॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड - ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'B++' grade

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण–२०२० नुसार पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक २२ एप्रिल २०२६ रोजी संपन्न झालेल्या मा.विद्यापरिषद बैठकीतील विषय क्र.०८/६४–२०२६ च्या ठरावानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील राष्ट्रीय शैक्षणिक धोरण–२०२० नुसार पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्यास मा.विद्यापरिषदेने मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील बी.एस्सी. तृतीय वर्षाचे खालील विषयाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६–२७ पासून लागू करण्यात येत आहे.

01	B.Sc. III Year Physics
02	B.Sc. III Year Geography
03	B.Sc. III Year Fishery Science
04	B.Sc. III Year Dyes & Drugs

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

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शै–१/परिपत्रक/पदवी/बीएस्सी/२०२६–२७/96
दिनांक : १४.०७.२०२६

उपकुलसचिव
शैक्षणिक (१–अभ्यासमंडळे) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :–
१) मा. कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. प्र.कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ
३) मा. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
४) मा. संचालक, परिक्षा व मुल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
५) मा. प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
६) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. यांना देवून कळविण्यात येते की, परिपत्रक अभ्यासक्रम संकेतस्थळावर प्रसिध्द करण्यात यावेत.

SWAMI RAMANAND TEERTH
MARATHWADA UNIVERSITY,
NANDED - 431 606 (MS)

(Credit Framework and Structure of Four Year UG Program with Multiple Entry and Exit Option as per NEP-2020)

UNDERGRADUATE PROGRAMME OF

SCIENCE & TECHNOLOGY

B. Sc. Third Year

Major in **PHY (Physics)**

Under the Faculty of Science & Technology

Effective from the Academic year 2026-27

(As per NEP-2020)

From the Desk of the Dean, Faculty of Science and Technology

Swami Ramanand Teerth Marathwada University, Nanded, enduring to its vision statement "***Enlightened Student: A Source of Immense Power***", is trying hard consistently to enrich the quality of science education in its jurisdiction by implementing several quality initiatives. Revision and updating curriculum to meet the standard of the courses at national and international level, implementing innovative methods of teaching-learning, improvisation in the examination and evaluation processes are some of the important measures that enabled the University to achieve ***the 3Es, the equity, the efficiency*** and ***the excellence*** in higher education of this region. To overcome the difficulty of comparing the performances of the graduating students and to provide mobility to them to join other institutions the University has adopted the cumulative grade point average (CGPA) system in the year 2014-2015. Further, following the suggestions by the UGC and looking at the better employability, entrepreneurship possibilities and to enhance the latent skills of the stakeholders the University has adopted the Choice Based Credit System (CBCS) in the year 2018-2019 at graduate and post-graduate level. This provided flexibility for the students to choose courses of their own interests. To encourage the students to opt the world-class courses offered on online platforms like NPTEL, SWAYAM, and other MOOCS platforms, the University has implemented the credit transfer policy approved by its Academic Council and has made a provision of reimbursing registration fees of the successful students completing such courses.

SRTM University has been producing a good number of high caliber graduates; however, it is necessary to ensure that our aspiring students are able to pursue the right education. Like the engineering students, the youngsters pursuing science education need to be equipped and trained as per the requirements of the R&D institutes and industries. This would become possible only when the students undergo studies with an updated and evolving curriculum to match global scenario.

Higher education is a dynamic process and in the present era the stakeholders need to be educated and trained in view of self-employment and self-sustaining skills like start-ups. Revision of the curriculum alone is not the measure for bringing reforms in higher education but invite several other initiatives. Establishing industry-institute linkages and initiating internship, on job training for the graduates in reputed industries are some of the important steps that the University would like to take in the coming time. As a result, revision of the curriculum was the need of the hour, and such an opportunity was provided by the National Education Policy 2020. National Education Policy 2020 (NEP 2020) aims at equipping students with knowledge, skills, values, leadership qualities and initiates them for lifelong learning. As a result, the students will acquire expertise in specialized areas of interest, kindle their intellectual curiosity and scientific temper, and create imaginative individuals.

The curriculum given in this document for BSc SY Physics has been developed following the guidelines of NEP-2020 and is crucial as well as challenging due to the reason that it is a transition from general science based to the discipline-specific-based curriculum. All the recommendations of the ***Sukanu Samiti*** given in the **NEP Curriculum Framework-2023** have been followed, keeping the disciplinary approach with rigor and depth, appropriate to the comprehension level of learners. All the Board of Studies (BoS) under the Faculty of Science and Technology of this university have put in their tremendous efforts in making this curriculum of international standards. They have taken care of maintaining logical sequencing of the subject matter with proper placement of concepts with their linkages for better understanding of the students. We take this opportunity to congratulate the Chairman(s) and all the members of various Boards of Studies for their immense contributions in preparing the revised curriculum for the benefits of the stakeholders in line with the guidelines of the **Government of Maharashtra regarding NEP-2020**. We also acknowledge the suggestions and contributions of the academic and industry experts of various disciplines.

We are sure that the adoption of the revised curriculum will be advantageous for the students to enhance their skills and employability. Introduction of the mandatory ***On Job Training, Internship program*** for science background students is praiseworthy and certainly help the students to imbibe firsthand work experience, teamwork management. These initiatives will also help the students to inculcate the workmanship spirit and explore the possibilities of setting up of their own enterprises.

Dr. M. K. Patil

Dean

Faculty of Science and Technology

From Desk of Chairman, Board of Studies of the Subject Physics

Preamble:

The education system is India has acquired a new form with inclusion of job-oriented work skill in combination with traditional fundamental core subjects along with multiple entries and choice-based exit system. The development of vocational work skills amongst the aspirants being one of the major goals for seeking the livelihood in short spam while competing with the world class education systems. Inclusion of multifold courses as clubbing of majors, minors, and electives with skills must take cognizant for following the education quality mandates too. To achieve this, the thrust of quality needs to be addressed, discussed and carried forward in a systemic manner. Accreditation is the principle means of quality assurance in higher education and reflects the fact that in achieving recognition, the institution or program of study is committed to and open for external review to meet certain minimum specified standards. The major emphasis of this accreditation process is to measure the outcomes of the program that is being accredited.

Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation from the program. A graduate program must ensure that the passing students understand the basic concepts of Physics, have gone through one field in department of appreciation and use its methodologies of analyses and design, and have acquired skills for life-long learning. The transformation of students from one program to another at any level of education exit must make him/herself reliable. UG program in Physics must therefore have a mission statement which is in conformity with program objectives and program outcomes that are expected for specific educational process. The outcomes of a program must be measurable and must be assessed regularly through proper feedback for improvement of the program. There must be a quality assurance process in place within the Institute to make use of the feedback for improvement of the program. The curriculum must be constantly refined and updated to ensure that the defined objectives and outcomes are achieved. Students must be encouraged to comment on the objectives and outcomes and the role played by the individual courses in achieving them. In line with this Faculty of Science and Technology of Swami Ramanand Teerth Marathwada University, Nanded has taken lead in incorporating philosophy of outcome-based education in the process of curriculum development. I, as Chairman, Board of Studies in Physics Swami Ramanand Teerth Marathwada University, Nanded, happy to state that, course objectives, expected outcomes were finalized in a meeting and are stated as below:

- To provide students with a strong foundation in the scientific and physical science fundamentals necessary to formulate, solve and analyze problems and to prepare them for graduate studies.
- To prepare students to demonstrate an ability to identify, formulate and solve problems pertaining to physical science concepts and fundamentals.
- To prepare students to demonstrate ability to understand the responsibility towards energy conservation and utilization of various resources for livelihood.
- To promote awareness among students for life-long learning and to introduce them to professional ethics and codes of professional practice.
- To develop ability to resolve the fundamental aspects relating to general physical concepts, theories and electricity related issues of different gadgets.
- To develop ability in identifications of physical qualities and their measurements techniques and applications at large too.
- To make them aware of working of different physical instruments and gadgets and capability to increase the working efficiency of the same.
- To make them responsible citizens through making aware of the importance of utilizing proper science at applicable places.

In addition to Program Objectives, for each course of undergraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome-based education. I believe strongly that small step taken in right direction will help in providing quality education to the stakeholders.

Dr. K. S. Kanse
Chairman,
Board of Studies in Physics
Swami Ramanand Teerth
Marathwada University, Nanded

Details of the Board of Studies Members in the subject Physics under the faculty of Science & Technology of S.R.T.M. University, Nanded

Sr. No	*Name of the Member*	*Designation*	*Address*
1.	Dr. K. S. Kanse Mob: 09850924426 kskanse@gmail.com	Chairman	Department of Physics, Lal Bahadur Shastri Mahavidyalaya, Dharmabad, Dist. Nanded
2.	Dr. M. K. Patil Mob: 08308298063 patil@associates.iucaa.in	Professor	School of Physical Sciences, S.R.T.M. University, Nanded
3.	Dr. Ms. M. P. Mahabole Mob: 9421850549 mpmsrtmunsps@gmail.com	Professor	School of Physical Sciences, S.R.T.M. University, Nanded
4.	Dr. S. N. Keshatti, Mob: 9422743448 keshatti.shrinivas@gmail.com	Professor	Department of Physics, Shivaji Mahavidyalaya, Parbhani
5.	Dr. C. T. Londhe Mob: 9850136648 londhect@gmail.com	Associate Professor	Department of Physics, Mahatma Gandhi Mahavidyalaya, Ahmedpur Dist. Latur
6.	Dr. M. A. Giri Mob: 9423440996 drmadangiri@gmail.com	Associate Professor	Department of Physics, Gramin (ACS) Mahavidyalaya, Vasantnagar Kotgyal Tq. Mukhed Dist Nanded
7.	Dr. V. D. Mote Mob: 9960639169 vmote.physics@gmail.com	Associate Professor	Department of Physics, Dayanand Science College, Latur
8.	Dr. A. A. Yadav Mob: 9975213852 aay_physics@yahoo.co.in	Professor	Department of Physics, Rajarshi Shahu Mahavidyalaya (Auto), Latur Tq. Dist. Latur
9.	Dr. R. A. Joshi Mob.: 9096655278 urajoshi@gmail.com	Associate Professor	Department of Physics, Toshniwal Arts, Commerce and Science College, Sengaon
10.	Dr. S. S. Jadhav Mob: 9405209939 santosh.jadhav28@yahoo.com	Professor	Department of Physics, D.S.M. Arts, Commerce and Science College, Jintur Dist Parbhani
11.	Dr. M. D. Shirsat Mob: 9422291987 mdshirsat.phy@bamu.ac.in	Professor	Department of Physics Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
12.	Dr. S. P. Yawale Mob: 9423125231 spyawale@rediffmail.com	Professor	Department of Physics, Govt. Vidarbha Institute of Science and Humanities, Amravati

13.	Dr. C. H. Ishwara Chandra Mob: 9403136630 ishwarx@gmail.com	Professor	National Centre for Radio Astrophysics, TIFR, Pune
14.	Dr. Ram Chitalkar Mob: 9325078845 ram_chitalkar@yahoo.com	Industry expert	Morganite crucible (India) Ltd. Morganite crucible (India)
15.	Dr. Pramod Watekar Mob: 9168187110 drpramodwatekar@iitkgp.ac.in	Professor	Department of Electronics and Electrical Communication Engineering, IIT Kharagpur
Invited Members			
16.	Dr. R. S. Mane Mob: 9850331971 rsmane_2000@yahoo.com	Professor	School of Physical Sciences, S.R.T.M. University, Nanded
17.	Dr. A. V. Sarode Mob: 9921340727 avsarode@gmail.com	Professor	School of Physical Sciences, S.R.T.M. University, Nanded
18.	Dr. K. A. Bogle Mob:7350845827 kashinath.bogle@gmail.com	Associate Professor	School of Physical Sciences, S.R.T.M. University, Nanded
19.	Trupti Nrusinh Kulkarni	UG student	Dayanand Science College, Latur Dist. Latur

B. Sc. Third Year Semester IV *(Level 5.5)*

Teaching Scheme

Sem	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Pract	Total	Theory	Pract
V	Major 51	Quantum Mechanics	3			3	
	Major 52	Solid State Physics	3			3	
	Major 53 IKS	Introduction to Ancient Indian Astronomy	2			2	
	Major 54	Practical		2			4
	Major 55	Practical		2			4
	Major E1 (Elective)	A. Basic Electronics B. Astrophysics	2			2	
	Major E1 (Elective)	Practical based on A. Basic Electronics Practical based on B. Astrophysics		2			4
	VSC 3	Renewable Energy		2			4
	FP			4			
			SEM V Credits		22		
VI	Major 61	Atomic, Molecular Physics and Nuclear Physics	3			3	
	Major 62	Digital and Communication Electronics	3			3	
	Major 63	Statistical Physics and Relativity	2			2	
	Major 64	Practical		2			4
	Major 65	Practical		2			4
	Major E2 (Elective)	A. Optical Fabre Communications B. Heat and Thermodynamics	2			2	
	Major E2 (Elective)	Practical based on A. Optical Fabre Communications Practical based on B. Heat and Thermodynamics		2			4
	VSC 4	Semiconductor Devices and Applications		2			4
	OJT			4			
			SEM VI Credits		22		
		Total Credits	20	24	44		

SEM V

Major 51: Quantum Mechanics

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Quantum Mechanics (Theory)		
Course Code:	Major 51	**No. of Credits:**	3
Contact Hours:	45	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	30 (40%)	**Summative Assessment (ESA)**	45 (60%)

Learning Objective:

The objective of this course is to introduce the students to the world of microscopic particles such as molecules, atoms, atomic nuclei and elementary particles, study their dynamics employing wave analogy, and make the connections between the rules governing the microscopic particles with that of the macroscopic bodies around us. This course is the pre-requisite for several advanced courses in physics and chemistry and is necessary for understanding the behavior of molecules, atoms and elementary particles.

Learning Outcomes:

- Recognize the limitations of Classical Physics and understand the quantum concept-based explanation.
- Identify the properties and quantum mechanical concepts applicable to Physical systems.
- Learn the physical and mathematical concepts of quantum physics.
- Apply the concept of quantum mechanics to derive equations and solve problems.
- Employ the quantum mechanical concept to explain certain physical phenomena and Analysis of specific problems.

Application and evaluation of the operators to explain various physical states.

Major 51: Quantum Mechanics	
Content	
Unit 1: Introduction to Quantum Mechanics	12
Introduction, Brief discussion on failure of classical physics to explain black body radiation (Black body Radiation), Planck's Quantum Hypothesis, Photoelectric effect, Compton effect; Compton scattering: Expression for Compton shift (With derivation). Matter waves: de Broglie hypothesis of matter waves, Wave particle duality, de Broglie Wave, Wave description of particles by wave packets, Group and Phase velocities and relation between them, Experimental evidence for matter waves: Davisson- Germer experiment, G.P Thomson experiment. Heisenberg uncertainty relation between momentum and position, energy and time; Illustration of uncertainty principle by Gamma ray microscope- thought experiment, Consequences of the uncertainty relations: Diffraction of electrons at a single slit, Two-slit experiment with photons and electrons.	
Unit 2: Schrodinger Equation	12
Introduction, Wave Function & its Physics interpretation, Time dependent Schrodinger Equation, Time independent Schrodinger equation and stationary states, operators in quantum mechanics (position, momentum, angular momentum, time and energy), postulates of quantum mechanics, expectation value, eigen functions and eigenvalues, Ehrenfest's theorem.	
Unit 3: Applications of Quantum Mechanics	09
Introduction, The particle in a box: energy quantization, The particle in a box: wave functions, The particle in a box: Momentum Quantization, The Harmonic Oscillator, The Harmonic Oscillator-Energy level, The particle in a three-dimensional box	
Unit 3: Quantum Theory of Hydrogen Atom	12
Introduction, Schrödinger's equation for the Hydrogen Atom in spherical polar co-ordinates, separation of Variables, ground state of the Hydrogen atom, solution of the radial wave function, interpretation of the Quantum: Principal quantum number or total quantum number, orbital quantum number, magnetic quantum number, spin quantum number.	

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, McGraw-Hill, 2009.
2. Quantum Physics, Berkeley Physics Course Vol. 4. E.H. Wichman, Tata McGraw-Hill Co., 2008.

3. P M Mathews and K Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill publication, ISBN: 9780070146174.
4. Ajoy Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer Publication ISBN 978-1-4020-2130-5.
5. Modern Physics; R. Murugeshan &K. Sivaprasath; S. Chand Publishing.
6. G Aruldhas, Quantum Mechanics, Phi Learning Private Ltd., ISBN: 97881203363.
7. Gupta, Kumar & Sharma, Quantum Mechanics, Jai Prakash Nath Publications.
8. Physics for Degree Students B.Sc., Third Year, CL Arora and PS Hemne, 1st edition, S. Chand & Company Pvt. Ltd., 2014.
9. Quantum Mechanics SP Singh & M. K. Bagade, S. Chand & Company LTD, 1989.
10. Quantum Mechanics VK Thankappan, 5th Edn
11. Principles of Quantum Mechanics R Shankar, 2nd Edn

Major 52: Solid State Physics

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Solid State Physics (Theory)		
Course Code:	Major 52	**No. of Credits:**	3
Contact Hours:	45	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	30 (40%)	**Summative Assessment (ESA)**	45 (60%)

Learning Objective:

This course is designed to provide fundamental knowledge of the crystallography, principles behind the formation of matter, their structure and physical properties.

Learning Outcome:

At the end of this course, students will be able to

- Classify the materials in different classes based on their physical, thermal, electrical, and magnetic properties.
- Understand the relationship between the internal structure and various properties of matter such as periodicity, structure and bonding in solids, making these solids an attractive material for the device applications.

Major 52: Solid State Physics	
Content	
Unit 1: Crystal structure	**12**
Introduction, Crystal Lattices and Translation vectors, Unit cell, Basis, Symmetry operations, Point groups, space group, Types of lattices, lattice directions and planes, interplanar spacing, Simple crystal structure (HCP, FCC, BCC, SC), Structure of Diamond, NaCl, Problems.	
Unit 2: Bonding in Solids and X-Ray Diffraction	10
Inter atomic forces and types of bonding, ionic bond, covalent bond, metallic bond, hydrogen bond, Vander-waal's bond. X-ray diffraction, Bragg's law, Laue's method, Rotating crystal method, Powder method, Reciprocal lattice, Reciprocal lattice to SC, BCC and FCC lattices, Properties of reciprocal lattice.	
Unit 3: Thermal properties of Solids	11
Specific heat of gases, Specific heat of solids, Classical theory of Lattice heat Capacity, Einstein's theory of heat Capacity, Debye's theory of specific heat of solids, Limitations of Debye model	
Unit 3: Free Electron Theory of Metals	12
The outstanding properties of metals, Drude-Lorentz theory, Thermal conductivity, Electrical conductivity, Widemann- Franz relation, Sommerfeld Model, Electrical conductivity and Ohms law, Electronic specific heat, Thermoionic emission, escape of electrons from metal, Superconductivity: Introduction and historical development, Meissner effect, BCS Theory.	

Reference Books:

1. Solid State Physics and Electronics – R. K. Puri & V. K. Babar (S.Chand & Co.)
2. Solid State Physics – Saxena,Gupta, Saxena (Pragati Prakashan Meerut)
3. Solid State Physics – Puri & Babar (S.chand & Co.)
4. Introduction to Solid State Physics -by Kittel, Wiley and Sons, 7th Edition.
5. Material Science by M. Arumguarn, Anuradha Publishers.
6. Solid state Physics – R.L.Singhal (Kedar Nath Ram Nath Co., Meerut)

Major 53 IKS: Introduction to Ancient Indian Astronomy

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Introduction to Ancient Indian Astronomy (Theory)		
Course Code:	Major 53	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

Learning objectives:

To provide students with a strong conceptual foundation in the historical evolution of Ancient Indian Astronomy, including the Vedic period, the contributions of Aryabhata, and the foundational contents of the Siddhantas.

To develop students' ability to understand and visualize the celestial sphere, including the diurnal motion of celestial bodies, the zodiac, the equator, poles, and equinoxes.

To enhance students' understanding of time measurement in Indian astronomy, covering solar and lunar months, seasons (Rtus), the Yuga system, and various historical Indian eras.

To equip students with the knowledge necessary to analyze various global calendars and specifically interpret the fundamental components of the traditional Indian Pancanga (Tithi, Naksatra, Yoga, Karana, Vara).

Learning outcomes:

After successful completion of the course the learners will be able to:

- Trace the historical continuity of the astronomical tradition in ancient India and outline the significance of classical astronomical texts and early astronomers.
- Map the celestial sphere to identify reference points such as horizons, meridians, the pole star, and the ecliptic, and explain the relative motions of celestial bodies.
- Differentiate between civil, sidereal, solar, and lunar timeframes, and systematically describe the structure of traditional Indian eras and microcosmic time scales.
- Compare the basis of the Gregorian, Islamic, and Hindu calendars, and practically decipher the five defining elements of the Indian Pachanga to track Hindu festivals and astronomical events.

Major 53 IKS: Introduction to Ancient Indian Astronomy	
Content	
Unit 1: Ancient Indian Astronomy	08
Introduction, Ancient Indian Astronomy, The Vedic Period and Vedangajyotisa, Siddhanta, Aryabhata I (1476 AD), Astronomers after Aryabhata, Contents of the Siddhantas: Madhyamadhikara, Spastadhikara, Triprasnadhikara, Chandra- and Surya- Grahanadhikara, Continuity in Astronomical Tradition	
Unit 2: Celestial Sphere	08
Introduction, Diurnal Motion of Celestial Bodies, Motion of Celestial Bodies Relative to Stars, Celestial Horizon, Meridian, Pole Star and Directions, Zodiac and Constellations, Equator and Poles (Visuvad Vrtta and Dhruva), Latitude of a Place and Altitude of Pole Star, Ecliptic and The Equinoxes.	
Unit 3: Time in Indian Astronomy	08
Introduction, Civil Day and Sidereal Day Solar Year and Civil Calendar, Solar Month and Lunar Month, Luni-Solar Year (or Lunar Year), Adhikamasa and Ksayamasa, Rutus (Seasons), Yuga System, Indian Eras Kali Era, Vikrama Saka, Salivahan Saka, Kollam Era, Time on Microcosmic Scale.	
Unit 3: Calendars and Indian Pachanga	06
Introduction, Hindu Calendar- Luni Solar Calendar, Solar Calendar, Hindu Festivals, Calendar and Indian Pachanga, Pachanga, Tithi, Naksatra, Yoga, Karana, Vara.	

Reference Books:

1. K. Ramasubramanian, A. Sule and M. Vahia, Eds. History of Astronomy: A Handbook, SandHI, I.I.T Bombay, and T.I.F.R., Mumbai, 2016.
2. Āryabhaṭīya of Āryabhaṭa, Edited with translation and notes, K. S. Shukla and K. V. Sarma, Indian National Science Academy, New Delhi, New Delhi, 1976.
3. B.V. Subbarayappa and K.V. Sarma, Indian Astronomy: A Source Book, Nehru Centre, Bombay, 1985.
4. Tantrasaṅgraha of Nīlakaṇṭha Somayājī, Translation and Notes, K. Ramasubramanian and M.S. Sriram, Hindustan Book Agency, New Delhi and Springer, 2011.
5. Karaṇapaddhati of Putumana Somayājī, Translation and Notes, Hindustan Book Agency, New Delhi and Springer, 2018.
6. S. N. Sen and K. S. Shukla, Eds., History of Astronomy in India, 2nd Ed., INSA, New Delhi, 2001.

Major 54: Practical

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Practical		
Course Code:	Major 54	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	4 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

List of experiments

1. To determine the coefficient of viscosity by oscillating disc method.
2. To determine the electric charge (e) of an electron by Millikan oil drop method.
3. To determine the specific change (e / m) of an electron by Thomson's method.
4. Determination of Planck constant (h) by photocell.
5. Determination of Planck constant (h) by LED.
6. Determination of resolving power of prism.
7. To determine the Cauchy's constant by using spectrometer.
8. Hartmann's dispersion formula.
9. Determination of Rydberg's constant using hydrogen spectral lines.
10. Determination of Young's modulus (Y) by Koenig's method.

STUDENT NEED TO PERFORM 10 (TEN) EXPERIMENTS.

****Note: Any two experiments can be added as per availability of instruments at the College.***

Major 55: Practical

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Practical		
Course Code:	Major 55	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	4 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

List of experiments

1. Determination of crystal structure using Laue pattern (using any software tool and provided raw data file)
2. Determination of temperature coefficient of thermistor
3. Study of energy bad gap of a semiconductor
4. Measuring resistivity of semiconductor by four probe method
5. Study of CRO Measurement of frequency and voltage sensitivity
6. Determination of electrical conductivity of graphite rod
7. Thermal conductivity of good conductor by Forbe's method
8. Comparison of capacity by Method of mixture
9. Thermal conductivity of an insulator by Lee's disc method.
10. Determination of I–V characteristics of a Solar cell.

STUDENTS NEED TO PERFORM 10 (TEN) EXPERIMENTS.

****Note: Any two experiments can be added as per availability of instruments at the College.***

Major E1 (Elective): (A) Basic Electronics

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	(A) Basic Electronics (Theory)		
Course Code:	Elective: (A) Basic Electronics	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

Learning Objectives:

To understand basic concepts of semiconductors, diodes and their characteristics.

To know construction, working of transistors and their applications

To understand basics and applications of operational amplifiers.

To use transistors in different combinations as oscillators for generating sinusoidal waves of different frequencies.

Learning Outcome:

After completing this course students will be able to

- Identify and understand construction and properties of different types of P-N junction diodes
- Apply knowledge of semiconductor devices to use them in different combinations to see their applications as amplifiers and oscillators
- Design different circuits using semiconductor devices and demonstrate their usage.

Major E1 (Elective): (A) Basic Electronics	
Content	
Unit I: Semiconductor Diodes	**08**
Semiconductors, Intrinsic and extrinsic semiconductors. Drift velocity, mobility & conductivity of intrinsic semiconductor. carrier concentration and fermi level for intrinsic semiconductors, carrier concentration and fermi level for extrinsic semiconductor. P-N Junction diode, Zener diode, Light Emitting Diode, Photodiode, Varactor diode and their V/I characteristics.	
Unit II: Bipolar Junction Transistors	**09**
Introduction to Transistors, Transistor Connections: Common base, common emitter, common collector. Characteristics of common base, common emitter, common collector connections. Hybrid (h) parameters, Determination of h-parameters. Analysis of common emitter amplifier and common collector amplifier using h-parameters (current gain, voltage gain, power gain, input resistance and output resistance).	
Unit III: Operational Amplifier	**08**
Basic circuit of differential amplifiers, common Mode and differential mode signals, block diagram of Op-Amp, schematic symbol. ideal Characteristics, input offset voltage; input offset current, input bias current, input impedance, Output impedance. open loop gain, CMRR, Slew rate, Inverting amplifier and noninverting amplifier. Integrator using Op amp, Differentiator using Op amp.	
Unit IV: Sinusoidal Oscillators	**05**
Introduction to oscillators, Types of sinusoidal Oscillators. Oscillatory circuit, Positive feedback Amplifier-Oscillator. Barkhausen Criterion, Hartley oscillator, Colpitts's oscillator. R-C Network, Phase shift oscillator.	

Reference Books:

1. Principles of Electronics – VK Mehta, Rohit Mehta (S. Chand & Co.)
2. Electronic Principles - AP Malvino
3. Electronic instrumentations - HS Kalsi
4. Electronic - RK Puri and VK Babbar
5. Basic Electronics (Solid State) - BL Thereja (S.Chand & Co.)
6. Basic Electronics & Linear Circuits - NN Bhargava, DC Kulshreshtha (TMH)
7. Op-Amps and Linear Integrated Circuits-Ramakant Gayakwad (PHI Delhi)
8. Digital & Analogue Techniques - Navneet, Gokhale & Kale (Kitab Mahal).
9. Introduction to Electronics - KJM Rao (Oxford and IBH Publishing Co.).
10. Electronics and Radio Engineering - ML Gupta (Dhanpat Rai and sons).

Major E1 (Elective): (B) Astrophysics

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	(B) Astrophysics (Theory)		
Course Code:	Elective: (B) Astrophysics	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

Learning Objectives:

Astronomy and Astrophysics is the oldest branch of science, perhaps started with the origin of the humankind, and has evolved systematically with time. In the present era with the availability of the state-of-the-art observing facilities across the electromagnetic spectrum, thanks to the technological advancements, the scope of the study of the astronomical objects have become more interesting and challenging. This study involves the knowledge of Classical Mechanics, Quantum Mechanics, Nuclear physics, Statistical Mechanics, Electrodynamics, Spectroscopy, Mathematical Physics, Modern Electronics, Chemistry and even biological sciences.

Learning Outcome:

At the end of course, the students will be able to

- Understand the important concepts of astronomical objects.
- To provide a fundamental connection between different fields of the science in general and physics in particular.

Major E1 (Elective): (B) Astrophysics	
Content	
Unit I: Fundamentals of astronomy	**09**
Brief history of astronomy (geocentric universe, heliocentric universe), co-ordinate systems (celestial sphere, horizon, equatorial co-ordinate systems), Greenwich Sideral time, Local Sideral time, zonal time, Hour angle and mean solar time, Astronomical Distance, astronomical unit (AU), light year, parsec, distance measurement in astronomy-stellar parallax	
Unit II: The Solar Family	**07**
Kepler's laws of planetary motion, the Earth's orbit and spin, the Moon's orbit and spin. the planets in the solar system - the terrestrial and Jovian planets, structure, composition and atmospheres of the planets, ring systems and satellites of the planes, asteroids, meteors and meteorites, comets and their origin, solar and lunar eclipses, Origin of the Solar System: The Nebular hypothesis.	
Unit III: Astronomical Techniques	**08**
Photon and non-photon astronomy, Photons (electromagnetic waves), Wavelength and frequency, Photon energy, Temperature, electromagnetic frequency bands – windows in astronomy Black body radiation- Planck laws, Wien displacement law, Brightness, Radiant Flux and Luminosity. Magnitude systems: Apparent and absolute magnitudes, Distance Modulus; Determination of Temperature and Radius of a star	
Unit IV: The Sun as a star	**06**
The Sun as a star, Solar Parameters, Solar Atmosphere, Solar Photosphere, Chromosphere, Corona, Solar Activity, Sunspots and sunspot cycle, solar limb darkening, solar neutrino puzzle.	

Reference Books:

1. Modern Astrophysics BW Carroll and DA Ostlie, 1996, Addison-Wesley Publishing Co.
2. The Physical Universe: An Introduction to Astronomy Frank H. Shu, 1982, University Science Books, Sausalito, California
3. Astrophysics by Baidyanath Basu
4. Introduction to Astrophysics by K D Abhyankar

Major E1 (Elective): Practical (A) Basic Electronics

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Practical		
Course Code:	Elective: (A) Basic Electronics	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	4 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

List of experiments

1. To Study the Zener Diode as voltage regulator
2. To Study the LED characteristics
3. To study PN junction diode characteristics
4. To Study Transistor characteristics (C-B mode)
5. To Study Transistor characteristics (C-E mode)
6. To Study the Characteristics of photo transistor
7. To Study the Power supply using Pi -filter (Full Wave rectifier)
8. To Study the Transistorized regulated power supply.
9. Study of transistorized CE amplifier (Frequency response, gain & 3db band width.)
10. To Study the Op-Amp as an inverting amplifier

STUDENTS NEED TO PERFORM 10 (TEN) EXPERIMENTS.

*****Note: Any two experiments can be added as per availability of instruments at the College.***

Major E2 (Elective): Practical (B) Astrophysics

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Practical		
Course Code:	Elective: (B) Astrophysics	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	4 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

List of experiments

1. To determine mass of Jupiter by studying revolution of its moons using the CLEA software
2. To study radiation pattern of the Sun and hence estimate effective surface temperature and luminosity of the Sun.
3. Estimating first-order atmospheric extinction of starlight using given data
4. Measuring sky brightness using solid state photometer
5. Studying solar limb darkening effect
6. Temperature of an artificial star
7. Photoelectric photometry of stars using CLEA software
8. Measuring distance to Moon by parallax method.
9. Identifying and measuring diameters of Craters on the Moon surface.
10. Measurement of distance of star clusters by main sequence fit method

STUDENTS NEED TO PERFORM 10 (TEN) EXPERIMENTS.

****Note: Any two experiments can be added as per availability of instruments at the College.***

VSC 3: Renewable Energy

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	VSC		
Course Code:	Renewable Energy	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	4 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

List of hands on/experiments

1. To study voltage and current of different Solar cells
2. To study the voltage and current of solar cells in series and parallel combinations
3. To study the current voltage characteristics and power curve to find maximum power point (MPP) of a solar cell
4. To calculate efficiency the efficiency of solar cell
5. To study application of solar cells for charging Ni-Cd batteries so that loads can be used even while the module is unexposed to light
6. To study application of solar cells to provide electrical energy to domestic appliances such as lamps, fans or radio.
7. To study spectral characteristics of solar cells.
8. To Study the principle and mechanism of production of biogas plant/ Visit to a plant/ make a prototype
9. To study principle and mechanism of Hydel power project/ visit to a plant/ make a prototype
10. To Study principle and mechanism of windmill/ visit to a windmill/ make a prototype
11. Installation of solar panels and solar energy harvesting.
12. To study the principle and mechanism of solar water heater/ visit to a plant/ make a prototype

STUDENTS NEED TO PERFORM 10 (TEN) EXPERIMENTS.

*****Note: Any two experiments can be added as per availability of instruments at the College.***

SEM VI

Major 61: Atomic, Molecular Physics and Nuclear Physics

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Atomic, Molecular Physics and Nuclear Physics (Theory)		
Course Code:	Major 61	**No. of Credits:**	3
Contact Hours:	45	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	30 (40%)	**Summative Assessment (ESA)**	45 (60%)

Learning Objectives:

Aim of this course is to introduce the students to the world of physics of atoms, molecules and nuclei, their structures, emission of Gamma rays, X-rays, optical and microwave spectra from these systems, the interaction of atoms and molecules with electric and magnetic fields.

Learning outcome:

At the end of the semester students will be able to

- Understand nuclear energy sources and reactions with its application in establishing nuclear reactors.
- Understand the importance of nuclear energy and its benefits as well as effects over the nature.

Major 61: Atomic, Molecular Physics and Nuclear Physics	
Content	
Unit 1: Atomic Physics	**12**
The Vector Atom Model, Quantum numbers associated with the vector atom model, LS and J-J coupling, Optical Spectra, The Pauli's exclusion Principle, Selection rules, Intensity rules, Interval rule, Fine structure of Sodium D line and Hα line, Normal Zeeman effect, Anomalous Zeeman effect, Stark effect	
Unit 2: Molecular Spectra	10
Regions of Electromagnetic Spectra, Classification of Molecular Spectra, Theory of pure rotational spectra, Theory of rotation-vibration spectra, Raman Effect, Experimental study, Applications of Raman effects in solid, liquid and gases.	
Unit 3: Nuclear Fission, Fusion Reactions	12
Nuclear Fission and energy release in fission, Bohr and Wheelers theory of nuclear fission, Controlled thermonuclear Reactions, thermo-nuclear reactor, the neutron cycle, Introduction to Nuclear fusion, Sources of Stellar energy, The carbon Nitrogen cycle and Proton-Proton cycle.	
Unit 3: Nuclear Reactions and Particle Accelerators	11
Nuclear transmutations (by alpha particles, protons, deuterons and neutrons), conservation laws, nuclear reaction kinematics, Need of particle accelerators, Van de Graff Generator, Linear accelerator, Cyclotron, Synchrotron, Betatron, Applications of particle accelerators	

Reference Books:

1. Modern physics- R. Murugeshan, Kruthigaprasath. (S.Chand & Co.)

2. Atomic physics – J.B.Rajam. (S.Chand & Co.)

3. Nuclear Physics – D.C.Tayal (Himalaya Publishing House)

4. Nuclear Physics – Irving Kaplan

5. Introduction to Atomic Spectra: H E White, McGraw Book Company, Inc.

6. Basic Nuclear Physics- B. N. Shrivastav.

Major 62: Digital and Communication Electronics

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Digital and Communication Electronics (Theory)		
Course Code:	Major 62	**No. of Credits:**	3
Contact Hours:	45	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	30 (40%)	**Summative Assessment (ESA)**	45 (60%)

Learning objectives:

This course enables the students to understand the importance and inter-convertibility of various number systems, principles of digital gates, and working principles of communication systems.

Study the basic principles of number systems and codes.

Understand the basic concepts of digital logic families.

Learning Outcomes:

After completing this course students will be able to

- Describe the outcomes of number systems.
- Know the concept of Logical families.
- Explain the methods of arithmetic circuits.
- Understand the basic principles of digital logic design.
- Elaborate on the digital logic families

Major 62: Digital and Communication Electronics	
Content	
Unit 1: Number System and codes	**09**
Introduction Decimal, Binary, Octal and Hexadecimal number systems, base conversions. representation of Signed and unsigned numbers, BCD code. Binary arithmetic, Ones complement representation, Twos complement representation, Inter-conversions of number systems, Binary coded decimal (BCD), Gray code, Excess-3 code.	
Unit 2: Digital Logic Gates &Arithmetic Circuits	12
AND gate, OR gate, NOT gate, NAND gate, NOR gate, EX-OR and EX-NOR gates, Universal properties of NAND and NOR gates. Boolean operations, logic expressions for 2,3 & 4 inputs, laws of Boolean algebra, De -Morgen's theorems, SOP form of Boolean expressions, simplification of Boolean expressions using K- maps (up to 4 variables), Half adder, Full adder Multiplexers, De-multiplexers, Decoders, Encoders, Flip-flops - SR, JK.	
Unit 3: Modulation and Demodulation	12
Introduction to modulation, need for modulation, Types of Modulation, Amplitude modulation, Expression for AM voltage, modulation index, AM waves, Applications of AM, Frequency modulation, Frequency spectrum of AM wave, AM Power, Expression for frequency modulated voltage, modulation index & side bands, Applications of FM, Principle of demodulation, linear diode AM detector or demodulator.	
Unit 3: Communication Electronics	12
Introduction, Block diagram of basic communication system, Essential elements of A.M. Transmitter. A.M. receiver: Turned Radio Frequency (TRF) Receiver, Super heterodyne receiver, Characteristics of radio receivers: sensitivity, selectivity, fidelity & their measurements.	

Reference Books:

1. Digital Fundamentals-Thomas L. Floyd, Universal Book Stall
2. Modern Digital Electronics- R.P. Jain, Tata McGraw Hill Pub. Company (Third edition).
3. Digital Principles and Applications- A. P. Malvino, (McGraw Hill International Editions (Fourth Edition)
4. Electronics and Radio Engineering – M. L. Gupta
5. Digital Electronics with Practical Approach- G. N. Shinde, Shivani Pub., Nanded
6. Electronics and Radio Engineering – M. L. Gupta

Major 63: Statistical Physics and Relativity

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Statistical Physics and Relativity (Theory)		
Course Code:	Major 63	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

Learning Objectives:

The objective of this course is to introduce the students to the concepts of macroscopic world, statistical approaches for understanding properties of the macroscopic bodies, ensembles, and their classification on the basic macroscopic and microscopic basis.

To understand the concept of theory of relativity in terms of space and time.

Learning Outcome:

After completing this course students will be able to

- After learning and understanding this paper, students will be able to
- Understand the basic differences between quantum mechanics, classical mechanics and mathematical correlations between them.
- Understand the relativistic phenomenon difference between two systems i.e. inertial and non-inertial.

Major 63: Statistical Physics and Relativity	
Content	
Unit 1: Statistical Basis and Thermodynamics	**08**
Statistical basis, probability, probability and frequency, principle of equal priori probability. Additive and multiplication rules of probability, conditional probability, permutation and combinations. Ensemble and average properties, micro and macro states. Thermodynamic probability, entropy and probability and relation connecting them.	
Unit 2: Classical Statistics and Quantum Statistics	08
Phase space, Maxwell-Boltzmann Distribution law. Quantum Statistics-Bose- Einstein Distribution law, Fermi- Dirac Distribution law. Comparison of M. B., B.E. and F. D. statistics Application of Quantum statistics to Photon gas and Electron gas.	
Unit 3: Theory of Relativity	08
Common term: particles, event, frame of references. Limitations of Newtons laws of motion. Galilean Transformation, Galilean Invariance (Newtonian Relativity-law of motion, conservation of momentum, Conservation of energy). Non inertial frame of reference-fictitious force. Postulates of Special Theory of Relativity.	
Unit 3: Applications of theory of relativity	06
Michelson Morley experiment. Lorentz transformations, Length contraction. Time dilation, Velocity addition. Relativity of mass, Mass energy relation.	

Reference Books:

1. Heat, Thermodynamics & Statistical Physics - Brij Lal, N Subrahmanyam, PS Hemne.
2. Thermodynamics and Statistical Physics - SL Kakani (S Chand)
3. Foundation of Electromagnetic Theory - John R Reitz & Frederic J. Milford (Narosa Publishing House)
4. Classical Electrodynamics - Gupta, Singh, Kumar (Pragati Prakashan, Meerut)
5. Introduction to Electrodynamics - David J. Griffiths (Prentices Hall, India)
6. Perspectives of Modern physics - Arthur Beiser
7. Modern Physics - R Murugeshan, K Shivaprasath (S Chand)
8. Electromagnetic Theory and Electrodynamics - Satya Prakash
9. Elements of properties of matters - DS Mathur (S Chand)

Major 64: Practical

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Practical		
Course Code:	Major 64	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	4 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

List of experiments

1. Study of the temperature dependence of Resistivity of a Semiconductor using Four Probe method and determining the band gap of experimental material (Ge).
2. To Study the Phase Diagram of Pb-Sn Alloy using Cooling Curve and Determine its composition.
3. To Determine the Mass Susceptibility of Paramagnetic Solution Using Quincke's Method.
4. To Determine the Lande g factor Using Electron Spin Resonance.
5. To Determine Hall coefficient (RH), Hall voltage (VH), types of charge carriers and Hall angle (θH) using Hall Effect experiment.
6. Diffraction at Cylindrical Object: Determination of Wavelength
7. To determine the wavelength of H-alpha emission line in Hydrogen spectrum
8. Determination of resolving power of prism
9. Determination of Planck constant (h) by photo cell.
10. e / m by Thomson's method

STUDENT NEED TO PERFORM 10 (TEN) EXPERIMENTS.

****Note: Any two experiments can be added as per availability of instruments at the College.***

Major 65: Practical

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	Practical		
Course Code:	Major 65	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	4 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

List of Experiments

1. Verification of truth table of basic gates (AND, OR, NOT) using ICs.
2. Construction of basic gates (AND, OR, NOT) using NAND gates.
3. Construction of basic gates (AND, OR, NOT) using NOR gates.
4. Construction and study of half adder using NAND gates.
5. Construction and study of full adder using NAND gates.
6. Implementation of Boolean expression from the given truth table using K- map.
7. Study of low pass and high pass filter using resistance and capacitance.
8. Clipper and Clamper circuits.
9. Study of AM Modulator.
10. Study of AM Demodulator.

STUDENT NEED TO PERFORM 10 (TEN) EXPERIMENTS.

*****Note: Any two experiments can be added as per availability of instruments at the College.***

Major E2 (Elective): (A) Optical Fiber Communications

Program Name:	B.Sc. in Physics	**Semester:**	VI
Course Title:	(A) Optical Fiber Communications (Theory)		
Course Code:	Elective: (A) Optical Fiber Communications	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

Learning Objectives:

This course is aimed to offer a broad view on the fundamentals and salient features of the modern communication technique i.e., fiber optical communication, which revolutionized communication technology and has become integral part of the Engineering and related technologies.

Learning Outcome:

After completing this course students will be able to

- Understand the fiber optical communication and salient features of designing and developing different types of optical fiber used for specific purposes.
- Learn the concepts of propagation and behavior of light rays through the optical fibers of different refractive indices.

Major Elective (E2): (A) Optical Fiber Communications	
Content	
Unit 1: Introduction to OFC	**09**
Introduction to Fiber optics, Snell's law, Total Internal Reflection, Transmission of light in optical fiber, Concept of Acceptance angle, Relation between acceptance angle and refractive indices of the media (i.e. Numerical Aperture of the fiber), Meridional rays and skew rays.	
Unit 2: Types of OFC	08
Types of fibers and their transmission ray characteristics, Step index single mode and multimode optical fiber waveguides, Guided modes or mode volume of step index multimode fibers, Normalized frequency	
Unit 3: Ray Propagation and Transmissions	08
Graded index fibers, Refractive index profiles with □ parameters, Ray transmission in graded index fibers, Comparison of Intermodal dispersion in Graded index and Step index fibers, Mode volume or Guided modes in Graded index fibers.	
Unit 3: Operations of OFC	05
Single mode fibers, maximum core diameter for single mode operation, cutoff wavelength.	

***Reference Books**:*

1. Optical Fiber Communications: Principles and Practice, John M Senior

2. Optical Fibers & Fiber Optical Communication Systems, S. K. Sarkar

3. Introduction to fiber optics, R S Khairnar

Major E2 (Elective): (B) Heat and Thermodynamics

Program Name:	B.Sc. in Physics	**Semester:**	VI
Course Title:	(B) Heat and Thermodynamics (Theory)		
Course Code:	Elective: (B) Heat and Thermodynamics	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

Learning objectives:

This course will introduce the students to the world of heat and thermodynamics and the behavior of the physical systems at different thermodynamical conditions.

Learning outcome:

At the end of the semester students will be able to

- Understand difference in the behavior of ideal and real gases, transport phenomenon in gases.
- Understand the working of various heat engines and the ways to increase their working efficiency.

Major Elective (E2): (B) Heat and Thermodynamics	
Content	
Unit 1: Thermometry	**05**
Types of Thermometers, Centigrade and Fahrenheit scale, relation between Celsius, Kelvin, Fahrenheit & Rankine scales, Platinum resistance thermometer, Seebeck effect, Thermoelectric thermometer	
Unit 2: Real Gases and Their Behavior	08
Behavior of gases at high pressure, Boyle temperature, Andrew's Experiment on CO2, Amagat's Experiment, Vander wall's Equation of State, Critical Constants, Corresponding states, Coefficients of Vander wall's Equation, Reduced Equation of State, Properties of matter near critical point, Inter molecular attraction, Joule Thomson Porous Plug Experiment, Temperature of Inversion, Relation between Boyle temperature and Temperature of Inversion	
Unit 3: Transport Phenomenon in Gases	08
Degrees of freedom, law of equipartition of energy, Molecular Collisions, Mean free path, Expression for mean free path, Transport Phenomena, Viscosity of Gases, Thermal Conductivity of Gases, Diffusion, Inter relation between three transport coefficients.	
Unit 3: Thermodynamics and Thermodynamical Relations	09
First Law of Thermodynamics, Relation connecting P, V and T in an Adiabatic Process, Second Law of Thermodynamics (Kelvin and Clausius statements), Carnot's cycle, Carnot's heat Engine, Carnot's Theorem, Entropy, Entropy of Irreversible processes entropy of reversible process, Third Law of Thermodynamics. Internal energy, Helmholtz' function, Enthalpy, Gibb's function, Maxwell's Thermodynamical Relations, T-dS equations, Clausius-Clapeyron latent heat equations.	

Reference Books

1. Heat and Thermodynamics – Brij Lal, N. Subrahmanyam, P. S. Hemne for B. Sc. Students as per UGC Model Syllabus, Sultan Chand & Company Ltd.
2. Heat and Thermodynamics – D. S. Mathur, Sultan Chand & Sons, New Delhi
3. Thermodynamics and Statistical Physics – S. L. Kakani
4. Thermodynamics, Kinetic Theory, and Statistical Thermodynamics – Sears and Salinger, Narosa Publishing House, New Delhi.

Major E2 (Elective): Practical (A) Optical Fabre Communications

Program Name:	B.Sc. in Physics	**Semester:**	VI
Course Title:	(A) Optical Fabre Communications (Practical)		
Course Code:	Elective: (A) Optical Fabre Communications	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

List of experiments

1. Demonstrate the use of fiber optic trainer kit
2. Identify the recourses and their uses on the given fiber optical trainer kit
3. Make optical fiber setup to transmit and receive analog and digital data
4. Demonstrate FM modulation and demodulation using OFC trainer kit using audio signal and voice link
5. Demonstrate PWM modulation and demodulation using OFC trainer kit using audio signal and voice link
6. Demonstrate PPM modulation and demodulation using OFC trainer kit using audio signal and voice link
7. Studying loss pattern of power due to transmission of signal through fibers of different lengths
8. Studying loss of power due to the bending of optical fibers.
9. Studying the communication mechanism through the OFC.
10. Effect of temperature over communications between source and receiver through OFC.

STUDENT NEED TO PERFORM 10 (TEN) EXPERIMENTS.

****Note: Any two experiments can be added as per availability of instruments at the College.***

Major E2 (Elective): Practical (B) Heat and Thermodynamics

Program Name:	B.Sc. in Physics	**Semester:**	VI
Course Title:	(B) Heat and Thermodynamics (Practical)		
Course Code:	Elective: (B) Heat and Thermodynamics	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	2 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

List of experiments

1. To Determine coefficient of thermal conductivity of rubber tube
2. To determine specific heat of liquid using Joules calorimeter
3. To determine coefficient of thermal conductivity of glass using Lees method
4. To study Newton's law of cooling for two different concentrations of salt solutions
5. To study factors affecting the rate of loss of heat of a liquid
6. To determine temperature of flame
7. To study the relation between temperature and time (cooling curve) of wax
8. To estimate the Latent heat of fusion of Ice
9. To determine the specific heat capacity of a solid by method of mixtures
10. To determine specific heat of liquid by Newtons law of cooling.

STUDENT NEED TO PERFORM 10 (TEN) EXPERIMENTS.

*****Note: Any two experiments can be added as per availability of instruments at the College.***

VSC 4: Semiconductor Devices

Program Name:	B.Sc. in Physics	**Semester:**	V
Course Title:	VSC		
Course Code:	Semiconductor Devices	**No. of Credits:**	2
Contact Hours:	30	**Duration of SEA/Exam:**	4 hrs.
Formative Assessment (CA):	20 (40%)	**Summative Assessment (ESA)**	30 (60%)

List of hands on/experiments

1. Study and compare the V-I Characteristics of various types of P-N junction diodes (e.g. general purpose, LEDs, Zener Diode, etc.)
2. Study and compare the working of Photo diode and Varactor diode
3. Study and compare the working properties of the *n*-channel and *p*-channel JFETs
4. Study and compare the working properties of the *n*-channel and *p*-channel MOSFETs
5. Construct and test the performance of a FET Amplifier
6. Study the working of half wave rectifier and determine ripple factor for different R, L, C filters
7. Study the working of full wave rectifier and determine ripple factor for different R, L, C filters
8. Study of SCR characteristics
9. Study of UJT characteristics
10. Construct UJT based free running oscillator and change its frequency.

STUDENT NEED TO PERFORM 10 (TEN) EXPERIMENTS.

*****Note: Any two experiments can be added as per availability of instruments at the College.***

Guidelines for Course Assessment:

A. Continuous Assessment (CA) (40% of the Maximum Marks):

This will form 40% of the Maximum Marks and will be carried out throughout the semester. It may be done by either conducting **Two Tests** (Test I on 50% curriculum) and Test II (remaining 50% syllabus) or by providing appropriate assignments, tutorials in regular interval of time. Average of the marks scored by student either in tests or assignments, tutorials of the theory paper will make his/her **CA** score.

B. End Semester Assessment (60% of the Maximum Marks):

(For illustration we have considered a paper of 02 credits, 50 marks and need to be modified depending upon credits of an individual paper)

1. **ESA Question paper will consist of 5 questions, each of 10 marks.**
2. **Students are required to solve a total of 3 Questions.**
3. **Question No.1 will be compulsory and shall be based on entire syllabus.**
4. Students need to solve **ANY TWO** of the remaining FOUR Questions (Q.2 to Q.5) and shall be based on entire syllabus.

Assessment of practical courses of 02 Credits

End Semester Practical Examination: 20 Marks, Viva-Voce examination: 05 Marks and Marks to be awarded proportionate to the number of practical's / activities done by the student during the semester: 03 Marks and Journal / Record book: 02 Marks.

Assessment of On-the-Job-Training (OJT) Course (for 04 credits)

Continuous assessment (CA) part ***(40%, i.e. 40 marks out of 100)*** of this course shall be done by the mentor of the student, where he /she is supposed to complete his On Job Training. This shall be based on regularity, participation and performance of the students at the place of OJT.

Semester End Assessment (SEA) ***(60%, i.e. 60 marks out of 100)*** of this course shall be done by a panel of examiners in two parts

i. based on the work report submitted by the student ***(50% i.e. 30 marks)***

ii. **Remaining 50%** (30 marks) shall be based on his presentation and viva-voce on the work carried to be assessed by the panel of examiners. This assessment shall be done along with practical examinations of respective courses / subjects.

Assessment of Field Project (FP) and Research Project (RP) (e.g. for 04 credits)

Continuous assessment (CA) part ***(40%, i.e. 40 marks out of 100)*** of this course shall be done by the mentor of the student based on regularity, experimental work and performance.

Semester End Assessment (SEA) ***(60%, i.e. 60 marks out of 100)*** of this course shall be done shall be done by a panel of examiners in two parts

i. based on the work report submitted by the student ***(50% i.e. 30 marks)***

ii. ***Remaining 50% i.e. 30 marks*** shall be based on his presentation and viva-voce on the work carried out by the student. This assessment shall be done along with practical examinations of the respective courses / subjects.

Note: Number of lectures required to cover syllabus of a course depends on the number of credits assigned to a particular course. One credit of theory corresponds to 15 Hours lecturing and for practical course one credit corresponds to 30 Hours. For example, for a course of two credits 30 lectures of one hour duration are assigned, while that for a three-credit course 45 lectures.