॥ 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 पदव्यूत्तर द्वितीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२४–२५ पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, या विद्यापीठा अंतर्गत येणा–या सर्व संलग्नित महाविद्यालयामध्ये शैक्षणिक वर्ष २०२४–२५ पासून राष्ट्रीय शैक्षणिक धोरणानुसार पदव्यूत्तर द्वितीय वर्षाचे अभ्यासक्रम लागू करण्याच्या दृष्टीकोनातून विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत येणा–या अभ्यासमंडळांनी तयार केलेल्या पदव्यूत्तर द्वितीय वर्षाच्या अभ्यासक्रमांना मा. विद्यापरिषदेने दिनांक १५ मे २०२४ रोजी संपन्न झालेल्या बैठकीतील विषय क्रमांक १५/५९–२०२४ च्या ठरावाअन्वये मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील खालील एम. एस्सी द्वितीय वर्षाचे अभ्यासक्रम (Syllabus) लागू करण्यात येत आहेत.

1) M. Sc. II year - Analytical Chemistry (Affiliated College)
2) M. Sc. II year - Biochemistry (Affiliated College)
3) M. Sc. II year - Organic Chemistry (Affiliated College)
4) M. Sc. II year - Physical Chemistry (Affiliated College)
5) M. Sc. II year - Inorganic Chemistry (Affiliated College)
6) M. Sc. II year - Analytical Chemistry (Campus)
7) M. Sc. II year - Industrial Chemistry (Campus)
8) M. Sc. II year - Medicinal Chemistry (Campus)
9) M. Sc. II year - Organic Chemistry (Campus)
10) M. Sc. II year - Physical Chemistry (Campus)
11) M. Sc. II year - Polymer Chemistry (Campus)
12) M. Sc. II year - Computer Management (Affiliated College)
13) M. Sc. II year - Computer Sciene (Affiliated College)
14) M. Sc. II year - Software Engineering (Affiliated College)
15) M. Sc. II year - System Administration & Networking (Affiliated College)
16) M. Sc. II year - Computer Application (Campus)
17) M. Sc. II year - Computer Network (Campus)
18) M. Sc. II year - Computer Science (Campus)
19) M. Sc. II year - Zoology (Campus)
20) M. Sc. II year - Zoology (Affiliated College)
21) M. Sc. II year - Physics (Campus)
22) M. Sc. II year – Physics (Affiliated College)

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/एनइपी/विवत्रंविपदवी/२०२४–२५/993
दिनांक १३.०६.२०२४

डॉ. सरिता लोसरवार
सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत : १) मा. आधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मुंल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
३) मा. प्राचार्य, सर्व संबधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) मा. संचालक, सर्व संकुले परिसर व उपपरिसर, प्रस्तुत विद्यापीठ
५) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. याना देवून कळविण्यात येते की, सदर परिपत्रक संकेतस्थळावर प्रसिध्द करण्यात यावे.

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED - 431 606

(R-2023)

TWO YEAR MASTERS PROGRAMME IN SCIENCE

M. Sc. First Year & Second Year

Subject: Physics

(Campus School)

Under the Faculty of

Science and Technology

(As per NEP-2020)

With effect from academic year 2023-24

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 also 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 to the students to choose courses of their own interests. To encourage the students to opt the world-class courses offered on the online platforms like, NPTEL, SWAYM, and other MOOCS platforms the University has implemented the credit transfer policy approved by its Academic Council and also 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 the self-employment and self-sustaining skills like start-ups. Revision of the curriculum alone is not the measure for bringing reforms in the 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 New 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 has been developed following the guidelines of NEP2020 and is crucial as well as challenging due to the reason that it is a transition from general sciencebased 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 standard. 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 praise worthy and certainly help the students to imbibe first-hand work experience, team work 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, Incharge *Dean,* *Faculty of Science and Technology*

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

Preamble:

The education system in India has acquired a new form with the inclusion of job oriented work skill in combination with traditional fundamental core subjects along with multiple entries, multiple exit option with choice based credit system. The development of vocational work skill amongst the aspirants being one of the major goal for seeking the livelihood in short spam, while competing with the world class education systems. Inclusion of multifold courses as clubbing of majors, minors, 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 in achieving recognition, the institution or program of study is committed 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 should have at the time of graduation from the program.

A post graduate program must ensure that, the passing students understand the basic, advanced and scientific concepts of Physics, have gone through one field in department to appreciate and use advanced, updated and recent methodologies for analysis and design, and have acquired skills for life-long learning. The transformation of students from one program to other at any level of education exit must make him/her self-reliable. PG program in Physics program 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 measureable 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, of the 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 mathematical, scientific and physical science fundamentals necessary to formulate, solve and analyze problems and to prepare them for scientific studies.
- To prepare students to demonstrate an ability to identify, formulate and solve problems pertaining to the concepts, fundamentals and advances of the physical sciences.
- To prepare students to demonstrate ability to understand the responsibility towards energy conservation and utilization as renewable energy sources.
- To promote awareness among students for the life-long learning and to introduce them to professional ethics and codes of professional practice.
- To develop ability for resolving the fundamental aspects relating to general physical concepts and theories.
- To develop ability in identifications of physical qualities and their measurements techniques too.
- To make them aware about working of different physical instruments and gadgets and capability to increase the working efficiency of the same.
- To make students self-reliable for development of scientific temperaments fostering for acquiring the advanced knowledge in applying the concepts of Physical Sciences.

In addition to Program Objectives, for each course of postgraduate 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 a small step taken in right direction will definitely help in providing quality education to the stake holders.

Dr. K. S. Kanse
Chairman, Board of Studies of the 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*	*Contact No.*
1.	Dr. K. S. Kanse	Chairman	Department of Physics, Lal Bahadur Shastri Mahavidyalaya, Dharmabad, Dist. Nanded	Mob: 09850924426 Email: kskanse@gmail.com
2.	Dr. M. K. Patil	Professor	School of Physical Sciences, S.R.T.M. University, Nanded	Mob: 08308298063 Email: patil@associates.iucaa.in
3.	Dr. M. P. Mahabole	Professor	School of Physical Sciences, S.R.T.M. University, Nanded	Mob: 9421850549 Email: mpmsrtmunsps@gmail.com
4.	Dr. S. N. Keshatti	Professor	Department of Physics, Shivaji Mahavidyalaya, Parbhani	Mob: 9422743448 Email: keshatti.shrinivas@gmail.com
5.	Dr. C. T. Londhe	Assistant Professor	Department of Physics, Mahatma Gandhi Mahavidyalaya, Ahmedpur Dist. Latur	Mob: 9850136648 Email: londhect@gmail.com
6.	Dr. M. A. Giri	Associate Professor	Department of Physics, Gramin (ACS) Mahavidyalaya, Vasantnagar Kotygal Tq. Mukhed Dist Nanded	Mob: 9423440996 Email: drmadangiri@gmail.com
7.	Dr. V. D. Mote	Assistant Professor	Department of Physics, Dayanand Science College, Latur	Mob: 9960639169 Email: vmote.physics@gmail.com
8.	Dr. A. A. Yadav	Associate Professor	Department of Physics, Rajarshi Shahu Mahavidyalaya (Autonomous), Latur Tq. Dist. Latur	Mob: 9975213852 Email: aay_physics@yahoo.co.in
9.	Dr. R. A. Joshi	Assistant Professor	Department of Physics, Toshniwal Arts, Commerce and Science College, Sengaon Dist Hingoli	Mob.: 9096655278 Email: urajoshi@gmail.com

10.	Dr. S. S. Jadhav	Associate Professor	Department of Physics, D.S.M. Arts, Commerce and Science College, Jintur Dist Parbhani	Mob: 9405209939 Email: santosh.jadhav28@yahoo.com
11.	Dr. S. P. Yawale	Professor	Department of Physics, Govt. Vidarbha Institute of Science and Humanities, Amravati	Mob: 9423125231 Email: spyawale@rediffmail.com
12.	Dr. Ishwar Chandra	Professor	National Centre for Radio Astrophysics, TIFR, Pune	Mob: 9403136630 Email: ishwarx@gmail.com
13.	Dr. Ram Chitalkar	Industry expert	Morganite crucible (India) Ltd. Morganite crucible (India)	Mob: 9325078845 Email: ram_chitalkar@yahoo.com
14.	Dr. Pramod Watekar	Chief Manager	Sterlite Technologies Ltd., Pune	Mob: 9168187110 Email: pramodwatekar@sterlite.com
15.	Miss Lute Vijaya Vilas	Students Representative	C/O Dayanand Science College, Latur	
16.	Walsangikar Am ogh Pramodrao	Students Representative	C/O Dayanopasak College, Prabhani	

Invited Members:

1.	Dr. A. C. Kumbharkhane	Professor	School of Physical Sciences, Swami Ramanand Teerth Marathwada University, Nanded	Mob: 9421869112 Email: akumbharkhane@gmail.com
2.	Dr. R. S. Mane	Professor	School of Physical Sciences, Swami Ramanand Teerth Marathwada University, Nanded	Mob: 9850331971 Email: rajarammane70@gmail.com
3.	Dr. A. V. Sarode	Assistant Professor	School of Physical Sciences, Swami Ramanand Teerth Marathwada University, Nanded	Mob: 9921340727 Email: avsarode@gmail.com
4.	Dr. K. A. Bogle	Assistant Professor	School of Physical Sciences, Swami Ramanand Teerth Marathwada University, Nanded	Mob: 7350845827 Email: kashinath.bogle@gmail.com

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science & Technology

Credit Framework for Two Year PG Program

Subject: Physics

Year & Level 1	Sem. 2	Major Subject: (DSC) 3	Major Subject: (DSE) 4	RM 5	OJT / FP 6	Research Project 7	Practicals 8	Credits 9	Total Credits 10
1	1	**SPHYC401 (4 Cr)** (Mathematical Methods in Physics) **SPHYC402 (4 Cr)** (Classical Mechanics) **SPHYC403 (4 Cr)** (Numerical Techniques)	**SPHYE401** (3 Cr) Electronic Devices OR Energy Management	**SVECR 401** Research Methodology **(3 Cr)**	--	--	**SPHYP401 (1Cr)** (Electronic Lab) **SPHYP402 (1Cr)** (General Phy. Lab) **SPHYP403 (1Cr)** (Num. Tech. lab) **SPHYP404 (1Cr)** (C-prog. lab)	22	44
	2	**SPHYC451 (4 Cr)** (Quantum Mechanics) **SPHYC452 (4 Cr)** (Statistical Mechanics) **SPHYC453 (4 Cr)** (Condensed Matter Physics-I)	**SPHYE451** (3 Cr) Atomic Molecular Physics OR Computational Physics	---	**SPHYOJ 451 (3 Cr)**	--	**SPHYP451 (1Cr)** (Spectro Lab) **SPHYP452 (1Cr)** (Sol. Stat. Phy. Lab) **SPHYP453 (1Cr)** (Semicond. Phy. Lab) **SPHYP454 (1Cr)** (Nuclear Phy. Lab)	22	
Exit option: Exit Option with PG Diploma *(after 2024-25)*									

2	**3**	**SPHYC501 (4 Cr)** (Electrodynamics) **SPHYC502 (4 Cr)** (Nuclear and Particle Physics) **SPHYC503 (4 Cr)** (Electronics-I) OR (Fiber Opt. & Lasers-I)	**SPHYE501 (4 Cr)** (***From same Department / School)*** ***Astrophysics-I*** OR ***Materials Science-I*** OR ***Nano Physics***	--		**Research Project** **SPHYR551 (4Cr)**	**SPHYP501 (1 Cr)** (Lab-I) **SPHYE502 (1 Cr)** (Lab-II)	**22**	**44**
	4	**SPHYC551 (4 Cr)** (Energy Studies) **SPHYC552 (4 Cr)** (Electronics-II) OR (Fiber Opt. & Lasers-II)	**SPHYE551 (4 Cr)** (***From same Department / School)*** ***Astrophysics-II*** OR ***Material Science-II*** OR ***Electronics Instrumentation***	**SVECP 551** Publication Ethics (2 Cr)		**Research Project** **SPHYR552** **(6 Cr)**	**SPHYP551 (1 Cr)** (Lab-III) **SPHYE552 (1 Cr)** (Lab-IV)	**22**	
Total Credits		**44**	**14**	**05**	**03**	**10**	**12**	**88**	

M. Sc. First Year Semester I (Level 6.0)

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SPHYC401**	Mathematical Methods in Physics	04	--	**04**	04	--
	SPHYC402	Classical Mechanics	04	--	**04**	04	--
	SPHYC403	Numerical Techniques and C-programming	04	--	**04**	04	--
Elective (DSE)	**SPHYE401**	Electronic Devices OR Energy Management	03	--	**03**	03	--
Research Methodology	**SVECR401**	Research Methodology	03	--	**03**	03	
DSC/ DSE Practical	**SPHYP401**	General Electronics Lab	--	01	**01**	--	02
	SPHYP402	Digital Electronics Lab	--	01	**01**	--	02
	SPHYP403	Numerical Techniques Lab	--	01	**01**	--	02
	SPHYP404	C- Programming Lab	--	01	**01**	--	02
Total Credits			**18**	**04**	**22**	**18**	**08**

M. Sc. First Year Semester I (Level 6.0)

Examination Scheme

[20% Continuous Assessment (*CA*) and 80% End Semester Assessment (*ESA*)]

Subject (1)	Course Code (2)	Course Name (3)	Theory: Continuous Assessment (CA) Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	ESA Total (7)	Practical CA (8)	ESA (9)	Total Col (6+7) / Col (8+9) (10)
Major	SPHYC401	Mathematical Methods in Physics	20	20	20	80	--	--	100
	SPHYC402	Classical Mechanics	20	20	20	80	--	--	100
	SPHYC403	Numerical Techniques and C-programming	20	20	20	80	--	--	100
Elective (DSE)	SPHYE401	Electronic Devices OR Energy Management	15	15	15	60	--	--	75
Research Methodology	SVECR401	Research Methodology	15	15	15	60	--	--	75
DSC/DSE Practical	SPHYP401	General Electronics Lab	--	--	--	--	05	20	25
	SPHYP402	Digital Electronics Lab	--	--	--	--	05	20	25
	SPHYP403	Numerical Techniques Lab	--	--	--	--	05	20	25
	SPHYP404	C- Programming Lab	--	--	--	--	05	20	25

M. Sc. First Year Semester II (Level 6.0)

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SPHYC451**	Quantum Mechanics	04	--	**04**	04	--
	SPHYC452	Statistical Mechanics	04	--	**04**	04	--
	SPHYC453	Condensed Matter Physics-I	04	--	**04**	04	--
Elective (DSE)	**SPHYE451**	Atomic and Molecular Physics OR Computational Physics	03	--	**03**	03	--
On Job Training	**SPHYO451**	ON Job Training	--	03	**03**	--	06
DSC/DSE Practical	**SPHYP451**	Spectroscopy Lab	--	01	**01**	--	02
	SPHYP452	Solid State Physics Lab	--	01	**01**	--	02
	SPHYP453	Semiconductor Physics Lab	--	01	**01**	--	02
	SPHYP454	Nuclear Physics Lab	--	01	**01**	--	02
Total Credits			**15**	**07**	**22**	**15**	**14**

M. Sc. First Year Semester II (Level 6.0)

Examination Scheme

[20% Continuous Assessment (*CA*) and 80% End Semester Assessment (*ESA*)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	SPHYC501	Quantum Mechanics	20	20	20	80	--	--	100
	SPHYC452	Statistical Mechanics	20	20	20	80	--	--	100
	SPHYC453	Condensed Matter Physics-I	20	20	20	80	--	--	100
Elective (DSE)	SPHYE451	Atomic and Molecular Physics OR Computational Physics	15	15	15	60	--	--	75
On Job Training	SPHYO451	ON Job Training	15	15	15	60	--	--	75
DSC/ DSE Practical	SPHYP451	Spectroscopy Lab	--	--	--	--	05	20	25
	SPHYP452	Solid State Physics Lab	--	--	--	--	05	20	25
	SPHYP453	Semiconductor Physics Lab	--	--	--	--	05	20	25
	SPHYP454	Nuclear Physics Lab	--	--	--	--	05	20	25

M. Sc. First Year Semester III (Level 7.0)

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SPHYC501**	Electrodynamics	04	--	**04**	04	--
	SPHYC502	Nuclear and Particle Physics	04	--	**04**	04	--
	SPHYC503	Electronics-I OR Fiber Opt. & Lasers-I	04	--	**04**	04	--
Elective (DSE)	**SPHYE501**	Astrophysics-I OR Materials Science-I OR Nano Physics	04	--	**04**	04	--
Research Project	**SPHYR551**	Research Project	--	04	**04**	--	04
DSC/ DSE Practical	**SPHYP501**	General Electronics Lab	--	01	**01**	--	02
	SPHYP502	Digital Electronics Lab	--	01	**01**	--	02
Total Credits			**16**	**06**	**22**	**16**	**08**

M. Sc. First Year Semester III (Level 7.0)

Examination Scheme

[20% Continuous Assessment (*CA)* and 80% End Semester Assessment (*ESA*)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SPHYC501**	Electrodynamics	20	20	20	80	--	--	100
	SPHYC502	Nuclear and Particle Physics	20	20	20	80	--	--	100
	SPHYC503	Electronics-I OR Fiber Opt. & amp; Lasers-I	20	20	20	80	--	--	100
Elective (DSE)	**SPHYE501**	Astrophysics-I OR Materials Science-I OR Nano Physics	20	20	20	80	--	--	100
Research Project	**SPHYR551**	Research Project	-	-	-	-	20	80	100
DSC/ DSE Practical	**SPHYP501**	General Lab -I	--	--	--	--	05	20	25
	SPHYP502	General Lab -II	--	--	--	--	05	20	25

M. Sc. First Year Semester IV (Level 7.0)

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SPHYC551**	Energy Studies	04	--	**04**	04	--
	SPHYC552	Electronics-II OR Fiber Opt. & Lasers-II	04	--	**04**	04	--
Elective (DSE)	**SPHYE551**	Astrophysics-II OR Material Science-II OR Electronics Instrumentation	04	--	**04**	04	--
Publication Ethics	**SVECP 551**	Publication Ethics	02	-	**02**	02	
Research Project	**SPHYR552**	Research Project	-	06	**06**	-	06
DSC/DSE Practical	**SPHYP551**	General Lab -III	--	01	**01**	--	02
	SPHYP552	General Lab -IV	--	01	**01**	--	02
Total Credits			**14**	**08**	**22**	**14**	**08**

M. Sc. First Year Semester II (Level 6.0)

Examination Scheme

[20% Continuous Assessment (*CA*) and 80% End Semester Assessment (*ESA*)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA			
			Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SPHYC551**	Energy Studies	20	20	20	80	--	--	100
	SPHYC552	Electronics-II OR Fiber Opt. & Lasers-II	20	20	20	80	--	--	100
Elective (DSE)	**SPHYE551**	Astrophysics-II OR Material Science-II OR Electronics Instrumentation	20	20	20	80	--	--	100
Publication Ethics	**SVECP 551**	Publication Ethics	10	10	10	40			50
Research Project	**SPHYR552**	Research Project					30	120	150
DSC/ DSE Practical	**SPHYP551**	General Lab -III	--	--	--	--	05	20	25
	SPHYP552	General Lab -IV	--	--	--	--	05	20	25

M.Sc. 1st Semester

SPHYC401: Mathematical Methods in Physics

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. Knowledge of number systems and mathematical operations.

Course objectives:

The main objective of this course is to introduce the students to apply mathematical formulation of mechanics problems and to interpret the solutions physically, to apply the concepts of classical mechanics to the rigid systems and to develop the skill of critical thinking and problem solving.

Course outcomes:

After completion of the course the students shall be able to apply Newton's laws of motion to solve complicated problems involving multiple bodies and use the concepts of classical mechanics to the classical rigid bodies. The knowledge acquired through this course will enable the students to lay the foundation of application of the classical dynamics, space dynamics and also for modern physics.

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Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Vector Spaces and Matrices**	**15**
	1.1	Linear dependence and independence of vectors, Inner product, Schmidt's orthogonalization method;	
	1.2	Matrices – Inverse, Orthogonal, Hermitian and unitary matrices, Transformation of vectors and matrices;	
	1.3	System of linear equations, eigenvalues and eigenvectors of square matrix, diagonalisation of a matrix, rotation matrix.	
2.0		**Special functions**	**15**
	2.1	Legendre equation, Rodrigues formula for Pn(x), generation functions and recurrence relation, Associated Legendre polynomial;	
	2.2	Bessel equation, Bessel function of first kind, generating functions and recurrence relation, Associated Legendre polynomial;	
	2.3	Hermite Equation, generating function and recurrence relation for Hermite polynomial.	
	2.4	Leguerre equation, generating function and recurrence relation, Rodrigue formula, Associated Lagurre polynomials.	
3.0		**Fourier Series and Integral Transform**	**15**
	3.1	Fourier series: General properties of Fourier series, Simple applications, properties of Fourier series, convergence, integration, differentiation;	
	3.2	Fourier Transform, Laplace Transforms, Properties of	

		Fourier and Laplace transforms (Linearity, first shifting and second shifting property);	
	3.3	Fourier sine and cosine transforms, Fourier and Laplace transform of derivatives, elementary Laplace transform;	
	3.4	Inverse Fourier and Laplace transforms, shifting theorm, step function, Solution of simple differential equation using Laplace Transform technique;	
4.0		**Complex function and Calculus of Complex function**	**15**
	4.1	Definition of complex function, exponential function and properties, circular function and properties, hyperbolic function and properties, Inverse hyperbolic function, logarithmic function;	
	4.2	limit of a complex function, continuity, derivative (theorm), anlytic functions, harmonic functions, complex integration;	
	4.3	Cauchy's theorm, Cauchy's integral formula, Series of complex term-Taylor's series, Laurentz series;	
	4.4	Zeros of an analytical function, Singularities of an analytical function (isolated, removable, poles and essential singularity), Residue Theorm-Calculus of residues.	
		Total	**60**

Text Books:

1. A. W. Joshi, Matrices and Tensors in Physics,
2. Mathematical Physics, B. S. Rajput
3. Higher Engineering Mathematics, By B. S. Grewal.
4. Mathematical Physics, S. L. Kakani.
5. Mathematical Physics, S. Chandra.
6. Advance Engineering Mathematics by H.K. Dass (S. Chand Publication)

Reference Books:

1. Mathematics for Engineers and Physicists (Pipe)
2. Mathematical Methods in Physical Sciences (Massy and Bias)

SPHYC402: Classical Mechanics

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. Students should possess knowledge of mechanics and systems.

Course objectives:

The main objective of this course is to introduce the students to apply mathematical formulation of mechanics problems and to interpret the solutions physically, to apply the concepts of classical mechanics to the rigid systems and to develop the skill of critical thinking and problem solving.

Course outcomes:

After completion of the course the students shall be able to apply Newton's laws of motion to solve complicated problems involving multiple bodies and use the concepts of classical mechanics to the classical rigid bodies. The knowledge acquired through this course will enable the students to lay the foundation of application of the classical dynamics, space dynamics and also for modern physics.

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Curriculum Details

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Elementary Principles**	15
	1.1	Review of Newtonian mechanics, Inertial reference frame; Galilean transformations; Motion of a charged particle in electromagnetic field;	
	1.2	Conservative and non-conservative forces; Mechanics of a single particle; Mechanics of a System of particles; Motion in a resistive medium;	
	1.3	Constraints and its types; Generalized coordinates, cyclic coordinates and degrees of freedom; Virtual displacement and virtual work; D' Alembert's principle.	
2.0		**Lagrangian Formulation**	15
	2.1	Lagrangian equation of motion from D' Alembert's principle, procedure for formation of Lagrange's equation; Variation technique; Generalized momenta and cyclic coordinates;	
	2.2	Kinetic energy in terms of generalized coordinates; Jacobi integral; Jacobi integral in terms of kinetic energy; Rayleigh's dissipation function; Gauge transformation for Lagrangian;	
	2.3	Symmetry properties and conservation laws; Invariance of Lagrangian equations under Galilean transformation; Variational principle; Derivation of Lagrangian equation from Variational principle.	

3.0		**Hamiltonian Formulation and Central Force**	**15**
	3.1	Transformation from Lagrangian to Hamiltonian; Derivation of Hamiltonian equations of motion from Hamiltonian principle; Δ Variation technique; Principle of least action; Canonical transformation; Condition for a transformation to be Canonical;	
	3.2	Poisson brackets; Properties of Poisson's bracket; Poisson's bracket of Canonical variables; Jacobi identity; Poisson's theorem; Invariance of Poisson's bracket under canonical transformation; Hamilton-Jacobi method.	
	3.3	Reduction of two-body problem into one-body problem; equation of motion under Central force; equation of Orbit; inverse square law;	
	3.4	Kepler's laws of planetary motion; Virial theorem; Scattering in a central force field; Rutherford scattering cross section.	
4.0		**Rigid body dynamics and small oscillations**	**15**
	4.1	Coordinate systems; Euler's angles; Angular momentum and inertia tensor; Principle axes; Components of angular velocity;	
	4.2	Rotational kinetic energy of a body; Euler's equation of motion for a rigid body; Torque free motion of a rigid body.	
	4.3	Potential energy and equilibrium; Stable and unstable equilibriums; Small oscillations in a system with one degree of freedom;	
	4.4	Small oscillations in a system with more than one degree of freedom; Normal coordinates; Normal modes and normal frequencies of vibration.	
		Total	**60**

Text Books:

1. Classical Mechanics by J. C. Upadhyaya, Himalaya Publishing House, New Delhi
2. Classical Mechanics by V. B Bhatia, Joag, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi
3. Classical Mechanics by P. V. Panat, Joag, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi

Reference Books:

1. Classical Mechanics by S. L Gupta, V Kumar and H. V Sharma Pragati Prakashan Meerut.
2. Classical Mechanics by Suresh Chandra, Narosa Publishing House, New Delhi
3. Classical Mechanics by N. C. Rana and P. S. Joag, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi

SPHYC403: Numerical Techniques and C-Programming

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. Knowledge of computer and programming is essential for numerical analysis.

Course objectives:

The main objective of this course is to introduce students to the useful numerical methods and tools that are being adopted for handling data in Physics. The course also aimed to introduce the students to C-Programming language, which is an essential tool for handling and solving numerical problems in physics.

Course outcomes:

After completion of the course students shall be able to employ the studied numerical techniques to solve problems in physics related to the applications like data handling and fitting, finding solutions and root of equations, solving the differential and integral equations, simultaneous equations and partial differential equations. They shall also be well versed with writing their programmes using C-language of computer programming. Students can apply these learned techniques not only to physics related problems but can extend the use and their applications to Engineering science and technology, Biotechnology, Biophysics etc.

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Curve fitting ,interpolation and Roots of equation**	**15**
	1.1	The Principle of Least squares, fitting a straight line, fitting a parabola, fitting an exponential curve, fitting curve of the form $y=ax^b$, fitting through a polynomial, Cubic spline fitting, Linear interpolation, difference schemes, Newton's forward and backward interpolation formula.	
	1.2	Polynomial and transcendental equations, limits for the roots of polynomial equation. Bisectional method, false position method, Newton Raphson method, direct substitution method, synthetic division, complex roots.	
2.0		**Numerical integrations and Solution of differential equations**	**15**
	2.1	Newton cotes formula, trapezoidal rule, Simpson's one third rule, Simpson's three eight rule, Gauss quadratics method, Monte Carlo method.	
	2.2	Taylor series method, Euler method, Runge Kutta method, predictor-corrector method.	

3.0		**Solution of simultaneous equation, Eigen values and eigenvectors of a matrix and Partial differential equations.**	**15**
	3.1	Gaussian elimination method, pivotal condensation method, Gauss-Jordan elimination method, Gauss-Seidal iteration method, Gauss-Jordan matrix inversion method, Gaussian-elimination matrix inversion method.	
	3.2	Computation of real eigen values and corresponding eigenvectors of a symmetric matrix, power method and inverse power method.	
	3.3	Difference equation method over a rectangular domain for solving elliptic, parabolic and hyperbolic partial differential equation	
4.0		**C- Programming**	**15**
	4.1	Elementary information about digital computer principles, compliers, interpreters, and operating systems, C programming, flow charts, integer and floating point arithmetic, expression, build in functions, executable and non-executable statements, assignment, control and input-output elements, user defined functions, operation with files: pointers	
	4.2	**Random numbers**: Random numbers, Random walk, method of importance sampling.	
		Total	**60**

Reference Books:

1. H. M. Antia: Numerical methods for scientists and engineers.
2. Suresh Chandra Computer Applications in Physics with FORTRAN, BASIC and C, Narosa Publishers
3. Vetterming, Teukolsky, press and Flannery: Numerical recipes.
4. Sastry: Introductory method of numerical analysis.
5. Rajaraman: Numerical analysis.
6. Numerical Computational methods, P. B. Patil and U. P. Verma.
7. Numerical methods and computation – B. K. Bafna.
8. Advanced engineering mathematics – Erwin Kreszing 5^{th} or 7^{th} edition john Willey and sons inc.
9. C Programming : Balgurusamy
10. Suresh Chandra Applications of Numrical Techniques with C Narosa Publishers.

SPHYE401: Electronic Devices

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. Knowledge of basic electronic devices and gadgets operations and principles

Course objectives:

This paper covers the construction and working of analog and digital electronic devices, which are utilized by us in day to day life while using mobile phone, television, microwave, calculators, computer, etc. This paper is designed with an objective to expose students to the basics and advances of the electronic device technology and to inculcate them towards future device technology/research.

Course outcomes:

At the completion of this course, students will be able to explain the working and application of devices in various electronic circuits used at home/industries.

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Semiconductor Devices**	**12**
	1.1	Fundamentals of semiconductor	
	1.2	Classification based on band gap (insulator, conductor, and semiconductor), n-type and p-type semiconductors.	
	1.3	Structure and characteristics of p-n junction diodes, and bipolar transistors	
	1.4	Structure and characteristics of field effect transistor, metal oxide field effect transistor, uni-junction transistors, silicon control rectifier, and gun diode.	
2.0		**Photonic Devices**	**12**
	2.1	Basics of photonic devices, Direct and indirect band gap of the semiconductor, radiative transitions,	
	2.2	Photoconductors, photodiodes, phototransistors, and photo-detectors (construction, working, and application),	
	2.3	Light emitting diodes (Visible and Infrared), solar cells (Solar radiations and ideal conversion efficiency P-N junction solar cell, spectral response, I-V characteristics)	
3.0		**Operational Amplifier**	**11**
	3.1	OP-AMP parameters, ideal OP-AMP, differential amplifier	
	3.2	OP-AMP as; Inverting amplifier, non–Inverting amplifier, adder, subtractor, differentiator, integrator, Schmitt trigger, and comparator	
	3.3	OP-AMP as: High, low, and bandpass active filters.	
	3.4	Monostable and astable multivibrators using IC555	

4.0		**Digital Electronics**	
	4.1	Number system: Binary, decimal, and hexadecimal no. system and its algebra,	**15**
	4.2	Logic devices: AND, OR, NOR, NAND, XOR (symbols, working and truth tables)	
	4.3	Registers: Flip–flop-R-S, J-K, T, D (logic symbols, working and truth tables)	
	4.4	Applications of logic devices as; Shift registers, Synchronous and asynchronous counters, Encoder and decoder (8:3 and 3:8), Multiplexer and demultiplexer (4:1 and 1:4), DAC: R-2R ladder network, ADC using comparators and introduction to 8085 microprocessor.	
		Total	**45**

Text Books:

1. V K Mehta "Principles of electronics", S. Chand Publishing, 2022.
2. Donald P Leach and Albert Paul Malvino "Digital Principles and Applications (SIE)" Tata McGraw Hill Education Private Limited NEW DELHI
3. Floyd Thomas L. "Digital Fundamentals" Pearson Education India
4. Anil K. Maini "Digital Electronics Principles, Devices and Applications" John Wiley & Sons

Reference Books:

1. Thomas F. Schubert Jr. and Ernest M. Kim "Fundamentals of Electronics" Morgan and Claypool Life Sciences
2. B. L. Theraja "Basic Electronics: Solid State" S. Chand Publishing, 2007
3. B. Ghosh "Fundamentals Principles of Electronics" Books & Allied Ltd

SPHYP401: General Electronic Laboratory

Course pre-requisite:

1. Knowledge of Principles of work
2. Basic information about instruments, gadgets etc.
3. Knowledge of precautionary measures.

Course objectives:

- The main objective of practical course is to engage the student in the subject and help them get a better understudying of the topic studies in Physics lesson.
- To allow hand on experiments to learn and understand fundamental principle of operation.
- To develop the scientific attitude amongst student.

Course outcomes:

- ✓ Students will be able to understand different concepts and principles of Physical instrumentations.
- ✓ Student will learn about validity of concepts by doing the experiment.

Sr. No	*Name of Experiment*
1.	p-n junction diode characteristics and studying clipping and clamping circuit.
2.	Transistor characteristics, biasing and its application as amplifier.
3.	FET characteristics, biasing and its application as amplifier.
4.	MOSFET characteristics, biasing and its application as amplifier.
5.	UJT characteristics and its application as oscillator.
6.	SCR characteristics and its application as half wave and full wave rectifier.
7.	Photodiode or LDR characteristics.
8.	Phototransistor characteristics.
9.	Active filters (low pass, high pass and band pass).
10.	OP-AMP as inverting and non-inverting amplifiers.
11.	OP-AMP as adder, differentiator and integrator.
12.	Multivibrators (monostable, bistable and astable) using IC 555.
13.	Design of a Regulated Power Supply.

SPHYP402: Digital Electronic Laboratory

Course pre-requisite:

1. Knowledge of Principles of work
2. Basic information about instruments, gadgets etc.
3. Knowledge of precautionary measures.

Course objectives:

- The main objective of practical course is to engage the student in the subject and help them get a better understudying of the topic studies in Physics lesson.
- To allow hand on experiments to learn and understand fundamental principle of operation.
- To develop the scientific attitude amongst student.

Course outcomes:

- ✓ Students will be able to understand different concepts and principles of Physical instrumentations.
- ✓ Student will learn about validity of concepts by doing the experiment.

Sr. No.	***Name of experiment***
1.	Verification and interpretation of truth tables for AND, OR, NOT and NAND gates
2.	Realization of logic functions with the help of universal gates-NAND Gate.
3.	Realization of logic functions with the help of universal gates-NOR Gate.
4.	Construction of a NOR gate latch and verification of its operation.
5.	Implementation and verification of truth table for J-K flip-flop, D flip-flop and T flip-flop.
6.	Design and implementation of shift register to function as i) SISO, ii) SIPO, iii) PISO, iv) PIPO, v) shift left and vi) shift right operation.
7.	Design and implementation of i) Ring counter, ii) ripple counter.
8.	Parallel adder / subtractor using IC 7483.
9.	Code convertors using encoders and decoders.
10.	Design and set up a 4:1 Multiplexer and 1:4 demultiplexer.
11.	Basic programming of microprocessor 8085.

SPHYP403: Numerical Technique Laboratory

Course pre-requisite:

1. Knowledge of Principles of work
2. Basic information about numerical techniques.
3. Knowledge of computer utilizations and programming.

Course objectives:

- The main objective of practical course is to engage the student in the subject and help them get a better understudying of the topic studies in Physics lesson.
- To allow hand on experiments to learn and understand fundamental principle of operation.
- To develop the scientific attitude amongst student.

Course outcomes:

- ✓ Students will be able to understand different concepts and principles of Physical instrumentations.
- ✓ Student will learn about validity of concepts by doing the experiment.

Sr. No.	***Name of experiment***
1.	Lagrange's Interpolation
2.	Solution of differential equation using Euler's method
3.	Solution of differential equation using Runge-Kutta method
4.	Finding the roots of quadratic equation.
5.	Finding roots of a polynomial equation using Bisectional method
6.	Gauss elimination method
7.	Integration by trapezoidal rule
8.	Integration by Simpson rule
9.	Linear least square fitting

SPHYP404: C-programming laboratory

Course pre-requisite:

1. Knowledge of Principles of work
2. Basic information about numerical techniques.
3. Knowledge of computer utilizations and programming.

Course objectives:

- The main objective of practical course is to engage the student in the subject and help them get a better understudying of the topic studies in Physics lesson.
- To allow hand on experiments to learn and understand fundamental principle of operation.
- To develop the scientific attitude amongst student.

Course outcomes:

- ✓ Students will be able to understand different concepts and principles of Physical instrumentations.
- ✓ Student will learn about validity of concepts by doing the experiment.

Sr. No.	***Name of experiment***
1.	Factorial
2.	Largest number
3.	Addition of matrix
4.	File handling
5.	Addition of matrix by using file handling
6.	Addition of series
7.	Ascending order
8.	Eigen values & Eigen vectors of real asymmetric 2 X2 matrix.
9.	Generation of Random numbers
10.	Power method

M.Sc. 2nd Semester

SPHYC451: Quantum Mechanics

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. Knowledge of basic concepts of mechanics and systems.

Course objectives:

The main objective of this course is to introduce the students to apply mathematical formulation of mechanics problems and to interprete the solutions physically, to apply the concepts of classical mechanics to the rigid systems and to develop the skill of critical thinking and problem solving.

Course outcomes:

After completion of the course the students shall be able to apply Newton's laws of motion to solve complicated problems involving multiple bodies and use the concepts of classical mechanics to the classical rigid bodies. The knowledge acquired through this course will enable the students to lay the foundation of application of the classical dynamics, space dynamics and also for modern physics.

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Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Basics Of Quantum Mechanics**	**15**
	1.1	Derivation of time dependent and time independent Schrodinger equation, Physical significance of wavefunction, Quantum numbers, Postulates of Quantum Mechanics ;	
	1.2	Commutation relations for position and momentum operator, Dirac Delta function and its properties, Ket and Bra notations, Completeness of Eigen functions;	
	1.3	Matrix representation of an operator, Unitary Transformation.	
2.0		**Angular Momentum**	**15**
	2.1	Angular momentum and rotations, Orbital angular momentum, Spin angular momentum, Rotational symmetry and conservation of angular momentum;	
	2.2	Commutation relations for Spin, orbital and total angular momentum, Ladder operators, eigen values of the angular momentum operators; L2 , Lz, J2 , Jz, J+ and J-;	
	2.3	Reflection invariance and Parity, Addition of two angular momenta– Clebsch –Gorden Coefficient , calculation of C.G.coefficient;	
3.0		**Approximation methods**	**15**
	3.1	**Time independent Perturbation Theory:** Stationary perturbation theory, Non-degenerate case; First order	

		correction to energy, First order correction to wave function, Second order perturbation, and corrections, Stark effect in the ground state of hydrogen atom, Time independent perturbation theory: degenerate case, application for the He atom, degenerate case – Stark effect.	
	3.2	**Time dependent perturbation Theory:** Zero order perturbation, First order perturbation, second order perturbation, Fermi Golden rule, adiabatic and sudden approximation.	
	3.3	**Variational Method:** The basic Principle, expectation value of energy in ground state, application to excited state, application to two electrons atom,	
	3.4	**WKB approximation:** The classical limit, One dimensional case, turning point, connection formulae, the application to bound state	
4.0		**Collision in 3-d and Scattering**	**15**
	4.1	Laboratory and Centre of Mass reference frames, scattering amplitude, differential scattering cross section, total scattering cross section, Asymptotic form of scattering states,	
	4.2	Relation between angles and cross sections in the laboratory and center of mass systems, Scattering by spherically symmetric potentials, Integral equation of scattering,	
	4.3	The Born approximation, Partial Waves and Phase shifts, Scattering by a perfectly rigid sphere and by square well potential, Complex potential and absorption.	
	4.4	Identical particles, symmetric and asymmetric wave functions and their construction for N particle system, Slater's determinant, Collision of identical particles (Mathematical derivations are not expected)	
		Total	**60**

Text Books:

1. 1.Quantum mechanics - Ghatak and Loknathan
2. Modern quantum mechanics - J. J. Sakurai (Addison Wesely)
3. Quantum Mechanics - G.Aruldhas

Reference Books:

1. Quantum mechanics - L. I. Schiff (McGraw Hill)
2. Quantum mechanics (concepts and Application)- Nouredine Zettili
3. Perspectives of Modern Physics (Arthur Beiser (McGraw-Hill Int.Edition)
4. Quantum mechanics - A. P.Messiah

SPHYC452: Statistical Mechanics

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. Knowledge of basic concepts of mechanics and systems.

Course objectives:

The main objective of this course is to make students aware of studying physical properties of matter "in bulk" on the basis of dynamical behavior of its microscopic constituents. Fundamentals of heat and laws of thermodynamics with the help of statistics will be covered in order to obtain physical properties on the basis of distribution laws including their applications in view of classical and quantum statistics. The course also includes basics of phase transition with their applications.

Course outcomes:

The main outcome after learning the course is that students can apply and extend concepts learned in this course to theoretical physics. Students will be well acquainted with the particle nature on the basis of distribution laws and their uses in order to illustrate properties of most exotic systems like white dwarf stars, superfluid materials, etc.

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Classical Statistics**	**15**
	1.1	**Fundamentals** Foundation of statistical mechanics, specification of states of a system, contact between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox	
	1.2	**Ensembles** Micro canonical ensemble; phase space; trajectories and density of states; Liouville's theorem; Canonical ensemble and Grand Canonical ensemble; partition function, Calculation of statistical quantities, Energy and density fluctuations.	
	1.3	**Maxwell-Boltzmann Statistics** Maxwell-Boltzmann System: Maxwell-Boltzmann distribution formula; Evaluation of constants α and β, Maxwell-Boltzmann velocity distribution formula;	
2.0		**Quantum Statistics**	**15**
	2.1	Density matrix, statistics of ensembles, statistics of indistinguishable particles.	

	2.2	**<u>Fermi-Dirac Statistics</u>** Fermi-Dirac Gas:- Fermi Dirac distribution formula, ideal F.D. gas, Weakly degenerate Fermi gas; Strongly degenerate Fermi gas; thermodynamic functions of degenerate F.D. gas,	
	2.3	Thermionic emission; electron gas, Free electron model, Photo electric emission, Pauli's theory of Para magnetism, Statistical equilibrium in a white dwarf star.	
3.0		**Bose-Einstein Statistics and condensation phenomenon**	**15**
	3.1	**<u>Bose-Einstein Statistics</u>** Bose-Einstein Gas :-Bose-Einstein distribution formula, Ideal B.E. gas,	
	3.2	Black body radiation, Photon statistics, Phonon statistics,	
	3.3	B.E. condensation, liquid helium, London Theory, Tisza's two fluid model, Landau's theory.	
4.0		**Theory of Imperfect gas and Phase Transitions**	**15**
	4.1	**<u>Cluster Exapansion</u>** Cluster expansion for a classical gas, Virial equation of state, Ising model, mean field theories, Ising model in one, two, three dimensions, and exact solution of one dimensions.	
	4.2	**<u>Phase Transitions</u>** Landau's theory of phase transition, Critical indices.	
	4.3	Fluctuations and transport phenomena, Brownian motion, Langevin's theory, fluctuation dissipation theorem, The Fokker-Plank equation	
		Total	**60**

Reference Books:

1. Statistical Mechanics by R. K Patharia, Pregamon Press, Oxford
2. Statistical Mechanics by J. K Bhaltacharjee, Allied Pubishers Limited, New Delhi
3. Fundamentals of Statistical Mechanics and thermal Physics by F. Reif, McGraw- Hill International Editions
4. Statistical Mechanics by S. K Sinha, Tata M2 Graw-Hill Publishing Co. Ltd. New Delhi
5. Statistical Mechanics by Suresh Chandra, CBS Publishers & Distributors, New De
6. Statistical Mechanics by K. Haung (2008) Wiley.
7. Statistical mechanics by R. K. Pathria and P. D. Beale, (2011) Elsevier.
8. Statistical Mechanics by D. A. Mcquarrie, (2018) Viva Books.
9. Introduction to Statistical Mechanics, by D. Chandler, (1987) Oxford University Press.

SPHYC453: Condensed Matter Physics-I

Course pre-requisite:

1. M.Sc. I^{st} sem Physics students
2. Basic knowledge about materials properties and types

Course objectives:

The main objective is to provide an overview of different types of materials and illustrate how their properties depend on the microscopic structure. The course will deliver basic knowledge about the materials, its crystal and electronic structure.

Course outcomes:

After completing the course students will have knowledge of different types of solids and their microscopic structure. In addition to this they will understand the effect of microscopic structure on transport of charges through it.

Curriculum Details

ModuleNo.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Crystal structure**	15
	1.1	Basic of crystal structure, Bravais lattices in two and three dimension, packing fraction, symmetric properties and coordination number.	
	1.2	Some important crystal structure: Simple cubic (SC), body centered cubic (BCC), face centered cubic (FCC), hexagonal close packed (HCP), NaCl and diamond structure	
	1.3	Miller indices and spacing between set of a crystal planes.	
2.0		**X-ray diffraction and Crystal defects**	15
	2.1	Generation and interaction of X-ray and Braggs law, X-ray Diffraction methods: Laue method, Rotating crystal method and power method	
	2.2	The Reciprocal lattice and its properties, Reciprocal lattices of simple, body centered and face centered cubic lattices	
	2.3	Crystal defects: Point defects, line defects and surface defects	
3.0		**Band theory**	15
	3.1	Electron motion in crystal (one dimensional), Density of states and Fermi-Dirac statistics	
	3.2	Bloch theorem and its implementation in Kroning-penny model, Concept of effective mass of electron	
	3.3	Distinguish between metal, insulator and semiconductor	

		using band theory	
	3.4	Free electron model, nearly free electron model, tight binding approximation, orthogonalized plane wave model and pseudopotential model.	
4.0		**The Fermi surface**	**15**
	4.1	Fermi surface and Brillouin zones,	
	4.2	Fermi surface in metals	
	4.3	Characteristics of Fermi surface	
	4.4	Experimental determination of Fermi surface	
		Total	**60**

Text Books:

1. A. J. Dekker "Solid State Physics" Springer Link 1969
2. B. S. Saxena "Solid State Physics" Pragati Prakashan 2013
3. S. O. Pillai "Solid State Physics" NEW AGE International Pvt Ltd 2022

Reference Books:

1. L. Azaroff "Introduction To Solids" McGraw Hill Education; New edition (2017)
2. Charles Kittle "Introduction to Solid State Physics" Wiley; Eighth edition (2012)
3. Omar Ali "Elementary solid state physics", Pearson India; 1st edition (2002).

SPHYE451: Atomic and Molecular Physics

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics.
2. Knowledge about materials properties and characterization techniques

Course objectives:

Atomic and molecular physics is of great importance and very basic field in physics. The basic of all matter, which exist in nature, is based on atomic and molecular structure. It is one of the most important subjects for the testing grounds of the quantum theory. Specific objectives are:

- To introduce the world of atoms and molecules to the students.
- To focus on development of various atomic models and to explain the importance and application of Bohr atomic model for atomic spectra of hydrogen like atoms.
- To shed light on various basic concepts like vector atomic model, introduction of spin, coupling schemes for many electron atoms, term symbols to designate quantum states.
- To bring into notice the basic concepts of molecular spectroscopy and their types, origin of rotational, vibrational , electronic and Raman spectra of various molecules and to explain the importance of polymeric materials to humanity and molecules
- To introduce the working principle of various spectroscopic techniques and instrumentation used for analyzing spectra of various types of molecules.

Course outcomes:

Upon successful completion of these modules, students will be able to understand and explain the following;

- ✓ The atomic spectra of one valance electron atoms.
- ✓ what is meant by LS and JJ coupling in case of two valance electron atoms and the origin of spinorbit interaction
- ✓ Use appropriate quantum numbers for labeling of energy levels/terms symbols.
- ✓ The change in behavior of atoms in external applied electric and magnetic field.
- ✓ Diatomic molecules, the origin of electronic, vibrational and rotational energy levels, calculate energy levels,
- ✓ Analyze rotational, vibrational, electronic and Raman spectra of molecules
- ✓ To undertake simple calculations of bond lengths, rotational constant, dissociation energy, and relative level populations

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Atomic structure and atomic spectra**	**15**
	1.1	**Spectra of Monovalent atoms** Quantum mechanical results of hydrogen atom, Atomic spectra of Hydrogen, Quantum numbers and their role, atomic orbitals, orbital and spin angular momenta., spin orbit interaction, vector atom model, spectroscopic terms and their notations, Fine structure in hydrogen energy levels, spectra of alkali elements, different series in alkali spectra. The doublet fine structure.	
	1.2	**Spectra of Divalent atoms** Coupling scheme, L-S and j-j coupling, Building up principle: the Aufbau principle, Equivalent and non-equivalent electrons: Pauli's exclusion principle, Hund's rules. spectral terms, Breit's scheme.	
	1.3	**Magnetic and electric field effects** Normal and anomalous Zeeman effect, Lande g factor, Interaction energies's, Paschen Back effect, interaction energy, co-relation between Zeeman and Paschen Back effects, Stark effect with weak and strong field, Hyperfine structure	
2.0		**Microwave Spectroscopy of Molecules**	**15**
	2.1	Preliminaries, Types of molecules	
	2.2	Diatomic molecules -Rotational spectra of diatomic molecule, Rigid rotator and Non-rigid rotator, energy levels, selection rules and resulting spectra, the effect of isotopic substitution, Intensities of spectral lines in rotational spectra	
	2.3	Polyatomic molecules - Linear molecules, determination of inter-atomic distances using isotopic substitution, Symmetric top molecules: calculation of energy, selection rule, spectra. Microwave spectrometer, problem solving	
3.0		**Infrared and Electronic spectroscopy of molecules**	**15**
	3.1	**Vibrational spectroscopy of diatomic molecules** Vibrational energy of diatomic molecule, the simple harmonic oscillator model energy The anharmonic oscillator, Morse potential curve, Energies, selection rules, spectra, frequencies of fundamental and overtones and hot band The diatomic vibrating rotator with and without Born-Oppenheimer approximation, energy levels, selection rules, P, Q and R branches.	
	3.2	**Polyatomic molecules** Fundamental vibrations and their symmetry, CO2 and H2O molecules, techniques and instrumentations, IR spectrometer	
	3.3	Electronic spectra of diatomic molecules Born-Oppenheimer approximation, vibrational coarse structure	

		of electronic bands, progressions and sequences, P, Q and R branches. The band head formation and shading of bands, Franck Condon principle, dissociation energy and dissociation products	
4.0		**Raman spectroscopy of molecules**	**15**
	4.1	Introduction, quantum theory of Raman effect, classical theory of Raman effect, molecular polarizability,	
	4.2	**Pure rotational Raman spectra** linear diatomic molecules, intensity alteration in Raman spectra of diatomic molecules, Raman spectra of symmetric top molecule, R and S branches in Raman spectra	
	4.3	**Vibrational Raman spectra** Raman activity of vibrations (H2O and CO2 molecules), rule of mutual exclusion, nature of polarized light, structure determination from Raman and infra-red spectroscopy, Experimental setup for Raman spectroscopy	
		Total	**60**

Text Books:

1. Fundamentals of Molecular Spectroscopy by Colin N. Banwell (Tata MacGrawHill, New Delhi)
2. Spectra of Atoms and Molecules by Peter Bernath (Oxford Uni. Press, USA)
3. Introduction to Atomic Spectra by H. E. White (Tata McGraw Hill, New Delhi)
4. Spectroscopy Vol. 1, 2 & 3 by Straughan B. P. and Walker M. A. (Chapman and Hall, London)
5. Atoms, Molecules and Lasers by K. P. Rajappan Nair (Narosa Publishing House, Delhi)

Reference Books:

1. Atomic Spectroscopy by K. P. Rajappan Nair (MJP Publishers, Chennai)
2. Atom, Laser and Spectroscopy by S. N. Thakur, D. K. Rai (PHI Learning Private Ltd., Delhi) Faculty of Science, M.Sc. Physics Syllabus (2016) Page 18
3. Elements of Spectroscopy by Gupta-Kumar-Sharma (PragatiPrakashan, Meerut
4. Atomic Spectra and Atomic Structure by G. Herzberg, New York Dover Publication 1944
5. Introduction to Molecular spectroscopy by C. M. Barrow

SPHYE451: *Computational Physics*

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. Sound background of Python language

Course objectives:

This paper covers techniques used in modeling physical systems numerically and analyzing data. It is designed to help the students gain experience with programming languages in carrying out this work and use of computer programming to solve scientific problems in physics and related areas.

Course outcomes:

After completion of this course, students can get knowledge about how to solve problems in physics using computer programming and simulation.

Curriculum Details

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Approximations and Errors in Computation**	**11**
	1.1	Approximate numbers and Significant Figures, rounding off errors, Mathematical Preliminaries,	
	1.2	Types of errors, general formula, Formula to the fundamental operations of arithmetic and logarithms	
	1.3	Accuracy in the evaluation of formula, error in series approximation, floating point arithmetic.	
2.0		**Introduction to Numerical Methods**	**11**
	2.1	Basics of Linear algebra, matrices and vectors,	
	2.2	Interpolation and curve fitting	
	2.3	Numerical Integration and Ordinary differential equations	
3.0		**Introduction to Python, Simulation, Particle and Planetary motions and dynamics of many particle systems**	**12**
	3.1	Introduction to Python	
	3.2	Optimization techniques	
	3.3	Simulating single particle motion and visualizing trajectories in 2D and 3D	
	3.4	Planetary motions and other few body problems	
4.0		**Monte Carlo Simulation**	**11**
	4.1	Deterministic randomness , Random sequences (theory), Random number generation (algorithm)	
	4.2	Implementation: Random Sequence, Assessing randomness and uniformity	

	4.3	Monte Carlo Applications: A random walk problem, Random walk simulation, Implementation: Random walk, Radioactive decay (Problem), discrete decay (model), continuous decay (model), decay simulation with Geiger counter sound.	
		Total	**45**

Reference Books:

1. Computational Physics Problem Solving with Computers; Rubin H. Landau Manuel Jose Paez, Cristian C. Bordeianu
2. An Introduction to Computer Simulation Methods Applications to Physical System Harvey Gould, Jan Tobochnik, and Wolfgang Christian
3. Numerical analysis by Bhupendra Singh
4. Numerical Methods In Engineering & Science by Dr. B.S. Grewal
5. H. M. Antia: Numerical methods for scientists and engineers.
6. Sastry: Introductory method of numerical analysis.
7. Rajaraman: Numerical analysis.
8. Numerical Computational methods, P. B. Patil and U. P. Verma.
9. Numerical methods and computation – B. K. Bafna.
10. Advanced engineering mathematics – Erwin Kreszing 5^{th} or 7^{th} edition john Willey and sons inc.
11. Suresh Chandra Applications of Numrical Techniques with C Narosa Publishers.

SPHYP451: Spectroscopy Laboratory Experiments

Course pre-requisite:

1. Knowledge of Principles of work
2. Basic information about spectroscopic instruments, gadgets etc.
3. Knowledge of precautionary measures, light theory etc.

Course objectives:

- The main objective of practical course is to engage the student in the subject and help them get a better understudying of the topic studies in Physics lesson.
- To allow hand on experiments to learn and understand fundamental principle of operatation.
- To develop the scientific attitude amongst student.

Course outcomes:

- ✓ Students will be able to understand different concepts and principles of Physical instrumentations.
- ✓ Student will learn about validity of concepts by doing the experiment.

Sr. No.	***Name of experiment***
1.	Michelson Interferometer
2.	Talbott’s Bands
3.	Constant deviation spectrometer
4.	Hartmann dispersion formula
5.	λ by biprism
6.	Polarizibility of liquids

SPHYP452: Solid State Physics Laboratory Experiments

Course pre-requisite:

1. Knowledge of Principles of work
2. Basic information about materials properties and instrumentation handling etc.
3. Knowledge of analysis of properties is must.

Course objectives:

- The main objective of practical course is to engage the student in the subject and help them get a better understudying of the topic studies in Physics regrading materisl properties.
- To allow hand on experiments to learn and understand fundamental principle of operation and analysis of properties.
- To develop the scientific attitude amongst student.

Course outcomes:

- ✓ Students will be able to understand different concepts and principles of Physical instrumentations.
- ✓ Student will learn about validity of concepts by doing the experiment.

Sr. No.	***Name of experiment***
1.	To study the variation of energy band gap (Eg) of diode with temp.
2.	Determination of electronic charge by investigating rectifier equation of solid state diode.
3.	Determination of dielectric const. of liquids.
4.	Determination of elastic const. using piezoelectric effect.
5.	Determination of Specific Heat of Solids.
6.	Conductivity and resistivity of graphite rod.
7.	Determination of Fermi energy of metals.
8.	Determination of Boltzmann Constant

SPHYP453: Semiconductor Physics Laboratory

Course pre-requisite:

1. Knowledge of Principles of electronic devices working.
2. Basic information about semiconductors and properties.
3. Knowledge of precautionary measures, electricity is essentials.

Course objectives:

- The main objective of practical course is to engage the student in the subject and help them get a better understanding about electronic devices and semiconductors.

Course outcomes:

- ✓ Students will be able to understand different concepts and principles of Physical instrumentations.
- ✓ Student will learn about validity of concepts by doing the experiment.

Sr. No.	*Name of experiment*
1.	Determination of Hall co-efficient, number of majority carriers and type of a given semiconductor specimen
2.	Temperature dependence of current of p-n junction diode – estimation of band gap of semiconductor materials
3.	Determination of resistivity and band gap of semiconductors using Four Probe Method
4.	To study the band gap of thermister
5.	To determine value of Planks constant using LED
6.	Determination of dielectric constant of some dielectric materials

SPHYP454: Nuclear Physics Laboratory

Course pre-requisite:

1. Knowledge of Principles of Nuclear physics.
2. Basic information about nuclear fusion and fissions.
3. Knowledge of precautionary measures, handling is essentials.

Course objectives:

- The main objective of practical course is to engage the student in the subject and help them get a better understanding about nuclear physics and technologies.
- To make aware about the use of nuclear methodologies for human welfare.

Course outcomes:

- ✓ Students will be able to understand different concepts and principles of Physical instrumentations.
- ✓ Student will learn about validity of concepts by doing the experiment.

Sr. No.	***Name of experiment***
1.	Study the characteristics of a GM tube and determination of its operating voltage.
2.	Determination of the dead time using single source.
3.	Study of nuclear counting statistics.
4.	Verification of Inverse square law for γ- rays.
5.	Attenuation of β- rays
6.	Measurement of short half-life.
7.	Measurement of long half-life.
8.	Calibration of Gamma-ray spectrometer using Cesium and Cobalt 60 sources.
9.	Determination of energy of any unknown gamma source

Course Assessment:

A. Continuous Assessment (CA) (20% of the Maximum Marks):

This will form 20% of the Maximum Marks and will be carried out throughout the semester. It may be done by conducting **Two Tests** (Test I on 40% curriculum) and **Test II** (remaining 40% syllabus). Average of the marks scored by a student in these two tests of the theory paper will make his **CA** score (col 6).

B. End Semester Assessment (80% of the Maximum Marks):

(For illustration we have considered a paper of 04 credits, 100 marks and need to be modified depending upon credits of an individual paper)

1. **ESA Question paper will consists of 6 questions, each of 20 marks.**
2. **Students are required to solve a total of 4 Questions.**
3. **Question No.1 will be compulsory and shall be based on entire syllabus.**
4. Students need to solve **ANY THREE** of the remaining Five Questions (Q.2 to Q.6) and shall be based on entire syllabus.

%%%%%

M.Sc.

Physics

IIIrd Semester

SPHYC501: Electrodynamics

Course pre-requisite:

1. M.Sc. II[nd] sem Physics students

Course 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.

Course outcomes:

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.

ModuleNo.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Maxwell equations and Electromagnetic waves**	**15**
	1.1	Maxwell's equations and their physical significance. Equation of continuity & relaxation time, Vector and scalar potentials,	
	1.2	Lorentz and Coulomb gauge, gauge transformation, electromagnetic energy and Poynting's theorem,	
	1.3	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	
2.0		**Electromagnetic waves in bounded media**	**15**
	2.1	Reflection and refraction of plane electromagnetic waves at a plane interface: normal incidence, oblique incidence, Fressnel's equations, Brewster's angle	
	2.2	Total internal reflection. Reflection and refraction from metallic surfaces, Electromagnetic wave propagation between two parallel conducting plates, waves in hollow conductors,	
	2.3	Rectangular wave guides - TE and TM modes.	
3.0		**Radiations from moving charges**	**15**
	3.1	Concept of retarded potential, The Lienard-Wiechert potentials, Field produced by moving charges, radiation from a linearly accelerated charged particle at low velocity,	
	3.2	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,	
	3.3	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	
4.0		**Covariance and Relativistic Electrodynamics**	**15**
	4.1	Galilean transformations, Lorentz transformations and basic kinematical results of special relativity (length contraction, time dilation, addition of velocities, charge invariance, field transformation, etc), Minkowski space-time diagram, light cone, relativistic momentum and energy of a particle, mathematical properties of space-time in special relativity	
	4.2	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.	
		Total	**60**

Text 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)

Reference Books:

1. Electricity and Magnetism - Panofsky and Philips
2. Electromagnetic waves and fields - R.N.Singh (Tata McGraw Hill)
3. Electromagnetic Waves and Radiation system - Jordan and Balman (PHI)
4. Electromagnetic Fields and waves -Paul Lorrain and Dale Corson (CBSPub)
5. Electromagnetics - B.B.Laud (New Age Intl. Pub.)
6. Introduction to Electrodynamics- A. Z. Capri and P. V. Panat (Narosa)

SPHYC502: Nuclear and Particle Physics

Course pre-requisite:

1. M.Sc. I^{st} sem Physics students
2. …………………………

Course objectives:

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.

Course outcomes:

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 No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Basic Nuclear Properties and Interaction of Radiation with Matter**	**15**
	1.1	Nuclear mass, Nuclear size : Nuclear Radius & its determination by Rutherford scattering, electron scattering & mirror nuclei method	
	1.2	Nuclear quantum numbers, Angular momentum, nuclear dipole moment, electric quadruple moment, Nuclear Binding ,	
	1.3	Average binding energy and its variation with mass number, Semi empirical mass formula & its applications.	
2.0		**Interaction of nuclear radiation with matter and elementary particles**	**15**
	2.1	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	
	2.2	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	
	2.3	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.	
3.0		**Nuclear Forces and Nuclear Models**	**15**
	3.1	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, neutronproton scattering at low	
	3.2	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. Swami Ramanand Teerth Marathwada University, Nanded M. Sc. Physics (CBCS) Syllabus (Campus School) 60 Liquid drop model: assumptions, achievements, Bohr Wheeler theory of fission, Failure and limitations of liquid drop model,	
	3.3	Collective model: vibration and rotation states, achievements of Bohr and Mottelson collective model Fermi gas model: assumptions, achievements, limitations of Fermi gas model	
4.0		**Nuclear decay & Nuclear decay Reactions**	**15**
	4.1	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 .	
	4.2	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.	
		Total	**60**

Text 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.

Reference Books:

1. L. Azaroff "Introduction To Solids" McGraw Hill Education; New edition (2017)
2. Charles Kittle "Introduction to Solid State Physics" Wiley; Eighth edition (2012)
3. Omar Ali "Elementary solid state physics", Pearson India; 1st edition (2002).

SPHYC503A: Electronics-I: Microwave Devices

Course pre-requisite:

1. M.Sc. Ist sem Physics students
2. …………………………

Learning Objectives: The paper on Microwave Devices and Transmission Lines is well designed and concentrates on Microwave Electronics and Measurements. It has covered basic as well as applied aspects of microwaves, covering microwave sources, properties, applications. This paper gives exposure to the electric field and magnetic field and combination of these two fields forming EM waves. Microwave waveguide components and microwave devices such as GaAs diode, READ diode, IMPATT, BARITT diodes are explained along with PIN and Schottky diodes.

Learning Outcomes: Completion of this course enables the students to understand the basic EM theory and microwave devices. The microwave components have been reinvented in the form of strip line and microstrip form and this MIC technology has drastically reduced the size as well as cost. Moreover, the method of measurements is also included in this paper. This specific study enables the student to work in R & D organizations for further studies and jobs in private/Govt. Sectors..

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Microwave Fundamentals and Transmission Lines**	**15**
	1.1	Microwave frequency region and band designation, Microwave advantages and applications, types of Microwave transmission lines.	
	1.2	Two wire transmission lines, characteristics impedance, Microwave transmission line analysis, equation and solutions, Propagation constant and Losses in transmission lines,	
	1.3	Reflection coefficient ,Standing waves, sanding wave ratio(SWR),VSWR ,Quarter and Half wavelength lines. Smith Chart and application	
2.0		**Microwave active devices**	**15**
	2.1	Microwave vacuum tube devices, High frequency limitations of conventional tubes, Microwave Tubes, Klystrons, Two cavity klystron, velocity modulation, bunching process, Reflex klystron, characteristics and efficiency.	
	2.2	Traveling wave tube (TWT), Helix TWT's, amplification process, Magnetron, Principle & operation of magnetron.	
	2.3	rowave solid state devices, Microwave transistor, BJT, HBT, FET, HEMT, Transferred electron devices, Gunn effect, principle of operation, Read diode, IMPATT and TRAPATT diodes, parametric devices.	
3.0		**Microwave passive devices**	**15**
	3.1	wave guide Microwave Junctions, Scattering parameters, Microwave Tee Junctions, H-plane Tee Junction, E-Plane Tee Junction, E-H-plane Junction (Magic Tee Junction)	
	3.2	Directional Couplers, coupling factor, Directivity,	

		Isolation,Insertion loss, Two hole Directional Coupler.	
	3.3	Ferrite Materials, Ferrite Devices, Isolator, Circulator, Phase Shifters, Microwave Attenuators, slide screw tuner. Microwave bend, Match Load, Waveguide Termination.	
4.0		**RADAR System**	**15**
	4.1	Introduction, application and advantages of Radar. Classification of radar, Radar block diagram and operation, Radar range equation, factors affecting range of radar, maximum unambiguous range.	
	4.2	Pulsed Radar systems, radar display, scanning and tracking with radar, Doppler effect, CW Doppler radar	
	4.3	Moving Target Indicator (MTI) Radar, CW Doppler radar and Radar Antennas.	
		Total	**60**

Text Books:

1. Microwave Radar Engineering- *by M. Kulkarni, Umesh Publicatios, New Delhi.*
2. Microwave Devices and circuits- by *Samuley Y. Liao, Prentice Hall of Gredia Private Limited, New Delhi*
3. Microwave Engineering: *G. S. Raghuvanshi*
   Publisher: CENGAGE Learning

Reference Books:

1. Microwave Devices and Applications by Dinesh C Dube Narosa Publishing House New Delhi
2. Understanding Microwaves-*by Allan W. Scott, A. John Wiley & Sam Ins. Publications*
3. The Microwave Engineering Handbook Vol. I, II and III *–by L. Smith & Michel Henri Carpentire, Springer Industrial edition.*
4. Microwave Circuits and Passive devices-*by M.L. Sisodia &G.S. Raghuvanshi, Wiley Eastern Limited, New Delhi.*
5. Microwave Engineering- *by Sanjeev Gupta, Khanna Publication, New Delhi.*
6. Electronics Communication System *–by Kennedy George, McGraw Hill book Company*
7. Communication Componants & Circuits-*by Edgar Hund, Mc-Graw Hill*

SPHYC503B: Fiber Optics and Lasers- I

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. …………………………

Course objectives:

Use of the optical fibers in the communication system has revolutionized the global telecommunication scenario. With its very high range data handling capability and high rate capacity, optical fiber systems link globe with end users. They have enabled the internet and changed our society. This course is to introduce the student to the subject of lasers and fiber optics. This course is designed to cover the operation and characteristics of the lasers along with fiber optics, which is playing a vital role in current e-communication technology.

Course outcomes:

Upon successful completion of our fiber optic and laser course, the student will build his/her knowledge of different types of lasers used for various applications from home to industry and signal transport through fiber optics for e-communication applications.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Optical Fiber Waveguides**	**15**
	1.1	Fundamentals of optics: Ray Theory, Total Internal reflection, Acceptance angle, Numerical aperture, Skew ray, Electromagnetic mode theory: Electromagnetic waves, modes in planer waveguides, phase and group velocity.	
	1.2	Phase shift with TIR and Evanescent field, Goose-Effective refractive index, Basics of optical fiber and their types, Optical Fiber Structures, wave guiding	
	1.3	Dispersion and losses in optical Fiber Modes in cylindrical fibers and coupling, Cut-off wavelength, mode field diameter and spot size	
2.0		**Optical Fibers: Synthesis and Fabrication**	**15**
	2.1	Preparation of optical fiber, Liquid phase (melting) technique and fiber drawing	
	2.2	Vapour phase deposition technique, Outside vapour phase oxidation process, Vapour deposition	
	2.3	Modified chemical vapour deposition, Plasma activated chemical vapour deposition	
3.0		**Lasers and Types of Lasers**	**15**
	3.1	Basics of Lasers: Properties of Lasers: directionality, intensity, mono-chromaticity, coherence, Einstein’s quantum theory of radiation, Einstein’s coefficients, momentum transfer, lifetime, possibility of amplification.	

	3.2	Population inversion and optical pumping: 2 and 3- level systems, Pumping sources: Electrical (Glow discharge) and Optical (Flash and Arc lamps)	
	3.3	Resonators, Quality factor Q, Mode locking	
	3.4	Types of Lasers: Gas Lasers: He-Ne lasers, N2 lasers, Excimer lasers Solid State Laser: Neodymium laser, Ruby laser	
4.0		**Applications of Lasers**	**15**
	4.1	Optical Communications, Ranging and Navigation	
	4.2	Meteorology and Machining,	
	4.3	Surgery, Medicine, Chemical and Physical processes	
		Total	**60**

Text Books:

1. Lasers & Nonliner Optics, B B Laud, Wiley Eastern
2. Introduction to Lasers, Koichi Shimoda, Springer Verlag
3. Optics and Lasers, M Young, springer Verlag

Reference Books:

1. Masers & Lasers, J S Thorp, Mcmilan
2. Laser Electronics, Verdeyen Prentice Hall
3. Optical Fiber Communication: Principles & Practices, John M Senior

SPHYE501A - Astrophysics- I

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics

Course objectives:

Astrophysics course of this university is designed in such a way that it leads the students to build their foundation to understand the excitements in the deepest quests of the physical universe and acts as the capstone of M. Sc. Physics. The course will introduce the learners to the astronomical observational techniques, including photometry, imaging, spectroscopy, and interferometry; develop skill of error analysis, problem solving in analytic, computational, and telescope plus detector systems; and effective scientific writing through project dissertation reports. The science of astrophysical bodies involves the study of matter and radiation in the universe with an objective to understand it through the laws of physics. Astronomical phenomena encompasses extreme range of physical conditions, from super-fluid neutrons in neutron stars, high-temperature nuclear reactions in supernovae, and strong gravitational fields near black holes, to the unique state of the universe during its earliest phases. Therefore, it is not an exaggeration to say that, "Astronomy is celestial art gallery and infinite Physical and Chemical laboratory. Theoretical attempts to describe these and more familiar phenomena (such as stars and galaxies) enable the students to achieve important level of understanding in several cases and enable them to stretch the knowledge of contemporary physics to its limits in attempting to understand physical conditions, which otherwise cannot be reproduced in terrestrial laboratories. Astrophysics applies the knowledge of Classical Mechanics, Quantum Mechanics, Nuclear physics, Statistical Mechanics, Electrodynamics, Spectroscopy, Mathematical Physics, Modern Electronics and even Chemistry also. Therefore, the pre-requisite of the course is that the students who select this course as their skill enhancement elective course must have adequate knowledge of all the core courses in Physics. The concentration in Astrophysics introduces students to a broad range of phenomena through a program of both observational and theoretical courses and represents a departure from conventional courses by encouraging them to develop, debug, research, design, and explore all aspects necessary for astronomical observations. This course is mainly designed with "hands-on" strategy and will utilize a great deal of the understanding developed M Sc. Physics First Year core course. The students will learn how to use, handle small optical telescopes, the computer-operated 16" ACF MEADE telescope, CCD imagers, solid state photometers, and the small radio telescope. Operating the rooftop telescope for conducting observational exercises of astronomical bodies is an essential component of the course. On an average observing time load during the year would be about 30-40 hours per student. Students doing their observing projects / dissertations are required to use these facilities over the clear nights throughout the year in order to complete their projects.

Course outcomes:

The students after completing this course will become conversant with basic error analysis and propagation; conduct real, quantitative telescopic observations and experiments; write comprehensive lab reports in good scientific writing style; conduct quantitative image analyses; perform quantitative photometry; perform quantitative spectroscopy; learn about the signal-to-noise ratio and its relation to the astronomical observations; expert in analyzing data with regard to convolution, de-convolution, and Fourier analysis and perform function fitting to the real data; expert in optics concepts and optical designs and data mining. This course provides good base for the students to further their higher studies for M.Phil and Ph.D. in the field of Astronomy & Astrophysics. After successful completion of the Masters' degree with good scores, the students have opportunities to join leading research institutes in the field as research scholars leading to the Ph.D. and also to become astrophysicists, scientists or research officers in the field of space research in various institutes within India and in foreign countries. They can also join teaching profession in universities, colleges and institutes after clearing NET exam conducted by CSIR, New Delhi.

Module-I: Observational Techniques (15 Hrs)
Brief history of astronomy (geocentric universe, heliocentric universe), co-ordinate systems (celestial sphere, horizon, equatorial, ecliptic co-ordinate systems), various windows in astronomy (multiwavelength astronomy), 21-cm line and its importance in astronomy. Astronomical distances: astronomical unit (AU), light year, parsec, distance measurement in astronomy-stellar parallax and other methods. Telescopes: Basic optics, Optical telescopes- reflecting and refracting type, various focusing methods, telescope mountings, new technology telescopes, HST. Radio Telescopes and interferometers, very large array (VLA), concept of Very long baseline interferometry (VLBI). Infrared, Ultraviolet and X-ray astronomy (elementary idea), Chandra Telescope, ASTROSAT. Detectors: Photographic plates, photometers, CCDs. Filter systems, NICMOS camera and X-ray detector.

Module-II: Radiative Processes (15 Hrs)
Black body radiation - specific intensity, flux density and luminosity, Planck's law, Wien's displacement law and Sefan's law. Description of the radiation field, Opacities, Basics of radiative transfer - emission coefficient, absorption coefficient, source function, formation and structure of spectral lines. Radiative processes: Synchrotron emission-for a single electron and an ensemble of electrons, Compton scattering, bremstrahlung and thermal bremstrahlung.

Module-III: Stellar Astrophysics (15 Hrs)
Stellar brightness - luminosity, stellar magnitudes, distance modulus, colour index, and stellar temperature. Stellar spectra – spectral classification of stars, luminosity classification of stars, the HertzsprunRussell (H-R) diagram, Observational data on stars (HR diagram), Stellar population- Population I and II, Star clusters-open clusters, globular clusters. The Sun: solar interior- energy transport, magnetic activity in the Sun, Sunspots and sunspot cycle, solar limb darkening, solar neutrino puzzle

Module-IV: Stellar Structure and Evolution (15 Hrs)
Star formation: Interstellar gas and dust, the Jean's criteria, formation of protostar, pre-main sequence evolution of stars Basic equations of stellar structure, Hydrostatic equilibrium, pressure equation of state, Stellar energy sources and nucleo-synthesis (p-p chain reaction, CNO cycle, triple alpha reaction, r & s processes), energy transport in stars Stellar Evolution: Post-Main sequence Evolution in the main sequence, Late stages of stellar evolutionGiant, Super giant phase. End state of stars: White dwarfs, degenerate matter, Chandrashekhar limit, mass-radius relation for a white dwarf star; Neutron stars- its upper mass limits, pulsars; Black Holes. Introduction to Supernova & supernova remnants, neutron stars, pulsars and magnetars.

Reference Books:
1. Modern Astrophysics – B.W. Carroll and D.A. Ostlie, 1996, Addison-Wesley Publishing Co., Inc.
2. The Physical Universe: An Introduction to Astronomy – Frank H. Shu, 1982, University Science Books, Sausalito, California.
3. Theoretical Astrophysics, Vol I:Astrophysical Processes, T. Padmanabhan, Cambridge University Press.
4. Fundamental Astronomy – ed. H. Karttunen, P. Kroger, H. Oja et al., 1987, Springer-Verlag, Berlin.
5. Introductory Astronomy & Astrophysics, M. Zeilik and S. A. Gregory, 4th edition, Saunders College Publishing.
6. The New Cosmos, 4th edition - A. Unsold and B. Baschek, 1991, Springer-Verlag, Berlin.
7. Astrophysics: Stars and Galaxies – K.D. Abhyankar, 1992, Tata McGraw Hill Publishing Co., New Delhi.
8. Cosmology and Astrophysics through Problems – T. Padmanabhan (Cambridge Univ Press)
9. Text Book of Astronomy and Astrophysics with Elements of Cosmology – V.B.Bhatia, 2001, Narosa Publishing House, New Delhi.

SPHYE501B: Material Science- I

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. …………………………

Course objectives:

The course is intended to make the students to get familiar with basic concepts of phase diagram especially binary phase diagrams and microstructure of different materials. It is to be noted that microstructure plays a vital role in deciding the properties of the materials. Thus, it is importance of phase diagram and microstructure evolution. The objective of the course is to provide a technological background of production of vacuum, to understand the operation of mechanical, diffusion, and ion pump systems, to get acquainted with thin film technology. The aim is to impart knowledge of mass transfer operations like diffusion, absorption. To shed light on applications of crystals to various industries, various techniques for crystallization, basic steps of crystallization.

Course outcomes:

Students will be able to know that microstructure decides the properties of the materials and will be able to relate the phase diagram information for microstructural evolution. Students will be able to describe its importance of vacuum in various industries and research field and will be able to apply important laws of physics for working of vacuum system. Students will be able to understand the fundamental equilibrium and transport properties in adsorption and diffusion process. Students will be able to grow crystals, differentiate various growth techniques, to understand

importance of growth processes

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Phase Diagram**	**15**
	1.1	Basic concepts, solubility limit, phases, phase equilibrium, Gibb's phase rule, unary diagram, effect of pressure on phase diagram, binary isomorphous phase diagrams; Copper-Nickel system, Microstructure formation under equilibrium solidification & non equilibrium solidification of an alloy, coring,	
	1.2	Binary eutectic systems; Lead–Tin system, Silver-Copper system and Fe-Fe3C system	
	1.3	Solidification of eutectic, hypo-eutectic, and hyper-eutectic alloys and microstructure formation under equilibrium cooling, salient features, invariant reactions, Lever rule, determination of phases & phase fractions	
2.0		**Mass Transport Phenomenon**	**15**
	2.1	Diffusion: Introduction, diffusion mechanisms, steady state diffusion, non-steady state diffusion, Fick's first and	

		second law, factors influencing diffusion, other diffusion paths, diffusivity in gas mixtures, liquid mixtures and solids, numerical problems	
	2.2	Adsorption: Introduction, Physical & chemical adsorption, adsorption materials, nonporous & porous adsorbents, factors affecting adsorption, characteristics of adsorption, types of adsorption, adsorption isotherms, classification, Freundlich's and Langmuir adsorption isotherms, applications of adsorption	
3.0		**Vacuum Physics and Thin Film Technologies**	**15**
	3.1	Introduction to vacuum, types of flow, pumping speed, throughput, construction and working principle of Pumps, rotary pump, oil diffusion pump, adsorption pump, sputter ion pump, Turbo molecular pump, construction and working principle of gauges, thermocouple gauge, pirani gauge, ionization gauge, penning gauge	
	3.2	Thin Films: Physical Vapour Deposition, Chemical Vapour Deposition, Sputtering, Spray pyrolysis, Dip coating and Spin coating, Electron –beam deposition, Laser Ablation.	
4.0		**Crystal Growth**	**15**
	4.1	Introduction, Steps in crystallization, super saturation, nucleation, crystal growth, crystal growth techniques;	
	4.2	solution growth technique, critical size, Gel growth technique, Flux growth, Hydrothermal technique,	
	4.3	Melt growth; czochrolski crystal pulling method, zone melting, Verneuil Flame Fusion Method, Vapour phase epitaxy	
		Total	**60**

Text Books:

4. Materials Science and Engineering An Introduction, William Callister,Jr., (Wiley India)
5. Vacuum Physics and Techniques, Delcher
6. Handbook of Vacuum Science and Technology, Hoffman
7. Vacuum Science and Technology, Rao, Ghosh, K.L.Chopra, Allied Publishers Ltd.

Reference Books:

4. Thin Film Process: J. L. Vossen and Kern, (Academic Press)
5. Thin Film Phenomena: K. L. Chopra, (Mc Graw Hill)
6. Crystallization by Mullin
7. Crystal Growth, Santhana Raghavan & Ramaswamy, KRU Publications
8. Materials Science and Engineering , V.Raghavan, Prentice-Hall of India PVT

SPHYE501C:Nano Physics

Coursepre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. ………………………

Courseobjectives:

- This course provides research-focused teaching and training for post-graduates wishing to develop a career in nano physics and functionalmaterials.
- Students will gain an in-depth understanding of the various nanofabrication techniques, synthesis strategies, and different characterization techniques.

Courseoutcomes:

- Students will get an understanding of fundamental concept of nano physics i.e. Nanoscience and Nanotechnology (Module-I)
- Students will learn properties of Nanomaterials(Module-II)
- Students will learn physical and chemical and biological synthesis methods (Module-III)
- Students will learn in detail about X-raydiffractometry, Scanning probe microscopy and
- scanning tunneling microscopy , Opticalmicroscopy– SEM, TEM, AFM, UV-Vis-NIRspectrometry and FTIR (Module-IV)

ModuleNo.	UnitNo.	Topic	Hrs. Required to cover the contents
1.0		**Fundamentals of Nanoscience and Nanotechnology**	**15**
	1.1	History of Nanotechnology, Feynmann‟s vision on Nano Science & technology, bulk vsnanomaterials, Introduction of Nanoscience and nanotechnology, Classification based on the dimensionality	
	1.2	**Zero-dimensional nanostructures**: metal,semiconductor and oxide nanoparticles. **One-dimensional nanostructures**: nanowires andnanorods,	
	1.3	**Two-dimensional nanostructures**: Thin films, Three-dimensional nanomaterials,**Special Nanomaterials**: Carbon fullerenes and carbon nanotubes, micro and mesoporousmaterials, core-shell structures.	
2.0		**Properties of Nanomaterials**	**15**
	2.1	Size and shape dependent properties,**Optical properties**: Surface plasmon resonance in metal nanoparticles and quantum size effect in Semiconductors. **Mechanical properties**: Stresses in thin films, Mechanical constants of thin films,	
	2.2	**Electrical conductivity**: Surface scattering, change of electronic structure, quantum transport, effect of microstructure, **Magnetic properties**: Ferroelectrics, dielectrics and superparamagnetism	
3.0		**Synthesis of Nanomaterials**	**15**
	3.1	Introduction to thin films, thermal evaporation methods (introduction only), chemical bath deposition: ionic and	

		solubility products, preparation of binary semiconductors,	
	3.2	Electrode position: Deposition mechanism and preparation of compound thin film, Spray pyrolysis: Deposition mechanism and preparation of compound thin Films, co-precipitation, hydrothermal andsolvothermal synthesis, sol-gel synthesis.	
4.0		**Methods of Materials Characterization Techniques**	**15**
	4.1	**Structural**: Principles of X-ray diffraction – Bragg´s law, powder XRD, Bragg-Brentano geometry thin film XRD in this geometry, crystalline size using Debye-Scherer equation.	
	4.2	**Electrical**: Two Probe and Four Probe Resistivity technique. **Magnetic**:Vibrating Sample Magnetometer (VSM),	
	4.3	**Optical**:UV-Vis – NIR Spectroscopy, Fourier Transformed Infrared Spectroscopy (FTIR), Raman Spectroscopy. **Morphological**: Scanning electron microscopy (SEM), Atomic Force Microscopy (AFM), Transmission electron Microscopy (TEM).	
		Total	**60**

Reference books:

1. Chemistry of nano materials: synthesis, properties and applications by C. N. R. Raoet, al, Wiley-VCH, 2004.
2. Introduction to Nanoscience and Nanotechnology by K. K. Chattopadhyay and A. N.Banerjee, PHI Learning View All, 2009.
3. Thin Film Phenomena by K L Chopra McGraw -Hill Book Company, NY 1969.
4. Nanoscience and Nanotechnology V. S. Muralidharan, A. Subramania(Ane Books Pvt. Ltd.)(For unit V).
5. Nanoparticle technology handbook by Masuo Hosokawa et. al, Elsevier Science,2007,
6. Springer handbook of nanotechnology- Bharat Bhushan, 2004.
7. Nanoscience and Nanotechnology V. S. Muralidharan, A. Subramania(AneBooks Pvt. Ltd.)(For unit V)
8. Thin Film Fundamentals (New Age International P ublishers, New Delhi), by A. Goswami
9. Encyclopedia of Nanoscience S. K. Prasad (Discovery Publishing house, New Delhi)
10. Characterization of Materials Vol 1 &2, by Elton N. Kaufmann, John Wiley and Sons Publication, 2003. New Jersey
11. .T. Pradeep, A text book of Nano Science and Technology, Tata McGraw-Hill Education, 2012.
12. G. Cao and Y.Wang, Nanostructures and Nanomaterials, 2nd Ed., Imperial College Press, 2004.

LIST OF EXPERIMENTS

M. Sc. IIIrd Semester

Lab-I:

SPHYP501A – Electronics-I

1. To study characteristics of Gunn diode using X-band microwave setup
2. To study the characteristics of Reflex Klystron tube using X-band
3. To determine the frequency & wavelength in a rectangular wave guide Working on TE10 mode.
4. To determine theVoltage Standing wave Ration (VSWR) and Reflection coefficient of given load using X-band microwave setup
5. To study function of Microwave Directional coupler and compute (i) Coupling Factor and (ii) Directivity
6. To study Properties of Microwave E-Plane Tee.
7. To study Properties of Microwave H-plane Tee using microwave setup.

SPHYP501B -Fibre Optics and Lasers-I

1. To determine the diameter of wire from the study of Fraunhoffer diffraction pattern.
2. To determine the wavelength of laser beam with the help of Fraunhoffer diffraction pattern obtained by wire.
3. To determine the micro spacing of given sample (groove) using laser diffraction.
4. To determine the wavelength of He-Ne laser beam by using groove object.
5. To determine the Fraunhoffer diffraction pattern of Circular Aperture.
6. To determine the Power distribution within the laser beam.
7. To determine the Spot size of the laser beam.
8. Plot power distribution of laser at two locations and hence determine the divergence of the laser beam
9. To determine the grating constant for a given grating by means of the laser beam.
10. Find out the laser wavelength by means of given grating (grating constant= 0.08mm)
11. Observe the diffraction of the laser beam from a given vernier scale and find the wavelength of laser beam.
12. Show the diffraction pattern from the venire scale and hence determine the minimum distance between adjacent two lines on vernier.

Lab-II:

SPHYE502A –Astrophysics-I

1. Studying Solar Limb darkening
2. Estimating color of a star and hence effective surface temperature by differential photometry
3. Characterizing a CCD camera for gain, read-noise, linearity and flat-field
4. Broad band imaging of celestial objects using CCD camera
5. CCD data reduction
6. Classification of galaxies in the Virgo cluster
7. Verifying Hubble's law of expanding universe and hence estimating age of the universe (CLEA)
8. Estimating distance of the Galactic nova
9. Gravitational bending of the starlight
10. Acquiring the spectra of stars, classifying them and hence identifying chemical elements in the stars.(CLEA)
11. Estimating mass of the Andromeda galaxy by studying its dynamics
12. Photometric study of variable stars (Light curve)

13. To estimate the relative magnitudes of a group of stars by a CCD camera
14. To study the atmospheric extinction for different colors
15. Differential photometry of a program star w.r.t. a standard star
16. To study the effective temperature of stars by B. V. photometry
17. To estimate the night sky brightness with a photometer
18. To estimate the distance to the moon by parallax method
19. Calibration of a 1420 MHz radio reciever and spectrometer
20. Detection of 21-cm line of neutral hydrogen from our galaxy
21. To estimate the distance to a Cepheid variable
22. To study the variability of delta Scuti type stars
23. To study the variability of RS CVn binaries
24. To measure the polarization of day/moon light
25. Surface photometry of elliptical galaxy
26. CCD imaging photometry of star clusters

SPHYE502B - Material Science-I

1. Preparation of CdS thin film by CBD technique and to determine band gap of CdS .
2. To deposit ZnS thin film on glass substrate by CBD technique at RT and to determine band gap using UV-VIS technique.
3. To deposit thick film of ZnO by sol gel technique.
4. To deposit thin films by spray pyrolysis technique.
5. To deposit copper thin film by electroplating.
6. To deposit Cadmium telluride (CdTe) films by successive ionic layer adsorption and reaction (SILAR) method
7. To grow single crystal (sodium oxalate) using silica hydrogel and to characterize it by TGA.
8. To study thermal analysis of a Pb-Sn alloy.
9. To determine the magnetic susceptibility arising due to water in the solution of (MnCl2).
10. To determine the magnetic susceptibility of a solid material.
11. To identify unknown element from the X-ray diffraction pattern
12. To synthesize nickel ferrite nano-particles.
13. To study the photo catalytic properties of a given catalyst.
14. To prepare /synthesize Polyaniline.
15. To deposit polymer film on glass substrate by casting method and its characterization by FTIR technique.

SPHYE502C – Nano Physics (Lab)

1. Co-precipitation synthesis of CuO nanoparticles
2. Low temperature Resistivity measurement of a thin film.
3. Synthesis of ZnO Nanoparticles using Co-precipitation technique and confirm the sizedependent variation in band gap.
4. Thin film Preparation of Metal Oxide (Spray Pyrolysis).
5. UV-Vis-NIR Spectroscopy to extract Band gap of a Semiconductor.
6. Synthesis of Iron oxide nanoparticles by wet chemical method and confirm the synthesis by band gap analysis.
7. Synthesis of Nickel ferrite nanoparticles by co-precipitation method and characterize theproduct by FTIR analysis.
8. Synthesis of SnO_2 nanostructures.

9. Sol-gel method for ZnO – band edge in UV - Vis spectroscopy – size of the particle.Hydrothermal synthesis of TiO_2 nanoparticles.
10. To deposit semiconductor metal oxide film on glass substrate by Chemical Bath method and its characterization by Raman spectroscopy technique
11. Chemical Bath deposition of PbS.
12. Electrodeposition of NiO film.

M.Sc.

Physics

IVth Semester

SPHYC551: Energy Studies

Course pre-requisite:

1. B. Sc. Students with Physics
2. …………………………

Course objectives:

This paper covers the basics of renewable energy, types of renewable energy sources, their construction and operation mechanisms. This paper explains the phenomena associated with energy sources and their utility of commercial electronic industry.

Course outcomes:

At the completion of this course, students will be able to Students after completing their post graduation in Renewable Energy will be eligible to get employment as an assistant professor, teacher, etc. in private, semi government, government in colleges and schools after fulfilling the requirements and can rise up to the top positions and pursue their higher studies in related fields universities.

ModuleNo.	UnitNo.	Topic	Hrs. Required to cover the contents
1.0		**Introduction**	**15**
	1.1	Conventional and non-conventional energy sources, Types of energy sources (Mechanical energy chemical energy, Nuclear energy, Hydro energy, renewable energy)	
	1.2	Solar energy; source, solar radiation (types), data (irradiance, insolation), measurement of solar radiation, solar cell parameters and equivalent circuit	
	1.3	Photovoltaic technology, creation of solar power, block diagram of photovoltaic configuration	
	1.4	Silicon solar cells, thin film solar cells, third generation concepts, advantages and disadvantages of solar cells	
2.0		**Tidal, wave energy, fuel cells**	**15**
	2.1	Energy from the tides, Barrage and Non Barrage Tidal power systems	
	2.2	Energy from waves, wave power devices	
	2.3	Principle of working- various types – construction and applications of Fuel cells	
3.0		**Biomass energy and geothermal energy**	**15**
	3.1	Energy from Bio mass: conversion processes-Biomass Cogeneration-Environmental Benefits	

	3.2	Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes	
	3.3	Classification of water turbine, Turbine theory, Essential components of hydroelectric system	
4.0		**Energy Exploitation, Conservation and Management**	**15**
	4.1	Importance of energy exploitation, conservation and management, Energy conservation planning, types of natural resources	
	4.2	Management of natural resources, types, preservation and conservation (Bio-based, habitat, energy conservation)	
	4.3	Conservation of natural resources, Government policy,	
	4.4	Energy conservation legislation and energy policy	
		Total	**45**

References Books

1. Solar Energy Fundamentals, Technology, and Systems, Delft University of Technology, 2014

2. Non Conventional Energy Sources, Shobh Nath Singh, Person press

3. Renewable Energy Sources By John Twidell (forth edition)

4. Non Conventional Energy Sources and Utilisation by R.K.Rajput, S. Chand publisher

5. Non Conventional Sources of Energy by G.S. Sawhney, PHI publisher

6. Non Conventional Energy Sources by BH Khan, Mc Graw Hill Education Publisher

SPHYC552A: Electronics-II: Microwave Measurements, Systems and Applications

Course pre-requisite:

1. B. Sc. Students with Physics
2. …………………………

Course objectives:

This paper mainly concentrates on Microwave systems, Microwave electronics measurements, Material Characterization and applications. It has covered basic of Microwave Electronics systems as well as applied aspects of Microwaves. The Scientific, Industrial and Medical Applications covering Microwave heating Sensor, medical and Remote sensing through microwave are included in the paper.

Course outcomes:

This enables the students to understand the Material Characterization and Communication systems. Moreover, the method of measurements using advanced techniques such Network Analyser and RADAR are also included in this paper. This specific study enables the student to work in R & D organizations for further studies and jobs in private/Govt. Sectors.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Microwave Antennas**	**15**
	1.1	Basic antenna parameters, Radiation pattern, radiation intensity, directivity, radiation resistance, efficiency and gain. Effective aperture antennas, effective height, dipole antenna.	
	1.2	Microwave Horn antennas, E-plane Horn Antenna, H-Plane Horn Antenna, Pyramidal Horn Antennas and	
	1.3	Microwave paraboloids or microwave dish antennas, Lens antennas, slot antennas, Microstrip antennas	
2.0		**Microwave Measurements**	**15**
	2.1	Microwave Bench, General Measurement setup, Measurement devices and Instrumentation, slot line, wave meter and detection of Microwaves, Crystal detector.	
	2.2	Measurement of power, Attenuation measurements, Frequency measurements, measurement of Phase Shift.	
	2.3	Measurement of voltage standing wave ratio VSWR, low and High VSWR measurement, Measurement of Impedance, measurement of insertion loss, Measurement of Dielectric constant, Measurement of Noise & Quality factor	
3.0		**Microwave integrated circuits**	**15**
	3.1	Introduction, Types of Microwave integrated Circuits, Discrete Circuit, Integrated Circuit, Hybrid Integrated Circuit, Monolithic Microwave Integrated Circuits (MMIC).	
	3.2	Materials used for Microwave integrated circuits, substrate materials, conductor Materials, dielectric Materials,	

		resistive materials. MMIC fabrication technique	
	3.3	Thin Film devices, Planar resistor film, planar inductor film, planar Capacitor film, Hybrid Integrated circuit fabrication.	
4.0		**Microwave Applications**	**15**
	4.1	Network Analyzer (Block diagram) and application, Time Domain Reflectometry (TDR) technique (block diagram) and application. Measurement of dielectric constant and dielectric loss of Materials.	
	4.2	Microwave Processing of Advance Electronic Materials, Heating Mechanism, Microwave oven.	
	4.3	Microwave communication systems, propagation modes, ground wave communication, sky wave communication, line of sight (LOS) communication and Satellite communication.	
		Total	**60**

Text Books:

1. Microwave Radar Engineering- *by M. Kulkarni, Umesh Publicatios, New Delhi.*
2. Microwave Devices and circuits- by *Samuley Y. Liao, Prentice Hall of Gredia Private Limited, New Delhi*
3. Microwave Engineering: *G. S. Raghuvanshi, Publisher: CENGAGE Learning*

Reference Books:

1. Microwave Devices and Applications by Dinesh C Dube Narosa Publishing House New Delhi
2. Understanding Microwaves-*by Allan W. Scott, A. John Wiley & Sam Ins. Publications*
3. The Microwave Engineering Handbook Vol. I, II and III *–by L. Smith & Michel Henri Carpentire, Springer Industrial edition.*
4. Microwave Circuits and Passive devices-*by M.L. Sisodia &G.S. Raghuvanshi, Wiley Eastern Limited, New Delhi.*
5. Microwave Engineering- *by Sanjeev Gupta, Khanna Publication, New Delhi.*
6. Electronics Communication System *–by Kennedy George, McGraw Hill book Company*
7. Communication Componants & Circuits-*by Edgar Hund, Mc-Graw Hill*
8. *Binary Polar Liquids by S.C. Mehrotra, Ashok Kumbharkhane and Ajay Chaudhari, Elsevier Publication, Netherland 2017.*

SPHYC552B: Fiber Optics and Lasers- II

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. …………………………

Course objectives:

This paper is designed to cover in details about the solid state lasers and respective detectors used. Along with this it gives understanding to students about the characteristics of fibers through experimental analysis of the fiber and its losses.

Course outcomes:

Upon successful completion of our fiber optic and laser-IIpaper, the student gets knowledge of solid state lasers and the detectors. The experimental part in this paper will provide hand on training on different parameters of fibers which may decay the signal transport through fiber.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Optical Sources**	**15**
	1.1	Types of optical light sources. Injection laser diodes, Optical emission from semiconductor, spontaneous emission carrier recombination. Other radiative recombination processes.	
	1.2	Stimulated emission and lasing, heterojunctions, semiconductor materials, semiconductor injection lasers efficiency	
	1.3	Strip geometry, laser modes, injection laser structure: gain guided and index guided structures. Injection lasers characteristics Light emitting diodes: LED power and efficiency, double hetrojunction LED, surface emitter, LEDs and Edge emitted LEDs, LED characteristics	
2.0		**Optical Detectors**	**15**
	2.1	Optical detection principle, photoelectric effect, absorption, quantum efficiency and responsivity p-n and p-i-n photodiodes	
	2.2	Speed of response, detector noise, signal to noise ratio, detectivity, beat error rate, noise equivalent power typical fiber optics sensor.	
	2.3	Photodiode with internal gain, avalanche photodiode and silicon reach through APDs. Light detection techniques (photodiode, PMT and scintillation)	
3.0		**Transmission Characteristics of Optical Fibers**	**15**
	3.1	Attenuation Material absorption losses.	

	3.2	Linear scattering losses Nonlinear scattering losses, Dispersion: intramodal and intermodal	
4.0		**Optical Fiber Measurements**	**15**
	4.1	Fiber attenuation measurement Fiber dispersion measurement Fiber refractive index profile measurement	
	4.2	Fiber cutoff wavelength measurement Fiber numerical aperture measurement Fiber diameter measurement	
	4.3	Mode field diameter of single mode fiber Reflectance and optical return loss and optical time domain reflectometery	
		Total	**60**

Text Books:

8. Optical Fiber communications: Principles and Practices – John M. Senor (Phi)

9. The Elements of Fiber Optics – S. L. W. Meardon (Regents and Ph)

10. Optical Fiber communications – Ger Keiser (Mcgraw Hill)

11. Introduction of Fiber Optics- A Ghatak And Tyagrajan (Cambridge University Press)

12. Fiber Optic communications – Joseph C. Palais

Reference Books:

9. Masers & Lasers, J S Thorp, Mcmilan

10. Laser Electronics, Verdeyen Prentice Hall

11. Optical Fiber Communication: Principles & Practices, John M Senior

SPHYE551A: Astrophysics- II

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. ……………………

Course objectives:

Since ancient times, mankind has gazed up at the night sky and wondered. How large is the universe? How old is it? Did it have a beginning, and if so, how old is it? Will it have an end? How did the Earth form and how did life originate? Astrophysics-II course is intended to provide students with adequate knowledge on the formation, structure and composition of the Milky Way and other galaxies in the Universe, active galaxies and active galactic nuclei, interaction among the galaxies in dense environment, expansion of the Universe, theory of general relativity, nonEuclidean space-time geometry and Cosmological models. It also introduces the students to the standard Cosmological model, the open questions and the current research lines in the field. The prerequisite of this course is that the students have studied Astrophysics-I skill enhancement elective course offered by the School in Semester-III.

Course outcomes:

The students after completing this course along with the laboratory course will Understand the bases of advanced topics selected at the frontier of high energy physics, astrophysics and cosmology and apply them consistently, apply the theory of cosmic perturbation to the problem of the formation of the structure of the universe, distinguish and analyze the problems of the classic Big Bang theory. The students through this course will be able to ddistinguish between the different types of active galaxies, tackle the problem of the evolution of galaxies in its totality, and understand the fundamentals and evolution of the Milky Way. This course provides good base for the students to further their higher studies for M.Phil and Ph.D. in the field of Astronomy & Astrophysics. After successful completion of the Masters' degree with good scores, the students have opportunities to join leading research institutes in the field as research scholars leading to the Ph.D. and also to become astrophysicists, scientists or research officers in the field of space research in various institutes within India and in foreign countries. They can also join teaching profession in universities, colleges and institutes after clearing NET exam conducted by CSIR, New Delhi.

Module-I: The Milky Way and ISM (15 Hrs)

True shape and size of the Milky Way, Stellar populations, Differential rotation (kinematics) and estimation of mass of the Milky Way, Oort's analysis, Galactic center, Galactic plane. spiral structure of the Milky Way. Interstellar Matter: Composition and properties of interstellar matter, dust extinction, color excess, Visual absorption. Interstellar reddening law and Polarization. Stellar masses and radii – measuring masses in binary stars - visual binary, eclipsing binary, spectroscopic binary; Gravity in close binary, X-ray binaries

Module-II: Extragalactic Universe (15 Hrs)

Classification of galaxies: Hubble's tuning fork diagram, Elliptical galaxies, Lenticular galaxies, Spiral galaxies, Irregular galaxies, spiral structure, distribution of light and mass in regular galaxies. Gamma-ray bursts & Active galactic nuclei; Accretion process in astrophysics; Astrophysical jets - emission from jets and beaming, Active galaxies: Seyfert galaxies, Radio galaxies, Quasars. Interaction of galaxies, mergers, clusters of galaxies. Extra-galactic distance scale, expansion of the universe: Hubble law

Module-III: General Relativity (15 Hrs)

Review of tensor calculus: Idea of Euclidean and non-Euclidean space, Metric tensor and its properties, Concept of curved spaces and space-times, tensor algebra, Covariant differentiation, Parallel transport, Geodesics, principle of equivalence, action principle and energy tensor, Bianchi Identities, vanishing of Riemann-Christoffel tensor as the necessary and sufficient condition of flatness, Ricci tensor, Einstein tensor. Einstein's field equations, the Newtonian limit. Derivation of Schwarzschild metric: properties and nature of the Schwarzschild metric at R=2M surface Experimental tests of general relativity: gravitational red shift, perihelic shift of planet mercury, bending of star light-black holes.

Module-IV: Gravity Waves and Cosmology (15 Hrs)

Concept of Gravitational Waves, wave equation in linearised theory, Plane waves, transverse traceless gauge, effect on test particles, principles of detection and generation of gravitational waves, types of detectors, the LIGO detector. Newtonian cosmology, Einstein universe, expanding universe, simplifying assumptions of cosmology (Robertson-Walker line element), cosmological red-shift, Hubble's law. Einstein field equations in cosmology, solution of Friedmann's equations- Euclidean, closed and open sections, space-time singularity, luminosity distance (Einstein de Sitter model, closed model and open model), cosmological models with the -term.

Reference Books:

1. Modern Astrophysics – B.W. Carroll and D.A. Ostlie, 1996, Addison-Wesley Publishing Co., Inc.

2. Quasars and Active Galactic Nuclei, A. K. Kembhavi and J. V. Narlikar, Cambridge University Press.

3. Introduction to Cosmology – J.V. Narlikar, 1995, Cambridge University Press, Cambridge.

4. General Relativity and Cosmology – J.V. Narlikar, Macmillan Co. of India Ltd., New Delhi.

5. Classical Theory of Fields, Vol. 2, L. D. Landau and E. M. Lifshitz, Oxford : Pergamon Press.

6. Structure Formation in the Universe, T. Padmanabhan,Cambridge University Press.

7. Fundamental Astronomy – ed. H. Karttunen, P. Kroger, H. Oja et al., 1987, Springer-Verlag, Berlin.

8. The New Cosmos, 4th edition - A. Unsold and B. Baschek, 1991, Springer-Verlag, Berlin.

9. The Physical Universe: An Introduction to Astronomy – Frank H. Shu, 1982, University Science Books, Sausalito, California.

10. Astrophysics: Stars and Galaxies – K.D. Abhyankar, 1992, Tata McGraw Hill Publishing Co., New Delhi.

SPHYE551B: Material Science- II

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. …………………………
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Course objectives:

To introduce the world of Nanoscience to the students, to focus on basic concepts & selected methods of preparation, and to explain the importance and applications of Nanoscience to society and various industries. To shed light on various novel materials with variety of properties having societal importance & applicability. To bring into notice the basic concepts of polymeric materials and to explain the importance of polymeric materials to humanity. To introduce the working principle of various characterization techniques used for analyzing various types of materials.

Course outcomes:

Upon successful completion of these modules, students will be able to understand that nanoscience is a multidisciplinary field. They will be able to know the characteristics of nanomaterials, various research fields therein and general applications. Students will be able to understand various ceramic materials, biomaterials and composites with their applications in diverse fields. Students will get acquainted with various concepts for polymers and will be able to calculate weight of polymers, chain length, and degree of polymerization. Students will able to understand the working principle of various characterization techniques and will be able to analyze the samples using various techniques.

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Nanomaterials**	**15**
	1.1	Introduction to nanomaterials, importance of nanoscale, classification of nanomaterials, quantum size effect, characteristics & properties of nanomaterials,	
	1.2	Clusters, Metallic nanoparticles, magic numbers, geometric structure, semiconducting nanoparticles	
	1.3	Optical Properties of Clusters , synthesis of nanoparticles, applications	
2.0		**Novel Materials**	**15**
	2.1	Ceramics, structures, classification, Phase diagram of ZrO2-CaO, SiO2-Al2O3, Al2O3-Cr2O3, fracture, brittle fracture	
	2.2	Griffth's theory of ceramics, silicates ceramics, structure of silicates, influence of porosity, composites, biomaterials & biosensors	
3.0		**Polymers**	**15**
	3.1	Introduction, degree of polymerization, average molecular weight, molecular structure, molecular configuration,	

		Thermoplastic & thermosetting polymers, copolymers, polymer crystallinity,	
	3.2	Mechanisms of polymerization, diffusion in polymers, polymer types(plastics, elastomers, fibers), applications of polymers (coatings, adhesives, films, foams), polymer additives.	
4.0		**Characterization Techniques**	**15**
	4.1	Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), X-Ray Diffraction (XRD), X-ray photoelectron spectroscopy (XPS)	
	4.2	Thermo Gravimetric /Differential thermal Analysis (TG/DTA)	
	4.3	Atomic Absorption Spectroscopy (AAS), Nuclear Magnetic Microscopy (NMR), Electron Spin Spectroscopy (ESR)	
		Total	**60**

Text Books:

13. Materials Science and Engineering An Introduction, William Callister,Jr., (Wiley India)

2. Materials Science and Engineering , V.Raghavan, Prentice-Hall of India PVT

3. Nanoscale Science and Technology, R.Kelsall, I.Hamley, M. Geoghegan, Wiley

4. Nanotechnology: Basic calculations for Engineers and Scientists, L. Theodore

5. Fundamentals of Molecular Spectroscopy, Banwell and McCash , Tata McGraw-Hill Publishing Company Ltd.

Reference Books:

12. Thin Film Process: J. L. Vossen and Kern, (Academic Press)

13. Thin Film Phenomena: K. L. Chopra, (Mc Graw Hill)

14. Analytical Techniques, Skoog

15. Crystal Growth, Santhana Raghavan & Ramaswamy, KRU Publications

16. Materials Science and Engineering , V.Raghavan, Prentice-Hall of India PVT

SPHYE551C: Electronic Instrumentation

Course pre-requisite:

1. B. Sc. Students with Physics and Mathematics
2. ……………………

Course objectives:

To introduce the world of electronics to the students, to focus on basicconcepts & selected methods of preparation, and to explain the importance and applications of electronics instrumentation to society and various industries. Student can learn the purpose and classification of instrumentation and measurements. Students can learn the principle and classification of transducers

Course outcomes:

- To know the principle, block diagram and working of some digital instruments
- To study the working and applications of Automation in digital instruments
- To teach the some basics of data acquisition system instruments
- To acquire the knowledge about recorders.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1.0		**Instrumentation**	**15**
	1.1	Introduction, definition, purpose of instrumentation.	
	1.2	Measurement, types of measurements, importance of measurements, classification of instruments,	
	1.3	Generalized measurement system, instrument characteristics-Static and dynamic, error, types of errors.	
2.0		**Transducers**	**15**
	2.1	Definition, types of transducers, classification of transducers, Resistive transducer: potentiometer, resistance pressure transducer, Strain gauge: Resistance wire gauge,Inductivetransducer, Capacitivetransducer: Load cell (Pressure cell)	
	2.2	Piezoelectrictransducers, photoelectric transducers: photo multiplier tube, photo conductive cells or photo cells. Temperature transducers: Thermistors, thermocouple, optical transducers.	
3.0		**Digital Instrumentation**	**15**
	3.1	Introduction, Digital multimeters (DMM), Digital frequency meter (DFM), Digital Measurement of time, pH measurements,pH meter.	
	3.2	Automation in digital instruments, auto-zeroing, auto-ranging, automatic polarity indication. Digital storage oscilloscope,Q meter, lock in amplifier.	
4.0		**Telemetry and data acquisition system**	**15**
	4.1	Introduction, types of data acquisition system, basic elements of data acquisition system,	
	4.2	Land line telemetering system-Voltage telemetering systems–Current telemetering system-Position	

		telemetering system,	
	4.3	Sample and hold circuit, Recorders-X-Y recorder, strip chart recorder, magnetic tape recorder	
		Total	**60**

Reference books:

1. Electrical and Electronics Measurement and Instrumentation – A.K.Sawhney, DhanpatRai& Sons Publication.
2. Transducers and instrumentation-D. V. S. Murthy, PHI, 1995.
3. Electronic Instrumentation-H. S. Kalsi, Tata McGraw Hill Publications.
4. Instrumentation, measurement and analysis-B. C. Nakra and K. K. Choudhri, Tata McGraw Hill Publications.

LIST OF EXPERIMENTS

M. Sc. IVth Semester

Lab-III:

SPHYP551A – Electronics-II

1. To study the radiation pattern and Gain of Waveguide Horn Antenna using X-band Microwave setup
2. To study properties of Microwave Magic Tee
3. Measurement of Dielectric constant of a given sample.
4. To measure an unknown impedance of a given load
5. To study Faraday rotation by applying different magnetic field across microwave propagating in a rectangular waveguide using X-band.

SPHYP551B: Fiber Optics and Lasers-II

1. To determine the diameter of the Circular Aperture with the help of Fraunhoffer diffraction pattern.
2. To determine the power loss in optical fibre by micro bend pressure sensor and calculate its pitch.
3. To determine the Numerical Aperture of a given multi modefibre using far field scanning measurement.
4. To determine the Refractive Index of the given liquid using laser beam.
5. To determine the Refractive Index profile of multi modefibre by transmitted near field scanning technique.
6. To determine the MFD of s fundamental mode in a single mode fibre by measurement of far field

Lab-IV:

SPHYE552A – Astrophysics-II

1. Polar aligning a telescope and measuring declination of Polaris
2. Measuring distance to Moon by parallax method
3. Identifying and measuring diameters of Craters on the Moon surface
4. Finding rotation period of the Sun by measuring motion of sun-spots
5. Estimating temperature of an artificial star
6. Fraunhofer lines in the Sun spectrum
7. Temperature of flame by line reversal method
8. Estimating mass of Jupiter using Kepler's laws of planetary motion
9. Measurement of distance of star clusters by main sequence fit method
10. Measuring duty cycle and period of a pulsar (CLEA)
11. BVRI photometry of stars and estimating their effective surface temperatures (CLEA)
12. Studying limiting magnitude and resolving power of 8' LX50 telescope
13. Studying atmospheric extinction of star light

SPHYE552B - Material Science-II

1. To calculate the speed of rotary pump.
2. To study adsorption of oxalic acid on charcoal and to study adsorption isotherm by Freundlich equation.
3. To determine the diffusion coefficient of Fe3+ /Co2+ / Ni2+ ions by using egg membrane.
4. To determine the diffusion coefficient of Fe3+ /Co2+ / Ni 2+ ions by using agar gel.
5. To study adsorption of vapours on adsorbent and to study adsorption isotherm.
6. To fractionate human serum proteins by Paper electrophoresis

SPHYE552C – Electronic Instrumentation Lab

1. Characteristics of Photo diode and photo transistors.
2. Thermistor Characteristics –Thermal and electrical. (H & C).

3. To study the sample and hold circuit using op-amp.
4. To study the characteristics of Cathode ray oscilloscop.
5. To study the characteristics of Load Cell / strain gauge.
6. Study the characteristics of Energy gap of semiconductor.