UNIVERSITY OF KOTA

SCHEME OF EXAMINATION

AND

COURSES OF STUDY

Department of Pure & Applied Physics
Faculty of Science

M.Sc. (Physics)
Course Code PHY11750P

Third Semester Examination, December 2023
Fourth Semester Examination, June2024

UNIVERSITY OF KOTA

MBS Marg, Near Kabir Circle, KOTA (Rajasthan)-324 005

INDIA

Edition: 2023

Course Structure with Distribution of Marks:

Year / Semester	Serial Number, Code & Nomenclature of Paper			Duration of Exam	Teaching Hrs/Week & Credit			Distribution of Marks			Min. Pass Marks	
	Number	**Code**	**Nomenclature**		**L**	**P**	**C**	**Conti. Assess.**	**Sem. Assess.**	**Total Marks**	**Conti. Assess.**	**Sem. Asses.**
II Year III Semester	3.1	PHY3001	Nuclear Physics – I	3 Hrs	4	--	4	30	70	100	12	28
	3.2	PHY3002	Classical Electrodynamics–II	3 Hrs	4	--	4	30	70	100	12	28
	3.3	PHY3003	Solid State Theory	3 Hrs	4	--	4	30	70	100	12	28
	3.4	PHY3004	Elective-I : A] Energy Studies-I / B] Material Science I / C] Microwave Electronics-I / D] High Energy Physics-I E] Plasma Physics-I	3 Hrs	4	--	4	30	70	100	12	28
	3.5	PHY3005	Physics Laboratory-III	6 Hrs	--	16	8	--	**200**	**200**	**--**	**100**
	Total				**16**	**16**	**24**	**120**	**480**	**600**	**--**	
II Year IV Semester	4.1	PHY4001	Nuclear Physics-II	3 Hrs	4	--	4	30	70	100	12	28
	4.2	PHY4002	Solid State Physics	3 Hrs	4	--	4	30	70	100	12	28
	4.3	PHY4003	Lasers Physics	3 Hrs	4	--	4	30	70	100	12	28
	4.4	PHY4004	Elective-II: A] Energy Studies-II B] Material Science II C] Microwave Electronics-II D] High Energy Physics-II E] Plasma Physics-II	3 Hrs	4	--	4	30	70	100	12	28
	4.5	PHY4005	Physics Laboratory-IV	6Hrs	--	16	8	--	**200**	**200**	--	**100**
Total					**16**	**16**	**24**	**120**	**480**	**600**	**--**	

Note:-The allotment of an elective shall reserve with the department, which depends upon the availability of faculty members, infrastructure and laboratory facility available to run the elective and an elective cannot be offered by the department if the number of students is less than the 25% of the total sanctioned strength of the programme.

Objectives of the Course:

Innovation and Employability:Physics is fundamental to all physical sciences which explains the nature. Physicists have to be competent enough to design and build new instruments, from satellites to measure the properties of planetary atmospheres to record-breaking intense magnetic fields for the study of condensed matter. Most of the conveniences of modern life are based directly on the understanding provided by physics. Many techniques used in medical imaging are derived directly from physics instrumentation. Even the internet is a spin-off from the information processing and communications requirement of high-energy particle physics.

Department of Pure and Applied Physics, University of Kota, Kota has started the M.Sc. (Physics) course from July, 2007. This course aims to provide a thorough understanding of Physics of both pure and applied nature with extensive theoretical and experimental knowledge in major areas of Physics with specialization in Energy Studies / Plasma Physics / Materials Science. The students after completing the course shall find placements in premier research institutes and companies in India and abroad, qualify NET/GATE/JEST examinations and will be eligible for M.Tech., Ph.D. and teaching.

Duration of the Course:

The course M.Sc. (Physics) shall consist of two academic years divided into four semesters.

Eligibility for Admission:

The basic eligibility for admission to the programme is B.Sc. with Physics, Chemistry and Mathematics with minimum marks for GEN category candidates of Rajasthan-55%; Other state-60%; SC/STOBC/SOBC-Minimum Pass Marks. The admission in the course is based on the merit of the percentage obtained in their B.Sc. course. However, the students of the B.Sc, (Hons.)-Physics as Honors and Mathematics as subsidiary subject under Integrated B.Sc.-M.Sc. (Physics) are directly admitted to the M.Sc. (Physics) Programmes.

Structure of the Programme:

The M.Sc. (Physics) programme consists of:

(i) Core and applied courses of theory as well as practical papers which are compulsory for all students.

(ii) Dissertation/Project Work/Summer training/Field work which can be done in an organization (Government, Industry, Firm, Public Enterprise, *etc.*) approved by the Department.

Attendance:

Every teaching faculty handling a course shall be responsible for the maintenance of attendance Register for candidates who have registered for the course. The teacher of the course must intimate the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students. Each student should earn 75% attendance in the courses of a particular semester failing which he or she will not be permitted to appear in the End-Semester Examinations. However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons and such exemptions should not under any circumstance be granted for attendance below 65%.

Teaching Methodologies:

The classroom teaching would be through conventional lectures or power point presentations (PPT). The lecture would be such that the student should participate actively in the discussion. Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skills. In the laboratory, instructions would be given for the experiments followed by demonstration and finally the students have to do the experiments individually.

Maximum Marks:

Maximum marks of a theory and practical paper shall be decided on the basis of their contact hours/credit per week. One teaching hour per week shall equal to one credit and carry 25 maximum marks and therefore, four teaching hours/credit per week shall carry 100 maximum marks for each theory paper/course. Each four contact hours per week for laboratory or practical work shall be equal to two credits per week and carry 25 maximum marks and therefore, sixteen teaching hours per week shall carry 100 maximum marks for laboratory or practical work.

Scheme of Examinations:

The examination shall be divided into two parts in which first part is continuous assessment or internal assessment and second part is semester assessment or external assessment. The schemes for the internal and external examinations shall be as under:

a) The assessment of the student for theory paper shall be divided into two parts in which first part is continuous assessment or internal assessment (30% of maximum marks) and second part is semester assessment or external assessment (70% of maximum marks). For practical papers there will be only one external assessment (100% of maximum marks).
b) The internal assessment for each theory paper shall be taken by the teacher concerned in the Department during each semester. There will be two components of internal assessment; one by test having 20% weightage (20 marks) and another by seminar / assignment / presentation / quiz / group discussion / vivo of 10% weightage (10 marks), for theory papers in each semester. Internal assessment test shall be of one hour duration for each paper and shall be taken according to academic calendar notified by the University / Departments. There will be no internal examination in the practical paper.
c) A student who remains absent (defaulter) or fails or wants to improve the marks in the internal assessment may be permitted to appear in the desired paper(s) (only one time) in the same semester with the permission of the concerned Head of the Department. A defaulter / improvement fee of Rupees 250/- per paper shall be charged from such candidates. Duly forwarded application of such candidates by the teacher concerned shall be submitted to HOD who may permit the candidate to appear in the internal assessment after depositing the defaulter/ improvement fee. A record of such candidates shall be kept in the Department.
d) The external assessment shall be of three hours duration for each theory paper and six hours duration for practical paper. The practical examination shall be taken by the panel of at least one external and one internal examiner at the end of each semester.
e) The syllabus for each theory paper is divided into five independent units and each theory question paper will be divided into three sections as mentioned below:
    - ***Section-A*** *shall have 01 compulsory question comprising 10 questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark and total marks of this section will be 10. This section will be compulsory in the paper.*
    - ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words) and examiners are advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
    - ***Section-C*** *will contain five long answer type questions. One compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) of and any two more questions (answer about in 400 words) out of remaining four questions.Paper setter shall be instructed to design question paper covering from all five units.*
f) The pattern of question paper of internal and external shall be as follows:

(A) Continuous or Internal Assessment:

30% weightage of Maximum Marks (30 Marks out of 100 Maximum Marks)

DEPARTMENT OF PURE & APPLIED PHYSICS
UNIVERSITY OF KOTA, KOTA
First/Second Internal Test 20…….

Duration of Exam: 1.00 Hr **Max. Marks: 20**
Class: M.Sc. (Physics) **Semester:**
Subject: **Paper:**
No. of Students: **Teacher:**

Note: The question paper contains three sections as under:
Section-A : One compulsory question with 04 parts. Please give short answers in 20 words for each part.
Section-B : 02 questions to be attempted having answers approximately in 250 words.
Section-C : 01 question to be attempted having answer in about 500 words.

SECTION A

Q.1(a)		1
(b)		1
(c)		1
(d)		1
(e)		1
	SECTION B	
Q.2		4
Q.3		4
Q.4		4
Q.5		4
	SECTION C	
Q.6		7
Q.7		7

(B) Semester or External Assessment:
70% weightage of Max. Marks (70 Marks out of 100 Max. Marks)

Duration of Examination: 3 Hours **Max. Marks: 70**

SECTION-A: 10x1=10
(Answer all questions)
(Two question from each unit with no internal choice)
Q. No. 1
(i) ………............................……………………………………………… **1 Mark**
(ii) ………............................……………………………………………… **1 Mark**
(iii) ………............................……………………………………………… **1 Mark**
(iv)………............................……………………………………………… **1 Mark**
(v)………............................……………………………………………… **1 Mark**
(vi)………............................……………………………………………… **1 Mark**
(vii)………............................……………………………………………… **1 Mark**
(viii)………............................……………………………………………… **1 Mark**
(ix)………............................……………………………………………… **1 Mark**
(x)………............................……………………………………………… **1 Mark**

SECTION-B: 5x5=25
(Answer all questions)
(One question from each unit with internal choice)

(Maximum two sub-divisions only)

Q. No. 2. . ……………........…………………………………………

Or

……….........………………………………………………….

5 Marks

Q. No. 3. …………….........…………………………………………

Or

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5 Marks

Q. No. 4. …………………………..........……………………………

Or

……………………………………..........………………………

5 Marks

Q. No. 5. ……………………………………………............………………

Or

…………………………………………………………..........……....

5 Marks

Q. No. 6. ………………………………………………………….............

Or

…………………………………………………………….................

5 Marks

SECTION-C: 1x15 + 2x10=35
(Answer any three questions including compulsory Q.No. 7)
(Maximum four sub-divisions only)

Q. No. 7. …………………………………………………………… **15 Marks**

Q. No. 8. …………………………………………………………… **10 Marks**

Q. No. 9. …………………………………………………………… **10 Marks**

Q. No. 10. ………………………………………………………… **10 Marks**

Q. No. 11. ………………………………………………………… **10 Marks**

Distribution of Marks for Practical Examinations:

Duration of Exam: 06 Hours **Maximum Marks: 200**

S. No.	Name of Exercise	Marks
1.	Exercise No. 1	120
2.	Viva-voce	50
3.	Practical Record	30
	Total Marks	**200**

Rules regarding determination of results:

Each semester shall be regarded as a unit for working out the result of the candidates. The result of the each semester examination shall be worked out separately (even if he/she has appeared at the paper of the lower semester along with the papers of higher semester) in accordance with the following conditions:

a) The candidate shall be declared as pass in a semester examination, if he/she secures at least 40% marks in each theory paper separately in external & internal examination and 50% marks in each practical paper and at least 50 % marks in project/dissertation with 50% aggregate marks in that semester.

b) A candidate declared as fail/absent in one or more papers at any odd semester examination shall be permitted to take admission in the next higher semester (even semester) of the same academic session.

c) A candidate may be promoted in the next academic session (odd semester) if he/she has cleared collectively at least 50% of the papers of both semesters of previous academic session with 50% of the aggregate marks. The candidate who does not fulfill the above condition will remain as an ex-student and will reappear in the due papers along with next odd/even semester exams.

d) If any student who is provisionally admitted in higher odd semester but could not secure prescribed minimum marks in previous semesters will be treated as ex-student and his/her admission fee will be carry forwarded to the next odd semester of forthcoming academic session.

e) If a candidate, who is declared as pass, wishes to improve his/her performance in the theory papers of previous semester, he/she may re-appear only one time in these papers in next odd/even semester examinations.

f) Candidate shall not be permitted to re-appear or improve the marks obtained in the external examination of practical / dissertation in any condition.

g) If the number of papers prescribed in a semester examination is an odd number, it shall be increased by one for the purpose of reckoning 50% of the papers for considering the student pass/fail.

h) A candidate may be given only two additional chances for passing the semester thus maximum tenure for completing the two years' postgraduate course will be limited to four years, for three years postgraduate programme up to five years and so on.

i) The marks secured in the Gen Hindi, Gen English, Elementary Computer applications and Environment studies shall not be counted in awarding the division to a candidate.The candidate shall have to clear the compulsory subjects in the additional three chances and non-appearance or absence in the examination of compulsory subjects shall be counted as chance and shall be declared fail in that examination.

j) The grace marks scheme shall be applicable as per University norms.

Classification of Successful Candidates:

The classification of successful candidates after last semester examination shall be as under:

Description of Marks Obtained	**Division / Result**
• 80% and above marks in a paper.	Distinction in that paper.
• A candidate who has secured aggregate 60% and above marks	First Division
• A candidate who has secured aggregate 50% and above but less than 60% marks	Second Division

Course Learning Outcomes:

The M.Sc. (Physics) course equips the individual with advanced analytical abilities, general competence, and knowledge that are required in industry, consultation, education, and research. Students who complete a major or second major in physics will gain proficiency in handling a wide range of challenging circumstances. During their project work and assignments, students learn about research and development. They will demonstrate this by identifying and applying relevant physical laws and concepts to challenges. M.Sc. (Physics) graduates can find employment across the public and private sectors.

III SEMESTER

PHY301- Nuclear Physics-I

Unit-I

Basic nuclear properties: size, shape and charge distribution, spin and parity, Binding energy, semi-empirical mass formula, liquid drop model, Two Nucleon system and Nuclear Forces, General nature of the force between nucleons, saturation of nuclear forces, charge independence and spin dependence.

Unit-II

General forms of two nucleon interaction, central, non-central and velocity dependent potentials, analysis of the ground state ($3S^1$) of deuteron using a square well potential, range-depth relationship, excited states of deuteron, quantitative discussion of the ground state of deuteron under non-central force, calculation of the electric quadrupole and magnetic dipole moments and the D-state admixture.

Unit-III

Nucleon-Nucleon Scattering and Potentials: Partial wave analysis of the neutron-proton scattering at low energy assuming central potential with square well shape, concept of the-scattering length, coherent scattering of neutrons by protons in ortho and Para hydrogen molecules, conclusions of these analyses regarding scattering lengths, the effective range theory and the shape independence of nuclear potential, A qualitative discussion of proton-proton scattering at low energy and high energy.

Unit-IV

Interaction of radiation and charged particle with matter: Law of absorption and attenuation coefficient, Photoelectric effect, Compton scattering, pair production, Energy loss of charged particles due to ionization, Bremstrahlung, energy target and projectile dependence of all three processes, Range-energy curves, Straggling.

Unit-V

Experimental Techniques: Gas filled counters, Scintillation counter, Cerenkov counters, Solid state detectors, Surface barrier detectors, Electronic circuits used with typical nuclear detectors, Multiwire proportion chambers, Nuclear emulsions, Proton synchrotron, Linear accelerators, Acceleration of heavy ions.

Text/Reference Books:

1. Nuclear Physics by Irving Kaplan, (Addison Wesley Pub. Co.), 2nd Ed
2. Nuclear Physics Theory and Experiment by R. R. Roy, B. P. Nigam (New Age Internation Pub.), 1997.
3. Atomic Nucleus by R.D. Evans (McGraw Hill), X ed., 1965
4. Nuclear Physics by S. N. Ghoshal (S. Chand, New Delhi), 2006
5. Introduction to Experimental Nuclear Physics by R. M. Singru (Wiley Eastern pvt. Ltd.)
6. Nuclear Physics: an Introduction by S. B. Patel (Wiley Eastern Ltd.), 1992.
7. Theoretical Nuclear Physics: J.M. Blatt & V.E. WeissKipf.
8. Introductory Nuclear theory: -L.R.B. Elton, ELBS Publs. Londan 1959.
9. Structure of the Nucleus: - M.A. Preston &R.K.Bhaervi, Addision Wesley
10. Nuclear Physics:- Techniques of Nuclear Structure (vol. I) England
11. Introduction to Nuclear Physics:-H.Enge.Addision Wesley
12. Elements of Nuclear Physics:- W.E.Burcham, ELBS Longman.

13. Concepts of Nuclear Physics:- B.L. Cohen, Tata Mc Graw Hill,1988.
14. Nuclei & Particles -E.Segre, Benjamin 1972.
15. Introductory Nuclear Physics:-D.Halliday Willey 1955
16. Introduction of Nuclear Physics & Chemistry :-Harvey.
17. The Physics of Nuclear Reactions :-W.M.Gibson, Pergamon Press.
18. Nuclear Interaction:- S.De Benedetti, Wiley 1955.

PHY302- Classical Electrodynamics-II

Unit-I

Plane Electromagnetic Waves and Wave Equation: Plane waves in a non-conducting medium, Frequency dispersion characteristics of dielectrics, conductors and plasmas, waves in a conducting or dissipative medium, superposition of waves in one dimension, group velocity, casualty connection between D and E, Kramers-Kroning relations.

Unit-II

Magneto-hydrodynamics of conducting fluids and Plasma Physics:Plasma Physics, Introduction of Lab and Space plasma, Plasma Parameters, Debye Length, Electron and Ion Temperature, Electron and Ion Number Density, Characteristic Frequencies, Plasma Frequencies, Cyclotron Frequencies.

Unit-III

Plasma Waves and Oscillations, Modes of a Cold, Warm and Hot Plasmas, Effect of Magnetic Field on Plasma Dispersion Characteristics, Pinch effect,Instabilities, Hydrodynamic and Velocity Space, Linear and non-linear phenomena, MHD equations, magnetic field lines, magnetic hysteresis, hydro-magnetic waves.

Unit-IV

Radiation by moving charges : Lienard-Wiechert Potentials for a point charge, Total power radiated by an accelerated charge, Larmour's formula and its relativistic generalization, Angular distributionof radiation emitted by an accelerated charge, Radiation emitted by a charge in an arbitrary ultra relativistic motion, Distribution in frequency and angle of energy radiated by accelerated charges, Thomson scattering and radiation, Scattering by quasi free charges, coherent and incoherent scattering, Cherenkov radiation.

Unit-V

Radiation damping, self fields, of a particle, scattering and absorption of radiation by a bound system: Introductory considerations, Radiative reaction force from conservation of energy, Abraham Lorentz evaluation of the self force, difficulties with Abraham Lorentz model,Integro-differential equation of motion including radiation damping,Line Breadth and level shift of an oscillator, Scattering and absorption of radiation by an oscillator, Energy transfer to a harmonically bound charge.

Text/Reference books:

1. Classical clectrodynamics by J.D. Jackson, (John Wiley & Sons), II Ed., 1975.
2. Classical Electricity and Magnetism by Panofsky & Philips, (Indian Book, New Delhi), 1962.
3. Introduction to Electrodynamics by Griffiths, (Pearson Education), 2005.
4. Classical theory of Electrodynomics by Landau &Lifshitz, (Pergaman Press, New York), 1960.
5. Electrodynamics of Continuous Media by Landau & Lifshitz, (Pergaman Press New York), 1960.
6. Elements of Electromagnetics by Mathew N.O. Sadiku, (Oxford Univ. Press), II ed., 1999.

PHY303-- Solid State Theory

Unit-I
Nearly free electron model, origin and magnitude of energy gap, Bloch function, Kronig-Penney model, wave equation of electron in periodic potential, number of orbitals in a band, Fermi surfaces, various schemes for construction of Fermi surfaces, De Hass-van Alfen affect.

Unit-II
Analysis of strain, elastic compliance and stiffness constants, elastic energy density, elastic stiffness constants of cubic crystals and elastic waves in cubic crystals, Vibration of crystals with monatomic basis, two atoms per primitive basis, quantization of elastic waves, phonon momentum, inelastic scattering by phonons.

Unit-III
Meissner effect, heat capacity, London's equation, microwave and infrared properties, isotope effect, flux quantization, density of states, Types of Superconductors, AC and DC Josephson tunneling, Cooper pairs and derivation of BCS Hamiltonian, results of BCS theory (no derivation), coherence length field quantization in a superconducting ring, duration of persistent current, high temperature superconductors.

Unit-IV
Semiconductors: Band gap in semiconductors, equation of motion, effective mass in semiconductors, intrinsic carrier concentration, calculation of impurity conductivity,Law of mass action, ellipsoidal energy surfaces in Si and Ge, Hall effect recombination mechanism, Optical transitions and Shockley Read theory, excitons, photoconductivity, photo luminescence.

Unit-V
Linear Combination of atomic orbitals method, Density function theory, Hartree Fock methods, spin-polarized relativistic Korringa-Kohn-Rostoker Green's function, APW, Projector Augmented Plane wave, linear muffin tin orbitals, **k.p** methods, Molecular dynamics simulation, Monte Carlo methods, Applications to systems of classical particle.

Text Reference Books:

1. Introduction to Solid state Physics by C. Kittel, (John Wiley), VII Ed.,1995.
2. Solid State Physics by A. J. Dekker, (Macmilam), London, 1965.
3. Solid State Physics by S. O. Pillai, (New Age International Publishers), 2005.
4. Intermediate Quantum theory of solids- A.D.E.Animalu,(Prentice Hall).
5. Solid State Physics Source books- S.P. Parker, (Mc. Graw Hill).
6. Solid State Physics- Harrison, (Benjamin Press).
7. Quantum Solid State Physics-S.V.Vonsovsky& M.I. katsnelson, (Springer Verlag)
8. High.T. Superconductivity- Sinha, (Nova Science, New York USA)
9. Solid State Physics- Ashcroft and Mermin.
10. Frenkel D. and Smith, B., Understanding molecular simulation from algorithm to applications, Kluwar Academic Press, 1999.
11. Ohno, K, Esfarjani. K. and Y. Kawazoe, Introduction to Computational Materials Science from ab-initio to Monte Carlo Methods, Springer-Verlag, 1999.

PHY304- [A] Energy Studies I

Unit- I

Solar Radiation and Thermal Energy Conversion: Electromagnetic spectrum- Solar spectrum, solar constant, spectral distribution and variation of extraterrestrial radiation, air mass, beam, diffuse and global solar radiation, irradiance, solar insolation. Measurement of solar radiation – Pyranometer, pyrheliometer, Sunshine recorder, albedometer. Solar radiation geometry -latitude angle, declination angle, hour angle, surface azimuth angle, solar azimuth angle. Calculation of solar angle of incidence - Surface facing due south, horizontal, inclined surface and vertical surface. Solar time or Local apparent time (LAT), equation of time (E). Sunrise, sunset, solar day length, tilt factors, Calculation of total solar radiation on horizontal and tilted surfaces, basics of conversion of solar radiation to thermal energy, property of glass and green house effect, solar thermal devices- solar cookers- hot box, parabolic, indirect type; solar dryers, solar distillation still and solar water heater.

Unit -II

Solar thermal collectors: Liquid flat plate collectors -performance analysis, collector efficiency factor, collector heat removal factor, parametric analysis, testing procedure, evacuated tube collector, applications, advantages and disadvantages.
Concentrating collectors: Concentration ratio, acceptance angle, tracking, Introduction to flat plate collectors with reflectors, cylindrical parabolic collector, compound parabolic collector, parabolic dish collector, central receiver collector, application areas of solar concentrators,
Solar thermal power generation-low temperature, medium temperature and high temperature.

Unit -III

Solar Photovoltaics (SPV): Basic manufacturing process of monocrystalline and poly crystalline silicon solar cell- Silicon material, ribbon silicon, production of junctions, oxidation process. Optical, recombination and ohmic losses in solar cells and measures to reduce losses, high efficiency solar cells, bifacial solar cells, basic components of thin film solar cell, thin film materials- amorphous silicon, copper indium diselenide, tandem cells, organic solar cells. Equivalent circuit of solar cell, Characteristic curve of solar cell, I-V curve, P-V curve, fill factor, solar cell efficiency, variation of efficiency with radiation and temperature, series and parallel connection of solar cells, use of bypass and blocking diodes, solar PV module, use of charge controller, battery and inverter in solar PV system, application areas of solar PV systems, introduction to SPV water pumping.

Unit -IV

Wind Power Generation: Physical principles-wind turbine aerodynamics, lift and drag forces, basic wind turbine configurations-horizontal and vertical axis wind turbines, Betz limit, technical description of generation system for three blade horizontal axis wind turbine, energy conversion, losses and characteristic power curve, tip speed ratio, solidity, cut-in speed, cut-out speed, power control- active and passive stall and pitch control, advantages and disadvantages of wind power systems, introduction to hybrid systems- solar-wind hybrid, solar-diesel hybrid, wind-diesel hybrid and solar-wind-diesel hybrid system.

Unit -V

Hydroelectric Power Generation: Principles, construction types and classification, system components-Dam,weir or barrage, intake, penstock, turbine, outflow and tailrace, shaft

coupling and transmission, generator, transformer, regulation; reaction and impulse turbines, energy conversion chain, losses and power curve.
Energy Storage: Applications and need for energy storage, specifying energy storage devices-self discharge time, unit size, efficiency, cycle life, energy density, specific energy; Fuel-higher heating value, lower heating value; Energy storage methods: Thermal-sensible heat, latent heat-phase change, hydration-dehydration, chemical reactions; Thermochemical-biomass storage-solids, ethanol, biodiesel, syngas, Mechanical-compressed air, flywheels, pumped hydro; Electrical Energy storage- Ultracapacitor, superconducting magnetic energy storage (SMES), secondary batteries, flow batteries.

Text/Reference Books:

1. Physics of solar cells : Peter Wurfel (Wiley- VCH)
2. Stand Alone Solar Electric Systems : Mark Hankins (Eartnscan Expert Series)
3. Solar Domestic Water Heating : Chris Laughton (Earthscan Expert Series).
4. Principles of Energy Conversion: A.W. Culp.
5. Direct Energy Conversion: M.A.kettani.
6. Energy Conversion systems: Begamudre, Rakoshdas.
7. Renewable Energy Sources and Conversion Techonology: N.K. Bansal, M.K. Kaleemann.
8. Solar Engineering of Thermal Process: Duffie and Beckman (J. Wiley).
9. Power Generation Through Renewable Sources of Energy: B.R.Pai,M.S.Ramprasad (Tata Mcgraw Hill).
10. Solar Power Engineering: B.S. Mangal (Tata-Mcgraw Hill).
11. Wind Energy Explained: Theory, Design and Application, Manwell, McGowan, Rogers (Wiley).
12. Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific).
13. Photovoltaic Solar Energy Conversion: A. Goetzberger, Springer.
14. Energy Science: Principles, technologies and impacts: John Andrews and Nick Jelly (Oxford).
15. K.Sukhatme, Suhas P.Sukhatme., "Solar energy: Principles of thermal collection and storage", Tata McGraw Hill publishing Co. Ltd, 8th edition, 2008.

Web Resources

https://esc.fsu.edu/documents/lectures/ECSI/SolarRadiation.pdf
https://curry.eas.gatech.edu/Courses/6140/ency/Chapter3/Ency_Atmos/Radiation_Solar.pdf
http://www.diva-portal.org/smash/get/diva2:1305017/FULLTEXT01.pdf
https://www.vskills.in/certification/tutorial/solar-radiation-geometry/
http://web.cut.ac.cy/wp-content/uploads/sites/13/2014/08/1-1-b-Basic-Solar-Geometry.pdf
https://www.eia.gov/energyexplained/solar/solar-thermal-collectors.php
https://testbook.com/electrical-engineering/solar-power-plant-definition-types-and-components
https://www.energy.gov/eere/solar/solar-photovoltaic-technology-basics
https://www.eia.gov/energyexplained/solar/photovoltaics-and-electricity.php#:~:text=A%20photovoltaic%20(PV)%20cell%2C,or%20particles%20of%20solar%20energy.
https://www.energy.gov/eere/wind/wind-energy-basics
https://www.energy.gov/eere/water/hydropower-basics#:~:text=What%20is%20Hydropower%3F,moving%20water%20to%20generate%20electricity.
https://www.eesi.org/files/FactSheet_Energy_Storage_0219.pdf
https://www.nrel.gov/docs/fy23osti/84500.pdf

PHY304- [B] Material ScienceI

Unit I

Electronic and atomic structures, atomic bonding in solids, structure of metals and ceramics, density computations, silicates, fullerenes, polymorphism, allotropy, polycrystalline and non-crystalline materials. Polymeric structures, molecular configuration of polymers, thermosetting and thermoplastic polymers, copolymers, polymer crystallinity, semiconductors, imperfections in solids.

Unit II

Diffusion mechanisms, factors affecting diffusion, diffusion in ionic and polymeric materials, phase diagrams, solubility limit, phase, microstructure, phase equilibria, Unary phase diagram, Binary phase diagram, alloys, phase transformations, kinetics, meta-stable and equilibrium states.

Unit III

Mechanical properties of metals, concepts of stress and strain, Hooke's law, tension, compression and shear. Stress-strain diagram and thermal stresses. Elasticity in metals and polymers, plastic deformation, yield stress, shear strength, strengthening mechanisms, effect of temperature.

Unit IV

Electrical properties of metals, ionic materials, semiconductors and polymers, dielectrics, dielectric strength, ferroelectricity, piezoelectricity, optical properties, light interaction with solids, atomic and electronic interactions, optical properties of metals, optical properties of non-metals, applications of optical properties- luminescence, photoconductivity.

Unit V

Thermal properties, thermal expansion, heat capacity, thermal conductivity, thermal stresses, magnetic properties, diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism and ferri-magnetism, domains and hysteresis, soft and hard magnetic materials, Basic properties of superconductivity.

Text/Reference Books:

1. William D. Callister "Fundamentals of Materials Science and Engineering", John Wiley & Sons, New York.
2. Rose, R.M., Shepard L.A., and. Wulff, J. 'The Structure and Properties of Materials" Wiley Eastern Ltd.
3. Sheckel ford J., F. Muralidham M.K., "Introduction to Materials Science for Engineers", 6thedition, Pearson, 2007.
4. Murr L.E., "Solar Material Science" , Academic Press.
4. RaghavanV., "Materials Science and Engineering", Prentice-Hall India, 2007.
5. Askeland D.R., "Science and Engineering of Materials", 4thedition, Thomson, 2003.
6. Ramamrutam S., "Strength of Materials", 16thedition, Danpat Rai Publications, 2010.

PHY304- [C] Microwave Electronics I

Unit I

Wave guides:Rectangular wave guides; wave equation and its solutions, TE & TM Modes, Dominant mode & choice of wave-guide dimension, methods of excitation wave-guide. Circular wave-guide : wave equations and its solutions (TE, TM &TEM modes), Causes of attenuation in wave guides, wall current & derivation of attenuation constant, Q of the wave guide.

Unit II

Resonators (a) Resonant modes of rectangular & cylindrical cavity resonator of the cavity resonator frequency meter, (b) Ferrites: Microwave propagation in ferrites, Faraday rotation, Device employing Faraday rotation (Isolator Gyrator, circulator).

Unit III

Microwave antennas: Magnetic currents, Electromagnetic current sheets, field of Huygen's source, radiation from a slot antenna, open end of a wave guide & electromagnetic horns, Radiation field of Micro strips wave guide, microstrip antenna calculations, Microstrip design formulas.

Unit IV

Microwave tubes: Space charge spreading of an electron beam, beam focusing, Klystron: Velocity Modulation, Two cavity Klystron, Reflex Klystron, Efficiency of Klystron, Magnetron-Types and description, theoretical relation between electric & magnetic field of oscillation, Modes of oscillation, & operating characteristics, Travelling wave tubes O & M type travelling wave tubes.

Unit V

(a)Avalanche transit time Device: Read diode, Negative resistance of an avalanching P-N diode IMPATT oscillator.

(b)Transferred Electro Device: Gunn effect, Two valley model, high field domains, different modes for microwave generation.

Text/Reference Books:

1. Theory of Applications of Microwaves-AB Brownwell& R.E. Beam Mc Graw Hill
2. Introduction to Microwave Theory- Atwater, Mc Graw Hill.
3. Microwave Electronics-R.F. Soochoo, Addisey Wesley Publi. Company
4. Foundation of Microwave Engineering-R.E. Collins, Mc Graw Hill.
5. Solid State Physical Electronics-A.Vanderziel, PHI India
6. Semi-Conductor & Electronic Devices-M. Barler, PHI India
7. Hand book of Microwave Measurement-M. Sucher & J. Fox. Vol-II Polytechnic Press, New York.
8. Microwave Devices & circuits-S.Y. Liao. PHI India
9. Solid State Physical Electronics-B.G. Strcetman.PHI India
10. Microwave Principles-H.J. Reich, CBS
11. Principles of Microwave Circuits-G.C. Montgomery, Mc Graw Hill
12. Micro strip Antenna Tech-K.R. Carver & J. W. Finic I.E.T.E. Trans
13. Build Microstip Antenna with paper thin dimension-I.J. Bahi, Microwave Journal vol.18 pg 50-60
14. Antenna theory & Design- R.S. Edlliott, PHI Ltd India.
15. Antenna theory & Design-E.Wolff, J. Wiley & Sons.
16. Microstrip Antenna-Bahl & Bhartiya, Artech House Messachusetts.
17. Microwave Electroics-R.F.Soohoo A. Dalisaon Wesley Publ. Compo Massachusetts.

PHY304- [D] High Energy Physics I

Unit I

Discovery of Muon, mesons, pions, nucleon interaction and isospin analysis, Discovery of resonances and stranger particles, Gell-Mann Nishima Scheme, K-decays, strangeness oscillation and Ko regeneration phenomenon, Discovery of j/p Si Particles, charm and bottom flavours.

Unit II

Qualitative ideas of interactions, QED, QCD weak interaction, Addition conservation laws, Charge, colour, Baryon number, lepton number, flavour etc. and particle decays.

Unit III

Invariance and operators in Quantum mechanics, Translations and rotations, Parity, tests of Parity conservation, charge conjugation invariance, eigen state of charge conjugation operators, Positronium decay, Experimental taste of E-invariance, Time reversal invariance, Tests of CPT invariance.

Unit IV

SU (2) of isospin, Isospin of two nuclear system, isospin for antiparticles C-party, SU (3) (colour and flavour), quark-antiquark states, mesons, 3 quark states, Baryons magnetic moment, Heavy quark: charm and beyond, Hardon masses colour factors.

Unit V

Non-relativistic time dependent perturbation theory, Rules for scattering amplitudes in Feynmann- Struckelberg approach cross section in terms of invariant amplitude M variables, Decay Rates in terms of M invariants.

Text/Reference Books:

1. Introduction to High Energy Physics, D.H. Perkins.
2. Quarks andLeptons, Halzin and Martin.

PHY304- [E] Plasma Physics I

Unit I

Introduction to plasmas: Plasma-the fourth state of matter, Debye length, plasma frequency, applications, equation of motion, equation of continuity, momentum loss via collisions, pressure gradient force, linearized equation of motion, dc drift velocity, negative differential conductivity and runaway electrons.

Unit II

Plasma response to fields and RF conductivity of plasmas: Plasma response to constant amplitude radio frequency electric field, electrical conductivity, plasma response to RF field of slow time varying amplitude, electron heating by RF field, plasma response to uniform RF electric field, ponderomotive force due to non-uniform RF field, cyclotron motion, conductivity tensor, Hall field, Cowling effect.

Unit III

Electromagnetic wave propagation in plasmas: Frequencies of interest, plane wave representation, effective plasma permittivity, transverse and longitudinal waves, electromagnetic wave dispersion relation, phase velocity and attenuation constant, electromagnetic wave dispersion relation, phase velocity and attenuation constant, skin depth, energy flow with an EM wave, power loss in db, reflection at normal incidence, plasmas with gentle density gradient, WKB solution, oblique propagation.

Unit IV

Grad B and curvature drifts and thermonuclear fusion: Review of electron motion in crossed F and B fields, electron motion in a non-uniform magnetic field, ∇B drift, election motion in an azimuthal field, curvature drift, radial magnetic field, axial motion of an orbiting electron, magnetic moment of a gyrating electron, axial force, adiabatic invariance of magnetic moment, mirror confinement: loss cone angle, basic reactions, Lawson criterion, magnetic fusion, inertial confinement fusion, basics of toroidal confinements.

Unit V

Electromagnetic waves propagation in magnetised plasma:Anisotropic plasma behaviour, conductivity tensor, effective plasma permittivity tensor, wave propagation along the dc magnetic field, RCP mode, LCP mode, Faraday rotation, electron cyclotron heating, longitudinal propagation $\left(\vec{k} \parallel \vec{B}_s\right)$, RCP mode, LCP made, whistler, ion cyclotron and Alfven waves, Faraday rotation, cyclotron resonance heating.

Text/Reference Books:

1. An Introduction to Plasma Physics by F.F. Chen, (Plenum Press),1974.
2. Methods in Non-linear Plasma theory by R.C. Davidson, (Academic Press), 1972.
3. Plasma Physics in Theory and Application by W.B.Kunkel, (McGraw Hill), 1966,
4. Fundamentals of Plasma Physics by J.A. Bitten Court, Third Edition, Springer Publications.
5. Statistical Plasma Physics by S. Ichimaru, Addition Wesley Publishing Co.
6. STIX, T.H., Theory of Plasma Waves, McGraw-Hill, New York (1962).
7. Plasma Physics (Midway Reprint Series) by S K Trehan (Edited), S. Chandrasekhar, Chicago press.

PHY305- Physics Laboratory-III

1. To determine the ultrasonic velocity and obtain the compressibility of a given liquid.
2. To study dynamics of a lattice using electrical analogue.
3. To study variation of rigidity of a given specimen as a function of the temperature.
4. To determine the modulus of rigidity of matter by using torsional oscillator (simple brass and iron rod).
5. To determine half-life of a radio Isotope using G.M. Counter.
6. To study absorption of particles and determine range using at least two Sources.
7. To study characteristics of G.M. Counter and to study statistical nature of radio-active decay.
8. To study spectrum of β-particles Using Gamma ray spectrometer.
9. To calculate the solar azimuthal angle for solar radiation with solar time (8:00 a.m. to 4:00 p.m.) for 21 March, 21 June and 21 December.
10. To calculate the angle of incidence of solar radiation in degree at solar noon for different days (at an interval of 20 days) of a year at surface inclined at 0°, 45° and 90° facing towards south (surface azimuth angle = 0°) & to plot the results.
11. Determine the operating frequency of Reflex Klystron.
12. Draw the V-I characteristics of Reflex Klystron.
13. Draw the characteristics of Attenuator.
14. To verify the Waveguide Law.
15. To study the directivity and coupling coefficient of Directional Coupler.
16. To study the properties of Magic Tee and also determine isolation and coupling coefficient.
17. To measure the VSWR of (i) short circuit (ii) open circuit (iii) matched load (iv) unmatched load.
18. To study the properties and E-plane and H-plane Tees. Determine Isolation and coupling coefficient.
19. To determine the optical band gap of a given materials either in bulk or in film form by UV-VIS-NIR spectrometer.
20. Any other experiments of the equivalent standard can be set.

IV SEMESTER

PHY 401- Nuclear Physics-II

Unit-I

Nuclear shell model: Single particle and collective motions in nuclei, assumptions and justification of the shell model, average shell potential, spin orbit coupling, single particle wave functions and level sequence, magic numbers, shell model predictions for ground state parity, angular momentum, magnetic dipole and electric quadrupole moments and their comparison with experimental data, nuclear isomerism.

Unit-II

Collective nuclear models: Collective variable to describe the cooperative modes of nuclear motion, Parameterization of nuclear surface, brief description of the collective model Hamiltonianin the quadratic approximation, Vibrational modes of a spherical nucleus, Collective modes of a deformed even-even nucleus and moments of inertia, Collective spectra and electromagnetic transition in even nuclei and comparison with experimental data, Nilsson model for the single particle states in deformed nuclei.

Unit-III

Nuclear gamma decay: Electric and magnetic multipole moments and gamma decay probabilities in nuclear system (no derivations), Reduced transition probability, Selection rules, internal conversion and zero-zero transition.

Unit-IV

Nuclear beta decay:General characteristics of weak interaction, nuclear beta decay and lepton capture, electron energy spectrum and Fermi- Curie plot, Fermi theory of beta decay,Fermi and Gammaw-Teller selection rules, ft-values, Experimental verification of parity violation, The V-A interaction and experimental evidence.

Unit-V

Nuclear Reactions: Theories of Nuclear Reactions, Partial wave analysis of reaction Cross section, Compound nucleus formation and breakup, Resonance scattering and reaction, Breit-Wigner dispersion formula for S-waves (l= 0), continuum cross section, statistical theory of nuclear reactions, the optical model, Stripping and pick-up reactions and their simple theoretical description, nuclear structure studies with deuteron stripping (d,p) reactions.

Text/Reference books:

1. Nuclear Physics by Irving Kaplan, (Addison Wesley Pub. Co.), 2nd Ed.
2. Nuclear Physics Theory and Experiment by R. R. Roy, B. P. Nigam (New Age Internation Pub.), 1997.
3. Atomic Nucleus by R.D. Evans (McGraw Hill), X ed., 1965.
4. Nuclear Physics by S. N. Ghoshal (S. Chand, New Delhi), 2006.
5. Introduction to Experimental Nuclear Physics by R. M. Singru (Wiley Eastern pvt. Ltd.)
6. Nuclear Physics: an Introduction by S. B. Patel (Wiley Eastern Ltd.), 1992.
7. Theoretical Nuclear Physics: J.M. Blatt & V.E. WeissKipf.
8. Introductory Nuclear theory: -L.R.B. Elton, ELBS Publs. Londan 1959.
9. Structure of the Nucleus: - M.A. Preston &R.K.Bhaervi, Addision Wesley
10. Nuclear Physics:- Techniques of Nuclear Structure (vol. I) England
11. Introduction to Nuclear Physics:-H.Enge.Addision Wesley
12. Elements of Nuclear Physics:- W.E.Burcham, ELBS Longman.
13. Concepts of Nuclear Physics:- B.L. Cohen, Tata Mc Graw Hill,1988.

14. Nuclei & Particles -E.segre, Benjamin 1972.
15. Introductory Nuclear Physics:-D.Halliday Willey 1955
16. Introduction of Nuclear Physics & Chemistry :-Harvey.
17. The Physics of Nuclear Reactions :-W.M.Gibson,Pergamon Press.
18. Nuclear Interaction:- S.De Benedetti, Wiley 1955.

PHY402- Solid State Physics

Unit-I
Magnetic Properties of materials, Quantum theory of Diamagnetism and Paramagnetism, Susceptibility of rare earth and transition metals, Ferromagnetism: Weiss molecular field and exchange, Heisenberg's exchange interaction, relation between exchange integral and mean-field constant, spin waves, Magnons dispersion relation, Antiferromagnetism, Ferrimagnetism.

Unit-II
Electrical properties of metals, ionic materials and semiconductors, dielectrics, dielectric strength, ferroelectricity, piezoelectricity, optical properties of materials, light interaction with solids, atomic and electronic interactions, optical properties of metals, optical properties of non-metals.

Unit-III
Thermal properties, thermal expansion, heat capacity, thermal conductivity, thermal stresses,Nuclear magnetic resonance, Line width, Motional narrowing of resonance line, hyperfine splitting, Nuclear quadrupole resonance, Electron paramagnetic resonance, Principle of MASER action.

Unit-IV
Vacuum Techniques: basic idea of conductance, pumping speed, Vacuum Pumps; Mechanical Pump, Diffusion pump, Turbo Molecular Pump, Ion Pump; Gauges; Thermocouple Gauge, Penning Gauge, Pirani Gauge, Hot Cathode Gauge.
Imperfection in solids: Point, line planer and defects, colour centers, F-Centre and aggregate centers in alkali halides, John Teller effect, Single crystal growth, crystal whiskers.

Unit-V
Basic theory of X-ray diffraction, Indexing of Debye-Scherer patterns from powder samples, Electron microscopes (SEM & TEM), Scanning probe microscopes (SPM), Scanning Tunneling microscope, atomic force microscope, Basic principles of X-ray absorption fine structure Spectroscopy, X-ray photo-emission Spectroscopy.

Text/Reference Books:

1. Intermediate Quantum theory of solids- A.D. E .Animalu, (Prentice Hall).
2. Solid State Physics-Kittel, (John Wiley 7th ed.).
3. Quantum theory of Solids- Kittel, (John Wiley).
4. Solid State Physics Source books- S.P. Parker, (Mc. Graw Hill).
5. Solid State Physics- Harrison, (Benjamin Press).
6. Quantum Solid State Physics-S.V.Vonsovsky& M.I. katsnelson, (Springer Verlag)
7. High.T. Superconductivity- Sinha, (Nova Science, New York USA)
8. Nano-Science & Nano Technology-Retner-Retner.
9. Solid State Physics- Ashcroft and Mermin.
10. Fundamentals of Materials Science and Engineering, William D. Callister, John Wiley & Sons, New York.

PHY403- Laser Physics

Unit-I

Spontaneous and Stimulated emission, Population inversion, Idea of laser. Gaussian beam and its properties, Stable and Unstable Optical Resonators, Longitudinal and Transverse modes of laser cavity, Gain in a regenerative laser cavity, Threshold for 3 and 4 level laser systems.

Unit-II

Q-switching and mode locking – Pulse shorting – nano, pico and femtosecond operation, Ruby laser, He-Ne laser, carbon oxide laser, Excimer laser, X-ray laser, Dye laser, Neodymium : YAG and Neodymium : glass laser, Fiber laser, Semiconductor laser, Quantum-well laser, Diode – Pumped solid state laser

Unit-III

Laser fluorescence and Raman scattering, Laser induced multiphoton process, Ultrahigh resolution spectroscopy with lasers and its applications.

Unit-IV

Holography: Construction of hologram and reconstruction of the image, Types of Hologram, Medical and Engineering applications of lasers, Potential of lasers in defense applications.

Unit-V

Optical Fibers, Light wave communication, Light propagation- total internal reflection, Acceptance angle and Numerical aperture, Fiber materials and Fabrication, Fiber cables, comparison of Fiber cables with conventional metallic cables, Optical Fibers- step index, single and multimode, graded index, Fiber losses and dispersions.

Text/Reference books:

1. Laser Fundamentals by William T. Silfvast (Cambridge University Press), 1998.
2. Optical Electronics by Ajoy Ghatak and K. Thyagarajan (Cambridge University Press), VII Reprint, 2006.
3. Lasers by Ajoy Ghatak and K. Thyagarajan, (Cambridge University Press)
4. Lasers by Orazio Svelto, (Springer Science Inc., USA), IV Ed, 1998.
5. Laser Spectroscopy by W. Demtroder, (Springer-Verlag), Berlin, III Ed., 2003
6. Optoelectronics: An Introduction, J. Wilson and J.F.B. Hawkes, (Prentice Hall International (UK) Limited), II Ed., 1989.
7. Optoelectronic Devices and Systems by S.C. Gupta, (Prentice Hall India), 2005
8. Laser Electronics by Joseph T. Verdeyen, (Prentice Hall of India Private Limited), II Ed., 1993.
9. Lasers: Principal and Applications by J. Wilson and J.F.B. Hawkes, (Prentice Hall International (UK) Limited).
10. Laser by P.W. Milonni, J.H. Eberly, John-Wiley & Sons.
11. Lasers and Optical Engineering by P.Das, Narosa Publishers.

PHY404- [A] Energy Studies II

Unit I

Nuclear reactions : Stable, unstable nuclides; neutron-proton ratio, isotopes, mass defect, Binding Energy, mass energy equivalence, difference between energy levels of atoms and nucleus, nuclear stability and radioactive decay, modes of radioactive decay- alpha decay, beta decay, gamma emission, electron capture, internal conversion, isomeric transition; radioactive decay constant, half life, activity. radioactivity calculations. Neutron interactions-neutron scattering reaction- elastic scattering, inelastic scattering-absorption reaction, radiative capture, particle ejection, fission; Introduction to fission and fusion nuclear energy, typical reactions.

Unit II
Nuclear Fission, Liquid drop model, Compound nucleus formation, critical energy of fission, fissile material, fertile material, fissionable material, neutron sources- intrinsic and installed, thermal neutrons, neutron interaction, microscopic and macroscopic cross sections, neutron flux, reaction rates, neutron moderation, average logarithmic energy decrement, macroscopic slowing down power, moderating ratio, fission neutrons-prompt and delayed, fission products, energy released in fission, γ -ray interaction with matter, neutron flux spectrum, neutron life cycle, four factor formula, six factor formula, neutron poisons.

Unit III
The Fission Reactor: The fission chain reaction, reactor fuels, conversion and breeding, the nuclear power resources, nuclear power plant and its components, , nuclear fission power reactors, CANDU reactor, PHWR, BWR, Breeder reactor, current status of nuclear fission power generation in India. Reactor Theory: Neutron flux, continuity equation, diffusion equation, boundary conditions, solutions of the DE, Neutron moderation. Health Hazards: radiation protection & shielding. Nuclear Fusion: Fusion reactions, reaction cross-sections, reaction rates, Lawson criterion, magnetic and inertial confinement, introduction to ITER, ASDEX.

Unit IV
Energy Conservation and Management: Thermodynamic basis of energy conservation, Irreversible processes, Reversibility and Availability, Exergy and available energy, Energy conservation in HVAC systems and thermal power plants, Energy conservation in buildings, UValue of walls / roof, Lighting Systems - Different light sources and luminous efficacy, Insulation use – Materials properties, Optimum thickness, Introduction to Energy audit and Instrumentation.

Unit V
Energy Efficient Buildings: Thermal comfort, classification of climate zones, Heat flow calculations in buildings, thermal resistance and U-factor calculation, Direct heat gains through windows. Convective gains/losses, Gains from people, appliances, infiltration, ventilation etc. Passive and low energy concepts and applications. Trombe Wall, effect of insulation, Passive cooling/heating concepts, building form and orientation, internal and external shading devices, ventilation, evaporative and nocturnal cooling, earth–air tunnel, solar chimney-based system.

Text/Reference Books:
1. Nuclear Energy 6th Edition: An introduction to the Concepts, Systems and Applications of Nuclear Processes- Raymond LeRoy Murray (Elsevier).
2. Nuclear Energy in the 21st Century: World Nuclear University Press- Ian Hore-Lacy.
3.Energy Science: Principles, technologies and impacts – John Andrews and Nick Jelly(Oxford).
4. Energy Management Handbook, W.C. Turner, S. Doty, CRC Press, 2006.

5. Nuclear Physics: L.Kaplan, Addi Wesley 1963.
6. The Physics of Nuclear Reactions :W.M.Gibson, Pergamon Press.
7. Sustainable Construction: Green Building Design & Delivery – Charles J. Kibert, JohnWiley & Sons (Third Edition).
8.Department of Energy Fundamental Handbook-DOE-HDBK-1019/1-93 Nuclear Physics and Reactor Theory.

Web Resources

http://www.sfu.ca/phys/346/121/lecture_notes/lecture26_nuclear_reactors.pdf
http://large.stanford.edu/courses/2013/ph241/kallman1/docs/nuclear_reactors.pdf
https://www.sciencemediacentre.org/uploads/2013/04/Nuclear-reactors.pdf
https://www.world-nuclear.org/uploadedFiles/Pocket%20Guide%202009%20Reactors.pdf
https://www.cea.fr/english/Documents/thematic-publications/cea-nuclear-reactors.pdf
http://large.stanford.edu/courses/2010/ph240/sagatov1/docs/nfc.pdf
https://web.mit.edu/nuclearpower/pdf/nuclearpower-ch4-9.pdf
https://www.nuclear-power.com/nuclear-power/reactor-physics/neutron-diffusion-theory/
https://world-nuclear.org/information-library/current-and-future-generation/nuclear-fusion-power.aspx
https://www.iaea.org/sites/default/files/19/02/the-nuclear-fuel-cycle.pdf
https://www.beepindia.org/wp-content/uploads/2013/12/Passive-measures-for-energy-efficiency_20.pdf
https://www.ctc-n.org/system/files/dossier/3b/4.2%20Consolidated%20chapters.pdf
https://www.unido.org/sites/default/files/2009-02/Module18_0.pdf
https://www.seai.ie/publications/SEAI-Energy-Audit-Handbook.pdf

PHY404- [B] Material Science II

Unit-I

Nanostructures: Definition of nanoscience and nanotechnology, classification of the nano materials, zero dimensional nanostructures, one dimensional nanostructures-nanowires, nanorods and nanotubes, two dimensional nanostructures-graphene, Thinfilms, three dimensional nanostructures.

Unit-II

Properties of Nanomaterials. Shape and size dependant properties- electrical, linear and nonlinear optical properties, magnetic, thermal and mechanical properties of nanomaterials, melting point and lattice constants, surface plasma resonance.

Unit-III

Synthesis of Nanomaterials: Synthesis of nano-structured materials, Bottom-up Synthesis - Top-down Approach, sol-gel processing, microwave synthesis, self-assembly, Langmuir-Blodgett (LB) method, electrochemical deposition, chemical vapor deposition, Sputter deposition, pulsed laser deposition, magnetron sputtering, molecular beam epitaxy, lithography.

Unit-IV

Quantum Confinement: Quantum confinement of electrons in semiconductor nanostructures, Quantum dots(QDs), Quantum wires (QWRs), Quantum wells (QWs).

Characterization techniques: Basic theory of X-ray diffraction, Indexing of Debye-Scherer patterns from powder samples, Photoluminescence, Hall Effect.

Unit-V

Electron microscopes (SEM & TEM), Scanning probe microscopes (SPM), Scanning Tunneling microscope, atomic force microscope, Basic principles of X-ray, X-ray absorption Spectroscopy, X-ray photo-electron Spectroscopy.

Text/Reference books:

1. S.K.Kulkarni, Nano technology; principle and practices by, (Capital Publishing Company), 2007.
2. Guozhong Cao, Nanostructures and Nanomaterials–Synthesis, Properties and Applications, Imperial College Press, London, 2004.
3. Michael Kohler and Wolfgang Fritzsche, Nanotechnology-an introduction to Nanostructuring techniques, Wiley-VCH, 2004.
4. Emil Rodune, Nanoscopic materials - size dependant phenomena, Royal society of Chemistry publishing, 2006.

PHY404- [C] Microwave Electronic II

Unit-I

Parametric Amplifier: Varactor, Equation of capacitance in linearly graded & abrupt P-N junction, Manley –Rowe relations, parametric up converter and negative resistance parametric amplifier, use of circulator, Noise in parametric amplifier.

Unit-II

Microwave measurement: Power, frequency, Attenuation, Impedance (use of smith Chart) VSWR Directivity, Coupling Reflectometer, complex permittivity of materials and its measurements.

Unit-III

Definition of complex permittivity, loss tangent-their importance and correlation, Measurement of complex permittivity of solids, liquids and powder, using shift of minima method, Introduction to frequency perturbation method & Hestenet method of evaluate complex permittivity of materials.

Unit-IV

Microwave filters: Basic theory, Quarter wave & direct coupled cavity filters, Passive Device: Termination (short circuit & matched termination) Attenuator, Phase changers E & H plane Tees, hybrid junctions, Directional coupler.

Unit-V

Monolithic Micro Wave Integrated Circuits: Substrate materials, Conductor materials, Dielectric & resistance films, Fabrication techniques, monolithic integrated circuits.

Text/Reference Books:

1. Theory of Applications of Microwaves-AB Brownwell& R.E. Beam Mc Graw Hill
2. Introduction to Microwave Theory- Atwater, Mc Graw Hill.
3. Microwave Electronics-R.F. Soochoo, Addisey Wesley Publi. Company
4. Foundation of Microwave Engineering-R.E. Collins, Mc Graw Hill.
5. Solid State Physical Electronics-A.Vanderziel, PHI India
6. Semi-Conductor & Electronic Devices-M. Barler, PHI India
7. Hand book of Microwave Measurement-M. Sucher & J. Fox. Vol-II Polytechnic Press, New York.
8. Microwave Devices & circuits-S.Y. Liao. PHI India
9. Solid State Physical Electronics-B.G. Strcetman.PHI India

10. Microwave Principles-H.J. Reich, CBS
11. Principles of Microwave Circuits-G.C. Montgomery, Mc Graw Hill
12. Micro strip Antenna Tech-K.R. Carver & J. W. Finic I.E.T.E. Trans
13. Build Microstip Antenna with paper thin dimension-I.J. Bahi, Microwave Journal vol.18 pg 50-60
14. Antenna theory & Design- R.S. Edlliott, PHI Ltd India.
15. Antenna theory & Design-E.Wolff, J. Wiley & Sons.
16. Microstrip Antenna-Bahl & Bhartiya, Artech House Messachusetts.

PHY404- [D] High Energy Physics II

Unit-I

An electron interacting in field, calculating, cross section for $e^+e^-\rightarrow e^+e$- Moller scattering and e.m. scattering arid process $e^+e^-\rightarrow e^+e$-. Helicity conservation of high energies in lab frame, Kinematice relevant to the parton model.

Unit-II

Photons and their polarization vectors propagators of (I) Spinless particles (II) electron (III) photon, The prescription for propagators, summary of Feynmann rules for QED, producing a charge distribution with electrons, form factors.

Unit-III

e-p scattering ep-ex formalism for analyzing as (Virtual) photon-proton, total cross section and Bjorken scaling, Quarks with in the proton gluons.

Unit-IV

Classification of weak interactions: Nuclear Decay, Fermi theory, Inter partition of coupling, G-parity violating and V-A form of weak current Cobalt-60 experiment, Parity violation in B-decay.

Unit-V

Experimental determination of neutrino helicity, Lepton helicities in pion and muon-decay, weak decays of strange particles: Cabibbo theory, Quantitative ideas about discovery of $W^{\pm}$ and Z^0.

Text/Reference Books:

1. Introduction to High Energy Physics, D.H. Perkins.
2. Quarks and Ieptons, Halzin and Martin.

PHY404- [E] Plasma Physics II

Unit-I

Beam plasma system: Beam plasma system, physical mechanism of wave growth, equilibrium, response of beam and plasma electrons to a perturbation, dispersion relation, growth rate, saturation of instability, remarks on non-relativistic two stream instability.

Unit-II

Free electron laser: Response of relativistic electron beam to electrostatic wave, growth rate, practical applications, slow wave structure, relativistic election beam response to TM mode, growth rate, saturation, magnetic Wiggler, kinematics of radiation generation, operating frequency, relativistic electron beam response, mechanism of beam bunching, phase space behaviour.

Unit III

Compton free electron laser: Ponderomotive force, electron bunching in retarding phases of the ponderomotive wave, evolution of electron energy and phase of the ponderomotive wave, electron trapping, energy gain, energy gain in untapered FEL, tapered wiggler, potential energy buckets, Compton regime operation.

Unit-IV

Tokamak operation and laser interaction with plasma embedded with clusters: Schematic of tokomak, plasma equilibrium, Grad-Shafranov equation, Ohmic current, basic elements, tokamak parameters, inductive current drive, Ohmic heating, overview of tokamak operation, ion Coulomb explosion, neutron production, surface enhanced Raman scattering (SERS), Rayleigh scattering, laser interaction with nanotubes.

Unit-V

Instabilities in plasmas: Other schemes of self generated magnetic fields, plasma in a gravitational field $\vec{g}\times\vec{B}$ drift, physical mechanism of Rayleigh Taylor instability, instability analysis, dispersion relation, growth rate, applications, need for plasma confinement, wave-particle interaction, Landau damping, plasma diffusion,
ambipolar diffusion.

Text/Reference Books:

1. An Introduction to Plasma Physics by F.F. Chen, (Plenum Press),1974.
2. Methods in Non-linear Plasma theory by R.C. Davidson, (Academic Press), 1972.
3. Plasma Physics in Theory and Application by W.B.Kunkel, (McGraw Hill), 1966,
4. Fundamentals of Plasma Physics by J.A. Bitten Court, Third Edition, Springer Publications.
5. Statistical Plasma Physics by S. Ichimaru, Addition Wesley Publishing Co.
6. STIX, T.H., Theory of Plasma Waves, McGraw-Hill, New York (1962).
7. Plasma Physics (Midway Reprint Series) by S K Trehan (Edited), S. Chandrasekhar, Chicago press.

PHY405- Physics Laboratory-IV

1. To study the Electro-Optic effect and AC modulation.
2. To study of thermal expansion of quartz crystal using Newton's Ring method.
3. To study the Acoustic-Optic effect.
4. To study the Brewster angle and refractive index of a given materials.
5. To determine the attenuation and bending losses of an optical fiber.
6. Study the Gaussian distribution of intensity of a laser beam.
7. To study the spatial and temporal coherence of laser.
8. To determination particle size by diode laser.
9. To study the nature of polarization.
10. To determine the speed of light using laser.
11. To calibrate a scintillation spectrometer and determine energy of gamma-rays from an unknown Source.
12. To study Compton scattering of gamma-rays and verify the energy Shift formula.
13. To study the alpha particles using Spark chamber.
14. To study the Bremstralung effect Using Scintillation spectrometer.
15. To determine the end point energy of β-particles using β--ray Spectrometer.
16. To study the Hall effect in Semiconductor and determination of Allied parameters.
17. To find the Band gap of given Semiconductor Material with the help of Four Probe method.

18. Measurement of Magnetic susceptibility of paramagnetic Solution by Quinck Method.
19. To study numerical aperture of optical fiber and losses in Optical fiber.
20. Any other experiments of the equivalent standard can be set.