.
9. A Workbook for Astronomy, Jerry Waxman
10. Telescope and Techniques, C.R. Kitchin, Springer.
11. Astrophysical Techniques, C.R. Kitchin, CRC Press.
12. Observational Astrophysics, R.C. Smith, Cambridge University Press.
13. Telescopes and Techniques, C.R. Kitchin , Springer
14. Observational Astronomy, D.S. Binney, G. Gonzalez, and D. Oesper, Cambridge University Press

DSE – 3: Astronomy and Astrophysics–I Lab

Course Code: PPPCLD2 **Credit: 2 (0+0+2)**

Name of the experiments

1. Study of Quasar
2. Study of the Orbit of a visual Binary Star
3. Determine the mass of Saturn and its rotational velocity
4. Verification of Hubble's law and determination of Hubble's constant and age of the Universe
5. Study of light curves of Cepheid variable stars
6. Study of proper motion of stars
7. Determination of period and distance of pulsar
8. Photoelectric photometry of Pleiades star cluster
9. Study of expansion of the universe and calculate the age of universe using computer program CLEA
10. Determine the distance of small Magellanic Cloud (SMC) using Period-Luminosity Relation of Cepheid Variable star

DSE – 3: iv. Molecular Spectroscopy–I **Credit: (3+0+0)**

Course Code: PPPCTD2

Course Objectives

- To provide theoretical basis of molecular states (Rotational, vibrational and electronic) and their interaction
- Interpretation of rotational, vibrational and electronic spectra of molecules
- Techniques for calculating the electronic wave functions of molecules
- Measuring the vibrational spectra (FT-IR, Raman) and their applications in understanding molecular structure and intermolecular interaction, structural-spectral correlations
- Measuring electronic spectra (UV-VIS) and its spectral analysis and applications

Unit – I: Classification of molecule: Linear, Symmetric top, Asymmetric top and Spherical top; Rotational Energy of Spherical, Prolate and Oblate Symmetric Rotors, Rotational Raman Spectra; Parallel and Perpendicular type Bands in Linear and symmetric Rotor Molecules. Qualitative description of Type A, B and C bands in Asymmetric Rotor Molecules.

Unit – II: Molecular orbitals, Separation of electronic and nuclear wavefunctions, Born-Oppenheimer approximation, Electronic states of diatomic molecules, Electronic angular momenta, Approximation methods for the calculation of electronic Wave function, The LCAO approach, Coulomb, Exchange and Overlap integral, Symmetries of electronic wavefunctions; Shapes of molecular orbital; σ and π bond; Term symbol for simple molecules.

Unit – III: UV-visible absorption spectroscopy: Principle, Lambert-Beer's law, Absorption law, Deviation from Beer's law, Instrumentation. Single beam and split beam instruments. Quantitative & Quantitative and Analysis of absorption spectra, Molecular transitions, Luminescence spectroscopy (fluorescence, phosphorescence, chemiluminescence)

Unit – IV: Infrared Spectroscopy: Theory and Instrumentation of dispersive and FT-IR spectroscopy, Raman Spectroscopy: Theory and Instrumentation; Spectra-Structure Correlations in Raman Spectroscopy; Electron Spin Resonance (ESR) Spectroscopy; Nuclear Magnetic Resonance (NMR) spectroscopy, Chemical shift; shielding and DE shielding of protons, Nuclear spin-spin interaction.

Reference Books:
1. Fundamentals of Molecular Spectroscopy: C.N. Banwell.
2. Molecular Spectra and Molecular Structure-III Electronic Spectra and Electronic structure of polyatomic Molecules: G. Herzberg.
3. Modern Spectroscopy: J.M. Hollas.
4. Introduction to Molecular Spectroscopy: G.M. Barrow.
5. Chemical Applications of Group Theory: F.A. Cotton.

DSE – 3: v. Material Science –I **Credit: (3+0+0)**
Course Code: PPPCTD2

Course Objectives:
The course aims to develop an understanding of:
- The basic principles, theory and experimental details for understanding the structure, properties and applications of materials.
- Defects, diffusion and phase transitions in solids and how these affect the properties.
- Also gives an overview of various methods for the synthesis of single crystals, thin films and nanomaterials.

Course Outcome:
At the end of the course, students will be able to understand:
- The structure property relationship of solid-state materials.
- Learned about different types of advanced materials, its synthesis and properties.

Unit – I: Uniary and Binary phase diagrams (water, Iron, Lead-tin and Iron-carbon phase diagram), Lever rule, homogeneous and heterogeneous nucleation, growth and transformation kinetics, micro-structural changes during cooling and heating.

Unit – II: Preparation of bulk, thin film and nano-materials: solid state reactions method, sol-gel method, precipitation method, nanomaterials: Bottom up method, Top down method, lithography, advantages and disadvantages of various synthesis methods.

Unit – III: Polymers, mechanism of polymerization, Molecular weight distribution in linear polymers, condensation. Polymers, size distribution in polymer molecules, Effect of polymer structure on properties, conducting polymer,

Unit – IV: Ferroelectric materials, important characteristics and applications of ferro-electric materials, para, ferro, anti-ferro magnetic properties of materials, hysteresis losses, hard and soft magnetic materials, structure and properties of spinals, garnets and hexagonal ferrites and their uses..

References:
1. Materials Science &Engineering: V. Raghavan
2. Elements of materials science &Engineering: L.H. Van
3. The Structure and properties of materials: R.M. Rose & J. Wulff
4. KP Jain, Physics of semiconductor nanostructures, Narosa Publishing House.
5. G. Cao, Nanostructures and nanomaterials: synthesis, properties and applications, Imperial College Press.

DSE – 3: vi. Accelerator Physics–I **Credit: (3+0+0)**

Course Code: PPPCTD2

Course Objective

The course aims to develop an understanding of:

- This course will give knowledge to the students about the fundamentals of accelerators and different type of accelerator.
- This course will help the students to understand the different ion sources and their applications.
- This course will help the students to understand the beam optics, beam transport and beam line components.

Learning Outcome

Upon successful completion of this course, students will be able to address following points:

- The students will have understanding about the fundamentals of accelerators and different type of accelerator.
- The students will be able explain different ion sources and their applications.
- The students to will be able to demonstrate the beam optics, beam transport and beam line components.

Unit – I: Some Basics of Accelerator: History of Accelerators, Livingston plots, Fundamental concepts of Accelerator, Motion of charge particle in electric and magnetic field, Achievements of Accelerators, Brief descriptions of Accelerators centers worldwide, Accelerator Centers in India, Applications of accelerators in medical science, semiconductors, industry, food sterilization etc.

Unit – II: Accelerators: Electrostatic accelerators: DC Accelerators, Cockcroft-Walton Accelerator, Van-de-Graaff Accelerator, Principle of Tandem Accelerator, Tandem Pelletron Accelerator,IUAC tandem pelletron Accelerator, GGV Tandem Pelletron Accelerator
Pulsed Accelerators: Cyclotron accelerator, SynchrotronAccelerators and RRCAT Indore synchrotron,Concept of synchrotron radiation in linear and circular accelerator, Betatron Accelerator, Radio frequency (RF) accelerators: Linear Accelerators (LINAC); Physics of Collision and concept of Storage Rings.

Unit – III: Ion Sources: Production of charged particles, impact ionization,I-V characteristics of electrical discharge, Extraction & focusing geometries, positive and negative ion sources, radio frequency (RF) ion sources, penning ionization source, plasmatron&duo-plasmatron, ECR source, TORVIS, sputter ion source: SNICS and MC-SNICS.

Unit – IV: Beam Optics & Beam Transport: Motion of charged particles in electric and magnetic Felds; Electric rigidity, Magnetic Rigidity, Beam and beam emittance, focusing devices: Magnetic Dipole, Einzel lens, Magnetic and Electrostatic steerer, Electrostatic Raster Scanner, solenoid, Magnetic and Electrostatic quadrupole, quadrupole matrix, Beam Line component: Beam profile monitor, Faraday cup, slit.

Reference Book

1. Accelerator Physics, S.Y. Lee, World Scientific, Singapore, 1999
2. Principles of Cyclic Particle Accelerators, J.J. Livingood, D. Van Nostrand Co. 1961
3. The physics of particle accelerators: an introduction by Klaus Wille, Oxford Press USA, 2000.
4. Particle Accelerators, J.P. Blewett, McGraw Hill Book Co.
5. Particle Accelerator physics by H. Wiedemann, Springer, Year: 2007

DSE – 3: Respective Discipline Specific elective Lab – 3 **Credit: 2 (0+0+2)**
Course Code: PPPCLD2

Semester – IV

Core–9: Atomic and Molecular Physics **Credit: 5 (4+1+0)**
Course Code: PPPDTT1
Course Objectives:
The course aims to develop
- An understanding of Vector atom model and Coupling Schemes
- Ability to understand the splitting of spectral lines and understanding the phenomenon related to the application of electric and magnetic field.
- Understanding the different molecular spectra and deeper understanding of branches.
- Ability to Understand Raman phenomenon and its versatile applications
- Understanding of different molecular states

Learning Outcomes:
At the end of this course student will demonstrate the ability to:
- Understand the classical and quantum mechanical description of the atomic structure and related phenomena. Vector atom model and coupling of spin and angular momenta.
- Understand the origin of different spectra of alkali materials, Coupling schemes, Breit scheme, and splitting of energy levels for lighter and heavy atoms.
- Understand the origin of different molecular spectra. Molecular symmetry, vibrational and rotational spectra and phenomena related to it.
- Understand the relations and connections between vibrational spectra.(such as IR and Raman) and symmetry of polyatomic molecules along with their electronic structure.
- Apply the knowledge of molecular states to explain the molecular spectra.

Unit – I: Quantum state of one electron atoms, Atomic orbits, Hydrogen spectrum Pauli's principle, Spectra of alkali elements, Spin orbit interaction and fine structure in alkali spectra. Selection rules, concept of parity. Quantum mechanical description of Helium atom.

Unit – II: Equivalent and non-equivalent electrons, normal and anomalous Zeeman effect, Paschen Back effect, Stark effect. Multi electron atom. Interaction energy in LS and JJ coupling. Hyperfine structure of Spectral lines. X-Ray Spectra, Line broadening mechanisms.

Unit – III: Type of molecules-Diatomic linear symmetric top, asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotor, Energy levels and spectra of non rigid rotor-intensity of rotational lines. Vibration energy of diatomic molecule –PQR branches, IR spectrometer (qualitative). General idea of IR and Raman spectroscopy, analysis of simple diatomic molecules, Intensities of vibrational lines. Selection rules.

Unit – IV: Electronic Spectra: Franck-Condon Principle, Electronic band spectra in absorption, Rotational structure of electronic bands, Molecular electronic states, Forbideden transitions in molecular spectra, Determination of Molecular states.

Reference Books:
1. Introduction to atomic spectra-H.E.White
2. Fundamentals of molecular spectroscopy-C.B.Benwell
3. Spectroscopy Vol. I II III- Walker & Straughen
4. Introduction of molecular spectroscopy- G.M.Barrow

5. Spectra of diatomic molecules –Herzberg
6. Molecular spectroscopy Jeanne L Michele
7. Modern spectroscopy –J.M.Holias
8. Molecular spectroscopy –J.M.Brown
9. Spectra of atoms and molecules -P.F.Bernath

Core–10: Electrodynamics **Credit: 5 (4+1+0)**
Course Code: PPPDTT2
Course Objective:

- To study basics law of electromagnetic field, Maxwell's equations and electromagnetic boundary conditions.
- To study dielectric and polarizations and its theory.
- To study Electromagnetic wave in Matter, Propagation in linear media, reflection and transmission at normal incident, and oblique incidence.
- To study wave Guide, Coulomb and Lorentz Gauge.
- To study the laws of electrodynamics under relativistic motion and the concept, and principle of electromagnetic radiation.

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

- Explain basic law of Electrodynamics, Maxwell's equations in matter and Poynting's theorem.
- Explain laws of reflection, refraction as outcomes of electromagnetic boundary condition
- Understand the idea of electromagnetic wave propagation through waveguides and transmission lines.
- Express the laws of electrodynamics under relativistic methods and the concept and principle of electromagnetic radiation.

Unit – I: Electromagnetic field:Motion of charged particle in electromagnetic field, Uniform E and B fields, Nonuniform fields, Diffusion across magnetic fields, Time varying E and B fields, Adiabatic invariants, First, second and third adiabatic invariant.
Electromotive force and Electromagnetic induction: Poynting's theorem, Wave equations for electric and magnetic fields and their solutions.

Unit – II: Relativistic Electrodynamics: Four-vector and Lorentz transformation in four dimensional space, Proper time and Proper Velocity, Relativistic energy and Momentum, relativistic Kinematics, Magnetism as Relativistic phenomenon, Relativistic Potentials, electromagnetic field tensor in four dimensions and Maxwell's equations, Dual field tensor.
Potentials and Fields: Vector and scalar potential, Retarded potential, LienardWienchert Potential,Gauge Transformation, Coulomb and Lorentz Gauge.

Unit – III: Electromagnetic Wave: Electromagnetic wave in matter, Propagation in linear media, Reflection and Transmission at Normal incident and Oblique incidence, Electromagnetic Waves in conductors, Skin depth, relative directions, phase of E and H in conducting medium. Boundary conditions on the field at interface of two media, Frequency dependence of Permittivity, introduction of Wave Guide.

Unit – IV: Electric Fields in Matter: Dielectric materials, Polarization, Electric field of a polarized material, Bound charges, Gauss's law in dielectric materials, Linear dielectric materials, Boundary conditions at the interface of two dielectrics. **Radiations**: Dipole radiation, Electric and Magnetic dipole radiation, Radiation from arbitrary source, angular distribution of power radiated, Bremsstralung, Introduction of matter radiation interaction.

Reference Books:

1. Classical Electrodynamics, J. D. Jackson, (John Wiley).
2. Introduction to electrodynamics, D. J. Griffiths,
3. Classical theory of fields, L. D. Landau and E. M. Lifshitz, (Addison-Wesley).
4. Electrodynamics of continuous media, L. D. Landau and E. M. Lifshitz, (AddisonWesley).
5. Electrodynamics, A. Somerfield, (Academic Press, Freeman and Co.).
6. Classical Electricity and Magnetism, W.K.H. Panofsky and M. Phillips: (AddisonWesley).
7. Feynman Lectures Vol. II.
8. Berkeley Series Volume II.
9. Electricity and Magnetism, Reitz, Milford, Christy
10. Introduction to Electrodynamics, A. Z. Capri and P. V. Panat (Narosa)

DSE – 4: i. Advanced Condensed Matter Physics–II **Credit: 3 (3+0+0)**
Course Code: PPPDTD1
Course Objectives:
The course aims to develop an understanding of:
- Understanding of various methods of density functional theory
- Super conductivity and its applications be understood.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Advanced concepts condensed matter physics be cleared
- Advanced device applications may be derived

Unit – I: Electrons in a periodic lattice: the tight-binding method, elementary ideas of cellular, APW, OPW and pseudo potential methods of calculating band structures.

Unit – II: Many electron interactions: Hartree and Hartree-Fock approximations, self-consistent field method, correlation energy, dielectric screening, dielectric function of an electron gas, random phase approximation.

Unit – III: Electron-electron interaction: quasi-particle, Landau's Fermi liquid theory, Meissner effect, London equations, coherence length, Cooper pair, BCS theory of superconductivity, concept of Ginzburg-Landau theory.

Unit – IV: Electron-photon interaction: polarons, transport phenomena, Onsager relations, Boltzmann transport equations and its linearization, relaxation time approximation, application to lattice and electronic conduction in insulators and metals.

Reference Books:
1. Madelung : Introduction to solid state theory
2. Huang : Theoretical solid state physics
3. Charles Kittel : Quantum Theory of Solids, 2nd Revised Edition ,Wiley
4. Verma & Srivastave : Crystallogrphy for solid state physics
5. Charles Kittel : Solid state physics, Wiley
6. Aschroft & Mermin : Solid State Physics,
7. M A Wahab: Solid State Physics
8. Omar: Elementary Solid State physics

Credit: (3+0+0)

DSE – 4: ii. Advanced Nuclear Physics – II
Course Code: PPPDTD1
Course Objectives:
The course aims to develop an understanding of:

- To develop deep understanding about nuclear reactions
- To develop the understanding of nuclear instrumentations and learn basic electrons involved in the experiments.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- Perform the experiments with basic understanding of nuclear instrumentation.
- Details of nuclear reaction theory to understand the exciting nuclear structure

Unit – I: Nuclear Reactions: Classification of nuclear reactions, Direct and Compound nuclear reaction mechanisms, Discussion of Compound nucleus model, Resonance, level density, decay, cross-section, entrance channel effect, Statistical model, Pre-equilibrium model, Direct reactions: elastic and inelastic scattering, examples of direct reactions, nuclear spectroscopy from direct reactions. Concept of Optical Model, Rearrangement collision: DWBA approach.

Unit – II: Heavy ion induced nuclear reactions: Heavy ion reactions (Semiclassical approach), Elastic scattering, Coulomb excitation, Deep inelastic collisions, Fusion, Fission, Coulomb excitation and its applications. Spontaneous fission, Mass energy distribution of fission fragments.

Unit – III: Measurements Techniques: Interaction of charged particles and radiation with matter, Simplified detector model , Detection technique, detector characteristics (sensitivity, response, efficiency, dead time), Ionizing Radiations, gas detectors, Scintillation counters **:** Organic and inorganic scintillators - Theory, characteristics and detection efficiency Solid state detectors: semiconductor detectors, surface barrier detectors, experimental techniques in particle and gamma ray spectroscopy, gamma detector arrays, coincidence method.

Unit – IV: Nuclear Electronics and Statistics: Analog and digital pulses, Signal pulses, Transient effects in an R-C Circuit, Pulse shaping, Linear amplifiers, Pulse height discriminators, General characteristics of single & multi-channel methods, Introduction to data acquisition system (MCA,CAMAC and VME). Statistics of counting, Poisson and Gaussian distribution, statistical quality of data, chi-square test.

Reference books:

1. Introducing Nuclear Physics by K. S. Krane (Wiley India., 2008) .
2. Introductory Nuclear Physics S. M. Wong (Wiley-VCH Verlag GmbH & Co. KGaA)
3. Nuclear Physics - Theory & Experiments by R.R. Roy &B.P.Nigarn (New Age lnternational, 2005)
4. Kaplan Irving, Nuclear Physics, Narosa Publishing House, (2000).
5. Introduction to nuclear reaction - Carlos Bertulani, Pawel Danielewicz
6. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
7. Theoretical Nuclear Physics, J.M. Blatt &V.F.Weisskopf (Dover Pub.Inc., 1991)
8. Techniques for Nuclear and Particle Physics Experiments. W.R. Leo, (Springer- Verlag,1993)

DSE – 4: iii. Astronomy and Astrophysics– II **Credit: (3+0+0)**
Course Code: PPPDTD1
Course Objectives:
The course aims to develop an understanding of:

- The type of waves and various phenomenon of optics.
- The superposition of waves, progressive and stationary waves, optical phenomenon based on superposition of waves such as Interference and Diffraction.

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- The basic quantities used in astronomy such as coordinates, Stellar Distance, magnitude, and Stellar Luminosity etc. and measurement techniques of astrophysical quantities as well as spectral classification of stars.
- Formation and Evolution of Star and the fate of low and high mass stars, as well as the physics of white dwarfs, neutron starts, pulsars and black holes.
- Binary Stars and Star Clusters, as well as their Classifications.
- The workings of astronomical instruments as well as their use.

Unit – I: Variable Stars: Classification of Variable Stars, Cepheid Variables, Period-Luminosity Relations of Cepheid Variables, RV Tauri Variables, Mira Variables, Red Irregular and Semi-regular Variables, Beta Canis Major Variables, U Geminorum and Flare Stars, Pulsation theory of Variable Stars.

Unit – II: Milkyway Galaxy and Normal Galaxies: The Milkyway Galaxy: Structure of the Milkyway, Oort's Theory of Galactic Rotation, Dynamics of the Spiral Arms, Distribution of Interstellar matter, Central regions of the Milkyway. Normal Galaxies: Classification of galaxies, Hubble Sequence: Elliptical, Lenticulars and Spiral Galaxies, and Their Properties, Distribution of Light and Mass in Galaxies, Brightness Profiles, Distribution of Gas and Dust in Galaxies.

Unit – III: Active galaxies: Active Galactic Nuclei (AGNs), Seyfert galaxies, BL Lac Objects, LINERs, and Radio Galaxies: General Properties, Superluminal motion, Quasars: Properties and Energy Requirements, Nature of Quasar redshifts, Supermassive Black Hole Model and Unified model of AGNs.

Unit – IV: Cosmology: Cosmology: Cosmological Principle, Robertson-Walker Line Element, Cosmological Red shift, Hubble's Law, Models of the Universe, Friedman Models, Density Evolution, Critical Density, Models with the Cosmological Constant, Observable Quantities – Luminosity and Angular Diameter Distances, Red shift- Magnitude Relation, Steady State Cosmology.

Relics of the Big Bang, Early Universe, Thermodynamics of the Early Universe, Primordial Neutrinos, Helium Synthesis and Other Nuclei, Cosmic Microwave Background (CMB).

Reference Books:

1. Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wealey publishing Co.
2. The Physical Universe: An Introduction to Astronomy, F. Shu, Mill Valley: University Science Books.
3. Universe, R.A. Freedman and W.J. Kaufmann, W.H. Freeman & Co
4. Fundamental of Astronomy, H. Karttunen et al., Springer
5. The Physics of Stars, A.C. Phillips, John Wiley & Sons, Ltd.
6. An Introduction to Astrophysics, Baidyanath Basu, Prentice Hall of India.
7. Textbook of Astronomy and Astrophysics with Elements of Cosmology, V.B. Bhatia, New Delhi, Narosa Publishing House.
8. Theoretical Astrophysics, Vol. I: Astrophysical processes T. Padmanabhan, Cambridge University Press.
9. Theoretical Astrophysics, Vol. – II: Stars and Stellar Systems, T. Padmanabhan, Cambridge University Press.
10. Theoretical Astrophysics, Vol. – III: Galaxies and Cosmology, T. Padmanabhan, Cambridge

University Press.
11. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th edition, Saunders College Publishing.
12. The New Cosmos, A. Unsold and B. Baschek, Newyork, Springer Velas.
13. Galactic Astronomy, J. Binney and M. Merrifield, Princeton University Press.
14. Galactic Dynamics, J. Binney and S. Tremaine, Princeton University Press.
15. An Introduction to Active Galactic Nuclei, B.M. Peterson, Cambridge University Press.
16. Quasars and Active Galactic Nuclei, A.K. Kembhavi and J.V. Narlikar, Cambridge University Press.
17. Introduction to Cosmology, J. V. Narlikar, 3 rd edition, Cambridge University Press.
18. General relativity and Cosmology, J. V. Narlikar-Delhi: Macmillan Company of India Ltd.
19. Structure Formation in the Universe, T. Padmanbhan, Cambridge University Press.

DSE – 4: Astronomy and Astrophysics–II Lab
Course Code: PPPDLD1 **Credit: 2 (0+0+2)**
Name of the experiments

1. Study of Quasar
2. Study of the Orbit of a visual Binary Star
3. Determine the mass of Saturn and its rotational velocity
4. Verification of Hubble's law and determination of Hubble's constant and age of the Universe
5. Study of light curves of Cepheid variable stars
6. Study of proper motion of stars
7. Determination of period and distance of pulsar
8. Photoelectric photometry of Pleiades star cluster
9. Study of expansion of the universe and calculate the age of universe using computer program CLEA
10. Determine the distance of small Magellanic Cloud (SMC) using Period-Luminosity Relation of Cepheid Variable star

DSE – 4: iv. Molecular Spectroscopy– II **Credit: (3+0+0)**
Course Code: PPPDTD1

Unit – I: Properties of Laser Beams; Pumping Schemes; Threshold pump power, Optical resonators, Stability of resonators, Role of Plane and Confocal cavity resonators, Mode selection, Generation of Ultra short Pulses; Characteristics of Gaussian beam, Transverse and longitudinal modes, mode selection, losses in a resonator, mirror mounts, optical coating etc., Q-switching and Mode locking;

Unit – II: Types of Lasers: Solid-State, Dye, and Semiconductor Lasers; Laser Tuning; Reasons for Multimode Oscillation; Single-Mode Selection; Non-linear polarization of lasers and some applications: Second harmonic generation using non-linear optical methods.

Unit – III: Spectrograph and Monochromator, Interferometer, Comparisons between spectrometers and Interferometers; Detectors: Photomultiplier tube (PMT), Charge coupled detectors (CCD), Thermal detectors; Dispersion and Resolving power of prism and gating instruments;

Unit – IV: Non-linear Spectroscopy: linear and non-linear absorption; Two photon absorption, Stimulated Raman Scattering; Coherent Anti-Stokes Raman Scattering Special Techniques: Resonance Raman Spectroscopy; Surface Enhanced Raman Spectroscopy; Time-resolved Raman Spectroscopy.

Reference Books:

1. Laser Theory and Applications: K. Thyagarajan and A.K. Ghatak
2. Principles of Lasers : O. Svelto.
3. Laser Spectroscopy and Instrumentation : W. Demtroder.
4. Laser Material Processing : William M. Steen
5. Modern Spectroscopy, J. M. Hollas
6. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E.M. Mc Cash,
7. Advances in Laser spectroscopy: Edited by F.T.Arecchi 8. Laser Applications: Monte Ross

DSE – 4: v. Material Science – II **Credit: (3+0+0)**
Course Code: PPPDTD1

The course aims to develop an understanding of:

- Student will gain knowledge about the advanced materials and classifications.
- This paper will help students to understand various Material characterization techniques.

Learning Outcome

Upon successful completion of this course, students will be able to address following points:

- The students will understand the basics of ion-solid interactions.
- The student will be able to understand various Materials Characterization techniques.
- The students will understand various thermal analysis.

Unit – I:: Elementary idea of Advanced materials: General features and classifications, Structure models for amorphous materials, Structure and properties of metallic glass and amorphous semiconductors, Quasicrystal line materials, Materials for solar cell applications, Hydride materials (Hydrogen storage materials), Materials for Sensors and transducers application

Unit – II: Materials Characterization techniques: X- ray diffraction methods for materials characterization, powder diffraction methods, Indexing of powder diffraction patterns, Determination of particle size, Increase in x-ray diffraction peaks of nanoparticles, Shift in photo luminescence peaks, Raman and FTIR spectroscopy of materials, Photoemission microscopy

Unit – III: Light / Optical Microscopy: Optical microscope- Basic principles & components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarised light, Hot stage, Interference techniques), Electron Microscope and its applications in materials characterisation.Principle of Scanning Electron Microscope, study of microstructure, determination of grain size etc, Advantages of Neutron diffraction.

Unit – IV: Thermal Analysis: Thermal analysis, Thermogravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermomechanical analysis and dilatometry,

Reference Books:

1. Introduction to solid state physics : C.Kittel
2. Superconductivity Today : T.V. Ramkr ishnan and C.V. R.R
3. Raghvan, V., Materials Science & Engineering, PHI (1998).
4. Callister, W.D., Materials Science & Engineering: An Introduction, Wiley & Sons (2001).
5. Smith, W., Principles of Materials Science and Engineering., McGraw Hill (1990).
6. Cao, G., Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Emperial College Press (2004).

Credit: (3+0+0)

DSE – 4: vi. Accelerator Physics– II
Course Code: PPPDTD1
Course Objective
The course aims to develop an understanding of:
- This course will help to know about the ion-solid interactions and its consequences.
- Student will gain knowledge about the use of ion beam induced materials modification, materials synthesis, synthesis of nanostructures and nanopatterns.
- This paper will help students to understand various nuclear/ion beam analysis techniques.
- This paper will be useful to the students to understand heavy ion nuclear reactions.

Learning Outcome
Upon successful completion of this course, students will be able to address following points:
- The students will understand the basics of ion-solid interactions.
- The student will be able design different experiments using ion beam.
- The students will understand various nuclear/ion beam analysis techniques.
- The students will understand heavy ion nuclear reactions.

Unit – I: Ion-Solid Interaction: Interaction of an energetic charged particle with a free electron gas, ion-solid interaction, and Energy loss process: nuclear stopping and electronic stopping, Synergic Effects of nuclear and electronic energy Loss, Coulomb explosion, Thermal spike, and pressure spike models, Range of ions, energy and range straggling, Basic ion beam simulation programs, SRIM & TRIM, limitations and modifications, stopping and range of ions in matter by Monte-Carlo methods,

Unit – II: Materials Modification with Ion Beam: Ion implantation, Ion Irradiation, radiation damage and structural change; Ion sputtering, phase transformations; Ion beam mixing, impurity incorporation; Synthesis of nanostructured materials under electronic excitation, Ion induced crystallizations and epitaxial crystallization, ion induced structural phase transitions, buried layers, Ion induced surface nano-structuring, nanostructures using self-organization

Unit – III: Nuclear Techniques/Ion Beam Analysis Techniques: Applications of Accelerator: Trace element analysis: various methods, Rutherford Backscattering Spectrometry (RB)S, RBS-channeling, Elastic Recoil Detection Analysis (ERDA), Particle Induced X-ray emission (PIXE), Nuclear Reaction Analysis (NRA), Particle Induced g-ray Emission (PIGE), Neutron Activation Analysis (NAA) technique, Accelerator Mass Spectrometry (AMS).

Unit – IV: Heavy Ion Nuclear Reactions: Special features of heavy ions scattering (Q-and L-window), semi classical models, deflection functions, rainbow and Glory scattering, quasi elastic and transfer reactions, deep inelastic scattering, complete and incomplete fusion, fission

Reference Book:

1. Ion Implantation and Synthesis of Material, M Nastasi and J W Mayer, Springer 2006.
2. Techniques for Nuclear and Particle Physics Experiment by W.R. Leo
3. Ion-Solid Interaction: Fundamentals & Applications By M. Nastasi, J.W. Mayer & J.K. Hirvonen.
4. Nano Fabrication by Ion Beam Sputtering, T Som and D Kanjilal.
5. Swift heavy ions for materials engineering and nanostructuring, D.K. Avasthi and G.K. Mehta, Capital publishing company, New Delhi (2011).
6. Material Science with Ion Beam, Harry Bernas, Springer 2010.

DSE – 4: Respective Discipline Specific elective Lab – 4
Course Code: PPPDLD1 **Credit: 2 (0+0+2)**

DEPARTMENT OF PURE AND APPLIED PHYSICS
M.Sc. (Electronics) Course structure under CBCS/LOCF
Academic year 2022– 2023

Sem	Course Opted	Course Code	Name of the course	Credit	L:T:P	Internal	External	Total
I	Core-1	PEPATT1	Mathematical Techniques for Electronics	5	4+1+0	30	70	100
	Core -2	PEPATT2	Semiconductors Materials & Devices	3	3+0+0	30	70	100
		PEPALT2	Semiconductors Materials & Devices Lab	2	0+0+2	30	70	100
	Core -3	PEPATT3	Analog and Digital Electronics	3	3+0+0	30	70	100
		PPPALT3	Analog and Digital Electronics Lab	2	0+0+2	30	70	100
	Open Elective		Opted from the pool and offered by other departments	5	5+0+0	30	70	100
	Other if any*							
			TOTAL	**20**				**600**
		Open Elective offered by the Department						
	Open Elective	OPNPET1	Applications of Nanotechnology in Electronics	3	3+0+0	30	70	100
		OPNPEL1	Applications of Nanotechnology in Electronics Lab	2	0+0+2	30	70	100
II	Core-4	PEPBTT1	Electromagnetic theory and Wave Propagation	5	4+1+0	30	70	100
	Core -5	PEPBTT2	IC Fabrication and VLSI Technology	5	4+1+0	30	70	100
	Core -6	PEPBTT3	Microprocessors and Microcontrollers	3	3+0+0	30	70	100
		PEPBLT3	Microprocessors and Microcontrollers Lab	2	0+0+2	30	70	100
	Discipline Specific Elective 1	PEPBTD1	Advanced Communication System-1	3	3+0+0	30	70	100
		PEPBLD1	Analog and Digital Communication System Lab	2	0+0+2	30	70	100
	Other if any*							
			TOTAL	**20**				**900**
III	Core-7	PEPCTT1	Power Semiconductor Devices and Control System	5	4+1+0	30	70	100
	Core-8	PEPCTT2	Sensors and Transducers	5	4+1+0	30	70	100
	Core-9	PEPCTT3	Optoelectronics Devices	3	3+0+0	30	70	100
		PEPCLT3	Optoelectronics Devices Lab	2	0+0+2	30	70	100
	Research Methodology	PEPCTR1#	Research Methodology in Electronics	2	2+0+0	30	70	100
	Discipline Specific elective 2	PEPCTD1	Advanced Communication System-2	3	3+0+0	30	70	100
		PEPCLD1	Advanced Communication System-2 Lab	2	0+0+2	30	70	100
	*Certificate/ FC/UEC			2		30	70	100
	Other if any							

			TOTAL	**22+2***				**700**
IV	Major Project Work With Dissertation	PEPDD01#	Major Project Work With Dissertation	12		30	70	100
	Industrial Training (Internship)	PEPDE01#	Industrial Training in the fields Related to the Programme with Project Report	08		30	70	100
			TOTAL	**20**				**200**

#The Code generated by the Department.

L=Lecture, T= Tutorial, P = Practical (Lab)

* Additional Credit courses (not mandatory in nature)

The Discipline specific courses will be treated as special paper of old pattern as and when needed.

DEPARTMENT OF PURE AND APPLIED PHYSICS
M.Sc. (Electronics) Course Syllabus under CBCS/LOCF
Academic year 2022 – 23

Semester - I

Core -1: Mathematical Techniques for Electronics
Course Code: PEPATT1
Credits = 5 (4+1+0)

Course Objectives:

- Create deep interest in learning mathematics techniques.
- To offer a gentle introduction to the concepts of Laplace transforms, Inverse Laplace transforms, solution of ordinary differential equations using Laplace transform, Fourier series and their properties with applications in real life.

Course outcomes:

The student after undergoing this course will be able to:

- Analyze, identify and solve the problem using Laplace Series.
- Analyze, identify and solve the problems using Fourier Series
- Apply -Transforms, Inverse Z-Transforms and solve Difference Equations.
- To apply the application of Mathematics in Electronics.

Unit I: Laplace Transform: Definition and Properties, Laplace Transform derivatives and integrals, Evaluation of differential equations using Inverse Laplace Transform, Applications of Laplace Transform , Fourier Series & Transform: Definition and Properties, Fourier series in the Interval, Uses of Fourier Series,Fourier sine and cosine transform of Derivatives, Finite Fourier Transform, and Applications of Fourier Transform.

Unit II: Partial differential equations: Homogeneous and non-homogeneous boundary conditions, Solutions by separation of variables and series expansion methods. Laplace, wave and diffusion equations in various coordinate systems. Integral equations: methods and solutions,

Unit III: Mathematical Transforms: Discrete time signal analysis and linear systems , Sampling theorem and applications , Sampling of continuous time signals. z-transform, inverse z-transform, Digital Filters: signal flow graph representation, basic structures for IIR and FIR filters, noise in digital filters, filter design techniques, Transforms: Discrete Fourier Transform (DFT) , properties and Fast Fourier Transforms (FFT)

Unit IV: Mathematical tool for Electrical circuits; Superposition, Thevenin, Norton and Maximum Power Transfer Theorems, Network elements, Network graphs, Nodal and Mesh analysisTime and frequency domain response, Passive filters, Two-port Network Parameters : Z, Y, ABCD and h parameters, Transfer functions, Signal representation, State variable method of circuit analysis, AC circuit analysis, Transient analysis, Zero and Poles, Bode Plots.

Reference Books:

1. Advanced Engineering Mathematics : E Kreyszig (John Wiley & Sons)
2. Higher Engineering Mathematics : Dr. B.S. Grewal, Khanna Publishers, New Delhi.
3. Advanced Engineering Mathematics: H. K. Das, S.Chand&company Ltd.
4. Theory and Application of Digital Signal Processing: L. R. Rabiner and B. Gold, Prentice Hall.

5. Introduction to Digital Signal Processing: J.R. Johnson, Prentice Hall.
6. Industrial Control Electronics – Applications and Design, Michael Jacob Prentice Hall

Core -2: Semiconductor Materials and Devices
Course Code: PEPATT2
Credits = 3 (3+0+0)

Course Objectives

- To provide basic knowledge and concepts of Semiconductor materials and devices.
- It provides a basic background for advanced courses in electronics, optoelectronics and VLSI design.
- To give an appreciation of the role of the physicist in shaping future electronics
- To provide overview of modern low dimensional semiconductor physics.

Course Outcomes

On completion of the course a student will be able to

- Apply basic concepts of semiconducting materials for electronic device applications.
- Understand major properties of semiconducting materials, explain energy band diagrams and connections with the device structures and properties.
- Holistic view of the latest progress in low-dimensional nano materials for electronic devices.

Unit – I: Introduction to Semiconductor, energy bands in solids, concept of effective mass, density of states, Fermi levels. Extrinsic semiconductors: n and p type doping, Densities of carriers in extrinsic semiconductors and their temperature dependence,

Unit – II: Carrier transport, Conductivity, Mobility and Hall Effect, Diffusion and drift of excess carriers, recombination mechanism, Trapping, Continuity Equation, Diffusion Length.

Unit – III: PN Junction, Diode equation and diode equivalent circuit, Breakdown in diodes, Zener diode, Tunnel diode, Metal semiconductor junction – Ohmic and Schottky contacts, Characteristics and equivalent circuits of JFET, MOSFET.

Unit – IV: Low dimensional semiconductor devices – quantum wells, quantum wires, quantum dots. High Electron Mobility Transistor (HEMT), Solar cells – I-V characteristics, fill factor and efficiency, LED, LCD and flexible display devices. Emerging materials for future Devices: Graphene, Carbon Nano tubes (CNT), ZnO, SiC etc.

Reference Books:

1. Physics of semiconductor Devices, S. M. Sze.
2. Semiconductor Devices, ISBN 0-471-36245-X, Jaspreet Singh,
3. Principles of electronic materials and devices, ISBN 0-07-295791-3, S. O. Kasap,
4. The Physics of Low Dimensional Semiconductors (J H Davies, Cambridge)
5. Physics of Semiconductors and their Heterostructures (J Singh, Wiley)
6. Electronic and Optical Properties of Semiconductor Structures (J Singh) Cambridge)
7. Quantum Wells, Wires and Dots, (P Harrison, Wiley)
8. Low Dimensional Semiconductors (M J Kelly Oxford)
9. Solid state Electron Devices-B. G. Streetman.
10. Semiconductor Physics and Device – Neamen, McGraw Hill

Core -2: Semiconductor Materials and Devices Lab
Course Code: PEPALT2
Credits = 2 (0+0+2)
Name of the experiments

1. Measurement of resistivity of sample at various temperatures by four probe method.
2. To calculate the energy band gap of given semiconductor sample.
3. To study the Hall Effect: determine the Hall coefficient, type of semiconductor and carrier concentration in the given semiconductor sample
4. I-V characteristics measurement of a p-n diode/Schottky diode calculate its device Parameters.
5. To study the performance of solar cell.
6. To study characteristics of JFET and its application as switch.
7. To study characteristics of MOSFET and its application.

Core - 3: Analog and Digital Electronics
Course Code: PEPATT3
Credits = 3 (3+0+0)

Course Objectives:

- To study rectifiers, ICs based regulated power supply, Transistor Biasing, FETs, operating point and stability, Amplifiers, and Various types of oscillators.
- To study the basic principles, configurations and practical limitations of op-amp. , to understand the various linear, non-linear applications of op-amp and frequency generators.
- To analyze, design and explain the characteristics and applications of active filters, and to analyze different types of Multi vibrators and their design procedures.
- To understand simplification of boolean algebra by Minimization techniques (Karnaugh maps and Quine-McCluskey),
- To analyze logic process and implement logical operation using combinational and sequential logic circuit, mixed logic combinational circuits, multiple output functions
- To understand characteristics of flip-flops, Counters Registers A/D and D/A Convertor, memory and their classifications.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- This course provides the foundation inrectifiers, ICs based regulated power supply, transistor biasing, amplifiers, and various types of oscillators.
- Able to understanding in operational amplifier and other linear integrated circuits, the op-amp's basic construction, characteristics, parameter limitations, various configurations of opamp,non-linear circuits, active filters and signal generators.
- Able to Analyze and design multivibrators, develop a digital logic and apply it to solve real life problems.
- Able to analyze design and implements combinational and sequential logic circuits.
- Able understanding and implementation of flip-flops, Counters, Registers, A/D and D/A Convertor, memory.

Unit – I: Rectifiers, Voltage regulated ICs and regulated power supply, Biasing of Bipolar junction transistors andFETs, operating point and stability, Amplifiers, Classification of amplifiers, Concept of feedback,Hartley, Colpitt's and Phase Shift oscillators.

Unit – II: Operational amplifiers (OPAMP) - characteristics, computational applications, comparators, Schmitt trigger, Instrumentation amplifiers, wave shaping circuits, Phase locked loops, Active filters, multivibrators, Voltage to frequency convertors (V/F), frequency to voltage convertors (F/V).

Unit – III: Combinational circuits : Logic Families, Logic Gates, Boolean algebra , minimization techniques :Switching equations, canonical logic forms, sum of product & product of sums, Karnaugh maps, two, three and four variableKarnaugh maps, simplification of expressions, Quine-McCluskeyminimization technique, mixed logic combinational circuits, multipleoutputfunctions.Sequential circuits: multiplexers and demultiplexers.

Unit – IV: Flip-flops, clocked and edge triggeredflipflops, Counters – Ring, Ripple, asynchronous and synchronous counters, counter design with state equations, Registers , serial in serial out shift registers, tristateregistor, timing considerations. A/D and D/AConverter, Sequential PLD, FPGA, Analysis and Design of digital circuits using HDL, Programmable Logic Devices (PLD), flip flops memories.

Reference Books:

1. Millman's Integrated Electronics - Analog and Digital Circuit and Systems.
2. A.P. Malvino, Electronic Principles, Tata Mcgraw Hill Publications.
3. Robert L. Boylestad& Louis Nashelsky, Electronic Devices & Circuit Theory.
4. Analysis and Design of Analog Integrated Circuits by Kenneth Martin Chan Carusone, David Johns
5. Digit al Principles &Application: Malvino& Leach.
6. Computer System Architecture: Moris Mano.
7. Digit al Electronic: Schaum Series.
8. Digit al Electronics: R.J.Tossi (PHI).
9. Digit al electronics: R.P. Jain.

Core - 3: Analog and Digital Electronics Lab
Course Code: PEPALT3
Credits = 2 (0+0+2)
Name of the experiments

1. Design some combinational circuits using NAND & NOR Gate.
2. Design circuit Using IC 7400 and 7402 to verify.
3. Study characteristics of FET and MOSFET.
4. Study characteristics of Colpit’s oscillator.
5. Experiment based on Operational Amplifier (like adder, subtractor and Others)
6. To Study the characteristics of op- amp as Inverting and non inverting.
7. To Study the characteristics of op- amp as Schmitt trigger & Comprator.
8. Study and designs flip flop.
9. Study and designs of A/D & D/A Convertor.

References:

1. Millman's Integrated Electronics - Analog and Digital Circuit and Systems.
2. Digit al Principles & Application: Malvino& Leach.
3. Digit al electronics: R.P. Jain.

Open Elective: Applications of Nanotechnology in Electronics
Course Code: OPNPET1
Credits = 3 (3+0+0)

Course Objectives

- Foundation knowledge of the nanoscience field
- To bring out the distinct properties such as electronic, optical properties of nanostructures
- To make the students acquire an understanding the nanomaterials and their applications

Learning Outcomes

Upon successful completion of this course, students will be able to address following points:

- Learn about the distinct properties of nanomaterials
- Understand the principles of nanomaterial characterization techniques
- Describe the principle and operation of nanomaterial-based devices

Unit – I: Definition of Nano-science and nano technology, History of nanoscience, Energy band-gap in semiconductors, Fermi level, Donors, acceptors and deep traps, Excitons, Mobility, Conduction electrons, density of states, Zero dimensional (0D), one dimensional (1D) , two dimensional (2D) , three dimensional (3D), Nano-structured materials, Influence of nano over micro/macro.

Unit – II: Properties of Nanomaterials: Size dependence of properties, Optical: Absorption, transmission, Photoluminiscence, Fluoroscence, Phosphorescence, Surface Plasmon Resonance, effect of size of nano particles. Electrical: Conduction mechanisms in 3D (Bulk), 2D (Thin film) and Low dimensional systems.

Unit – III: Type of Nanomaterials: different type of nano materials,Carbon nanotube, Fullerene, Type of CNT: SWNT (Single wall nano tube), Multi wall nano tubes, Graphite and Graphene, metal nano particle silver and gold, ZnO and TiO_2 metal oxides, Semiconductors, Nano-composites,Creating nanoparticles by using software.

Unit – IV: Synthesis of nanomaterials: Combustion method, Sol-gel method, Co-precipitation method. Characterization tools for nanomaterials: X-Ray Diffraction, UV-VIS Spectrophotometer, Spectrofluorophotometer, Scanning Electron Microscopy, Transmission Electron Microscopy.

Reference Books:

1. Introduction to Nanotechnology, Charles P. Poole, Jr., Frank J. Owens, Wiley India (P)Limited New Delhi.
2. Nanoscience and Nanotechnology, K.K. Chattopadhyay, A.N. Banerjee, PHI Learning Private Limited, New Delhi.
3. Understanding of Nano Science and Technology, PoorviDutta, Sushmita Gupta, Global Vision Publishing House, New Delhi.
4. Nanotechnology, WM Breck, CBS Publishers & Distributors Pvt Ltd, New Delhi.
5. Optical Imaging and Microscopy (Techniques and Advanced Systems), Peter Török, Fu-Jen Kao, Springer Publication.

Open Elective: Applications of Nanotechnology in Electronics Lab
Course Code: OPNPEL1
Credits = 2 (0+0+2)
Name of the experiments

1. To calculate the energy bandgap of nanoparticle from UV-VIS spectra.
2. To measure the average crystallite size using XRD data of a given nanomaterial.
3. Estimation of lattice strain in nanoparticle by XRD pattern.
4. To calculate the grain size of a material fromSEM micrograph.
5. To analyse the absorption and emission spectrum of a given material.
6. Synthesis of nanomaterial by combustion method.

Semester – II

Core-4: Electromagnetic Theory and Wave Propagation
Course Code: PLPBTT1
Credit: 5 (4+1+0)

Course Objectives:
The course aims to develop
- Ability to understand the propagation of electromagnetic waves in different medium
- Understanding of the Gauge transformation and invariance of the fields
- Mathematical analysis of the sinusoidal linear waves
- Ability to understand the physics involved in the waveguides and resonators
- Understanding of the optical fiber communication

Learning Outcomes:
At the end of this course student will demonstrate the ability to:
- Apply the maxwell's equation to explain the propagation of electromagnetic waves in different medium and their related phenomenon such as skin depth etc.
- Understand the concept of Lorentz and Coulomb Gauge.
- Interpret the natural optical phenomenon by using the concept of transverse nature of electromagnetic waves
- Understand the principles involved in the optical fiber communication

Unit – I: Maxwell's equation in terms of scalar and vector potential, Gauge Transformation, Lorentz and Coulomb Gauge, Retarded potential, Electromagnetic waves in free space, wave propagation in linear medium, propagation of sinusoidal voltages, complex analysis of sinusoidal waves and phasor.

Unit – II: Propagation of electromagnetic waves in isotropic dielectric medium. Propagation of em waves in anisotropic dielectric medium, Fresnel law of normal velocities, propagation of em waves in conducting medium, skin depth, Poynting vector in conducting medium, propagation of em waves in ionized gases, plasma frequency.

Unit – III: Interaction of electromagnetic waves with matter, Fresnel Formulae, Snell's law, Brewster's law, total internal reflection, Production of elliptically and circularly lights. Metallic reflection, Rectangular wave guide, TE mode, TM mode. Cavity resonators-TE and TM mode.

Unit – IV: Wave propagation in the wave guide, Power transmission and attenuation, waveguide current and mode excitation, Optical Fiber, Optical fiber transmission modes, Losses in fiber, measurement of fiber characteristics, introduction to fiber optical communication system.

Reference Books:

1. Principles of Electromagnetics by M.N.O. Sadiku and S.V. Kulkarni
2. Engineering electromagnetic by Hayt and Buck
3. Introduction to electrodynamics by David J. Griffiths

4. Optoelectronics an introduction by J. Wilson and J.F.B. Hawkes
5. Electromagnetics by B. B.Laud
6. Introduction to Electromagnetic theory by T. L. Chow
7. Electromagnetics by Schaum Series

Core -5: IC Fabrication and VLSI Technology
Course Code: PEPBTT2
Credit: 5 (4+1+0)

Course Objectives:
The course aims to develop an understanding of:
- Know the physics of semiconductor junctions, metal-semiconductor junctions and metal-insulator-semiconductor junctions.
- Know the physics and application of semiconductor hetero junctions and quantum-confined structures.
- Understand the fundamental principles and applications of modern electronic and optoelectronic semiconductor devices

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- To get understanding of device fabrication methods
- Understands the VLSI technology
- Understanding the IC Technology

Unit – I: Clean room technology - Clean room concept – Growth of single crystal Si , surface contamination, cleaning & etching. (Laboratory Practices : Cleaning of p-type & n-type Si-wafer by solvent method & RCA cleaning) Oxidation – Growth mechanism and kinetic oxidation, oxidation techniques and systems, oxide properties, oxide induced defects, charactrisation of oxide films, Use of thermal oxide and CVD oxide; growth and properties of dry and wet oxide, dopant distribution, oxide quality; (Laboratory Practices : Fabrication of MOS capacitor)

Unit – II: Solid State Diffusion – Fick's equation, atomic diffusion mechanisms, measurement techniques, diffusion in polysilicon and silicon di-oxide diffusion systems. Ion implantation – Range theory, Equipments, annealing, shallow junction, high energy implementation. Lithography – Optical lithography, Some Advanced lithographic techniques. Physical Vapour Deposition – APCVD, Plasma CVD, MOCVD. Metallisation - Different types of metallisation, uses & desired properties. VLSI Process integration.

Unit – III: Materials For Integrated Circuits and Fabrication Technology: Classification of IC's, Electronic grade silicon, Silicon shaping lapping polishing and wafer preparation, Vapour phase epitaxy, Molecular beam epitaxy, Optical lithography, Photomask, Photoresist and process, Limitation of optical Lithography, Idea of electron and X-ray Lithography, Wet chemical etching, reactive plasma etching.

Unit – IV: Microelectronic Fabrication: Fabrication of mono lithic diodes, Fabrication of integrated transistors, idea of burried layer fabrication, Monolithic circuit layout and design rule, Isolation methods, Monolithic FET, MOSFET, Processing idea of HEMT (High Electron Mobility transistor), CCD, MOS integrated circuit, Large and medium scale integrated, Hybrid Integrated circuit.

Reference Books:

1. Integrated Electronics : Milliman and Taub
2. Microelectronics : Milliman and Gros
3. Thin film Phenomenon : K.L. Chopra
4. Hand Books Of Thin Film : Marshe l and Gland
5. Physics of Semiconductor devices : Michel Shur
6. IC Fabrication : J. A. Ellcott
7. Semiconductor Devices Physics and Technology, Author: Sze, S.M.; Notes: Wiley, 1985
8. An Introduction to Semiconductor Microtechnology, Author: Morgan, D.V., and Board, K
9. The National Technology Roadmap for Semiconductors , Notes: Semiconductors Industry Association, SIA, 1994
10. Electrical and Electronic Engineering Series VLSI Technology, Author: Sze, S.M. Notes: McgrawHill International Editions

Core -6: Microprocessors and Microcontrollers
Course Code: PEPBTT3
Credit: 3 (3+0+0)

Course Objectives:

The course aims to develop an understanding of:

- The difference between microprocessor and microcontrollers
- Their architecture including designed, memory organizing, addressing modes, timing
- Data moving and transferring
-

Learning Outcomes:

After completion of this syllabus, students are able to understand:

- The difference between microprocessor and microcontrollers and their architecture.
- To write the programs and load the data on registers and perform the arithmetic and logical operations.

Unit – I: 8086 Architecture and Programming: 8086 Architecture – Min.Mode, Max.Mode – Software Model – Segmentation – Segmentation of address – Pipe line Processing. Addressing Modes – Instruction Set- Constructing Machine Code – Instruction Templates for MOV Instruction– Data Transfer Instructions– Arithmetic, Logic, Shift, rotate instructions Flag Control instructions-Compare, Jump Instructions– Loop and String instructions -Assembly programs- Block move, Sorting, Averaging, Factorial – Code Conversion : Binary to BCD, BCD to Binary.

Unit – II: 8051 Microcontroller Hardware Introduction – Features of 8051 – 8051 Microcontroller Hardware : Pin-out of 8051, Central Processing Unit (CPU), Internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input / Output pins, Ports and Circuits – External data memory and Program memory : External program memory, External data memory.

Unit – III: 8051 Instruction Set And Assembly Language Programming Addressing modes – Data moving (Data transfer) instructions : Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions : byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions : Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions : Jump and Call program range, Jump, CALL and subroutines – Programming.

Unit – IV: Interfacing to External World Interfacing keyboard: Simple keyboard interface, Matrix keyboard interface – Interfacing displays: Interfacing seven segment LED displays, Interfacing LCD display – Interfacing DAC to 8051– Interfacing ADC to 8051 – Interfacing sensors – Interfacing stepper motor.

REFERENCE BOOKS:

1. A. P. Godse and D. A. Godse, "Microprocessors & its Applications", Technical Publications, Pune,
2. Kenneth Ayala, "The 8051 Microcontroller", Third Edition, Delmar Cengage Learning, 2005.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D.McKinlay, "The 8051 Microcontroller and Embedded Systems", Second Edition, Pearson Education 2008.
4. W.A. Triebel and Avatar Singh, The 8086 /8088 Microprocessors- Programming, Software, Hardware and application, Prentice Hall of India, New Delhi.
5. Douglas V. Hall : - Microprocessors and Interfacing programming and Hardware (Tata Mc Graw Hill) (Unit 1)
6. B. Brey, 1995, Intel Microprocessors 8086/8088, 80186,80286,80486,80486, Architecture, Programming and Interfacing
7. Yu – Cheng and Glenn A. Gibson, The 8086 / 8088 family Architecture, Programming and Design, Prentice-Hall of India.
8. Muhammed Ali Mazidi and Janice Gillespie Mazidi, 2004, The 8051 Microcontroller and Embedded Systems, Fourth Indian Reprint, Pearson Education.
9. V. Vijayendran, 2002, Fundamentals of Microprocessor –8086- Architecture, Programming (MASM) and interfacing, Viswanathan, Chennai.

Core -6: Microprocessors and Microcontrollers Lab
Course Code: PEPBLT3
Credit: 2 (0+0+2)
Name of the experiments

1. Write an assembly language program to multiply two 16-bit hexadecimal numbers.
2. Write an assembly language program to convert a 16-bit hexadecimal numbers to decimal number
3. To write a language program to generate Fibonacci series.
4. To study working of IC 8086 (interfacing experiment)
5. Write an assembly language program to sort hexadecimal numbers in descending order.
6. Generation of Fibonacci series. Micro controller 8051
7. Addition, subtraction, multiplication and division of two 8-bit numbers.
8. Sum of a series of 8-bit numbers, average of N numbers.
9. Factorial of number, Fibonacci series of N terms.
10. Sorting in ascending and descending order – Picking up smallest and largest number

DSE 1: Advanced Communication System-1
Course Code: PLPBTD1
Credit: 3 (3+0+0)
Course Objectives:
The course aims:

- To understands the basics of Information theory, Source coding techniques and calculate Entropy.
- To study Data communication basics such as TCP/IP and the network management concepts.
- To understand various modulation and multiplexing mechanisms.
- To understand the basics of satellite communications and satellite systems.
- To understand the designing of satellite links and the earth station details and their designing.

Learning Outcomes:

Upon successful completion of this course, students will be able to address following points:

- How information is measured in terms of probability and entropy.
- An overview of the concepts and fundamentals of data communication and computer networks.
- Introduction to fundamental technologies of the mobile telecommunications.
- Satellite orbits, link analysis, antenna, interference and propagation effects, modulation techniques, coding, multiple access, and Earth station design.

Unit – I: Introduction to Information and Coding Theories-Information Theory: information measures, Shannon entropy, differential entropy, mutual information, capacity theorem for point-to-point channels with discrete and continuous alphabets.

Unit – II: Introduction to data communication - Introduction to data communication, layered network architecture (OSI and TCP/IP), Public Telephone Network, Cellular Telephone system, data communication codes, error detection and error control, Modems, LAN topologies, Division Multiplexing (WDM) and its network implementation

Unit – III: Mobile Communication elements and system design - Introduction to Cellular Mobile System - Performance criteria - uniqueness of mobile radio environment - operation of cellular systems- Hexagonal shaped cells - Analog and Digital Cellular systems- General description of the problem - concept of frequency channels -Co-channel Interference Reduction Factor -desired C/I from a normal case in a omnidirectional Antenna system - Cell splitting, consideration of the components of Cellular system

Unit – IV: Satellite communication-Introduction: Orbital mechanics and launching, earth station and satellite sub systems, satellite link: design and analysis, multiplexing techniques, multiple accesses

for satellite links: FDMA, TDMA CDMA and DAMA, propagation effects, DBS-TV, GPS. VSAT: Network architecture, access control protocol and link analysis.

Reference Books:

1. Communication Systems" by B P Lathi.
2. Communication Systems" by A B Carlson.
3. Communication Systems: Analog and Digital" by R P Singh and S Sapre
4. Introduction to Communication Systems" by Madhow Upamanyu.
5. Communication Systems" by Michael Moher Simon Haykin.
6. Communication Systems: Analog and Digital" by Sanjay Sharma.
7. Modern Digital and Analog Communication Systems" by B P Lathi and Zhi Ding.
8. Digital Communication: Theory, Techniques and Applications" by R N Mutagi.

DSE 1: Advanced Communication System I Lab
Course Code: PEPBLD1
Credit: 2 (0+0+2)
Name of the experiments

1. Study the sample signal and sample hold signal and its reconstructions.
2. ASK /FSK/ PSK generation and detection
3. Study of Frequency Modulation using Reactance Modulator.
4. Study of Frequency Modulation using Varactor modulator.
5. Study the operation of Quadrature Detector.
6. Study the operation of Detuned Resonance Detector.
7. Study the operation of Foster - Seeley Detector
8. Study the operation of Ratio Detector
9. Study the FM transmitter and receiver.
10. Study the AM transmitter and receiver.

Semester – III

Core-7: Power Semiconductor Devices and Control System
Course Code: PLPCTT1
Credit: 5 (4+1+0)

Course Objectives:
- To introduce students to the basic theory of power semiconductor devices and passive components, their practical applications in power electronics.
- To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
- To provide strong foundation for further study of power electronic circuits and systems.

Learning Outcomes: Upon completion of the course, the student should be able to:
- Relate basic semiconductor physics to properties of power devices, and combine circuit mathematics and characteristics of linear and non-linear devices
- Describe basic operation and compare performance of various power semiconductor devices
- Identify the various control system components and their representations.

Unit – I: Fundamentals of Semiconductors: Carrier concentration of semiconductor, Transport Equations, P-N Junction Diode, Schottky Junction Diode and MOSFET. Fundamentals of LED, essential band structures of LED. Fundamentals of semiconductor LASER with detail theory

Unit – II: Introduction to Power Semiconductor devices, Device Basic Structure and Characteristics , High current effects in diodes, Breakdown considerations for various devices, Junction Termination techniques for increasing breakdown voltage, edge termination in devices, beveling, open base transistor breakdown Structure & Performance of Schottky and PIN Power Diodes SCR, DIAC, TRIAC, power transistors, Protection of thyristors against over voltage and over current. SCR triggering - dv/dt and di/dt, triggering with single pulse and train of pulses, A.C. and D.C. motors - construction and speed control. Switched Mode Power Supply (SMPS). Uninterrupted Power Supply (UPS).

Unit – III :Control System: Terminology and Basic Structure-Feed forward and Feedback control theory- Electrical and Mechanical Transfer Function Models-Block diagram Models-Signal flow graphs models-DC and AC servo Systems-Synchronous -Multivariable control system.

Unit – IV: Open loop and closed loop control system, Block Diagram reduction techniques, transfer function and signal flow diagram, Stability criterion: Routh-Hurwitz and Nyquist plot, On-off controller, Proportional (P), Proportional-Integral (PI), Proportional-Derivative (PD), PID controllers.

References Books:

1. Baliga,G.J., Fundamentals of Power Semiconductor Devices, Springer.
2. S.M. Sze, Physics of Semiconductor Devices, 2nd ed., Wiley..
3. M.Gopal, ―Control System – Principles and Design‖, Tata McGraw Hill
4. J.Nagrath and M.Gopal, ―Control System Engineering‖, New Age International Publishers.
5. K. Ogata, ‗Modern Control Engineering', PHI,
6. S.K.Bhattacharya, Control System Engineering, Pearson,
7. Benjamin.C.Kuo, ―Automatic control systems‖, Prentice Hall of India.

Core-8: Sensors and Transducers
Course Code: PLPCTT2
Credit: 5 (4+1+0)
Course Objectives:
The course aims to develop an understanding of:
- To make students familiar with the constructions and working principle of different types of sensors and transducers.
- To make students aware about the measuring instruments and the methods of measurement and the use of different transducers.
- To know the construction and working of frequently used equipment's like CRO, Signal generator, spectrum analyzer etc.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- Use concepts in common methods for converting a physical parameter into an electrical quantity.
- Classify and explain with examples of Sensors.
- Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light.
- Locate different type of sensors used in real life applications and their importance
- To be familiar with various computers controlled test systems.

Unit – I: Optical sensors: Spectral response, Photoconductive sensors, Junction type photoconductors (PIN and PIN diode, NPN), Photo diode, photo resister, Application of photodiodes and photo resister in light operated relays, Electro-optics, shaft encoder, Photo-voltaic sensors, Photo emissive-sensors.

Unit – II: Transducers-I. Classification of transducers, Selecting a transducers, strain gauge, Gauge factor, Metallic sensing element, Gauge configuration, Idea of displacement transducers, capacitive and inductive transducers, Variable differential transformer, Oscillat ion, transducer.

Unit – III: Ttansducers-II: Photoelectric transducers, Piezoelectric transducers, potentiometric transducers, velocity transducers, resistive thermometer, thermocouples, thermister characteristic, Thermister application, photosensitive devices, filled phototube, multiplier phototube.

Unit – IV: Oscilloscopes: Cathode ray tube, Electrostatic. Screen of CRT, Idea of CRT circuits, Vertical deflection system, Horizontal deflection system, Delay line, Oscilloscope probes and transducers, Determination of frequency phase angle: and time delay measurements, Idea of storage oscilloscope, sampling Oscilloscope.

References Books:

1. Electric Instrumentation a nd M easurmentTechniques : W.D. C ooper& A. D Helfric.
2. Understanding Oscilloscopes :Sahny, Kulshrest ha, Gupta.

Core-9: Optoelectronics Devices
Course Code: PLPCTT3
Credit: 3 (3+0+0)

Course Objectives:
The course aims to develop an understanding as follows:
- To provide students with an understanding of optoelectronic process, materials and basic structure and working principles of devices such as light emitters, detectors, modulators, energy harvesting devices etc.
- To understand the governing equations to be able to perform calculations to characterize the performance of the devices and,
- To have the practical knowledge and an understanding of the trade-offs when using these devices in their respective applications.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:
- The students will understand the basic design, optimization, structure, operating principles, required modifications in structures of optoelectronic devices.
- The students will be able to find out newer applications of optoelectronic devices in many areas along with optoelectronic integrated circuits.

Unit – I: Review of Semiconductor Materials: Review of semiconductor materials of interest, Crystal Lattice, Bonding Forces and Energy bands in solids, Metal , Semiconductor and Insulators, Direct and Indirect Semiconductors, E-k diagrams, Electron and Hole concentration at Equilibrium, Density of states, Occupation probability, Fermi level, p-n junction, Schottky junction, Ohmic contacts.

Unit – II: Optical Process in Semiconductors: Electron–Hole pair formation, Radiative and Non-Radiative Recombination, Band-to-Band Recombination, Absorption in Semiconductors, Effect of Electric Field on Absorption: Franz-Keldysh and Stark Effects, Absorption in Quantum Well and Quantum -Confined Stark Effect

Unit – III: Emitters: Light Emitting Diode (LED): Introduction, The electroluminescent process, LED materials, Device configuration and Efficiency, LED Structures: Hetero junction LED, Burrus Surface Emitting LED, Edige Emitting LED, LED drive Circuit, LED characteristics,
Lasers: Absorption, Excitation, Spontaneous emission, population inversion, optical pumping, Stimulated Emission, Laser diode structure, Laser Cavity, Thresh hold conditions, Effect of temperature on Thresh hold current $I_{th}(T)$, Einstein coefficients, Heterojunctions Laser and Quantum well laser

Unit – IV: Photodetectors and Solar Cells: Semiconductor photodetectors, the pin photodetectors (PiN), Avalanche photo detectors (APD): Basic structure, theory and characteristics, Efficiency and responsvity of photodetectors
Introduction of Solar Cells, basic principles: Current–Voltage Characteristics, Parameters of Solar Cells (Voc, Isc, FF, and Efficiency), Heterojunction Solar cells

References Books:
1. Ajoy Ghatak, Optics, Tata McGraw Hill, New Delhi (2005)

2. J. Wilson and J. F. B. Hawkes, Optoelectronic:sAn Introduction, Prentice Hall India (1996)4.
3. S. 0. Kasap, Optoelectroincs and Photonics: Principles and Practices Pearson Education(2009)
4. Ghatak A.K. and Thyagarajan K., "Introduction to fiber optics," Cambridge Univ. Press. (1998)
5. Ben G. Streetman and Sanjay Kumar Banerjee, “Solid State Electronic Devices” Vith edition, PHI Learning 2013

Core-9: Optoelectronics Devices Lab
Course Code: PLPCLT3
Credit: 2 (0+0+2)

Name of the experiments

1. To study the I-V Characteristics of LED
2. To study the Voltage Vs. Intensity of a semiconductor laser Diode
3. To characterize the laser grating using semiconductor laser diode
4. To verify the law of Malus for plane polarzied light.
5. To find out the characteristics of a photodetector.
6. To characterize the solar cell and find out the FF and Efficiency of a solar Cell.
7. To Study of the Electro-optic Effect using Semiconductor laser diode.
8. To measure the numerci al aperture of an optical fiber. Using Semiconductor laser diode.

Research Methodology: Research Methodology in Electronics
Course Code: PLPCTR1
Credit: 2 (2+0+0)

Objective:

- To introspect the fundamentals of research methodology and its association in diverse areas of science**.**

Course Outcomes:

After completion of this course, post graduate will be able to

- Identify the research gap and various methodologies to solve the problems
- Analyze the data by using different methods and develop presentation skills
- Engage in research in the field of pure and applied physics and involve in lifelong learning

Unit – I: Research and Research Design: Introduction to Research, Types of research: exploratory, conclusive, modeling and algorithmic, , Tools used for review, journals, conferences, books, magazines and their quality and authenticity, effective searches, find relevant papers related to your area of research, capture critical information, understand and identify the bias, theoretical position and evidence produced, compare ideas and concepts from different papers, distinguishing own work from others work and acknowledging such references.

Unit – II: Problem identification and its solution: Identification of research problems, Identify key areas in research field, Identification of a problem and literature survey. Collection of data and analysis, Determine the nature and extension of papers that should be read, Identify the research gaps, Formulate the Problem Statement, Examples of effective and ineffective titles.

Unit – III: Data Analysis: Identify problem and experimental/theoretical data for comparison with proposed model, extrapolate/scale data for validation, Error Analysis and Numerical Methods, editing and coding of data, tabulation, graphic presentation of data, cross tabulation, testing of hypotheses.

Unit – IV: Presentation: Scientific Writing: Goals and Objectives, Structure of documents, importance of clear title, abstract or summary, Main message of presentation, highlight review points, structure of presentation key components of an oral presentation, show support material, feedback on oral presentation, prepare a set of questions.

Reference Books:

1. R L Dominowski: Research Methods (Prentice Hall of India, N J 1980)
2. John R Rice: Numerical Methods, Software and Analysis (Mc Graw Hill
3. ISE, 1985)
4. Gaur, R. R., Sangal, R., &Bagaria, G. P. (2010). A foundation course in human values and professional ethics. New Delhi: Excel Publishers.
5. Naagarazan, R. S. (2006). A textbook on professional ethics and human values. New Delhi: New Age International Pvt Ltd.
6. Verma, R. (2003). Modern trends in teaching technology. New Delhi: Anmol publishers Pvt. Ltd.
7. Rao, U. (2001). Educational teaching. New Delhi: Himalaya publishing house.

DSE 2: Advanced Communication System-2 **Credit: 3 (3+0+0)**
Course Code: PLPCTD1
Course Objectives:
The course aims to develop an understanding of:

- To understand the details of the various generations and their abilities and limitations.
- To understand the basic concepts of data communication, layered model, protocols and interworking between computer networks and switching components in telecommunication systems.
- To study various concepts related to optical communication.
- To study the functions of various blocks of Radar receivers and detection of Radar Range equation in detail.

Learning Outcomes:
Upon successful completion of this course, students will be able to address following points:

- At the end students should have knowledge about Cellular standards including 2G code-division multiple access (CDMA), Time-division multiple access (TDMA), Global System for Mobile (GSM), and Evolution of GSM technologies towards 4G.
- Recognize the different internet devices and their functions.
- This course designed to enable students to develop a full understanding of the components and the design and operation of optical communication systems.
- Analyze the statistical parameters of Noise and Radar cross section of targets

Unit – I: Mobile Communication: Mobile radio propagation.. Diversity. Multiple access. Cellular coverage planning. Wireless networking. Wireless systems and standards. WAP and other protocols for
internet access. Data transmission in GSM and UMTS, TCP in wireless environment, multi-user detection and its performance analysis. Blue-tooth and other wireless networks, system comparison. Spread spectrum concept. Basics of CDMA.

Applications of CDMA to cellular communication systems. Second and third generation CDMA systems/ standards. Multicarrier CDMA. Synchronization and demodulation. Diversity techniques and rake receiver.

Unit –II: Internet Communication: Modem, Modem-computer interfacing, modulation schemes, computer networks and different topologies, application layer protocols, transport layer protocols, network layer and routing, link layer and local area networks, security in computer networks.

Unit – III: Optical communication: Analog and Digital communication link design. WDM, DWDM, optical add/drop multiplexers, isolators, circulators, optical filters, tunable sources, and tunable filters,
arrayed waveguide grating, diffraction grating, optical amplifiers, optical integrated circuits, OTDR, SONET: frame format, overhead channels, payload pointer, multiplexing hierarchy. SDH: Standards, frame structure, and features. Optical switching, WDM networks, and Classification of optical sensors. Intensity-modulated, phase-modulated and spectrally modulated sensors.

Unit – IV: RADAR communication: An introduction to radar, The radar equation, CW, Pulsed Doppler Radar, and MTI, Tracking radar, Receiver noise and losses, Radar clutter., Matched filters, Radar detection and parameter estimation in clutter and noise background, pulse compression and coding techniques, Radar signal choice and ambiguity function, Radar applications.

Reference Books:

1. Advances in Analog and RF IC Design for Wireless Communication Systems" by imusti.
2. Optical Fibre Communication" by Kaiser
3. Digital Communications Systems : With Satellite And Fiber Optics Applications" by Kolimbiris.
4. Principles of Digital Communication Systems and Computer Networks" by Dr K V K Prasad.
5. Digital and Analog Communication Systems" by K Sam Shanmugam.
6. Digital Communications: Fundamentals and Applications" by Sklar & Ray.
7. Analog and Digital Communication (Special Indian Edition) (Schaum S Outline Series)" by Hsu Hp.

DSE 2: Advanced Communication System-2 Lab
Course Code: PL PCLD1
Credit: 2 (0+0+2)

Name of the experiments

1. Frequency Division Multiplexing and Demultiplexing of two signals
2. Time Division Multiplexing and Demultiplexing of two signals.
3. Wavelength Division Multiplexing and Demultiplexing of two signals.
4. Study of the IR Transmitter & Receiver.
5. Study the optical transmitter and Receiver.
6. Study and design of different types of Antenna.
7. Study the operation of Phase-Locked Loop Detector (IC4046 based)
8. Study of Frequency Modulation using VCO based Frequency modulator (IC XR2206 based).
9. Study of Phase locked loop detector (IC LM565 based) frequency Demodulator.
10. Study of Frequency deviation and modulation index using VCO based Frequency Modulator (IC XR2206 based)

Pre-PhD Course Work (Physics): Course Structure

Course Code	level	Course name	Credit	Remarks
	School level	Research Methodology& Computer Applications	04	Common to all
	Department level	Experimental, Theoretical techniques & Instrumentation inPhysics Research	04	Common to Physics Candidates
	Paper –III (Optional) Anyone of the followings	III A: Advanced Materials III B Spectroscopic Techniques III C Advances in Plasma Physics III D: Advance Nuclear Physics III E Advanced Astronomy and Astrophysics	04	Any course

Pre-PhD Course Work (Electronics)Examination Scheme

Course Code	level	Course name	Credi t	Remarks
	School level	Research Methodology& Computer Applications	04	Common to all
	Department level	Basic Electronic instrumentation & Electronic material characterization	04	Common to Physics Candidates
	Paper –III (Optional) Anyone of the followings	III	04	Any course

Syllabus Pre-PhD Course Work (Physics)

Paper I
Research Methodology & Computer applications

Mode of study includes: Assigning the topic to students based on their basic background and presentation in the form of seminar which will be followed by discussion and submission of the write-up. This will be evaluated by group of teachers.

Unit 1: Research methodology

Definition of Research, Components of Research Problem, Various Steps in Scientific Research : Hypotheses, Research Purposes, Research Design, Literature searching Literature Survey, defining the question and formulating hypothesis/ hypothesizes, Collection of research data, tabulating and cataloging. Sampling and methods of data analysis.

Unit 2: Errors in measurements and statistical methods:

Types of errors; mean deviation, standard deviation and probable errors; propagation of errors with summation, difference, product and quotient Probability Theories - Conditional Probability, Poisson Distribution, Binomial Distribution and Properties of Normal Distributions, Estimates of Means and Proportions; Chi-Square Test, Association of Attributes - t-Test - Standard deviation - Co-efficient of variations. Correlation and Regression Analysis, plotting of graphs.

Unit3: Laboratory practices and safety guidelines:

Safe working procedure and protective environment, Laboratory safety measures, Handling radiation, Chemical hazards and their types, Safe chemical use, Proper storage and disposal of hazardous materials, Bio-hazardous and other toxic experimental materials, Maintenance of equipments.

Unit 4: Computer applications in scientific writing skills

Applications of Microsoft Excel, power point and origin for data processing and data analysis, research paper – presentation using power point (which include texts, graphs, pictures, tables, references etc.) (oral in power point/poster);
Curve fitting, Method of least square fit, least square fit (straight line) to linear equations and equation reducible to linear equations. Non-linear curve fitting, back ground correction and mathematical manipulation in data using origin.
Structure and Components of Research Report, Types of Report: research papers, thesis, ResearchProject Reports, Pictures and Graphs, citation styles, writing manuscript in Latex,
Steps to better writing,

Unit 5: Ethics in Science:

The source of ethical issues in science: examples from different disciplines. Ethical issues in science research and reporting: objectivity and integrity, the problem of plagiarism and related issues, international norms and standards. Scientific temper and virtues, expectations from scientific community.

IPR and Patent regime: Recording and storage/retention of recorded materials. Management and useresponsibilities in proper utilization of the facilities. Socio-legal issues, originality

References:

1. “How to write and Publish” by Robert A. Day and Barbara Gastel, (Cambridge University Press).
2. “Survival skills for Scientists” by Federico Rosei and Tudor Johnson, (Imperial College Press).
3. “How to Research” by Loraine Blaxter, Christina Hughes and Malcum Tight, (Viva Books).
4. “Probability and Statistics for Engineers and Scientists” by Sheldon Ross, (Elsevier Academic Press).
5. “The Craft of Scientific Writing” by Michael Alley, (Springer).
6. “A Students's Guide to Methodology” by Peter Clough and Cathy Nutbrown, (Sage Publications).

Paper II

Paper –II: Experimental, Theoretical techniques & Instrumentation in Physics Research

Unit I

Synthesis of materials: Bulk Synthesis: Solid State Route, Sol Gel, Co- precipitation, Combustion methods, thin film fabrication: spin coating, dip coating, evaporation methods, Vacuum techniques, vacuum pumps (Rotary and Diffusion pumps), vacuum gauges.

Unit II Structural and composition characterization: Basics of X – ray diffraction (XRD), grazing incidence and powder XRD, Scanning Electron Microscope, Energy dispersive X – ray analysis, X – ray photoelectron Spectroscopy, Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM) and Transmission Electron Microscope, electrical measurements, .

UNIT III Physics of nanomaterials

Quantum confinement and surface effect, 2-D, 1-D and 0-D Nano systems, Quantum dots and 1-D nanostructures, Nanocomposites of inorganic and organic systems, Self assembly hierarchic structures and advanced functional materials for applications in energy harvesting, , catalysis, sensors etc.

UNIT IV

Ion beam Technology, Accelerators in Science & Technology, Ion beam irradiation and ion implantation in physics research especially in materials science, nuclear physics and plasma physics. Basics of nuclear techniques for ion beam analysis.

UNIT V

The electron gas without interaction; Electrons in a periodic potential., The interacting electron gas; The Hartree-Fock approximation; Quasielectrons, plasmons; The Dielectric constant of the electron gas, Ion-ion interactions; Phonons; Spin-spin interactions; Magnons; Diamagnetism; Paramagnetism.

Reference Books

1. Materials Science and Engineering (John Wiley & Sons, Inc.) By William D. Callister, Jr.
2. Introduction to Ceramics, W.D. Kingery
3. Introduction to Nanoscience and Nanotechnology, K.K. Chattopadhyay and A.N.Banerjee
4. Materials Science of Thin films, M. Ohring
5. Handbook of Vacuum Technology, Karl Jousten
6. Fundamentals of Molecular Spectroscopy, C.N. Banwell
7. Elements of X – ray diffraction, B.D. Cullity
8. A SQUID hand book, Ed. John Clark, and A.I. Braginskii
9. Introduction to Solid State Theory; Otfried Madelung; Springer.
10. Quantum Theory of Solids; C. Kittel; John Wiley and sons.
11. Solid State Physics; N. W. Ashcroft and N. D. Mermin.

Paper III A: Advanced Material

Unit I

Linear and non linear dielectric materials, Ferroelectric, piezoelectric and electro-optic materials, composite materials, Liquid crystals, Materials for solar cells and Fuel cells.

Unit II

Colossal magnetoresistance materials, magneto caloric materials, Multifunctional materials, magnetic field induced polarization and electric field induced magnetization.

Unit III

Properties of Individual Nano-particles, metal nano clusters, magnetic clusters, semiconductor nanoparticles, optical properties, methods of synthesis of nano particles,

Unit IV

Carbon allotropes, fullerene, carbon nano tubes, graphene, graphite oxide and applications, Applications of carbon materials, Functionalization of graphene and carbon nanotubes

Unit V

Low dimensional systems, preparation, size & dimensionality effects, excitons, single electron tunneling, applications of quantum nanostructures, self assembly, process of self assembly

Computational Techniques: Basics of ab-initio calculations, basic principles of density functional theory(DFT), exchange correlation energy functional, applications of DFT

Reference Books

1. Colossal magnetoresistance charge ordering and related properties of manganese oxides, C.N. R.Rao and B. Raveau
2. Dielectric relaxation in solids, A.K.Jonscher
3. Dielectrics and Waves, R. Von Hippel
4. Physics of Low dimensional semiconductors, J.H.Davies
5. Carbon Nanotubes, Dresselhaus M.S., Dresselhaus G. and Avouris P.
6. Carbon Nanomaterails, YuryGogotsi
7. Computational Chemisty, Lewars
8. Density Functional Theory: A practical approach, David S. Sholl, Janice A. Steckel

Paper III B: Spectroscopic Techniques

Unit-I Raman Spectroscopy

Instrumentation , Basic Components of Raman system, Spectrometer and Detectors, Raman Spectroscopy of Solid and Liquids, Raman spectroscopy of Materials, Qualitative versus Quantitative Raman, Vibrational Analysis, Spectral Analysis by Group Theory, Character Table

Unit –II IR-Spectroscopy

Instrumentation, Basic Components, IR-sources, Spectrometer and Detectors, Infrared absorption spectroscopy, Fourier transformed infrared spectroscopy attenuated total Reflectance(ATR) spectroscopy, diffuse reflectance spectroscopy.

Unit-III Electronic Spectroscopy Techniques

Instrumentation, Basic Components, UV-Visible sources, spectrometer and detectors, UV-Vis spectroscopy, Absorption., Transmission, Reflection, Photoluminescence, spectroscopy, florescence and phosphorescence, circular dichroism

Unit-IV Advance Spectroscopy Techniques

Surface Enhanced Raman Spectroscopy, UV Resonance Raman Spectroscopy, Tera hertz Spectroscopy,Laser Induced Breakdown Spectroscopy (LIBS)

Unit –V Other Techniques

Particle Induced X-ray emission, Nuclear Magnetic Resonance(NMR) spectroscopy, Electron SpinResonance (ESR) Spectroscopy

Text and Reference Books

1. Modern Spectroscopy, 4th Edition , J.Michael Hollas , Wiley
2. Chemical Application of Group Theory , 3rd Edition By F.Albert Cotton , Willey
3. Introduction to Molecular Spectroscopy : By Goron M.Barrow , Mc Grraw Hill New York
4. Handbook of Vibrational Spectroscopy , Vol0-I & II: By John M.Chalmers and Peter R.Griffiths,Wiley
5. Condensed Matter Optical Spectroscopy : An illustrated Introduction by Luhan Ionita , CRCPress
6. Handbook of Raman Spectroscopy : From the Research laboratory to the process line : By Lan R.Lewis , Howell Edwards .CRC Press
7. Infrared and Raman Spectroscopy of Biological Materials : By Hans Ulklrich Grelich , Bing YanCRC Press
8. Terahertz Spectroscopy : Principles and Applications , By Susan L.Dexheimer , CRC Press
9. NMR and Chemistry : An Introduction to modern NMR Spectroscopy , Fourth Edition By J.W.Akitt , B.E Mann , CRC Press
10. Laser Spectroscopy : Basic Concepts and Instrumentation 2nd Edition By Wolfgang DemtroderSprings

Paper III C (Optional)
Advances in Plasma Physics

Unit-I: Fluid theorem in Plasmas:

Single fluid and two fluid theorems', Mangnetohydrodynamics(MHD) fluid theory, fast slow and intermediate MHD wave, Dissipation in MHD Fluid, collisonless anistropic plasma, chew Goldberger and low theory

Unit-II: Nonlinear Phenomenon:

Concept of Sheath, wave particle interaction, Nonlinear landau damping, Wave kinetic equation, KDV Equations, Reductive perturbation analysis.

Unit-III: Instabilities in Plasma

Stable neutral and unstable systems, Analysis of stability and non-stability, kinetic theory, macro stabilities, self-gravitational stability, Rayleigh- Taylor (R-T) instability, Kelvin– Helmholtz (k-h) instability, structure formation, Micro stabilities, Electron cyclotron instability.

Unit-IV: Basin of Dusty (Complex) Plasmas:

Dusty plasma and parameters, Characteristics of complex plasma, Application, dust charging process, Dynamics of dust grain, strong coupling phenomenon, Complex plasma crystal formation.

Text and Reference Books:

[1] J.A Bittencourt, Fundamental of Plasma Physics, Pergamon press

[2] N A Krall and A W Trivelpiece, Principle of Plasma Physics, McGraw Hills

[3] F F Chen, Introduction to Plasma Physics and controlled Fusion, Plenum press

[4] P M Bellan, Fundamental of Plasma Physics, Cambridge University press

[5] P K Shukla and A A Mamun, Introduction to Dusty Plasma Physics, IOP

[6] I P Goedbloed and S Poedts, Principle of Magnetohydrodynamics, Cambridge press

[7] I D Landan and F M Lifshiz, Statistical Physics

[8] S Chandrashekhar, Hydrodynamics and Hydromagnetic stability, Claredon Press

Paper III D (Optional): Advance Nuclear Physics

Advance Nuclear Models: Single particle motion, Shell model with configuration mixing.Nilsson model. Strutinsky and shell corrections. Liquid drop model and collective motion.Rotation and vibration with particle coupling, Cranking models, Hartree-Fock model. quasipanicles and pairing

Experimental Techniques for Nuclear Structure Studies: Production of nuclei at extreme of spin. isospin and excitation energies. Nuclear reactions for production of various isotopes. Gamma ray spectroscopy for the study of discrete states of nuclei. Electromagnetic properties. Lifetime measurement: RDM. DSAM and Introduction to High-spin phenomena

Signal Processing: Pre-amplifiers. amplifiers. polezero cancellation. Base line restoration, Pile up rejection, Function generator. NIM & CAMAC Standards

Detectors: Energy loss of charged particles in matter, range & straggling. energy. position & time detection for charged particles with solid state detectors, ionization chamber. Multi wire proportional counter, semiconductor gamma detector, scintillation detectors,

Reference Books:

1. Nuclear Structure from a Simple Perspective, R. F. Casten
2. Basic Ideas and Concepts in Nuclear Physics, K Heyde
3. Introductory Nuclear Physics, S.M. Wong
4. In Beam Gamma ray Spectroscopy, H. Morinaga
5. Advance in Nuclear Physics – Vol 10, Baranger, Michel, Vogt, Erich
6. Techniques for Nuclear and Particle Physics Experiments, William R. Leo
7. Radiation Detection and Measurement, G.F.Knoll

Paper III E (Optional) Advanced Astronomy and Astrophysics

Unit-1

Introduction to Astronomy and Astrophysics

Stellar structure and evolution - The HR diagram - Colors, magnitudes, Spectral classification - White dwarfs, neutron stars, black holes – Binary Stars – Binary X-ray Sources & Accretion discs – Extra-solar planetary Systems - ISM - Structure of Milky Way - Stellar population and galactic structure.

Unit-II

Galaxies: Structure, Dynamics and Evolution

Galaxies as self gravitating objects, virial equilibrium - Estimates of collision times - Collisionless Boltzmann equation and some steady state solutions - Globular clusters - stability - Spiral structure, bars and disc dynamics - Ellipticals - Galaxy morphology - Chemical evolution - Galaxy formation and evolution.

Unit-III

Extragalactic Astronomy

Phenomenology of AGNs (Seyferts, Quasars, Radio Galaxies, LINERS, BL Lacs) with a survey of continuum, emission and absorption features of spectra - Black hole and accretion disc models for AGNs - Emission line regions (BLR, NLR) - Physics of jets and hot spots.

Unit-IV

Telescope: Ground Telescopes and Space based Telescopes

Photometry: Instrumental magnitudes and colors, seeing and atmospheric effects, extinction correction. Standard photometric systems: UBV and other systems, transformation to a standard photometric systems, Absolute and differential photometry

Unit-V

Basics of CCD data reduction: Plate scale, readout noise and gain, signal-to-noise ratio, correction for bias, dark and flat fielding, fringing and cosmetic effects.

Basic understanding of X-ray Astronomy: X-ray Optics – Detectors - X-ray Data Reduction and Analysis - Spectral & Timing Analysis

Recommended Text and Reference Books:

1. The physical universe, Shu F., (University of California).
2. Astrophysics for Physicists, Choudhuri, A.R. (Cambridge University Press).
3. An introduction to Modern Astrophysics, Bradley W. Carroll & Dale A. Ostlie. (Pearson International Edition).
4. Astronomical Photometry: Henden A. A. and Kaitchuck R H (Willmann-Bell).

5. Galactic Astronomy, Mihalas, D. and Binney, J. (W.H. Freeman & Co).
6. Galactic Dynamics, Binney, J. and Tremaine, S. (Princeton University Press).
7. An Introduction to Active Galactic Nuclei, Peterson B.M. (Cambridge University Press).
8. Handbook of CCD Astronomy, Howell S.B. (Cambridge University Press).
9. Handbook of X-ray Astronomy, K. Arnaud, R. Smith & A. Siemiginowska (Cambridge University Press).
10. High Energy Astrophysics, M.S. Longair Cambridge University Press).
11. Radiative Processes in Astrophysics, G.B. Rybicki & A.P. Lightman (Wiley-VCH)

Pre- Ph.D. Course work (Electronics)

Paper – II: Basic Electronic instrumentation and electronic material characterization

Unit I

Semiconductor devices, diodes, junctions, transistors, field effect devices, homo and heterojunction devices, Optoelectronic devices including solar cells, photodetectors, and LEDs; High frequency devices

Unit II

Operational amplifiers and their applications, Analog signal processing, Digital logic levels, Digital techniques and applications (registers, counters, comparators and similar circuits); A/D and D/A converters; Interfacing using IEE488 bus.

Unit III

Vacuum techniques, Vacuum pumps (Rotary, Diffussion pumps, Turbo molecular pump), Vacuum gauges, Thin Film and Thick Film synthesis: Physical methods (Vacuum evaporation, sputtering (D.C. & RF), PLD, etc.),film thickness measurements

Unit IV

Transducers, transducer characteristics, selection of instrumentation transducers, transducer as an electrical element, Instrument probes, power measurements.

Unit V

Fluctuation and noise in measurement system, types of noise, noise in frequency domain, source of noise, signal to noise ratio and experimental design, signal to noise enhancement, digital correlation and autocorrelation methods.

Reference Books:

1. Fundamentals of electronics, Malvino and Leach
2. Physics of Semiconducting devices, S.M.Sze
3. Measurement, Instrumentation and Experiment design in Physics and Engineering, MichealSayerand Abhai Man Singh
4. Materials Science of Thin films, M. Ohring
5. Handbook of Vacuum Technology, Karl Jousten

Paper III: Electronic materials and devices

Unit I

Linear and non linear dielectric materials, Ferroelectric, piezoelectric and electro-optic materials, composite materials, Liquid crystals, quasi-crystalline materials, hydride materials,

Unit II

Functional materials for device fabrication, sensor materials, shape memory alloys, hydrogen storage materials, solar cell fabrication and photovoltaic materials.

Unit III

Carbon allotropes, fullerene, carbon nano tubes, graphene, graphite oxide and applications, Applications of carbon materials, Functionalization of graphene and carbon nanotubes

Unit IV

Lithographic processes: Various types of lithographic processes, Photolithography, Electron beam lithography, Ion beam lithography, and advances in the field. Photoresists, Sensors fabrication, and FET fabrication.

Unit V

Nano machines and nano devices: Micro electromechanical systems, Nano electromechanical systems NEMS's, Carbon nanostructures, Carbon nanotube, Graphene and applications.s

Reference Books

1. Dielectric relaxation in solids, A.K.Jonscher
2. Dielectrics and Waves, R. Von Hippel
3. Physics of Low dimensional semiconductors, J.H.Davies
4. Carbon Nanotubes, Dresselhaus M.S., Dresselhaus G. and Avouris P.
5. Carbon Nanomaterails, YuryGogotsi
6. Principles of Lithography 3rd EDITION, H.J. Levinson

Code of Conduct

The student admitted to Guru Ghasidas Vishwavidyalaya to achieve academic excellence and shape their character to become responsible citizen. They must realize their responsibility towards the University and its components like faculty, staff and fellow students. Failure to maintain good standard of conduct shall result in disciplinary action**.**

Misconduct

Any of the following activities (but not limited to these only) will be termed as misconduct:

- Disruption of teaching activities or disturbing the learning process of other students in the campus.
- Any act on the part of the students, which disrupts the functioning of the university, endangers health & safety of campus residents & damages the university properties.
- Cheating in the examination & supplying false documents /information in order to seek any consideration/favour from the university.
- Possession or consumption of intoxicating beverages on the campus.
- Failure to return back the loaned material, settle university dues.
- Possession of weapons.
- Use of unparliamentarily language while in conversation with university staff & fellow students.

Disciplinary Actions:

Failure to adhere to good conduct may result in disciplinary actions like:

- A warning by the authorities.
- Suspension from the particular class.
- Suspension/Expulsion from the university.
- Suspension of campus privileges e.g. hostel, accommodation, etc.
- Withholding of examination results or withdrawal of awarded diploma/ degree certificate.
- Any other disciplinary action deemed appropriate by the university authorities.

Ragging

It is observed that perverse form of ragging is prevalent in institutions of higher learning. The Government and the apex courts of the country have taken very serious view to combat the menace of ragging in universities and other educational institutions. Ragging has been recognized as the "Cognizable offence" and is punishable under law. The following could be the possible punishments for those who are found guilty of participation in or abetment of ragging. The quantum of punishment shall, naturally depend upon the nature and gravity of the offence as established by disciplinary committee or the court of law.

Punishments :

- Cancellation of admission;
- Suspension from attending the classes;
- Withholding/withdrawing scholarships/fellowships & other benefits;
- Debarring from appearing in any tests / examination or other evaluation process; withholding results;
- Debarring from representing the institution in any national meet, tournament, youth festival, etc.;
- Suspension / Expulsion from the hostel;
- Rustication from the institution for period varying from 1 to 4 semesters;
- Expulsion from the institution &consequent debarring from admission to any other institution;
- Fine up to Rs. 25000/-and
- Rigorous imprisonment up to three years.

While the first ten types of punishment can be awarded by the appropriate authority of the institution itself, the last punishment can be awarded by a court of law.