।। सा विद्या या विमुक्तये ।।
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड
"ज्ञानतीर्थ" परिसर, विष्णुपूरी, नांदेड - ४३१६०६ (महाराष्ट्र)
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED
"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)
Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade
ACADEMIC (1-BOARD OF STUDIES) SECTION
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संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे **CBCS Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०–२१ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, **दिनांक २० जून २०२० रोजी संपन्न झालेल्या ४७व्या मा. विद्या परिषद बैठकीतील विषय क्र.११/४७–२०२०**च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या **संलग्नित महाविद्यालयांतील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील द्वितीय वर्षाचे** खालील विषयांचे **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०२०–२१ पासून लागू करण्यात येत आहेत.

1. M.Sc.-II Year-Botany
2. M.Sc.-II Year-Herbal Medicine
3. M.Sc.-II Year-Analytical Chemistry
4. M.Sc.-II Year-Biochemistry
5. M.Sc.-II Year-Organic Chemistry
6. M.Sc.-II Year-Physical Chemistry
7. M.Sc.-II Year-Computer Management
8. M.Sc.-II Year-Computer Science
9. M.Sc.-II Year-Information Technology
10. M.C.A. (Master of Computer Applications)-II Year
11. M.Sc.-II Year-Software Engineering
12. M.Sc.-II Year-System Administration & Networking
13. M.Sc.-II Year-Dairy Science
14. M.Sc.-II Year-Environmental Science
15. M.Sc.-II Year-Applied Mathematics
16. M.Sc.-II Year-Mathematics
17. M.Sc.-II Year-Microbiology
18. M.Sc.-II Year-Physics
19. M.Sc.-II Year-Zoology
20. M.Sc.-II Year-Biotechnology
21. M.Sc.-II Year-Bioinformatics

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.: शैक्षणिक–१/परिपत्रक/पदव्युत्तर–सीबीसीएस अभ्यासक्रम/२०२०–२१/**३३५**

दिनांक : १६.०७.२०२०.

स्वाक्षरित/–
उपकुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :
१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

SWAMI RAMANAND TEERTH MATHAWADA UNIVERSITY, NANDED

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड.

Syllabus of M. Sc. S. Y. Physics (CBCS) (Affiliated Colleges)

(effective from the Academic Year 2020-2021)

Disclaimer

Syllabus of ***M. Sc. Second Year Physics (Semesters III and IV)*** *in* ***Affiliated Colleges*** *given in this document was prepared following requirements of the* ***Choice Based Credit System (CBCS)*** *pattern, as recommended by the* ***UGC, New Delhi,*** *and has been duly approved by the* ***Faculty of Science and Technology, the Academic Council*** *and the* ***Management Council*** *of* ***S.R.T.M. University****. The same has been implemented from the academic year* ***2020-2021****.*

The Board of Studies in Physics of S. R. T. M. University, Nanded is as follows

Dr. M. K. Patil, ***Chairman,BOS*** ***Director and Professor,*** School of Physical Sciences, S.R.T.M. University, Nanded Contact No. 08308298063 Email: patil@associates.iucaa.in	**Dr. S. N. Keshatti,** Department of Physics, Shivaji Mahavidyalaya, Parbhani Contact No. 9422743448 Email: keshatti.shrinivas@gmail.com
Dr. K. S. Kanse, Department of Physics, Lal Bahaddur Shahstri Mahavidyalaya, Dharmabad, Dist. Nanded Contact No. 09850924426 Email: kskanse@gmail.com	**Dr. P. R. Mirkute,** Department of Physics, Yeshwant Mahavidyalaya, Nanded Contact No. 09420846627 Email: pravinmirkute@gmail.com
Dr. P. G. Gawali, Department of Physics, Bahirji Smarak Mahavidyalay, Basmath, Dist. Hingoli Contact No. 09421387622 Email: pggawali_123@rediffmail.com	**Dr. H. V. Bakshi,** *Head*, Department of Physics, Arts, Commerce & Science College, Shankarnagar,Tq.Biloli,Dist. Nanded Contact No. 09860058507 Email: hvbakshi@rediffmail.com
Dr. B. D. Achole, Department of Physics, Shri Havagiswami College, Udgir, Dist. Latur Contact No. 09422652892 Email: b_achole1234@rediffmail.com	**Dr. B. S. Munde,** *Head*, Department of Physics, Katruwar Arts, Ratanlal Kabra Science & B.R.Mantri Commerce College, Manwath, Dist. Parbhani Contact No. 008668413490 Email: bhaskarmunde@yahoo.com
Dr. S. D. Misal, *Head,* Department of Physics, Shri. Kumarswami Mahavidyalaya, Ausa, Dist. Latur Contact No. 09403244677 Email: misalsubhash31@rediffmail.com	**Dr. A. S. Chaudhari,** Professor, Department of Physics, Govt. Vidarbha Institute of Science, Amravati Contact No. 09421869109 Email: ajaychau5@yahoo.com
Mr. Dayanand Mane, Yog Kunj, 15, Sudashan Nagar, Pipri Meghe, Wardha Contact No.	**Dr. K. M. Jadhav,** *Professor,* Department of Physics, Dr.B.A.M.University, Aurangabad Contact No. 09422686061 Email: drjadhavkm@gmail.com
Dr. Tarun Sourdeep Ghosh, *Professor H,* IUCAA, Ganeshkhind, Pune Contact No. 020 25604212 Email: tarun@iucaa.in	**Dr. A. G. Bidwe,** Professor & Rgistrar, Sharanbasawa University, Kalburgi, Karnataka Contact No. 09243219188, email: agbidve@gmail.com
Ms. Aishwarya V. Patil, *Invitee Member, Student Representative (UG)*	**Mr. Nand Kiran Kishor,** *Invitee Member, Student Representative (PG)*

Syllabus of **M Sc Second Year Physics (Sem III and IV)** ***(Affiliated Colleges)*** given in this booklet was prepared jointly by the faculty of the School of Physical Sciences and affiliated Colleges of S.R.T.M. University, Nanded following model curriculum proposed by UGC, New Delhi and looking at the needs of the students to compete with the recent trends in higher education at national and international level. The same has been finalized by inviting comments, suggestions from experts in individual courses from various universities, institutes, industries and alumni of the School, which was then approved by the regular **Board of Studies (BOS) in Physics**, the **Faculty of Science & Technology** and the **Academic Council of the University**.

Preamble:

Swami Ramanand Teerth Marathwada University, Nanded since its establishment has been trying hard to enhance the education quality in its jurisdiction. In this endeavor the University has taken several initiatives for improving its academic standard, which include periodic upgradation and revision of the curricula in tune with the requirement at global level, using innovative methods in teaching-learning process, imparting skill based value added education, improvisation in the examination and evaluation processes, etc. These measures have found to be very effective in achieving **3Es, the *equity, efficiency and excellence*** in higher education of this region.

Following the guidelines of UGC, New Delhi and looking at the better employability, entrepreneurship possibilities and also to enhance the latent skills of the students S.R.T.M.U. has adopted the ***cumulative grade point average*** **(CGPA)** based ***Choice Based Credit System*** **(CBCS)** system for assessing performance of the students from the academic year 2016-2017. The CBCS system offers flexibility to the students in choosing courses of their own choice from the exhaustive list comprising core, elective, skill based, specializations and minor components that are evaluated following the grading system. The university shall be implementing the revised syllabus of M. Sc Physics Second Year from the academic year 2020-2021. This document provides detailed information on ethodology of choosing different components of M. Sc. First and Second Year Physics (Semester I through IV) theory and practical courses.

Master of Science (M Sc) Physics is a post graduation, two year, four semester course of S.R.T.M. University, Nanded. The Credit Based Grading System (CBCS) adopted under this course enables its stakeholders (the students) to develop a strong foundation of the fundamental Physics and also elevates their knowledge base to apply these foundations to the applied and advanced electives, specializations of their own choices. The students pursuing this course will develop in-depth understanding of various aspects of the core subjects of Physics by developing the deeper understanding level of different analogies, laws of the Nature through the subjects like classical mechanics, quantum mechanics, electrodynamics, statistical mechanics, condensed matter physics, atomic and molecular physics, nuclear physics, etc. The course also helps the students in enhancing their analytical skill through the embedded component of the problem solving skills, seminar activities and hands-on and minds-in activities of the course. The courses offered by the University are of

student-centric nature and help them to understand the basic laws of nature and develop necessary skills to apply them to the advanced areas of studies.

There are **twenty core or mandatory courses (ten theory and ten lab courses)** meant to provide adequate knowledge on various aspects of physics discipline and to prepare the students for applying them for advanced courses. In addition, there will be skill based elective (specialization) as well as few open elective courses enabling cross-discipline movement to the students. The skill based elective courses are of more advanced nature and help the students to develop their skills in specific fields through more of the hands-on activities. The details of the courses and activities are as follows:

Outline of the M. Sc. Physics Program (Choice Based Credit System):

Students of M Sc Physics program are required to complete a total of 100 credits to acquire M. Sc. Physics degree. These required 100 credits constitute following components:

i. Core Courses: Every student completing post graduation in Physics from this university is required to have a comprehensive knowledge of few of the core or compulsory courses**, which includes classical mechanics, quantum mechanics, statistical mechanics, electrodynamics, nuclear physics, etc. and the related practical courses.** There shall be **ten** such theory papers (four each in first and second semesters and one each in third and fourth semester) and corresponding laboratory courses distributed over the four semesters. These courses are designed and upgraded looking at the recent developments in the subject and are inducted in the course so as to prepare the students to apply the acquired knowledge in various skill based advanced elective courses. This could form about **70%** of the total credits of M. Sc Physics Program.

ii. Elective: Students have freedom to earn remaining 30% credits by opting courses of their own choice.

Objectives of the M Sc Physics program:

1. To develop skills of critical thinking, hypothesis building and applying the scientific method of physics concepts, theoretical models and laboratory experiments
2. To develop problem solving and analytical skills for identifying and formulating problems independently and creatively employing the theoretical and/or experimental methods that he has acquired during the course
3. To train the students with a working knowledge of experimental/computational techniques and instrumentation required to work independently in research and industrial environments
4. To prepare the students to successfully compete for current employment opportunities.

Program Ourcome:

Student after completing their post graduation in Physics (M Sc Physics) will

1. be eligible to get employment as an assistant professor, teacher,. in private, semi-government, government colleges and schools after fulfilling the requirements and can rise up to the top positions
2. pursue their higher studies in related fields including M Phil, Ph D in the national and international universities depending upon the eligibility conditions of the concerned universities
3. work as research fellow, scientist in research institutes and carry out research after qualifying the NET/SET/PET examinations
4. handle standard and advanced laboratory equipment, modern instrumentation and classical techniques to carry out experiments.

Duration:

The duration of M. Sc. Physics programme offered by the School is of 2 Years (4 semesters) with a total of 100 credits

Eligibility for Admissions to M Sc Physics Program:

- Any science graduate (B. Sc.) with Physics as main or optional subject at graduation level (B. Sc.) from any recognized university is eligible to apply for admission to the M. Sc. Physics offered by this University. However, the candidate is required to have earned at least **24 credits in Physics at his graduation**.

- Admissions to this course shall be given strictly on the basis of the merit list prepared at individual college depending on the score of the student in Physics at B. Sc level.

Examination/Evaluation Rules:

- For all the courses, 1 credit corresponds to 25 marks and requires 15 contact hours, which includes teaching, tutorials, remedial classes and seminars
- A minimum of 75 % attendance for theory and practical courses is a pre-requisite for appearing for examinations and qualifying a particular course
- The assessment of each of the theory course shall be done in two modes: i. Continuous Internal Assessment or **Mid Semester Assessment (MSA)**, and ii. **End Semester Assessment (ESA)**
- The Mid Semester Assessment shall be done throughout the semester in the form of mid-semester examinations, tests, home assignments, group discussions etc. Normally, there shall be two written tests, each of 10 marks and shall be of two hours duartion, and one home assignment of 5 marks.
- The first test shall be conducted after five weeks of the commencement of the particular course and the other test shall be conducted after the 10 weeks.
- The **Semester End Assessment (ESA)** shall be usually conducted at the end of the respective semester in co-ordination with external examiners
- The MSA and ESA, respectively, carry weightages of assessment of **25:75** percent.
- The minimum score required for passing a particular course is 40%
- There shall be independent passing for the MSA and ESA separately; otherwise the candidate shall be declaired FAIL in that particular course. However, they shall be **Allowed-To-Keep-Term (ATKT)** at the most up to 25% and shall be eligible to get admission in to the third semester.
- A student passing end semester evaluation shall have to independently pass the internal assessment as per the schedule announced by the School. There shall be no provision of conducting the repeat examination either in MSA or ESA. If a student remains absent for the internal assessment he shall be declared FAIL for that particular course
- Failed candidates reappearing for the concerned SEA have to appear for the next regular examination conducted at the end of the following semester.
- Every student admitted to M Sc Second Year Physics has to complete one project dissertation of 4 credits (100 marks). The performance of the student in project work shall be assessed in both the modes i.e., the MSA and the ESA. ESA will be conducted by a panel of external examinations, where the candidate shall give a presentation on the work that he has conducted throughout the year.
- The **evaluation and grading** of the courses shall be as per the guidelines of UGC, New Delhi and the modified **Grades and Grade Points** (As per UGC) shall be as follows:

UGC Letter Grade	UGC Grade Points	UGC Marks obtained
O : Outstanding	10	>80
A+: Excellent	9	70-79
A: Very Good	8	60-69
B+: Good	7	55-59
B: Above Average	6	50-54
C: Average	5	45-49
P: Pass	4	40-44
F: Fail	0	<40
Ab: Absent	0	---

M. Sc. Physics syllabus given in this document has been prepared by different subcommittees constituted in the meeting of the School of Physical Sciences and is finalized after inviting comments, suggestions from experts in the field in different universities, institutes, industrialists and alumni of the School. The same has been approved by the regular Board of Studies in Physics, the Faculty of Science & Technology and the Academic Council before implementation.

(Prof. M. K. Patil)
Chairman
Board of Studies in Physics

Course Structure and Marking Scheme of M. Sc. Physics in Affiliated Colleges

M. Sc. Physics First Year Semester I

Course Code	Name of the Theory Course	Credits	Contact hours		Assessment pattern (marking scheme)		
			Lect /Wk (L+T+R)	Total Hrs	MSA (T1+T2+HA)	SEA	Total Marks
PHY 101	Mathematical Methods in Physics	04	05	60	25	75	100
PHY 102	Classical Mechanics	04	05	60	25	75	100
PHY 103	Atomic and Molecular Physics	04	05	60	25	75	100
PHY 104	Electronic Devices and Applications*	04	05	60	25	75	100
PHY 105	Communication Skill / Seminar /Online Courses approved by UGC	01	--	--	--	--	25
Laboratory Courses (Annual Pattern)							
PHY 106	General Physics Laboratory	04	04	60	25	75	100
PHY 107	General Electronics Laboratory	04	04	60	25	75	100
	Total Credits / Marks	25 credits	---	---	---	---	625

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M. Sc. Physics First Year Semester II

Course Code	Name of the Theory Course	Credits	Contact hours		Assessment pattern (marking scheme)		
			Lect /Wk (L+T+R)	Total Hrs	MSA (T1+T2+HA)	SEA	Total Marks
PHY 201	Quantum Mechanics	04	05	60	25	75	100
PHY 202	Statistical Mechanics	04	05	60	25	75	100
PHY 203	Numerical Techniques in Physics	04	05	60	25	75	100
PHY 204	Condensed Matter Physics*	04	05	60	25	75	100
PHY 205	Communication Skill / Seminar/Online Courses approved by UGC	01	--	--	--	--	25
Laboratory Courses (Annual Pattern)							
PHY 206	Solid State Physics Laboratory	04	04	60	25	75	100
PHY 207	Spectroscopy & Numerical Techniques Laboratory	04	04	60	25	75	100
	Total Credits / Marks	25 credits	---	---	---	---	625

M. Sc. Physics Second Year Semester III

Course Code	Name of the Theory Course	Credits	Contact hours		Assessment pattern (marking scheme)		
			Lect /Wk (L+T+ R)	Total Hrs	MSA (T1+T2+HA)	SEA	Total Marks
PHY 301	Electrodynamics	04	05	60	25	75	100
PHY 302	Nuclear and Particle Physics	04	05	60	25	75	100
PHY 303	Basics of Lasers and Devices	04	05	60	25	75	100
PHY 304*	Elective Papers: PHY 304 (A / B /	04	05	60	25	75	100
PHY 305	Communication Skill / Seminar /Online Courses approved by UGC	01	--	--	--	--	25
Laboratory Courses (Annual Pattern)							
PHY 306	Nuclear and Lasers Laboratory	04	04	60	25	75	100
PHY 307	Thin Film and Nanophysics Laboratory	04	04	60	25	75	100
	Total Credits / Marks	25 credits	---	---	---	---	625

M. Sc. Physics Second Year Semester IV

Course Code	Name of the Theory Course	Credits	Contact hours		Assessment pattern (marking scheme)		
			Lect /Wk (L+T+ R)	Total Hrs	MSA (T1+T2+HA)	SEA	Total Marks
PHY 401	Fiber Optics and Optical Fiber Communication	04	05	60	25	75	100
PHY 402	Microwaves and Measurements	04	05	60	25	75	100
PHY 403	Microprocessors & Microcontrollers	04	05	60	25	75	100
PHY 404*	Elective Papers: PHY 404 (A / B /	04	05	60	25	75	100
PHY 405	Communication Skill / Seminar /Online Courses approved by UGC	01	--	--	--	--	25
Laboratory Courses (Annual Pattern)							
PHY 406	Microwave and Fiber Optics Laboratory	04	04	60	25	75	100
PHY 407	Project Work	04	04	60	25	75	100
	Total Credits / Marks	25 credits	---	---	---	---	625

PHY 301 – Electrodynamics

Credits: 04	*Contact Hours*: 60 *(L+T+R)*	*Total Marks:* 100 **[MSA: 25** *(T1+T2+HA=10+10+5)*; **ESA=75]**

Learning Objectives: *Objective of this course is to introduce the students to the concepts of electromagnetic field theory, interaction of EM waves matter, propagation in continuous media, reflection-refraction of EM waves at the boundaries separating two media and its application in communication theory. This paper also introduces the students to the sources of EM waves and antenna theory. Relativistic EM enables them to understand the effect of the radiation when sources are moving with relativistic velocities. Prerequisite for this course is that the students must have the idea of electrostatics, magnetostatics and electromagnetic induction phenomenon.*

Learning Outcome: *Upon successful completion of this course students will be able to apply the knowledge of Maxwell's equations to a variety of problems including various types of charge distributions including time-dependent processes, tackle the problems related to the propagation and scattering of EM waves in a variety of media, understand how to design EM sources of different powers, and will also be ablle to have a good understanding of the relativistic electrodynamics.*

Module I: Maxwell equations and Electromagnetic waves (15 Hrs)

Maxwell's equations and their physical significance. Equation of continuity & relaxation time, Vector and scalar potentials, Lorentz and Coulomb gauge, gauge transformation, electromagnetic energy and Poynting's theorem, electromagnetic wave equations in free space, their plane wave solutions, waves in conducting medium: skin effect and skin depth, waves in ionized medium (ionospheric propagation), polarization of EM waves. Concept of radiation pressure

Module II: Electromagnetic waves in bounded media (15 Hrs)

Reflection and refraction of plane electromagnetic waves at a plane interface: normal incidence, oblique incidence, Fressnel's equations, Brewster's angle. Total internal reflection. Reflection and refraction from metallic surfaces, Electromagnetic wave propagation between two parallel conducting plates, waves in hollow conductors, Rectangular wave guides - TE and TM modes.

Module III: Radiations from moving charges (15 Hrs)

Concept of retarded potential, The Lienard-Wiechert potentials, Field produced by moving charges, radiation from a linearly accelerated charged particle at low velocity, radiation from accelerated charged particles at low velocities in circular orbits-Larmor formula, radiation from accelerated charged particles at relativistic velocities in circular orbits-relativistic generalization of Larmor formula Multipole expansion of EM field, Electric dipole radiation, field due to oscillating electric dipole, magnetic dipole radiations, electric quadrupole radiation, fields due to linear centre-fed half wave and full wave antenna, array of antennae

Module IV: Covariance and Relativistic Electrodynamics (15 Hrs)

Basic kinematical results of special relativity (length contraction, time dilation, addition of velocities, charge invariance, field transformation), relativistic momentum and energy of a particle, 4-vectors in electrodynamics, 4-potential and 4-current, electromagnetic field tensor, Lorentz force and equation of motion of a charged particle in an electromagnetic field, Covariance of Maxwell's equations, transformation of EM fields and field tensor. Electromagnetic wave equation and plane wave solution in 4-vector form.

Reference Books:

1. Classical Electrodynamics - J.D.Jackson (John Wiley & Sons)
2. Introduction to Electrodynamics, (3rd Edition) by David J.Griffith. (Prentice-Hall, India)
3. Classical Electromagnetic Radiation - J.B.Marion (Academic Press)
4. The Classical theory of Fields - Landau & Lifshitz (Pergman Press)
5. Electrodynamics of continuous media - Landau & Lifshitz (Butter Worth)
6. Electricity and Magnetism - David J.Griffiths (PHI)
7. Electricity and Magnetism - Panofsky and Philips
8. Electromagnetic waves and fields - R.N.Singh (Tata McGraw Hill)
9. Electromagnetic Waves and Radiation system - Jordan and Balman (PHI)
10. Electromagnetic Fields and waves -Paul Lorrain and Dale Corson (CBSPub)
11. Electromagnetics - B.B.Laud (New Age Intl. Pub.)
12. Introduction to Electrodynamics- A. Z. Capri and P. V. Panat (Narosa)

PHY 302 – Nuclear and Particle Physics

Credits: **04**	*Contact Hours*: **60** *(L+T+R)*	*Total Marks:* **100** **[MSA: 25** *(T1+T2+HA=10+10+5)*; **ESA=75]**

Learning Objective: *This paper is about the Physics of Nucleus. It helps to introduce students about the fundamental principles of nucleus and understanding at deeper level concepts governing nuclear and particle physics and new phenomenon at each level. It gives information about elementary particles*

Learning Outcome: *After the completion of the subject the students are able to know its Scientific and technological applications in addition with social, economic and environmental implications.*

Module I: Basic Nuclear Properties and Interaction of Radiation with Matter (15 Hrs)

Basic Nuclear Properties: Nuclear mass, Nuclear size : Nuclear Radius & its determination by Rutherford scattering, electron scattering & mirror nuclei method, Nuclear quantum numbers, Angular momentum, nuclear dipole moment, electric quadruple moment, Nuclear Binding , average binding energy and its variation with mass number, Semi empirical mass formula & its applications.

Module II: Interaction of nuclear radiation with matter and elementary particles (15 Hrs)

Interaction of charged particles & electromagnetic rays with matter, range, straggling, stopping power, interaction of alpha, beta, gamma rays with matter, absorption law of gamma rays, photoelectric effect, Compton effect, pair production, annihilation of electron- positron pair

Nuclear Detectors: Classification, Ionization chamber: Principle, construction and working,

Proportional counter: Principle, construction and working,

Geiger Muller counter: Principle, construction and working (pulse formation, dead time, recovery time etc), quenching of discharge, Regions of multiplicative operations,

Scintillation Detector: photo multiplier tube, organic and inorganic scintillators, scintillation process, theory, characteristic and detection efficiency

Semiconductor Detector: properties, types (diffuse junction and surface barrier), Li drifted junction detector

Elementary particles: classification, their interaction, types: weak, strong and electromagnetic interactions, their quantum numbers (charge, lepton number, baryon number, iso-spin, strangeness etc), conservation laws: elementary ideas of CP and CPT invariance, Quark theory: assumptions, properties, classification, Gell- Mann mass formula colour of quark & its importance.

Module III: Nuclear Forces and Nuclear Models (15 Hrs)

Nuclear Forces: Introduction , properties, characteristics, spin dependence of nuclear forces, charge independence & charge symmetry of nuclear forces, Elements of two body problem (Deuteron), its properties, Meson theory of nuclear forces, exchange force and tensor forces, its properties, neutron-proton scattering at low energy, partial wave analysis, phase shift.

Nuclear Models:

Nuclear shell model: spin orbit coupling, nuclear magic numbers, experimental evidences of magic numbers, Angular momenta and parities of nuclear ground states, significance, achievements and limitations, magnetic moment and Schmidt lines.

Liquid drop model: assumptions, achievements, Bohr Wheeler theory of fission, Failure and limitations of liquid drop model,
Collective model: vibration and rotation states, achievements of Bohr and Mottelson collective model
Fermi gas model: assumptions, achievements, limitations of Fermi gas model

Module IV: Nuclear decay & Nuclear decay Reactions (15 Hrs)

Radioactive decay, laws of successive transformation, dosemetry, nuclear reactions: types, kinematics, transmutation, fission & fusion concept, energy production in stars, P-P and C-N cycles.
β – decay, three forms of β- decay, Fermi and Gamow Teller transitions, Fermi theory of β- decay, Kurie plot, Angular momentum and parity, selection rules, allowed and forbidden transitions, non conservation of parity in β- decay, neutrino hypothesis: detection and properties.

Reference Books:

1. Nuclear Physics, D.C.Tayal,(Himalaya Publishing House, Mumbai)
2. Introduction to Elementary Particles, D. Griffiths, 2nd Ed., Academic Press, 2008.
3. Introductory Nuclear Physics, S.S.M. Wong, 2nd Ed., Wiley VCH, 2004
4. Nuclear Physics, Kaplan, Addison Wesley, (Indian Ed., from Narosa Publishing House, New Delhi), 2002.
5. Introduction to nuclear physics , S.B Patel
6. Concept of Nuclear Physics, B.L. Cohen, McGraw-Hill, 2003.
7. Nuclear & Particle Physics: An Introduction, B. Martin, Willey, 2006.

PHY 303 – Basics of Lasers and Devices

Credits: **04**	*Contact Hours*: **60** *(L+T+R)*	*Total Marks:* **100** **[MSA: 25** *(T1+T2+HA=10+10+5)*; **ESA=75]**

Module I. Basics of Laser (15 Hrs)

Introduction, Interaction of Light and Matter, Quantum Behavior of Light, Energy Levels, Population, Thermal Equilibrium, Absorption and Emission of Light, Einstein's prediction and three processes, Light Amplification, High Intensity, Einstein's Relations, Conditions for Large Stimulated Emission, Conditions for Light Amplification, Population Inversion, Pumping, Pumping Methods: Optical; Electrical; Direct Pumping, Active Medium, Metastable States, Pumping schemes, Properties of Laser- Directionality, Intensity, Coherence, Monochromaticity, Polarization.

Module II. Optical Resonator and Laser Cavity Modes (15 Hrs)

Optical Resonator: Introduction, Action of Optical Resonator, Threshold Condition, Critical Population Inversion, Condition for Steady State Oscillation, Cavity Resonance Frequencies, Line Broadening Mechanism, Natural or Intrinsic Broadening, Collision Broadening, Doppler Broadening,

Laser Cavity Modes: Introduction, Cavity Configuration, Modes: Longitudinal and Transverse Modes, Single Mode Operation, Laser Rate Equation: Two Level System, Three Level System and Four Level System, Comparison of Three Level System and Four Level Lasers, Optimum Output Power, Properties of Laser Modes,

Module III. Types of Laser (15 Hrs)

Introduction, **Solid State Laser:-** General Description, Structure and Working: Ruby Laser, Nd: YAG Laser, Nd: Glass Laser**Gas Laser**:- General Description, Structure and Working of : He-Ne Laser, Argon Laser, CO_2 Laser **Semiconductor lasers**- Population inversion, pn junction, Lasing condition, Gain in a semiconductor, Optical cavity, Threshold condition for lasing, Threshold population inversion, and current density, Power output, Efficiency, Basic Laser structure, Diode laser operation

Module IV. Application of lasers (15)

Application of lasers : Introduction, optical fiber lasers (Low and High Power) for Industrial, Medical and Communication applications, High Power Gas Lasers

Material Processing with Lasers – Surface treatments, Drilling with Lasers, Cutting Process with Lasers, Laser Welding Process

Lasers in Nuclear Energy: Nuclear Fusion, Nuclear Fission, Laser in Isotopes Separation

Lasers in Medicine and surgery: Biological Effect of Electromagnetic Radiation , Laser Diagnostics,

Lasers in Electronics industry

Lasers in Consumer Electronics industry

Recommended Books:

1. An Introduction to Laser: Theory and Applications-M.N. Avadhanulu (S. Chand and Company Ltd. Ram Nagar, New Delhi 2008)
2. Lasers- Principles, Types and Applications- K.R. Nambiar, (New Age International Publishers 2006)

Reference Books:

1. Laser Fundamentals- William T. Silfvast Cambridge University, Press
2. Laser and its Applications – Ghatak and Thyagarajan (Mcmillan, India 2004)
3. Lasers and Non-Linear Optics- B.B. Laud (New Age International Publishers 2006)

PHY 304 – Elective Paper *A. This Film and Nano Physics*

Credits: 04	*Contact Hours*: 60 *(L+T+R)*	*Total Marks:* 100 **[MSA: 25** (*T1+T2+HA=10+10+5)*; **ESA=75]**

Module I. This Film Deposition Methods (15 Hrs)

Introduction to Thin Films, Physical Methods - Thermal evaporation methods: Resistive heating, Flash evaporation, Laser evaporation, Electron bombardment heating, Arc evaporation, Sputtering process: Glow discharge, DC sputtering, Radio frequency sputtering, Magnetron sputtering, Ion beam sputtering.

Module II. Chemical Methods (15 Hrs)

Chemical vapor deposition: Common CVD reactions, Methods of film preparation, laser CVD, Photochemical CVD, P lasma enhanced CVD, Chemical bath deposition: ionic and solubility products, preparation of binary semiconductors,

Electrode position: Deposition mechanism and preparation of compound thin film

Spray pyrolysis : Deposition mechanism and preparation of compound thin Films

Module III. Nucleation, Growth and Structure of films (15 Hrs)

Nucleation: Condensation process, Langmuir- Frenkel theory, other theories of condensation and experimental results

Growth: Liquid like coalescence, influence of deposition parameters, physical structure of films, Crystallographic structure of films: lattice constant, Size effect, Disordered and amorphous structures, Epitaxial growth of thin films: Influence of substrate and deposition conditions, theories of Epitaxy.

Module IV. Properties of Thin Films, Nanoscience and Nanotechnology (15 Hrs)

Mechanical properties: Stresses in thin films, Mechanical constants of thin films,

Electrical properties: Electrical conduction in thin metallic discontinuous films, Electricalconduction in thin metallic films, **Optical properties:** Optical constants of thin films, experimental methods as Reflection, Interferometric, and Critical angle method.

Nanoscience and Nanotechnology

Introduction, Nanoscience and nanotechnology, Quantum structures, Nanoclusters, organic nanocrystals. **Synthesis of Nanomaterials:** metal colloids, Nanoclusters, nanotubes, nanowires, nano rods, nanocrystalline materials, oxide nanoparticles. **Application of Nanotechnology**: Nanobiology, nanocatalysis, nanoelectrodes, nanoswitches, nanocomputers

Reference books

1. Thin Film Phenomena by K L Chopra McGraw -Hill Book Company, NY 1969
2. Thin Film Technology by O S Heavens (1970)
3. Properties of Thin Films by Joy George, Marcel and Decker, (1992) (For Units 1-3)
4. Physics of Thin Films L Eckertova, P lenum Press NY (1980) (For Unit 4)
5. Thin Film Fundamentals (New Age International P ublishers, New Delhi), by A. Goswami
6. Nanoscience and Nanotechnology V. S. Muralidharan, A. Subramania (Ane Books Pvt. Ltd.)(For unit V)
7. Encyclopedia of Nanoscience S. K. Prasad (Discovery Publishing house, New Delhi)

PHY 304 – Elective Paper *B. Materials Science*

***Credits:* 04**	***Contact Hours*: 60** *(L+T+R)*	***Total Marks:* 100** **[MSA: 25** *(T1+T2+HA=10+10+5)*; **ESA=*75*]**

Module I. Types of Materials and Glasses **(15 Hrs)**

Materials Science: Introduction, Importance of materials, Types of materials, Typicalmaterials behaviour, significant properties, Applications.

Glass: Types of glasses, Glass Manufacturing process, Ceramics: Types of ceramics, Processing ceramics, Concrete: properties of concretes, Constituents of concretes (Cement, Aggregate, Water, Admixtures), Characteristic of good concrete, Classification of concrete, properties of cement concrete, water proof concrete, R.C.C (properties, advantages and disadvantages, uses), Adhesives, abrasives, Application of concretes

Module II. Magnetic and Bio Materials **(15 Hrs)**

Magnetic Materials: Terms related to Magnetic Materials, origin of magnetism, Classification of magnetic materials, Magnetic Domains, Magnetization, Magnetic anisotropy, Losses in magnetic materials, Factors effecting permeability and Hysteresis loss, soft and hard magnetic materials, Ferro fluids.

Bio Materials : General aspects of good timber, Advantages and disadvantages of Timber, Uses of timber, Defects in timber, seasoning of timber, Decay of timber, Testing timber. Play-wood, Lamin board, Black board, Fiber board, Hard Board.

Module III. Dielectric and Ferroelectric Materials **(15 Hrs)**

Dielectric as an electric field medium, Leakage currents, Dielectric losses, Breakdown voltage and Dielectric strength, break down in solid dielectrics, liquid dielectrics, Gases as dielectrics, polarization, Electrical conductivity in solid liquid and gaseous dielectrics. Applications of dielectric materials.

Common ferroelectric materials, Properties of ferroelectric materials in static field, spontaneous polarization, causes for existence of curie temperature, application of ferroelectric materials. Antiferroelectric materials, piezoelectric materials, pyroelectric materials.

Module IV. Materials Synthesis **(15 Hrs)**

Solid State Reactions:general principles, processes of the reactions between solids, precursor, solution and gel methods, sealed tubes and special atmospheres, solution and hydrothermal methods, phase diagram and synthesis. Low temperature reactions, intercalation in layer structures, insertion compounds of metal oxides, ion exchange methods.

Synthesis by different wet chemical techniques viz., sol-gel, combustion, emulsion and polyol methods, Self-propagation combustion reaction, precursor dependent process, Microwave assisted process, Hydrothermal bomb calorimeter-hydrothermal and solvo-thermal process, Interfacial growth materials between the two immiscible phases,

Reference books:

1. Elements of Materials Science and Engineering, L Van Vlack, 6th ed., Addison Wesley, MA, 1999.
2. Materials Science and Engineering; An Introduction, W D Callister, Wiley, 2002
3. Modern Perspectives in Solid-State Chemistry,C N R Rao and J Gopalkrishanan, 1998
4. Electronic Ceramics, L M Levinson, Marcel Dekker, NY, 1988

PHY 306 – Nuclear Physics and Lasers Laboratory

Credits: **04**	***Contact Hours*: 60** *(Hands-on)*	***Total Marks:* 100** **[MSA=25; ESA=*75*]**

Nuclear Physics Lab.

1. Gamma Ray Spectrometer-1(Calibration)
2. Determination of operating voltage of G. M. tube
3. Random Nature of Radioactive decay
4. Absorption coefficient of Al.
5. Determination of half life of In.
6. Dead time of G.M.tube using single source
7. Dead time of G.M.tube using double source
8. Inverse square law
9. Gamma ray spectrometer-2

Laser Lab

1. To determine the grating pitch of transmission grating using laser.
2. To find the refractive index of transparent glass plate by measuring Brewster angle using laser.
3. To observe diffraction pattern and to calculate the slit width using laser.
4. To determine the absorption coefficient of liquid (water) using laser.
5. To study the shape of laser beam cross-section and to evaluate beam spot size.
6. To find the refractive index if transparent bar using diode laser.

Note: Every student is required to perform **at least Ten (10) experiments (five from each paper)** out of the list given above. They have to complete the record book / journal listing at least 10 experiments and have to submit/present before the panel of examiners at the time of their practical examination conducted by a panel of external examiners.

PHY 307 – Lasers, Thin Film and Nano Physics Laboratory

Credits: 04	*Contact Hours*: 60 *(Hands-on)*	*Total Marks:* 100 **[MSA=25; ESA=*75*]**

Laser Lab

1. To calculate the wavelength of laser using Michelson Interferometer.
2. To determine data track spacing on CDs using laser.
3. To determine the unknown concentration of the sugar solution using laser.
4. To determine the angle of wedge plate using laser.
5. To determine the refractive index of liquids using laser.
6. To determine and study the power distribution within the laser beam.

Thin Film and Nanophysics- Lab Work

1. Thin film deposition by Chemical bath deposition technique
2. Thin film deposition by Successive Ionic Layer Absorption and Reaction (SILAR)
3. Thin film deposition Deposition of electrodeposition
4. Crystal growth by gel technique
5. Measurement of Thermoelectric power
6. Determination of optical band gap
7. Study of Type of transition involved in optical absorption spectra of th in film
8. Photoconductivity Studies of thin film
9. Electrical Conductivity by Two Probe Method of thin film
10. Resistivity by Four probe method
11. Hall effect

Note: Every student is required to perform **at least Ten (10) experiments (five from each paper)** out of the list given above. They have to complete the record book / journal listing at least 10 experiments and have to submit/present before the panel of examiners at the time of their practical examination conducted by a panel of external examiners.

PHY 401 – Fiber Optics and Optical Fiber Communication

Credits: **04**	*Contact Hours*: **60** *(L+T+R)*	*Total Marks:* **100** **[MSA: 25** *(T1+T2+HA=10+10+5)*; **ESA=75]**

Module I. Elementary Theory of Optical Fibers (15 Hrs)

Ray Theory of transmission and preparation of optical fibers: Propagation of light in different media : propagation of light in an optical fiber, Basic structure and optical path of an optical fiber, Acceptance angle and acceptance cone, Numerical aperture(NA) (General), Modes of propagation, Meridional and skew rays, Number of modes and cut-off parameters of fibers.

Fiber Fabrication Techniques : Chemical vapour deposition technique, Double cruciblemethod.

Module II. Losses, Dispersion in Fibers, Sources and Detectors for Optical Fiber (15 Hrs)

Fiber Losses : Attenuation in optic fibers, Materials or impurity losses, Rayleigh scatteringlosses, Absorption loss, Leaky modes, Bending losses, Radiation losses.

Dispersion in optical fiber : Electrical Vs. optical bandwidth. Bandwidth-length product, Intermodaldispersion, Mixing modes, Material chromatic dispersion.

Light Sources and Detectors for Optical Fiber

Light Sources : Introduction, LED (Light Emitting Diode), Processes involved, structurematerial and output characteristics of LED, Fiber LED coupling, Bandwidth, Spectral emission of LEDs, LASERS : Operation types, Spatial emission pattern, Current Vs. output characteristics.

Detectors : Introduction, Characteristics of photodetectors (General), hotoemissive type, Photoconductive and photo voltaic devices, PN junction type, PIN photo diode, Avalanche photo diode (APD).

Module III. Fiber Optic Sensors, Communication Systems and Modulation (15 Hrs)

Fiber optic sensors : Introduction, Fiber optic sensors, Intensity modulated sensors, Micro bend strain intensity modulated sensor, Liquid level type hybrid sensor, internal effect intensity modulated sensor, Diffraction grating sensors and Interferometric sensors. **Communication systems :**Transmitter for fiber optic communication, High performancetransmitter circuit LED – Analog transmitter, LASER transmitter, Digital laser transmitter, Analog laser transmitter with A/D conversion and digital multiplexing, Fiber optic receiver, Fiber based modems : Transreceiver.

Modulation : LED analog modulation, Digital modulation, Laser modulation, Pulse code modulation (PCM), Intensity modulation (IM).

Module IV. Optical Fiber Communication and Measurements of Optical Fibers (15 Hrs)

Optical fiber communication systems : Introduction, Important applications of integratedoptic fiber communication technology, Long haul communication, Coherent optical fiber communication, Principle of coherent detection.

Measurements on Optical Fibers : Introduction, Measurements of numerical aperture (NA), Measurements of Fiber- attenuation, Optical time Domain Reflectometry (OTDR), Measurements of dispersion losses, Measurements of refractive index, Cut-off wavelength measurement, Measurements of Mode Field Diameter (MFD), Near field scanning technique.

Reference Books:

1. Optical Fiber Communications : Principles and Practices- John M. Senior(Phi)
2. The Element of Fiber Optic- S.I. W. Meardon (Regend and P h)
3. Optical Fiber Communication- G. Keiser (Mc Graw Hill)
4. Introduction to Fiber Optics- A. Ghatak and Tyagrajan (Cambridge University Press)
5. Optical Fiber Communication- Joseph C. Palais(Ph)
6. Fiber Optics- N.S. Kapany(Academic Press)
7. Optical Fiber and Optical Fiber Communication Systems S.K.Sarkar (S. Chand and Comp.)

PHY 402 – Microwaves and Measurements

Credits: 04	*Contact Hours*: 60 *(L+T+R)*	*Total Marks:* 100 **[MSA: 25** *(T1+T2+HA=10+10+5)*; **ESA=75]**

Module I. Microwave Fundamentals (15 Hrs)

Microwave frequencies and band description, Fundamentals of transmission lines and different types of transmission lines, characteristics of transmission line, propagation constant and losses in transmission line, transmission line equation solution, Reflection coefficient and transmission coefficient, Standing wave and standing wave ratio, Line impedance and admittance, Smith chart and its application.

Module II. Microwave Passive Devices (15 Hrs)

Rectangular wave guide, Circular wave guide, Microwave cavities, Microwave hybrid circuit, Directional coupler, Circulators and ferrit devices, Attenuators, Scattering matrix, Isolators

Module III. Microwave Active Devices (15 Hrs)

Klystron, Velocity modulation, bunching process, Reflex Klystron, efficiency, Basic principle of magnetron, Principles and operations of magnetrons and traveling wave tube, Helix TWT's amplification process, wave modes and gain.

Transfer electron devices: Gunn diode, Gunn effect, principle of operation, modes of operation, Pin diode.

Module IV. Microwave Measurements and Applications (15 Hrs)

Measurement: Attenuation measurement, Frequency measurement, Power measurement, Reflection coefficient and VSWR measurement, Impedance measurement.

Applications: Antenna fundamental, Microwave antennas, Power received from an antenna, Radiation pattern, Radiation resistance, Efficiency, Directivity and gain, Antenna types, Rectangular horn antennae, H and E plane Horn antennae, Radar system, Basic radar system, Radar range, Moving target indicator, Time domain reflectometry.

Reference Books:

1. Microwave Radar Engineering – M. Kulkani, Umesh Publication, New Delhi
2. Microwave Devices and Applcations – Danish C. Dube, Narosa Publshing House, New Delhi
3. Understanding Microwaves – Allan D. Scott, John Wiley & Sam Ins. Publication
4. Microwave Devices and Circuits- Samull Y. Lio, Prentice Hall of India Pvt. Ltd, New Delhi.
5. Microwave Communications Components and Circuits- Hunds, Mc Graw Hill, International Edition.
6. Microwave Techniques- D.C. Agarwal, S. Chand and Company.
7. Microwave Principles- Herbert S. Reich, C.B.S. Publications.
8. Microwave Propagation and Techniques- D.C. Sarkar, S. Chand and Company.
9. Microwave Fundamental- Sanjeeva, Gupta and Others, Khanna Publications.
10. Microwave Circuits and Passive Devices- Sisodia and Raghuvanshi, Wiley Easter Ltd.
11. Antenna Theory and Design- Warren L. Stutzman Gray A. Thiele, John Wiley and Sons, Inc.

PHY 403 – Microprocessors and Microcontrollers

Credits: **04**	*Contact Hours*: **60** *(L+T+R)*	*Total Marks:* **100** **[MSA: 25** *(T1+T2+HA=10+10+5)*; **ESA=75]**

Module I. Architecture of Microprocessor 8085 **(15 Hrs)**

Intel 8085- Block diagram, ALU, Timing and control unit, Registers, Data and address bus, Pin configuration, Instruction word size, Instruction cycle, Fetch operation, Execute cycle, Machine cycle and state, Instructions and data flow, Timing diagram, Memory read, I/O read, Memory write, I/O write

Module II. Programming of Microprocessor 8085 and Data Transfer Techniques **(15 Hrs)**

Introduction, Instruction set for 8085, Programming of 8085, Assembly language programming (Data Transfer, Arithmetic, Branching, and Logical group). Programmed data transfer, Synchronous, Asynchronous and interrupt drivers modes, DMA, Serial data transfer.

Module III. Microprocessor 8086 and Micro-controller 8051 **(15 Hrs)**

Architecture of 8086, Pin diagram and pin function, Register organization, Minimum and Maximum mode of 8086, Microprocessor 80286, 80386 (Block Diagram only)

Micro-controller 8051

Introduction to 8 - bit micro-controller, Architecture of 8051 signal description of 8051, Register set of 8051, Important operational features of 8051, Memory and I/O addressing by 8051, Interrupts of 8051, Instructions set of 8051, programming of 8051 (Simple Arithmetic and Logical programs).

Module IV. 16 Bit Micro-controller and Embedded Controllers **(15 Hrs)**

Introduction, Architecture of 16 bit micro-controller (MCS-96 or 80196), General features of 80196, Register set of 80196, I/O processor, UPI 452 (Universal Peripheral Interface), Intel 80960 (block Diagram and its description only).

Reference Books:

1. Microprocessor Architecture, Progrmmining and Applications- R. Gaonkar, Wily-Eastern Ltd.
2. Microprocessor and Microcontroller- B. Ram, Dhanpati Rai and sons Delhi
3. Advanced Microprocessor and Principles- A.K. Ray, K.M. Bhurchandi Tata Mc Graw Hill Publication Co. Ltd. New Delhi.
4. The 8085 Basics, Progamming and Interfacing- U.V. Kulkarni and T.R. Sontakke, Sadhu Sudha Prakashan, Nanded.
5. Microprocessor and Digital Systems- Dauglas Hall, Tata Mc Graw Hill
6. Introduction to Microprocessor- A.P. Matur(TMH)
7. Advanced Microprocessor and Interfacing- B. Ram (TMH).
8. Microprocessor Architecture, Progrmmining and Applications With 8086 / 8080- R. Gaonkar, Wily-Eastern Ltd.

PHY 404 – Elective Paper *A. Energy Physics*

***Credits:* 04**	***Contact Hours*: 60** *(L+T+R)*	***Total Marks:* 100** **[MSA: 25** *(T1+T2+HA=10+10+5)*; **ESA=75]**

Module I. Conventional and Non-conventional Energy Sources (15 Hrs)

World production and reserves of commercial energy sources - fossil fuel, hydroelectric power, Nuclear energy.
Indian energy scenario- fossil fuel, hydroelectric power, Nuclear energy power plants.
Non conventional energy sources: Solar energy, Bio mass and Bio gas energy, Tidal energy, Geothermal energy, Hydrogen energy, Fuel cells (brief description)

Solar constant, Solar radiation at earth's surface, Solar radiation measurement-The Moll-Gorezynskipyranometer, The Epplypyranometer, Sun shine recorder

Photo voltaic conversion technologies

Purification of Silicon, The Czocharalski (CZ) method of crystal growing, Silicon wafer to Solar cell fabrication , Module design, Photovoltaic applications

Module II. Solar energy collectorsand **Solar Energy Applications (15 Hrs)**

Solar energy collectors: Physical principle of the conversion of solar radiation into heat
Flat plate collectors: A typical liquid collector, basic elements, materials for Flat plate collectors Selective absorber coatings
Solar Concentrating Collectors: Parameters characterizing solar concentrators, Parabolic trough collector, Mirror strip collector, Fresnel Lens collector, Compound parabolic concentrator, Central Tower Receiver system

Solar Energy Applications:

Solar Water Heaters: Natural circulation solar water heater (pressurized and non pressurized)
Solar Cooker: Design principle and constructional details of Box Type Solar Cooker, Box Type Solar Oven (Multi reflector type), merits and limitations
Solar Desalination: Introduction, Simple Solar Still
Solar Drying of Food: Introduction, types of Solar Dryers- Natural Convection Solar Dryer, Mixed mode type Solar Dryer
Solar Pond: Introduction, Principle of operation and description of non-convective solar pond

Module III. Energy from Biomass and**Biogas generation (15 Hrs)**

Energy from Biomass: Introduction, Biomass conversion technologies- Biomass conversion, thermo chemical conversion, Wet processes, Dry processes

Biogas generation: Introduction, Anaerobic digestion and its advantages, Basic processes and energetic. Factors affecting generation of Biogas (brief description), Classification of Biogas plants Advantages and Disadvantages of floating drum and fixed dome type plant, KVIC digester

Module IV. Fuel Cells and Hydrogen Energy (15 Hrs)

Fuel Cells: Introduction, Design and principles of operation of a fuel cell, Types of fuel cells-Ion exchange membrane cell, Molten carbonate cell, photo chemically regenerative fuel cell, Advantages and Disadvantages of fuel cell,

Hydrogen Energy: Introduction, Hydrogen production, Electrolytic production of Hydrogen-Tank type and filter press electrolyzer, Hydrogen production and storage (brief description)

Reference Books:

1. Non conventional energy sources - G D Rai
2. Solar Energy -Garg and Prakash (PHI)
3. Solar Energy -S. P. Sukhatme (TMH)
4. Solar Cells -M. A. Green (PHI)
5. Biogas Technology -B. R. Veena (Ashish Pub. House)

PHY 404 – Elective Paper *B. Electronic Instrumentation*

***Credits:* 04**	***Contact Hours*: 60** *(L+T+R)*	***Total Marks:* 100** **[MSA: 25** *(T1+T2+HA=10+10+5)*; **ESA=75]**

Module I. Instrumentation **(15 Hrs)**

Introduction, definition, purpose of instrumentation. Measurement, types of measurements, importance of measurements, classification of instruments, generalized measurement system, instrument characteristics, error, types of errors.

Module II. Transducers **(15 Hrs)**

Definition, types of transducers, classification of transducers, resistive, inductive, capacitive, piezoelectric, photoelectric transducers. Temperature transducers, pressure and displacement transducers, strain gauges, optical transducers, detectors, biomedical electrode and transducers.

Module III. Electrical conductivity measurement and PC Instrumentation **(15 Hrs)**

Conductivity cell, AC electrodynamometer, pH measurements, pH meter. Automation in digital instruments, auto-zeroing, auto-ranging, automatic polarity indication. Digital storage oscilloscope.

PC Instrumentation

PC for measurement and control: Role of PC in instrumentation, application of PC for measurement of displacement, temperature measurement and control. AC motor speed measurement and control.

Module IV. Telemetry and data acquisition system **(15 Hrs)**

Introduction, types of data acquisition system, basic elements of data acquisition system, sample and hold circuit. Digital instruments-DFM, DMM, Q meter, lock in amplifier, thickness measurement using LVDT, humidity Measurement. Recorders-X-Y recorder, strip chart recorder, magnetic tape recorder.

Reference books:

1. B. C. Nakra and K. K. Choudhri: Instumentation, measurement and analysis, TMH,
2. D. V. S. Murthy: Transducers and instrumentation, PHI, 1995.
3. Rajesh Hongal: DBM PC and clones.

PHY 406 – Microwave and Fiber Optics Laboratory

Credits: 04	*Contact Hours*: 60 *(Hands-on)*	*Total Marks:* 100 **[MSA=25; ESA=*75*]**

Section A. Microwave Laboratory

1. Microwave bench and components setup study.
2. Characteristics of Reflex Klystron.
3. Characteristics of Gunn diode.
4. Study of Isolator, Circulator and Directional coupler,
5. To study Faraday rotator and determine Faraday rotation angle.
6. Measurement of VSWR / Reflection coefficient with different load.
7. Measurement of frequency of microwave source and establish relation between guided wavelength and free space wavelength.
8. Microwave detector characteristics.
9. To measure the performance of directional coupler.
10. To measure the performance of E-plane, H-plane and Magic tee.
11. Study of Horn antenna (Power distribution pattern).
12. To determine dielectric constant of solid using slotted section waveguide.
13. Dielectric constant of various liquids.

Section B. Fiber Optics Laboratory

1. Fiber end preparation launching of light into fiber.
2. Measurement of numerical aperture by zig method.
3. Measurement of numerical aperture by modal dispersion method.
4. Measurement of diameter of single mode fiber.
5. Determine the refractive index of glass slab and To study the total internal reflection.
6. Fiber to fiber (multimode) splice loss.
7. V-parameter of single mode fiber.
8. Loss measurement in single mode fiber.
9. Study of VDL (Visual diode laser).
a) Responsivity b) I / O Characteristics c) Inverse square law
10. Study of spectral response and spatial response of the detector.
11. To determine spatial, transverse and angular losses of a given multimode fiber.
12. To determine wavelength (λ) of laser source by diffraction grating.
13. To study the LED characteristics and determine the Plank's constant (h).

Section C. Microprocessor Lab

1. Write an ALP to transfer data bytes.
2. Write an ALP for various Arithmetic operations.
3. Write an ALP for different Logical operations.
4. Write an ALP to find out Smaller and Larger number.
5. ALP for port configuration of 8085 using 8255.
6. Study of 8255 (PPI).
7. Study of 8253 timer.
8. Study of 8257
9. Study of 8279
10. ALP for generation of Square wave

Section D. Microcontroller Lab

1. Write an ALP for addition and verification by using 8051 microcontroller.
2. Write an ALP for subtraction and verification by using 8051 microcontroller.
3. Write an ALP for multiplication and verif ication by using 8051 microcontroller.
4. Write an ALP for division and verification by using 8051 microcontroller.
5. Write an ALP to find the 1's compliment 8 bit and 16 bit number using 8051 microcontroller.
6. Write an ALP to find the 2's compliment 8 bit and 16 bit number using 8051 microcontroller.
7. Write ALP for ascending /descending order of data.
8. Interfacing of seven segment display.

Note: Every student is required to perform **at least Sixteen (16) experiments (minimum of six from each section)** out of the list given above. They have to complete the record book / journal listing a minimum 16 experiments and have to submit/present before the panel of examiners at the time of their practical examination conducted by a panel of external examiners.

PHYCL 407 Project Work

Credits: **04**	*Contact hours*: **60** *(Hands-on)*	*Total Marks:* **100** **[MSA=25(Seminar), ESA=*75(Project Work)*]**

All the students admitted to M Sc Second Year Physics program are required to complete one project dissertation of 4 credits (100 marks). The performance of the student in project work shall be assessed in both the modes i.e., the MSA of 25 marks and the ESA of 75 marks. The assessment of this Project Work shall be done as:

1. Project work (75 Marks)

The student will present his Project Work in the form of a Dissertation / Thesis based on the work he has carried out and the results derived out of it. He may carryout this work either independently or in association with a research group in the S.R.T.M. University Campus or in State or National Research Institutes.

2. Seminar (25 Marks)

Every student is required to deliver a seminar on the topic allotted to him. He will also be required to present it in the form of a report at the time of Examination.

Question Paper Pattern

Semester End Assessment
M. Sc. First and Second Year Physics (CBCS)

Time: 03 Hrs **Total Marks: 75**

Note: All questions are compulsory and carry equal marks

Question 1 – Single long questions **15 marks**

OR

Two sub-questions (a and b of 8 and 7 marks) **15 marks**

(Note: This question will be based on Module I)

Question 2 – Single long questions **15 marks**

OR

Two sub-questions (a and b of 8 and 7 marks) **15 marks**

(Note: This question will be based on Unit II)

Question 3 – Single long questions **15 marks**

OR

Two sub-questions (a and b of 8 and 7 marks) **15 marks**

(Note: This question will be based on Unit III)

Question 4 – Single long questions **15 marks**

OR

Two sub-questions (a and b of 8 and 7 marks) **15 marks**

(Note: This question will be based on Unit IV)

Question 5 – Write Short Notes on ANY THREE (each of 5 marks) **15 marks**

a.
b.
c.
d.

(Note: This question shall be based on entire syllabus and must have one sub-question from each of the module)

Question Paper Pattern for Practical Course
M Sc S Y Physics (CBCS)

Time: 03 Hrs **Total Marks: 75**

Note: ***i. Every student is required to perform TWO experiment in the Semester End Examination***
ii. The distribution of the marks will be as given below

(a) Experimental work	**50** ***marks***
(b) Viva-voce	**15** ***marks***
(c) Journal	***10 marks***

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