UNIVERSITY OF KOTA

SCHEME OF EXAMINATION

AND

COURSES OF STUDY

Faculty of Science

M.Sc. (Physics)

Course Code PHY11750P

Third Semester Examination, December 2025
Fourth Semester Examination, June2026

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

Edition: 2024

Course Code: PHY11750P

Type of Course: Regular

Title of Course: M.Sc. (Physics)

Level of Course: PG

Total Credit of Course of whole M.Sc.: 100 (Physics = 96 + CBCS Paper = 04)

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	Advanced Quantum Mechanics-II: Quantum Field Theory	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] Advanced Electronics-I F] Research Project Part - I	3 Hrs	4	--	4	30	70	100	12	28
	3.5	PHY3005	Physics Laboratory-III	6 Hrs	--	16	8	--	**200**	**200**	**--**	**100**
			CBCS Paper	--	2	--	2	--	**50**	**50**	**--**	**20**
	Total				**18**	**16**	**26**	**120**	**530**	**650**	**--**	
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] Advanced Electronics-II F] Research Project Part - 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. In case of Research project Part-I and II, the maximum allotment will be 20 % only.

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.

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 / 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.

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 / viva 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 two sections as mentioned below:

- ***Section-A*** *shall have 01 question comprising 10 parts taking two parts from each unit with no internal choice. Each question shall be of two marks and total marks of this section will be 20 marks (10 x2). This section will be compulsory in the paper.*
- ***Section-B*** *There will be five long answer type questions and examiners are advised to set one question with internal choice (may have subdivisons) from each unit. The weight of each question of 10 marks hence the total weightage of the section is 50 marks (10 x5).*

f) The pattern of question paper of internal and external shall be as follows:

<table>
<tr><td colspan="2">Continuous Assessment Weightage</td><td>External Assessment Weightage</td><td rowspan="3">Total Marks (Total credits)</td></tr>
<tr><td colspan="2">Regular Students</td><td rowspan="2">Paper based External Evaluation (End term examination)</td></tr>
<tr><td>Mid-Term</td><td>Seminar/project report/presentation</td></tr>
<tr><td>20</td><td>10</td><td>70</td><td>100 (04)</td></tr>
</table>

(A) Continuous or Internal Assessment:

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

UNIVERSITY OF KOTA, KOTA
Mid Term (Internal Continuous Assessment) 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 05 parts. Please give short answers in 20 words for each part.
Section-B : 03 questions to be attempted having answers approximately in 500 words.

SECTION A

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

(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: 10x2=20
(Answer all questions)
(Two question from each unit with no internal choice)
Q. No. 1
(i) ……….............................…………………………………………… **2 Mark**
(ii) ……….............................…………………………………………… **2 Mark**
(iii) ……….............................……………………………………………. **2 Mark**
(iv)……….............................…………………………………………… **2 Mark**
(v)……….............................…………………………………………… **2 Mark**
(vi)……….............................…………………………………………… **2 Mark**
(vii)……….............................……………………………………………. **2 Mark**
(viii)……..............................…………………………………………… **2 Mark**
(ix)……….............................…………………………………………… **2 Mark**
(x)……….............................…………………………………………… **2 Mark**

SECTION-B: 5x 10 =50
(Answer all questions)
(One question from each unit with internal choice)
(Maximum two sub-divisions only)

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

Or

………..........…………………………………………………….

10 Marks

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

Or

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

10 Marks

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

Or

……………………………………..........………………………

10 Marks

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

Or

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

10 Marks

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

Or

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

10 Marks

Distribution of Marks for Practical Examinations:

Duration of Exam: 06 Hours **Maximum Marks: 100**

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 rechaking 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 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
• 75% 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- Advanced Quantum Mechanics-II: Quantum Field Theory

Unit-I

Natural System of Units or Relativistic units (c = ħ =1), concepts of particles and fields, discrete and continuous mechanical systems, Euler –Lagrange equations, covariant and contra-variant notations. Lagrangian and Hamiltonian densities, Classical scalar fields-neutral scalar fields and complex scalar fields, gauge transformation of first kind, conserved four current, Energy –momentum density , Classical Maxwell fields

Unit-II

Need of first and second quantization, Classical radiation field, gauge transformation of second kind, transversality condition, radiation gauge method, Fourier decomposition and radiation oscillators, Quantization of radiation oscillators, Fock space, Dirac- Pauli commutation relations and Bose- Einstein statistics , Jordan – Wigner anti- commutation relations and Fermi – Dirac statistics. Properties of Eigen states of the Hamiltonian of radiation field, photon propagator, The Gupta- Bleuler Formalism.

Unit-III

Quantization of fields, Lagrangian densities for Klein- Gordan fields, energy momentum tensors and four current densities, particles and antiparticles, positive and negative frequency parts, Klein Gordan equation in Schrödinger form and spin of Klein Gordan particle. Meson propagator

Unit-IV

Occupation number representation for Fermions, second quantization of the Dirac field, energy momentum tensors and four current densities, particles and antiparticles, positive and negative frequency parts and creation and destruction (annihilation) operators for electron and positron. Fermion propagator

Unit-V

Concepts of Hilbert Space Formalism (HSF) and Path Integral Formalism (PIF), electron-positron pair creation and single world line representation, forward and backward propagation in time, concept of Feynman propagator theory, Green function or propagator for Schrödinger particle and Dirac free particle. Feynman diagrams for pair creation, pair annihilation, two- quantum pair creation, two- quantum pair annihilation, Compton scattering by electrons, Feynman diagram of Bhabha Scattering, Normal products, Dyson Chronological Product, Wick's Chronological Product, Wick's Theorem, Scattering matrix expansion.

References:-

1.Advanced Quantum Theory, *Paul Roman*, (Addison-Wesley)
2.Quantum Mechanics (second edition)-*E. Merzbeker* (John Wiley)
3.Relativistic Quantum Mechanics –*J.D. Bjorken & S. D. Drell* (Mc Graw hill)
4.Advanced Quantum Mechanics -*J.J.Sakurai* (Addison-Wesley)
5.Quantum mechanics-*Thankappn V.K.*(Wiley Eastern ltd. New Delhi)
6.Quantum field Theory-*F. Mandal & G Shaw* (John Wiley)
7.Elements of Advanced Quantum Theory- J.M. Ziman (Cambridge)
8. Introduction to Quantum Field Theory, *Paul Roman*, (John Wiley)
9. The Physics of Quantum Fields, *Michel Stone*, (Springer)
10. Relativistic Quantum Fields –*J.D. Bjorken & S. D. Drell* (Mc Graw hill)
11. Quantum Mechanics and Field Theory, *B. K. Agarwal* (Lok Bharti)

12.Advanced Quantum Mechanics and Fields, *S. L. Gupta & I. D. Gupta*, (S. Chand)

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, Tight Binding Approximation (Linear Combination of Atomic Orbitals theory).

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

Electron microscopes; Scanning Electron Microsope (SEM), Transmission Electron Microscope (TEM), Scanning probe microscope (SPM), Scanning Tunneling microscope (STM), Atomic Force Microscope (AFM).

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] - Advanced Electronics-I

Unit-I

Multivibrator, Astable, monostable and bisatble multivibrators. R-C Coupled amplifier, Transformer coupled amplifier, Direct-coupled amplifier.

Homo- and hetero-junction devices, device characteristics, device structure, frequency dependence, and applications, clipping and clamping.

Unit-II

Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors), Measurement and control, Signal conditioning and recovery, Impedance matching, amplification (Op-amp based, instrumentation amp, feedback), Operational amplifiers and their applications, filtering and noise reduction, shielding and grounding.

Unit-III

Digital Electronics: Adder, Subtractor, Comparator, multiplexer/demultiplexer, A/D converters (parallel comparator converters, counting converters, successive approximation converter, dual slop converter) and D/A converters (weighted resistance D/A, R-2R ladder converter, 0800 D/A converter).

Unit-IV

Introduction to integrated circuits, Basic concepts about fabrication and characteristics of integrated circuits, Microprocessor (8086/8088 Microprocessor) and microcontrollers (Overview of 8051 Micro Controller, Architecture, I/O ports, and Memory Organization, addressing modes and Instruction set of 8051, Simple Programs using Stack Pointer, Assembly language programming).

Unit-V

Flip -Flops: one-bit memory, The RS Flipflop, JK Flip- Flop, JK Master-Slave Flip -Flops, T Flip -Flop, D Flip- Flop, K-maps, Shift registers, Counters (asynchronous and synchronous), cascade counters, Binary counter, Decade counter,

Text/Reference Books:

1. Integrated Electronics by J. Millaman and C. Halkias, McGraw Hill, New York.
2. Electronic Devices and circuits by Malvino
3. Solid State Electronic Devices and Integrated Circuits by Ben. G. Sterectman, (Prentice Hall Inc.), 1995.
4. Physics of Semiconductors Devices by S.M. Sze (John Wiley & Sons), 1999.
5. Digital Principles and Applications by C. P. Malvino and D. P. Leach, Mc-Graw Hill, 1985.
6. Digital logic and computer design by M. M. Mano, Tata Mc-Graw Hill.
7. Digital Integrated Circuits by Taub and Shilling, Tata Mc-Graw Hill
8. Digital Fundamentals by Floyd, Mc-Graw Hill.

F] Research Project Part - I

The project shall be implemented in III semester but the final submission shall be in IV semester. However, a mid-term detailed presentation shall be made by the student with semester end examinations and he/she shall present the work plan and the work done till date. The evaluation of this paper is done with extenral practical examination.

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, Laue's Method, X-Ray Diffraction (XRD), Crystal Structure using XRD analysis, Basic principles of X-ray absorption fine structure Spectroscopy, X-ray Absorption Near Edge Structure (XANES), Extended X-ray Absorption Fine Structure Spectroscopy (EXAFS), X-ray Photo-Electron Spectroscopy (XPS).

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 6thEdition: 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 $e^+e^- \to e^+e$- Moller scattering and e.m. scattering arid process $e^+e^- \to e^+e$-. 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] - Advanced Electronics-II

Unit-I

Microwave Electronics: Introduction to Microwaves & its applications, General equation, input independence characteristic, Reflection & transmission coefficient, standing wave ratio, resonant and anti resonant line impedance matching, smith chart & its applications, coaxial, twin, strip & micro-strip lines.

Unit-II

Wave propagation in rectangular & circular wave guides, wave-guide modes, Q of wave guides, wave guide coupling, Microwave Passive Components: s-parameter representation and analysis of microwave component such as tees, two hole direction coupler attenuators, phase shifter, Rectangular cavity resonator, circulator & isolator.

Unit-III

Microwave Tube Devices: Conventional Vacuum tubes at microwave, O type device-Klystron (two cavity & reflex), M type device magnetron, Introduction to TWT (Travelling Wave Tubes), Microwave Semiconductor Devices IMPATT, TRAPATT & Gum Devices, Gyrotron, Free Electron Lasers.

Unit-IV

Opto-electronic devices: Basics of Optical Fiber, Optical Fibers- step index, single and multimode, graded index, Light propagation- total internal reflection, Acceptance angle and Numerical aperture, Fiber losses and dispersions, Optical Sources: Light Emitting diodes spontaneous emission – surface-emitting LED, edge emitters.

Unit-V

Optical Sources:LASER- stimulated emission, Double hetero structure LASER, drivers for LED and LASER, Optical Detectors: Photo detectors- characteristics of photo detectors-photoconductor, p-n photodiode, PIN photodiode Schottky barrier photodiode, Avalanche photodiode, Phototransistor.

Text/Reference Books:

1. Foundation of Microwave Engineering-R.E. Collins, Mc Graw Hill.
2. Microwave Devices & circuits-S.Y. Liao. PHI India
3. Solid State Physical Electronics-B.G. Strcetman.PHI India
4. Microwave Principles-H.J. Reich, CBS
5. Principles of Microwave Circuits-G.C. Montgomery, Mc Graw Hill.
5. Optical Electronics by Ajoy Ghatak and K. Thyagarajan (Cambridge University Press), VII Reprint, 2006.
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.

F] Research Project Part - II

Final report shall be submitted and sent to the external examiner for evaluation. The studentshall defend his/her project by presentation in-front of a panel of examiners consisting of one external examiner. The evaluation of this paper is done with extenral practical examination.

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.