(DEEMED TO BE UNIVERSITY)

STUDENT handbook 2023-2024

MSc Nanoscience and Technology

DEPARTMENT OF Physics

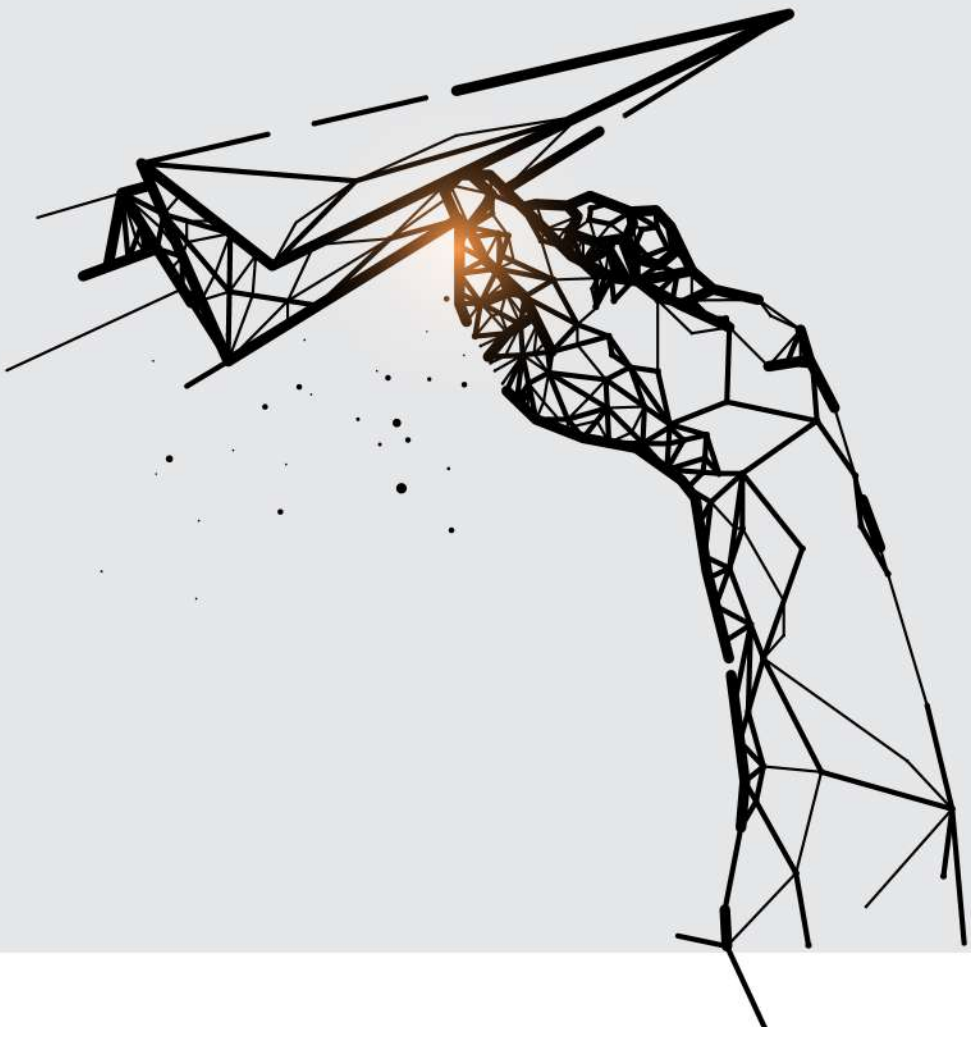
www.kluniversity.in

VISION

To be a globally renowned university.

MISSION

To impart quality higher education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of students of all sections enabling them to be globally competitive and socially responsible citizens with intrinsic values.




CATEGORY 1
UNIVERSITY
BY MHRD, Govt. of India
KL ACCREDITED BY
NAAC WITH A++
GRADE
nirf 2023
NATIONAL INSTITUTIONAL RANKING FRAMEWORK
RANKED 28
AMONG ALL
UNIVERSITIES
43 YEARS OF
EDUCATIONAL
LEADERSHIP

Koneru Satyanarayana,
Chancellor

Sri Koneru Satyanarayana, BE, FIE, FIETE, MIEEE graduated in Electronics and Communication Engineering in the year 1977. Along with Sri Koneru Lakshmaiah, he is the co-founder of the Institute which was established in the year 1980. He is an educationist of eminence and also an industrialist of great repute. He runs a number of industries in and around Vijayawada.

Dr. K. S. Jagannatha Rao
Pro-Chancellor

Prof. K. S. Jagannatha Rao was one of the leading scientists in neuroscience research in globe. He was the Director on Institute for Scientific Research and Technological Advances (INDICASAT AIP), Republic Panama and contributed lot in building innovation in higher education and research in Panama since 2010. He played a key role in building PRISM (Panamanian Research Institutes of Science and Medicine) in Latin America. Dr. Rao has his research area on Brain Research and established Alzheimer's Centre and published 165 papers in leading Biochemistry and Neuroscience Journals, supervised 19 Ph.D students. He is also adjunct faculty of Biomedical Informatics of UTHS, Houston, and Advisory Board Member of UT- El Paso Minority Health NIH program, USA and Adjunct Faculty, Methodist Research Institute, Houston, USA. He was elected Member of Panamanian Association for the Advancement of Science (APANAC) - Considered as National Science Academy of Panama. He received his undergraduate and Ph.D degrees from Sri Venkateswara University, Tirupati. Later, joined in Central Food Technological Research Institute, Mysore. He received Sir C. V. Raman Award by Karnataka State Council of Science and Technology, 2003.

Prof. G P S Varma
Vice-Chancellor

Prof. G P S Varma, Vice-Chancellor, KLEF, is one of the most widely experienced leaders in Indian higher education, known for his commitment to expanding student opportunity, catalyzing academic innovation, and encouraging university's civic engagement and service to society. He adorned the position of Chairman, ISTE (Indian Society for Technical Education)- AP State, TSEMCET Test Committee Member-2021 nominated By Telangana State Govt, APEAMCET Admission Committee Member in 2016 by Andhra Pradesh State Council of Higher Education, Govt. of Andhra Pradesh. He has been a very farsighted Peer Team Visit Member for National Assessment and Accreditation Council (NAAC), Expert Committee Member for University Grants Commission (UGC) Autonomous Visits. He has been an Advisory Council Member for (CEGR) Centre for Education Growth, and Research India International Centre, New Delhi, and Board Member for Big-Data Analytics Forum.

Dr. A. V. S. Prasad

Pro-Vice Chancellor

Dr. A. V. S. Prasad, M.E and Ph.D from JNTU, Hyderabad is a professor in Civil Engineering. He has a rich experience of 33 years in academics which includes 26 years in administration at various cadres ranging from Head of Department, Dean, Principal, Director and Pro-Vice Chancellor. He has served as Director of Audisankara group of institutions and Narayana Group of Institutions for 18 years and was instrumental in getting these institutions accredited by NAAC, NBA, Autonomous and gained many laurels from the State Government, JNTU etc. He has served as Pro-Vice Chancellor of KL University for 3 years.

He has extensive knowledge of administrative system, maintaining statutory norms of bodies like AICTE, UGC etc and has a good understanding of NBA, NAAC procedures and norms. He served as Member, Chairman of Board of Studies at JNTU(A), KLCE(Autonomous) and KL University.

Dr. Venkatram Nidumolu

Pro-Vice Chancellor

Dr. Venkatram Nidumolu, Pro-Vice Chancellor is High performing, strategic thinking professional with more than 15years of administration experience and 20 years of teaching experience in KLEFand 30 years overall experience in the higher education sector. He graduated in B.Tech (ECE) from Acharya Nagarjuna University, pursued M.S degree from BITS, PILANI in software Systems. He received Ph.D award from Acharya Nagarjuna University. He held the positions like HOD, Joint Register, Principal, and Dean-Academics before becoming Pro-Vice Chancellor. He was core member of all NBA, NAAC, & other accreditations since 2004 and he has good experience in handling of quality issues and assessment related practices.

Acronyms

Sl No	Acronyms	Full Form
1	KLEF	Koneru Lakshmaiah Education Foundation
2	CET	Common Entrance Test
3	KLEEE	KLEF Engineering Entrance Examination
4	JEE	Joint Entrance Examination
5	BT	Biotechnology
6	CE	Civil Engineering
7	CS	Computer Science &Engineering
8	EC	Electronics & Communication Engineering
9	EE	Electrical & Electronics Engineering
10	CM	Computer Engineering
11	ME	Mechanical Engineering
12	AD	Artificial Intelligence & Data Science
13	CI	Computer Science & Information Technology
14	CGPA	Cumulative Grade Point Average
15	SGPA	Semester Grade Point Average
16	LTPS	Lecture, Tutorial Practical, Skill
17	SEE	Semester-End Examinations
18	SIE	Semester-In Examinations
19	OJET	On-the-job Engineering Training
20	IRP	Industrial Relations and Placements
21	PS	Practice-School
22	OPAC	Online Public Access Catalog
23	QCM	Quality Circle Meeting
24	MOOC	Massive Open Online Course
25	MOU	Memorandum of Understanding
26	OD	On Duty
27	(A,B]	Between A and B excluding value A and including value B
28	COE	Controller of Examinations
29	VLSI	Very Large-Scale Integration
30	MTech	Master of Technology

31	COA	Council of Architecture
32	JEE	Joint Entrance Examination
33	NATA	National Aptitude in Architecture
34	PC	Professional Core
35	BSAE	Building Science and Applied Engineering
36	PE	Professional Elective
37	PAECC	Professional Ability Enhancement Compulsory Courses
38	SEC	Skill Enhancement Course
39	OE	Open Elective
40	CTIS	Cloud Technology and Information Security
41	DS	Data Science
42	IoT	Internet of Things
43	IPA	Intelligent Process Automation
44	PCI	Pharmacy Council of India
45	PY	Pharmacy
46	B. Com (H)	Bachelor of Commerce with Honors
47	ACCA	Association of Chartered Certified Accountants
48	HM	Hotel Management
49	BTK	Basic Training Kitchen
50	QTK	Quantitative Training Kitchen
51	ATK	Advanced Training Kitchen
52	MBA	Master of Business Administration
53	BBA	Bachelor of Business Administration
54	MSc (F&C)	Master of Science (Finance & Control)
55	BA	Bachelor of Arts
56	M.Sc.	Master of Science

CHAPTER 1: INTRODUCTION:

The President of Koneru Lakshmaiah Education foundation, Er. Koneru Satyanarayana, along with Late Sri. Koneru Lakshmaiah, founded the K L College of Engineering in the Academic year 1980-81. With the mighty vision and restless efforts of Er. Koneru Satyanarayana K L College of Engineering carved a niche for itself through excellence in engineering education, discipline and record numbers of placements and was the leading college in the state of AP. K L College of Engineering achieved NBA Accreditation for all its B.Tech. Programs in 2004 and later re-accredited in 2007. K L College of Engineering was transformed into an autonomous engineering college in the year 2006. In 2008 this college received a record grade of 3.76 on a 4 points scale with "A" Grade from NAAC; and in February 2009, the college, and Accredited by National Assessment and Accreditation Council (NAAC) of UGC as 'A^{++}' with highest Grade of 3.57 CGPA on 4-point scale in 2018, through its founding society "Koneru Lakshmaiah Education Foundation" was recognized as Deemed to be University by the MHRD-Govt. of India, Under Section 3 of UGC Act 1956. This Deemed to be University is named as "KLEF".

Location

KLEF is situated in a spacious 100-acre campus on the banks of Buckingham Canal of river Krishna, eight kilometers from Vijayawada city. Built within a rural setting of lush green fields, the institute is a virtual paradise of pristine nature and idyllic beauty. The campus has been aptly named "Green Fields" and the splendid avenue of trees and gardens bear testimony to the importance of ecology and environment. The campus ambience is most befitting for scholastic pursuits. The University is situated in a built-up area of around 15, 00,000 S.Ft.

Vision

To be a globally renowned university.

Mission

To impart quality higher education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of the students of all sections enabling them to be globally competitive and socially responsible citizens with intrinsic values.

Facilities

Central Library: E-Resources

The Central Library is the largest and holds materials to serve the whole University community. It has materials relevant to the Engineering, Science & Humanities courses offered by the University. The library system contains more than one lakh and fifty thousand books and periodicals on all subjects related to the teaching and research interests of the University staff and students. The library has over 65,926 electronic journal titles, academic databases and 15,19,512 eBooks. Access is available on campus on student computers and remotely.

The Data Centre

A State-of-the-Art Data center with advanced servers provides a highly interactive learning environment with full-fledged hardware and software training facilities.

Physical Education- Sports Facilities

KLEF encourages students to explore their latent talents by providing good games and sports facilities.

The institute is equipped with the following-

Sport/Game	No. of Courts	Sport/Game	No. of Courts
Athletic track	1	Handball Court	1
Hockey Field	1	Netball Courts	2
Badminton Courts	4	Throw ball courts	2
Tennikoit Courts	2	Beach Volleyball Court	1
Cricket Field with Net practice	3	Football Field	1
Volleyball Courts	2	Basketball Courts	2
Tennis Courts	2	Kabaddi Courts	2
Kho Kho Court	1	Table Tennis	6
Soft Ball	1	Chess	20
Archery	1	Caroms	12

The University had a State-of- the - Art Indoor stadium of 30000 sq. Ft with:

- 4 wooden Shuttle Courts/ Basketball Court
- Yoga and Meditation Centre
- Dramatics
- 8 Table Tennis Tables
- Hobby Centre
- Gymnasium for Girls
- Gymnasium for Boys
- Multipurpose room with Chess, Caroms etc.
- Power lifting/Weightlifting

Accommodation- Hostels

- KLEF has separate hostels for boys and girls with well furnished rooms and modern amenities.
- The overall atmosphere is very conducive for the students to concentrate on their studies.
- A state- of – the- art kitchen and spacious dining area has been provided for both the hostels.
- Generators have been provided as power backup. Emphasis has been laid on hygiene and cleanliness for healthy living. A customized menu caters to the student needs, it keeps changing according to their tastes.
- Teaching staff will have to address the academic and personal problems of the students. Round-the-clock security, communication, dispensary facilities are also available.

Facilities in the hostels

- Protected drinking water
- State of the art kitchen, dining hall
- Newspapers, telephones, toilets, and bathrooms are well maintained.
- Every student in the hostel is provided with a cot, study table, chair, and a rack.
- Fan and light are also provided in each room.
- Gas & Steam based hygienic food preparation.
- Palatable regional, national, and international cuisines
- Cleanliness and Safety STD/ISD Facilities
- Medical Kits and First Aid Boxes Soft drinks, snacks, Fruits etc.
- Laundry Stationary shop

Hostel Rules and Regulations

- Students are hereby informed that while staying in the hostel, it is essential to be responsible for maintaining dignity by upholding discipline.
- They must be obedient to the hostel warden/floor in –charges. Valuable items like jewelry etc. should not be kept with students while staying in the hostel.
- It is student's own responsibility to safeguard her/his Laptops, Money by locking suitcases and bags.
- If any loss is found, management will not take any responsibility. Students must intimate to the hostel authorities before giving police complaints against losses.
- Students are not allowed to indulge in smoking; consumption of Alcohol, Narcotic drugs etc., and defaulters will be strictly viewed upon.
- Students are directed that after locking their rooms they must hand over the keys to security and can collect them on returning to the hostel.
- Students must switch off Fans, Lights, Geysers, A/C's etc., before leaving their rooms.
- Visitors are not allowed inside the hostel at any time; however, they are allowed into the visitor's hall with the prior permission of the warden.
- Only family members listed by the parents are allowed to contact the student. Visiting hours are up to 7.30 pm only and after 7.30 pm visitors are required to leave the premises.
- Hostel students are not allowed to come into the hostel after 3.00 pm for morning shift students and 6.00pm for day shift students.
- Those students who are utilizing the computer lab, library etc., after the times specified must submit the permission slip to the security while entering the hostel.
- During public holiday outings, those who seek permission to leave the hostel will have to obtain written permission from the warden. Permission will be given only to those students who get permission from parents to leave the hostel during holidays/outings.
- Moving out of campus without permission is strictly prohibited. Strict study hours from 7.30 am to10.30 pm shall be maintained in the hostel.
- The hostellers must be in their allotted rooms during study hours. The general complaints of any kind should be noted in the complaint register, which is available at the hostel office.
- Registered complaints will only be entertained. Any health problem should be brought to the notice of Warden/Floor In – charge for necessary treatment.

Transportation

The institution runs 80 buses covering all the important points in Vijayawada City, Mangalagiri, Guntur & Tenali towns with a total seating capacity of 4000 students in two shifts. Transport is available 24 hrs, In case of any emergency in the institute /hostels. Transportation is available for conducting industrial tours and visits etc. Regular transport facility available up to 10PM.

Healthcare

A full-fledged health center with all the facilities is established to cater the needs of the students, staff, Faculty, and the public in the adopted villages. It consists of three doctors (Homoeopathy, Ayurvedic &Allopathy).

Cafeteria

KLEF has a spacious canteen with the latest equipment and hygienic environment which provides quality food and prompts service and caters to the needs of all the students and staff. A central cafeteria of 1500 Sq.m. is available on the campus. Mini cafes and fast-food centers are available in various blocks. The canteen is open from 6:30 a.m. to 8:30 p.m. There is a wide variety of North- Indian and South-Indian cuisine and the students enjoy the pleasure of eating during the breaks. Cool aqua water for drinking is available.

Placements

KLEF has meticulously planned to make all its outgoing students employed. The University had installed the infrastructure, employed well experienced faculty, designed and delivered programs that help to enhance the communication and soft skills which are required for making the students employable. An excellent system is in place that considers all the issues that make a student employable. The University has been successful for the last 7 years in employing all the students who have registered and eligible for placement through its offices located across the country. About 50 trained personnel work extensively to make the students ready for recruitment by the industry.

Counselling & Career Guidance

A special Counselling Cell consisting of professional student counsellors, psychologists, and Professors counsels/helps the students in preparing themselves to cope with studies, perform well in the tests & various competitions. This Cell provides its services to the students in getting the solutions for their personal problems and provides career guidance with the help of the Industrial

Relations and Placements (IRP) department. A group of 20 students are allotted to each faculty member who counsels them regularly and acts as their mentor.

Social Service Wing

KLEF has a social service wing which is used to channelize the social service activities of the faculty, staff, and students. It has adopted 5 nearby villages and conducts activities like medical camps, literacy camps and educates the villagers regarding hygiene and health care on a regular basis.

NSS/NCC wings

NCC/NSS is a credit course designed with an intent to transform NCC/NSS activities into curricular activities from an extracurricular thereby providing credits to students involved in NCC/NSS along with other attended advantages to the students in the university.

Hobby Clubs

Wholly and solely managed by the students, contributed much to the cultural life of the campus and to the cultural evolution of the students. Few student bodies and clubs operate in the campus like music society, dance club, drama society, literary and debating club, English press club, drawing club, painting club, mime club, computer club etc. Students manage entire activities and budget of the organization for the entire semester in advance. Around 4000 students are active members of the Hobby Clubs.

Life Skills and Inner Engineering

KLEF feels that it is its responsibility to mold the students as good human beings, contributing to the country and to society by producing responsible citizens. Along with the regular programs every student admitted into KLEF undergoes a one-week special life skills /orientation program. Through this program, KLEF is producing the students with clarity of thoughts and charity at heart. Strict regularity, implicit obedience, courtesy in speech and conduct, cleanliness in dress. Life skills and inner engineering teach a student his/her obligation towards GOD, himself /herself his/her country and fellow human beings. Every student is encouraged to practice his/her own religious faith and be tolerant and respectful towards other religions.

Technical Festival

KLEF organizes various programs for the all-round development of the students. The technical festival and project exhibition is organized in the odd semester (October) every year to elicit the innovative ideas and technical skills of the students.

Cultural Festival

The cultural festival in the even semester (February) of every year is the best platform for the students to exhibit their talents and creativity. Through these festivals KLEF is imparting organizational skills, leadership skills, competitive spirit, and team behavior skills to our students. Along with the knowledge, KLEF festivals provide recreation to the student community.

Center for Innovation, Incubation and Entrepreneurship (CIIE)

KLEF being a pioneering institute supporting Academics and Research in Engineering, Science and Technology is endowed with the entire infrastructure and highly experienced faculty, has a Centre for Innovation, Incubation and Entrepreneurship (CIIE) that comprises of: Innovation Centre which aims to inculcate a spirit of innovation. Incubation Centre which aims to incubate innovations through prototype product development. Entrepreneurship Development Centre (EDC) which aims at fostering entrepreneurial skills among the students

Department of Physics

The Department of Physics was established in the year 1980. The department offers M.Sc. program in Physics & Nanoscience and Technology, and Ph.D program in interdisciplinary research areas. The department is functioning with 14 highly experienced and qualified Doctoral faculty obtained Ph.D.'s from reputed National Institutions/Universities. Faculty are also having post-doctoral research experience from different countries over several years. Research work in the department is being carried out in various fields like Materials Science, Solar renewable energy, Nanotechnology, Space and Atmospheric Science, Theoretical & Computational Physics, Ultrasonics, and chemical thermodynamics. The department had 4 fully equipped sophisticated research labs of worth Rs. 3.5 Crores. The department is recognized as DST-FIST Level 1 department with grant of Rs.107 lakhs funded by the Department of Science and Technology, Govt. of India, New Delhi. The department also granted with good number of sponsored research projects of worth Rs. 3 crores under different schemes such as DST woman scientist scheme, young scientist scheme, early career research award, SERB-Start up research grant, Core research grant and international travel support. Recently the department of Physics and ECE bagged with a sponsored research project worth of Rs. 7 crores under DST-PURSE scheme to enhance infrastructure and research facilities in the university. The department has published more than 350 research publications in highly reputed international journals with high impact factor. The department faculty have published 17 patents and book chapters. Faculty from the department awarded with Associate Fellow of A.P Academy of Sciences, Amaravathi. The department faculty recognized as Top 2% renowned scientist in the world awarded by the Stanford University, California, USA. Implementing new innovative learning pedagogies to make learning easy and enthusiastic. We are offering research and skill-oriented courses, value-added courses, and industry driven curriculum as part of academic mandate to make students industry ready.

Exclusive focus on placement training and pre-placement with 100% placement record for all the registered and eligible students in different sectors like industry, R & D institutions/organizations, academic colleges, Banking and Communication. Exclusive student counseling for career guidance, academic growth, and personal well-being.

VISION OF THE DEPARTMENT:

To conquer new heights in academic and research with global perspective that will provide solutions to environmental, industrial and agricultural problems.

MISSION OF THE DEPARTMENT:

M1. To develop thrust research areas- Nanomaterials, Polymers, Phosphors, Glass Science & Technology, thin film technology, high energy materials, Atmospheric Science and Liquid Crystals.

M2. To develop a top-notch research centre with State-of-the art infrastructure facilities to foster scientific research and technology development programs.

M3. To offer a comprehensive exploration of basic science, applied science and lab science with an industry focus and to act collectively like a catalyst in enhancing, improving and supporting interdisciplinary research and training in cutting edge technologies to fit for industry and entrepreneur.

M4. To provide a quality education in pursuit of knowledge, that establishes a strong foundation for understanding developments in the rapidly advancing field of physics with the development of new technologies through research and education.

M5. To provide the nation with highly trained professional who are able to implement the scientific principles to the continuous improvement of the safe, quality and valuable services and products.

M6. Ensuring empowerment of India's incomparable human resource by creating strong infrastructure both for research and commercialization.

CHAPTER 2: PROGRAM EDUCATIONAL OBJECTIVES (PEOs) AND PROGRAM OUTCOMES (POs)

ACADEMIC STRUCTURE

PROGRAMME OUT COMES: (PO :)

The Program Educational Objectives (PEOs) are as follows:

PEO	DESCRIPTION
1	Understand and apply principles of physics, chemistry, biology, electronics and engineering for understanding the scientific phenomenon in nano domain.
2	To integrate multi-disciplinary research and teaching environments facilitating students-faculty alignment centered at various aspects of energy in the fields Physics, chemistry, biology, electronics, medicine, renewable energies etc., in industry, academia, research and day today life.

PROGRAMME OUT COMES: (PO)

PO	DESCRIPTION
PO1	Apply the knowledge of physics, chemistry, biology, and electronics to understand the nanoscience.
PO2	Ability to synthesis different materials, analyse and interpretation of data.
PO3	Capable of identifying different techniques in nano-scale processing and use of characterization methodologies for advanced nano-devices.
PO4	Able to propagate the knowledge of nanotechnology to address problems of social relevance related to energy, the environment, and health.
PO5	Ability to understand, communicate effectively, and possess professional and ethical responsibility.
PO6	Ability to use the techniques, skills, and modern technological tools necessary for nanotechnology practice and recognition of the need for, and an ability to engage in life-long learning.
PO7	Able to plan and execute their own innovative ideas in the form of projects, product design, and development.

CHAPTER 3: PROGRAMS LIST & ELIGIBILITY CRITERIA

PG HUMANITIES AND SCIENCES

Program	Duration	Eligibility	Percentage of Marks in the Qualifying Exam	Total Seats
M.SC. (NANO SCIENCE & TECHNOLOGY)	2 Years	bachelor's degree in sciences with Physics/Chemistry/biology/Electronics discipline Examination, from recognized institute/ University	50% marks or equivalent CGPA in Chemistry.	20
Ph. D	Minimum 3 years in case of Full Time and 4 years in case of Part Time	Post-Graduation in any branch of Law	55% or equivalent CGPA in Chemistry.	As per availability of Guide

Eligibility Criteria for Admission in M. Sc Nanoscience and Technology

Candidates should have passed bachelor's degree in science with Physics/Chemistry/biology/Electronics discipline Examination, from recognized institute/ University; with minimum of 50% marks or equivalent CGPA in Chemistry. Apart from the above, the candidates should have secured a qualifying rank in the PG admission eligibility test i.e., KLUEEE (Entrance Examination conducted by KLEF)

CHAPTER 4: ACADEMIC REGULATIONS

ACADEMIC REGULATIONS

This document supplements the KLEF rules and regulations to provide assistance to all M.Sc. M.Sc Nanoscience and Technology students. It is required that every individual must abide by these regulations.

Note: The regulations stated in this document are subject to change or can be relaxed / modified without prior notice at the discretion of the Hon'ble Vice Chancellor.

Terminology

- **Academic Council:** The Academic Council is the highest academic body of the University and is responsible for the maintenance of standards of instruction, education, and examination within the University. The Academic Council is an authority as per UGC regulations and it has the right to take decisions on all academic matters including academic research.
- **Academic Year:** It is the period necessary to complete an actual course of study within a year. It comprises of two consecutive semesters i.e., Even and Odd semester.
- **Academic Pathways:** Students of all programs of study are given the opportunity to choose their career pathways viz. Employability, Innovation and Research. Each of these pathways prepares the students in a unique way, enabling them to achieve the heights of their career.
- **Academic Bank of Credits (ABC):** It helps the students to digitally store their academic credits from any higher education institute registered under ABC in order to award Certificate / Diploma / Degree / Honors based on the credits earned by the student. All the credits acquired by the students are stored digitally by registering into Academic Bank of Credits (ABC) portal. It also supports retaining the credits for a shelf period and continue their program study with multiple breakovers.
- **Audited Course:** It is a course of study which has zero credits and has a "Satisfactory" or an "Unsatisfactory" grade.
- **Backlog Course:** A course is considered to be a backlog if the student has obtained a failure grade (F).
- **Board of Studies:** Board of Studies (BOS) is an authority as defined in UGC regulations, constituted by Vice Chancellor for each of the department separately. They are responsible for curriculum design and update in respect of all the programs offered by a department.
- **Branch of Study:** It is a branch of knowledge, an area of study or a specific program (Nanoscience and Technology related to Physics, chemistry, biology, electronics etc.,)

- **Compulsory course:** Course required to be undertaken for the award of the degree as per the program.
- **Course:** A course is a subject offered by the University for learning in a particular semester.
- **Course Handout:** Course Handout is a document which gives a complete plan of the course. It contains the details of the course viz. Course title, Course code, Pre-requisite, Credit structure, team of instructors, Course objectives, Course rationale, Course Outcomes and the relevant syllabus, textbook(s) and reference books, Course delivery plan and session plan, evaluation method, chamber consultation hour, course notices and other course related aspects. In essence, course handout is an agreement between students (learners) and the instructor.
- **Course Outcomes:** The essential skills that need to be acquired by every student through a course.
- **Credit:** A credit is a unit that gives weight to the value, level or time requirements of an academic course. The number of 'Contact Hours' in a week of a particular course determines its credit value. One credit is equivalent to one lecture hour per week or two hours per week of tutorials/ self-learning/ practical/ field work during a semester.
- **Credit Point:** It is the product of grade point and number of credits for a course.
- **Choice Based Credit System:** The institute adopts Choice Based Credit System (CBCS) on all the programs offered by it which enables the students to choose their courses, teachers and timings during their registration. This enables the students to decide on the courses to be done by them in a specific semester according to their interests in other activities.
- **Cumulative Grade Point Average (CGPA):** It is a measure of cumulative performance of a student over all the completed semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed upto two decimal places.
- **Curriculum:** Curriculum is a standards-based sequence of planned experiences where students practice and achieve proficiency in content and applied learning skills. Curriculum is the central guide for all educators as to what is essential for teaching and learning, so that every student has access to rigorous academic experiences.
- **Degree:** A student who fulfils all the Program requirements is eligible to receive a degree.
- **Degree with Specialization:** A student who fulfills all the Program requirements of her/his discipline and successfully completes a specified set of Professional elective courses in a specialized area is eligible to receive a degree with specialization.

- **Department:** An academic entity that conducts relevant curricular and co-curricular activities, involving both teaching and non-teaching staff and other resources.
- **Detention in a course:** Student who does not obtain minimum prescribed attendance in a course shall be detained in that course. Refer to Attendance & Detention Polo Policy
- **Dropping from the Semester:** A student who doesn't want to register for the semester should do so in writing in a prescribed format before commencement of the semester.
- **Elective Course:** A course that can be chosen from a set of courses. An elective can be Professional Elective, Open Elective, Management Elective and Humanities Elective.
- **Evaluation:** Evaluation is the process of judging the academic work done by the student in her/his courses. It is done through a combination of continuous in-semester assessment and semester end examinations.
- **ERP:** ERP (Enterprise Resource Planning) system is a comprehensive software solution designed to streamline and automate various administrative, academic, and financial processes within the University. It manages student information, including admissions, registration, enrollment, attendance, grades, and academic records.
- **Grade:** It is an index of the performance of the students in a said course. Grades are denoted by alphabets.
- **Grade Point:** It is a numerical weight allotted to each letter grade on a 10 - point scale.
- **Industrial Training:** Training program undergone by the student as per the academic requirement in any company/firm. It is a credited course.
- **Industrial Visit:** Visit to a company/firm as per the academic requirement.
- **In-Semester Evaluation**: Summative assessments used to evaluate student learning, acquired skills, and academic attainment during a course.
- **LMS:** LMS stands for Learning Management System. It is a platform used in the institution to manage and deliver courses. Students can access learning resources, participate in online discussions, submit assignments, take assessments, and communicate with their instructors and peers.
- **Make-up Test:** An additional test scheduled on a date other than the originally scheduled date.
- **Minor Degree:** A student who fulfills all the Program requirements of her/his discipline and successfully completes a specified set of courses from another discipline is eligible to receive a minor degree in that discipline.

- **Open Elective:** This is a course of interdisciplinary nature. It is offered across the University for All Programs.
- **Pre-requisite:** A course, the knowledge of which is required for registration into higher level course.
- **Professional Core:** The courses that are essential constituents of each engineering discipline are categorized as Professional Core courses for that discipline.
- **Professional Elective**: A course that is discipline centric. An appropriate choice of minimum number of such electives as specified in the program will lead to a degree with specialization.
- **Program:** A set of courses offered by the Department. A student can opt and complete the stipulated minimum credits to qualify for the award of a degree in that Program.
- **Program Outcomes:** Program outcomes are statements that describe what students are expected to know or be able to do at the end of a program of study. They are often seen as the knowledge and skills students will have obtained by the time they have received their intended degree.
- **Program Educational Objectives:** The broad career, professional, personal goals that every student will achieve through a strategic and sequential action plan.
- **Project:** Course that a student has to undergo during his/her final year which involves the student to undertake a research or design, which is carefully planned to achieve a particular aim. It is a credit based course.
- **Supplementary**: A student can reappear only in the semester end examination for the Theory component of a course, subject to the regulations contained herein.
- **Registration**: Process of enrolling into a set of courses in a semester/ term of the Program.
- **Re-Registration:** Student who are detained in courses due to attendance or marks criteria as per their regulation are given a chance to re-register for the same and complete it during the summer term.
- **Semester:** It is a period of study consisting of 16$\pm$1 weeks of academic work equivalent to normally 90 working days including examination and preparation holidays. The odd Semester starts normally in July and even semester in December.
- **Semester End Examinations:** It is an examination conducted at the end of a course of study.
- **Social Service:** An activity designed to promote social awareness and generate well-being; to improve the life and living conditions of the society.

- **Student Outcomes:** The essential skill sets that need to be acquired by every student during her/his program of study. These skill sets are in the areas of employability, entrepreneurial, social and behavioral.
- **Summer term:** The term during which courses are offered from May to July. Summer term is not a student's right and will be offered at the discretion of the University.
- **Term Paper:** A 'term paper' is a research report written by students that evolves their course-based knowledge, accounting for a grade. Term paper is a written original research work discussing a topic in detail. It is a credit-based course.

CHAPTER 5: PROGRAM CURRICULUM

PROGRAM CURRICULUM

For an academic program the curriculum is the basic framework that will stipulate the credits, category, course code, course title, course delivery (Lectures / Tutorials / Practice / Skill / Project/ Self Study / Capstone Design etc.), in the Choice Based Credit System. However, all such are essentially designed, implemented, and assessed in Outcome Based Education Framework.

Program Structure

a) Each Academic Year is divided into two semesters, each of, approximately, 15 weeks duration:

- Odd Semester (July – December).
- Even Semester (January – May)

b) All courses are categorized into three streams even, odd and dual semester courses.

c) Even semester courses are offered only during even semester i.e., January-May, Odd semester courses are offered only during odd semester i.e., July-December and dual semester courses are offered during both even & odd semesters.

d) A Program is a set of courses offered by the University that a student can opt and complete certain stipulated credits to qualify for the award of a degree.

e) A student can opt for dissertation either by means of research at the University (or) through Internship at an Industry; this is however allowed during 3rd (or) 4th semesters only.

Course work

a. Every course has a Lecture-Tutorial-Practice-Skill (L-T-P-S) component attached to it.

b. Based upon the L-T-P-S structure the credits are allotted to a course using the following criteria.

- Every Lecture / Tutorial hour is equivalent to one credit.
- Every Practical hour is equivalent to half credit.
- Every skill-based practice hour is equivalent to quarter credit.
- If the calculated value of credit is a fraction, it is rounded to the next integer.

Course Classification:

Any course offered under M.Sc program is classified as:

- **Induction Courses:** Student who gets admitted into M.Sc. program must complete a set of Induction courses for a minimum period of 1 weeks and obtain a "Satisfactory" result prior to registering into 1st Semester of the Program.
- **Bridge Courses:** Courses which are required to bridge the continuity among the Basic Sciences Courses / Engineering Sciences Courses / Professional Core Courses and are identified through gap analysis carried out using feedback obtained from various academic stakeholders are termed as Bridge Courses. These courses also do not yield any credits but require a "Satisfactory" result to register into the attached professional courses.
- **Humanities Arts & Social Science Courses (HAS):** Humanities, arts, and social sciences (HAS) courses are a broad field of study that encompasses the study of human culture and society. These courses focus on developing students' critical thinking, problem-solving, and communication skills. These skills are valuable in a variety of careers, and they can also help students become more engaged citizens.
- **Basic Science Courses (BSC):** Basic science courses are the foundation of all science education. They provide students with the knowledge and skills they need to understand the natural world. Basic science courses typically cover Mathematics, Physics, Chemistry, Biology etc., Basic science courses are essential for students who want to pursue careers in science, engineering, medicine, and other STEM fields.
- **Engineering Science Courses (ESC):** Engineering sciences courses are a subset of basic science courses that are specifically designed for engineering students. These courses provide students with the knowledge and skills they need to understand the physical principles that underlie engineering design and analysis.
- **Professional Core Courses (PCC):** Professional core courses are a set of courses that are essential for all engineering students. These courses provide students with the knowledge and skills they need to be successful in their chosen engineering discipline.
- **Professional Elective Courses (PEC):** Professional electives are a set of courses that are chosen by students to supplement their engineering education. Professional electives are a great way for students to customize their engineering education and prepare for their future careers. By choosing electives that are relevant to their interests and goals, students can gain the knowledge and skills they need to be successful in their chosen field.
- **Open Elective Courses (OEC):** Open electives are a set of courses that are not specifically related to engineering, but that can provide students with knowledge and skills that are valuable in

a variety of fields. Open electives are a great way for students to broaden their horizons and explore their interests outside of engineering. By choosing electives that are relevant to their interests and goals, students can gain the knowledge and skills they need to be successful in a variety of fields.

- **Skill Development Courses (SDC):** Skill development courses can provide students with the knowledge and skills they need to use specific software or hardware. This can be especially important for students who are interested in pursuing a career in a particular field.
- **Project Research & Internships (PRI):** Project, Research and Internships can help students gain a better understanding of their chosen field by giving them the opportunity to apply their knowledge and skills to real-world problems. These can help students explore their interests by giving them the opportunity to work on projects that they are passionate about.
- **Social Immersive Learning (SIL):** Social immersive learning is a type of experiential learning that allows students to learn by interacting with others in a simulated environment. This type of learning can be especially beneficial for B.Tech students because it can help them develop their soft skills, such as communication, teamwork, and problem-solving.
- **Audit Courses (AUC):** Any course offered in the University that has no assessment of student performance and no grading. Though "Satisfactory" completion of audit courses doesn't acquire any credit but they are part of the graduation requirements.
- **Value-Added Courses (VAC):** Courses leading to certification and those which are conducted exclusively for employability are referred to as value added courses. Though "Satisfactory" completion of value-added courses doesn't acquire any credit, but they are part of the graduation requirements.

Course Precedence:

The following are the guidelines for registering into courses with pre-requisites.

- Every course may have one or more of its preceding course (s) as pre- requisite(s).To register for a course, the student must successfully be promoted in these course(s) earmarked as pre-requisite(s) for that course.

Summer Term Courses:

KLEF offers summer term courses during May and June. The following are the guidelines to register into courses offered in Summer Semester.

- A student may register for course/s in each summer term by paying the stipulated fee.

- Students registering for more than one (1) summer course must ensure that there is no clash in the time table.
- A student can register into a detained course or a not-registered course (course offered in regular semester, but student failed to register due to the non- compliance of pre-requisite condition but has paid the fee.) A student can also register for other than the above two mentioned categories of courses only if they are permitted for acceleration.
- In any case, a student can register only for a maximum of 12 credits during summer term.
- Attendance & Promotion policy for summer term is same as compared to the regular semester except for condonation policy. Condonation is not applicable for summer term courses.

CHAPTER 6: REQUIREMENTS FOR THE AWARD OF DEGREE

Requirements for the Award of Degree

The student is awarded a M.Sc Nanoscience and Technology degree provided she/he

- Must successfully earn 80 credits, as stipulated in the program structure.
- Must have successfully obtained a minimum CGPA of 5.5 at the end of the program.
- Must have finished all the above-mentioned requirements in less than twice the period mentioned in the Academic structure for each program, which includes deceleration period chosen by the student, deceleration imposed by KLEF or debarred from the KLEF.

Name of the Program			M. Sc Nanoscience and Technology	
Course Category	No. of courses	No. of credits	Total credits	Minimum CGPA required
AUC	1	0	80	5.5
PCC	10	44		
FCC	1	3		
PEC	3	9		
OEC	2	4		
PRI	3	20		
VAC	1	0		

A student having cleared all the courses and met all the requirements for the award of degree with

a. $5.5 \leq$ CGPA < 5.75 will be awarded Pass class.

b. $5.75 \leq$ CGPA < 6.75 will be awarded Second class.

c. $6.75 \leq$ CGPA < 7.75 will be awarded First class.

d. CGPA ≥ 7.75 will be awarded First class with Distinction provided the student has cleared all the courses in first attempt, should not have any history of betterment and must have fulfilled all the program requirements in two years duration.

CHAPTER 7: ATTENDANCE RULES & DETENTION POLICY

Attendance policy for promotion in a course:

The student must maintain minimum 85% of attendance to be promoted in a course and to appear for Sem End Examination. In case of medical exigencies, the student/parent should inform the principal within a week by submitting necessary proofs and in such cases the attendance can be condoned up to an extent of 10% by Principal on the recommendation of the committee established for condonation.

- Attendance in a course shall be counted from the date of commencement of the classwork only and not from the date of his/her registration.
- Attendance for the students who are transferred from other institutes and for new admissions, attendance must be considered from the date of his/her admission.
- In case of attendance falling marginally below 75% due to severe medical reasons or any other valid reasons, the Principal / Program chair may bring such cases, along with valid and adequate evidence to the notice of the Dean Academics. The condonation board formed by Vice-Chancellor under the chairman ship of Dean-Academics will consider any further relaxation in attendance from the minimum attendance percentage requirement condition after going through case by case.

Attendance Waiver: Students maintaining a CGPA ≥ 9.00 and SGPA ≥ 9.00 in the latest completed semester get a waiver for attendance in the following semester. Students who thus utilize an attendance waiver will be awarded the marks allocated for attendance (if any) based on their performance in an advanced assignment specified by the course coordinator (emerging topics related to the course). S/he can appear in all assessments and evaluation components without being marked ineligible due to attendance-based regulations.

Attendance Condonation for Participation in KLEF / National / International Events: Only those students nominated / sponsored by the KLEF to represent in various forums like seminars / conferences / workshops / competitions or taking part in co- curricular / extra- curricular events will be given compensatory attendance provided the student applies in writing for such a leave in advance and obtain sanction from the Principal basing on the recommendations of the Head of the Department (HoD) for academic related requests; or from the Dean Student Affairs for extracurricular related requests. For participation in the KLEF's placement process the names of students will be forwarded by the placement cell in-charge to the respective Heads of the Departments. Students participating in KLEF/National/International events like technical fests,

workshops, conferences etc., will be condoned for 10% of total classes conducted for each course in the semester. This condonation is not applicable for summer term.

Course Based Detention Policy:

In any course, a student must maintain a minimum attendance as per the **attendance policy for promotion in a course**, to be eligible for appearing in the Sem-End examination. Failing to fulfill this condition, will deem such student to be detained in that course and become ineligible to take semester end exam.

Eligibility for appearing Sem – End Examination:

A Student registered for a course and maintained minimum attendance of 85% is eligible to write the Semester-End Examination for that course unless found ineligible due to one or more of the following reasons:

- Shortfall of attendance
- Detained
- Acts of indiscipline
- Withdrawal from a course

CHAPTER 8: ASSESSMENT & EVALUATION PROCESS

Assessment & Evaluation Process

The assessment is conducted in formative and summative modes with a weightage of 60% for Semester-In evaluation and 40% for Semester-End Evaluation.

The distribution of weightage for various components of formative and summative modes are decided and notified by the course coordinator through the course handout after approval by the Dean Academics, prior to the beginning of the semester. Students are advised to refer the course handout to get more detailed information on assessment.

- Sem-In tests and the Semester-End Examinations will be conducted as per the Academic Calendar.
- Students may have to take more than one examination in a day during Sem-In exams, Semester-End Examinations /Supplementary examinations.
- Examinations may be conducted on consecutive days, beyond working hours and during holidays.

Semester-In Evaluation

The following are the guidelines for the Semester-In evaluation.

- The process of evaluation is continuous throughout the semester.
- The distribution of marks for Semester-In evaluation is 60% of aggregate marks of the courses.
- To maintain transparency in evaluation, answer scripts are shown to the students for verification, within one week of conduct of exam. If there is any discrepancy in evaluation, the student can request the course-coordinator to re-evaluate.
- The solution key and scheme of evaluation for all examinations are displayed by the Course-Coordinator in the appropriate web portal of the course, on the day of the conduct of examination.
- In case the student is unable to appear for any evaluation component owing to hospitalization, participation in extra/ co-curricular activities representing KLEF/ state/ country; the Dean Academics can permit to conduct of re- examination for such students.
- In case a student has missed any of the two in-semester evaluations, S/he is eligible for and will be provided with an opportunity of appearing for re- examination.

Semester End Examination

- The distribution of marks for Semester-End evaluation is 40% of aggregate marks of the course
- The pattern and duration of Sem End examination are decided and notified by the Course Coordinator through the Course handout, after approval from the Dean Academics.
- To maintain transparency in evaluation, answer scripts are shown to the students for verification. If there is any discrepancy in evaluation, the student can request the Controller of Examinations to re-evaluate.
- If a student earns 'F' grade in any of the courses of a semester, an instant supplementary exam (for only Semester End Exam component) will be provided within a fortnight of the declaration of the results.

Assessment of Project/Research-Based Subjects

All project or research-based subjects must have a defined time limit for completion. The specific time limits and schedule for monitoring and evaluating student performance will be announced each term. The final project report, after obtaining a plagiarism certificate, will be considered, and evaluated by the panel of examiners. Student project reports must follow the guidelines prescribed by the Dean of Academics.

Absence in Assessment & Examination

If a student fails to take any formative assessment component (due to ill-health or any valid reason), no second chance will be given, and zero marks will be awarded for the same. In cases of excused absence, the instructor may provide an opportunity to the student to reappear in quizzes or assignments or any other internal assessment criteria based on the approval from the principal & the concerned Head of the Department in written. If a student fails to write Sem-In Exam-I or obtained less than 60% marks in Sem-In Exam-I, he must attend remedial classes and maintain a minimum 85% of attendance in remedial classes to be eligible for Make-up test for Sem-In exam-I. Further, the number of remedial classes to be conducted shall be 50% of regular classes held till the Sem-In exam-I. However, there is no make-up test for Sem-In Exam-II or for the Laboratory exams.

- A student's absence for Sem-In exams under the following circumstances are only considered for makeup test.
- Pre-approved participation in University/State/National/International co- curricular and extra-curricular activities
- Ill health and medical emergencies for the student leading to hospitalization with certification by the doctor stating inability of student to attend Sem-In exams clearly within the necessary dates.

- Death of immediate family member

Remedial Classes & Remedial Exam

The following categories of students are recommended to attend Remedial classes:

- Students who did not attend or obtain a minimum of 50% marks in the Sem-In examination-1
- Students for whom the learning objectives of CO1/CO2 are not attained in the Sem-In examination-1
- Any other student may also be permitted to attend remedial classes as per the discretion of the Principal.

The following are the guidelines to conduct remedial classes:

- Remedial classes are scheduled to be conducted usually one- or two- weeks after the conclusion of Sem-In exam-1.
- The number of remedial classes to be conducted shall be 50% of regular classes held until the Sem-In exam-I.
- Remedial classes MUST NOT be scheduled during regular class work hours.

The following are the guidelines for remedial exams:

- Students attending remedial classes must maintain attendance of minimum 80% in classes conducted under remedial classes, without fail for being eligible for attending remedial exam.
- After conduction of remedial test, the Sem-in exam-1 marks will be updated by considering the weightage of 75% of marks obtained by student in remedial exam, and 25 % of marks obtained by student in regular exam; with a CAP of 75% in overall marks.

Grading Process

At the end of all evaluation components based on the performance of the student, each student is awarded grade based on absolute/relative grading system. Relative grading is only applicable to a section of a course in which the number of registered students is greater than or equal to 25. Choice of grading system is decided by the Course-Coordinator with due approval of Dean Academics and is specified in the course handout.

Absolute Grading

The list of absolute grades and its connotation are given below

Performance	Letter Grade	Grade Point	Percentage of marks
Outstanding	O	10	90-100
Excellent	A+	9	80-89
Very Good	A	8	70-79
Good	B+	7	60-69
Above Average	B	6	50-59
Average	C	5	46-49
Pass	P	4	40-45
Fail	F	0	0-39
Absent	AB	0	Absent

Relative Grading

The following table lists the grades and its connotation for relative grading:

Letter Grade	Grade Point	Grade Calculation
O	10	total marks >= 90% and total marks >= mean + 1.50σ
A+	9	μ+0.50σ <= total marks < μ+1.50σ
A	8	μ <= total marks < μ+0.50σ
B+	7	μ-0.50σ <= total marks < μ
B	6	μ-1.00σ <= total marks < μ-0.50σ
C	5	μ-1.25σ <= total marks < μ-1.00σ
P	4	μ-1.50σ <= total marks < μ-1.25σ or ≥40
F	0	total marks <μ-1.50σ or total marks <=39
AB	0	Absent

μ is the mean mark of the class excluding the marks of those students who scored ≥ 90% and ≤40% after rounding the percentages to the next highest integer. σ is the standard deviation of the marks.

SGPA & CGPA

The SGPA is the ratio of sum of the product of the number of credit s with the grade points scored by a student in all the courses and the sum of the number of credits of all the courses undergone by a student, in a semester.

Where ‘Ci’ is the number of credits of the i^{th} course and *‘Gi’* is the grade point scored by the student in the i^{th} course.

The CGPA is also calculated in the same manner considering all the courses undergone by a student over all the semesters of a program, where ‘Si’ is the SGPA of the i^{th} semester and *‘Ci’* is the total number of credits in that semester.

- The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.
- CGPA can be converted to percentage of marks: 10 X CGPA -7.5
- A student appearing for a course having lab integrated with theory and in case obtains less than 40% in either of lab or theory component of semester end examination, and in such case the student must reappear for the component only in which he has secured less than 40%. Till successful attainment of minimum 40% of both components, the student remains in the F grade for that course.
- Audit/Certificate courses are graded as satisfactory (S) or non- satisfactory (NS) only.
- At the end of each semester, the KLEF issues a grade sheet indicating the SGPA and CGPA of the student. However, grade sheets will not be issued to the student if he/she has any outstanding dues.

Betterment

A student may reappear for semester end examination for betterment only in the theory part of the course for improving the grade, subject to the condition that, the student has passed the course, his/her CGPA is ≤ 6.75 and the grade in the respective course to be equal to or lower than “C”. In the case of reappearing for a course, the best of the two grades will be considered. A Student can re-register in any course in any semester during the program for improvement of grade if the current grade in the course is lower than B+ and with due approval from Dean Academics in accordance with academic regulations. A student cannot reappear for semester end examination in courses like Industrial Training, courses with their L-T/ST-P-S Structure like 0-0-X-X, Project, Practice School and Term Paper.

CHAPTER 9

PROMOTION

Rustication

A student may be rusticated from the KLEF on disciplinary grounds, based on the recommendations of any empowered committee, by the Vice Chancellor.

Award of Medals

KLEF awards Gold and Silver medals to the top two candidates in each program after successful completion of their study. The medals are awarded based on their CGPA during the Annual Convocation with the following constraints:

a. The grade obtained through betterment/ supplementary will not be considered for this award.

b. S/he must have obtained first class with distinction for the award of Gold or Silver-medal.

Academic Bank of Credits:

ABC helps the students to digitally store their academic credits from any higher education institute registered under ABC in order to award Certificate/Diploma/Degree/Honors based on the credits earned by the student. All the credits acquired by the students are stored digitally by registering into Academic Bank of Credits (ABC) portal. It also supports retaining the credits for a shelf period and continue their program study with multiple breakovers. Students may exit from their current program of study due to any unforeseen reasons or to focus on their chosen career path. In such cases, the student may break for a period of time (preferably not in the middle of an academic year) and may continue with the program of study at a later stage. Moreover, students must be able to complete their program by not exceeding the maximum duration of the program. If not, they may be issued with a Certificate, diploma, degree or honors based on the credits acquired over the period of time for all the programs approved by UGC.

ACADEMIC INSTRUCTIONS

GENERAL BEHAVIOUR

a. Students should speak in English only while on campus with the faculty or among themselves.

b. Students are expected to wish / greet all senior officials of the KLEF with due respect.

c. Students should be courteous and polite in dealing with all Faculty & staff.

d. Students should maintain silence and/or speak in a soft voice in and around the classrooms, library, laboratories, and offices of the Deans, Program Chairs, Senior Officials, faculty rooms and corridors of academic buildings. It must be noted that shouting, talking in loud voice or in chorus, using indecent, abusive and discourteous language anywhere within the institution premises are considered serious acts of indiscipline and are punishable.

e. Students should not loiter during the free time in the university ampus.

f. Students should not issue any public or press statement, send letters to editors, government, public servants or notaries without prior permission and approval of the Registrar of KLEF in writing.

g. Students should keep the status, dignity, prestige and reputation of KLEF high and not engage in anything that might directly or indirectly undermine the standing of the institution.

h. Students must always adhere to a prescribed/decent dress code befitting the dignity of a technical/professional student within the campus.

i. Ragging of any student is a serious act of indiscipline and has been totally banned by the Hon'ble Supreme Court of India. A student found involved in any form of ragging, verbal or physical, inside or outside the institutional campus, hostels, or buses shall be treated as per the anti-ragging rules of the KLEF.

j. Students must not be involved in quarreling or fighting or any indecent verbal or physical activity among themselves, or with staff and faculty or visitors. Direct or indirect involvement in any such activity will be considered as serious breach of discipline and strict disciplinary action will be taken against the students that engage in such activities.

k. Students are not allowed to sit on the steps, boundary walls on the higher floors of any building, or engage in gossiping, making noise or any other such activity.

KLEF WORKING HOURS

KLEF operates between 09:00 AM to 5:00 PM on all weekdays.

LECTURE CLASS ENVIRONMENT

The institute is a community of learners. Students have a responsibility of creating and

maintaining an environment that supports effective learning to receive effective instructions in classrooms, laboratories. KLEF expects students to conduct themselves in an orderly and cooperative manner by adhering to University Rules & Regulations.

LABORATORY ENVIRONMENT

A conductive learning environment in the laboratory is essential and the students are advised to follow the guidelines mentioned below:

a. Always listen carefully to the faculty especially for the safety precautions to take in the laboratories. Accidents resulting in injuries may occur if precautions are not taken.

b. Eating in laboratories is strictly prohibited.

c. Proper dress code is to be followed as prescribed by faculty in each lab.

d. Students should familiarize themselves with the location of all safety equipment which may be available.

e. Follow evacuation procedures quickly and quietly, if needed.

f. Students should always conduct themselves in a responsible and cautious manner. Risky behaviors such as pushing, running, jumping etc., are unwarranted.

g. Only materials required to complete and record the experiment instructions, (e.g. pencils or graph paper, etc.) should be brought into the laboratory.

h. Equipment must be carefully handled to prevent breakage or damage, otherwise appropriate penalties/disciplinary action may be levied/imposed.

i. Lab station must be cleaned prior to leaving a lab.

j. Any accident, no matter how small or big, must be reported to the concerned faculty immediately.

REGISTRATION PROCESS

For every course, the student must undertake the registration process prior to commencement of the coursework, based on the following conditions;

a. Registration into a course will be permitted only for such courses, which are offered by KLEF in that semester.

b. A student must clear the pre-requisite(s) if any, to register in to a course.

c. KLEF reserves the right to register.

d. Registration for add/drop/change of a course will be permitted only within one week from the scheduled date of commencement of classes.

e. Students can register upto a maximum of 26 credits of their choice in a semester to meet their program requirements.

f. KLEF reserves the right to withdraw within one week of the commencement of the semester any elective course offered, if adequate number of students have not registered or for any other administrative reasons. In such cases, the students are permitted to register for any other elective course of their choice provided they have fulfilled the eligibility conditions.

g. KLEF reserves the right to cancel the registration of a student from a course or a semester or debar from the degree on disciplinary / plagiarism grounds.

h. A student is solely responsible to ensure that all conditions for proper registration are satisfied. If, there is any clash in the timetable, it should be immediately brought to the notice of the Academic coordinator for necessary corrective action. The registration may be cancelled for a course or the entire semester either by KLEF if any irregularity is found at a later stage.

CHAPTER 10: STUDENT COUNSELING & FEEDBACK

COUNSELLING & FEEDBACK

Guidelines for effective counselling for students on academic and non-academic activities Student counselling ensures that every student gets to know the academic structure of the University and utilize maximum opportunities that the institute offers to fulfil their career and personal life goals. The objective of "Student Counselling / Mentoring Service" is to provide friendly support to the students for their well-being during their stay in the campus and for their holistic development. Student counselling promotes the development of students in the following aspects:

Academic: It disseminates information about different academic programs of the Institute and provides efficient time management and learning skills. It also addresses academic issues of students, e. g. inadequate academic performance, fall of attendance, lack of basic IT skills and language skills of students, particularly from non-English background. Besides, counselling helps students to take proper direction as they leave the campus, viz. higher education in a specialized field (both in India and abroad), job (different types of career options), entrepreneurship, etc.

Co-Curricular & Extra-Curricular: It strives to develop talents in students and encourages them to discover their extra-curricular interests/hobbies, viz. sports, fine arts, etc.

Personal: It provides a cushion against homesickness and assists in adjusting to the new environment by providing personalized guidance. The following Orientation/training programs could be organized:

a. Counselling for Academic Excellence - Closely monitoring the Academic Progress of the students.
b. Orientation Program for new students to acquaint them with the Institute.
c. Awareness on Anti-ragging, gender sensitization, etc.
d. Stress and time management
e. Health care and hygiene
f. Career counselling
g. Motivational lectures by eminent speakers.

Every student should approach her/his counsellor only, for any of his/ her requirements. One slot of 50 minutes duration per week is provided in the timetable for counselling.

Feedback System

At KLEF, monitoring of feedback is a continuous process. Feedback is obtained from students and parents on various aspects. Feedback is taken through personal interaction with students, interaction with parents in addition to mid-semester and end-semester feedback.

The institution assesses the learning levels of the students, after admission and organizes special programs for advanced learners and slow learners.

Feedback Types:

In first year SWEAR analysis is done for every student in such a way it identifies their interests, pre-existing knowledge, aspects to improve technical and logical skills based on their career choice. The following are the different types of feedback taken at regular intervals:

(i). Student General Feedback (Twice in a Sem.)

(ii). Student Satisfaction Survey (Once in a Sem.)

(iii). Student Exit Feedback (Once in a Year)

(iv). Academic Peers Feedback on Curriculum (Once in a Sem.)

(v). Parents Feedback on Curriculum (Once in a Sem.)

(vi). Alumni Feedback on Curriculum (Once in a Sem.)

(vii). Industry Personnel Feedback on Curriculum (Once in a Sem.)

(viii). Student Feedback on Curriculum (Once in a Sem.)

(ix). Faculty Satisfaction Survey (Once in a Sem.)

(x). Parent Teacher Association (Once in a Sem.)

Feedback Procedure:

- General Feedback to be taken from the students on the aspects like Course Contents, Teaching Learning Process, Outcomes, Resources and Evaluation twice in every semester (Mid semester and End Semester Feedback) in a structured format floated by dean academics office.
- Student Satisfaction Survey (SSS) to all innovative methods and approaches should be recorded at appropriate intervals and the process should be refined based on that. Students should be sensitized on the process and methods and their understanding of the same should be assured.
- Exit survey feedback to be taken from the final year students on the aspects like entrance test, admission process, Course Contents, Teaching Learning Process, Outcomes, Resources and Evaluation, placements etc.
- Structured feedback for design and review of syllabus – semester wise / year wise is received from Students, Alumni, Peers, Parent, Industry Personnel.

- Satisfaction Survey to be taken from the existing faculty on Course Contents, Teaching Learning Process, Outcomes, Resources and Evaluation once in every semester in a structured format floated by dean academics office.
- Parent Teacher Association (PTA) to develop the potential of parents and to strengthen their relationship with their children through planning and conducting a variety of developmental and recreational activities.
- Online Feedback is collected from all the students once at the end of the semester using well designed questionnaire. Informal feedback will be collected in parallel from selected student representatives within 4-5 weeks of commencement of the semester by the Office of Dean Academics.
- HODs have to submit monthly /semester / Academic Year Feedback reports with necessary comments and proofs to Dean Academics office duly signed by concerned Principal/Director. Visit following link https://www.kluniversity.in/site/feedsys.htm

CHAPTER 11: PROGRAM STRUCTURE

SEM	Course code	COURSE NAME	Short Name	Mode	Type	L	T	P	S	CR	CH	Pre requisites
1	23UC5201	Professional Communication Skills	PCS	R	AUC	0	0	4	0	0	4	NIL
1	23NS5101	Fundamentals of Nanoscience & Nanotechnology	FNST	R	PCC	3	0	0	0	3	3	NIL
1	23NS5102	Physics of Nanotechnology	PNT	R	PCC	3	1	0	0	4	4	NIL
1	23NS5103	Chemistry of Nanotechnology	CNT	R	PCC	3	1	0	0	4	4	NIL
1	23NS5104	Synthesis and characterizations of Nano Materials-1	SCNM-1	R	PCC	3	0	6	0	6	10	NIL
1	23ns5105	Nano Photonics	NPHT	R	PCC	4	0	0	0	4	4	PNT
2	23NS5206	Synthesis and Characterization of Nanomaterials-2	SCNM-2	R	PCC	3	0	0	12	6	15	SCNM-1
2	23NS5207	Emerging applications of nanotechnology	EANT	R	PCC	4	0	0	0	4	4	SCNM-1
3	23NS6108	Advanced Nanomaterials	ADNM	R	PCC	4	0	0	0	4	4	SCNM-2
3	23NS6109	Advanced Nanobiotechnology	ANBT	R	PCC	4	0	0	0	4	4	BNT
2	23NS6110	Micro and Nano Electronics Devices	MNED	R	PCC	4	0	0	0	4	4	PNT
3	23NS6121	Nano-Electronics	NE	R	FCC	2	0	0	0	2	2	
3	23NS6122	Artificial Intelligence Integration with Nanotechnology	AIN	R	FCC	2	0	0	0	2	2	
2	23NS52E1	Biology of Nanotechnology	BNT	R	PEC	3	0	0	0	3	3	NIL
2	23NS52E2	Bio Chemistry	BC	R	PEC	3	0	0	0	3	3	NIL
2	23NS52E3	Nanomagnetic Materials and Devices	NMD	R	PEC	3	0	0	0	3	3	SNM
2	23NS52E4	Societal Impacts of Nanotechnology	SINT	R	PEC	3	0	0	0	3	3	NIL
3	23NS61E5	Nanotechnology for Renewable Energy Materials	NREM	R	PEC	3	0	0	0	3	3	NIL

3	23NS61E6	Nanotechnology in Health Care	NHSC	R	PEC	3	0	0	0	3	3	ANM
2	OENS0001	Material Science and Engineering	MSE	R/M	OEC	2	0	0	0	2	2	NIL
3	OENS0002	Experimental Physics	EXP	R/M	OEC	2	0	0	0	2	2	NIL
2	**23IE5201**	Essentials of Research Design	ERD	R	PRI	1	1	0	0	2	2	NIL
3	23IE6104	Term Paper	TP	R	PRI	0	0	4	0	2	4	NIL
4	23IE6205	Dissertation	MAP	R	PRI	0	0	32	0	16	32	NIL
2	23CC5201	Value Added Course	VAC	R/M	AUC	2	0	0	0	0	0	NIL
		GRAND TOTAL				**44**	**3**	**58**	**12**	**80**	**122**	

LIST OF OPEN ELECTIVES OFFERED TO OTHER DEPARTMENTS

Open Elective Courses	SEM	Course code	Course Name	Short Name	Mode	Type	L	T	P	S	Cr	CH	PRE-REQUISITE
1	2	OENS0001	Material Science and Engineering	MSE	R/M	OEC	2	0	0	0	2	2	NIL
2	3	OENS0002	Experimental Physics	EXP	R/M	OEC	2	0	0	0	2	2	NIL

PCC - Professional Core related to Major area, PEC - Professional Elective Courses related to Specialization, PRI - Project, Research or Internship Courses, AUC - Audit Courses, VAC - Value Added Courses, OEC - Open Elective, FCC- Flexi core course which leads to specialization

Graduation requirements: Successful attainment of 80 credits, obtain all PEC credits from courses of specific specialization domain, complete 1 SCI publication and obtain Satisfactory in all 0 credit courses (AUC, VAC and PRI categories)

CHAPTER 12: ARTICULATION MATRIX

Program Articulation Matrix

S.No	Course code	COURSE NAME						POs						
			L	T	P	S	Cr	1	2	3	4	5	6	7
1	23UC5201	Professional Communication Skills	0	0	4	0	0	3				3		
2	23NS5101	Fundamentals of Nanoscience & Nanotechnology	3	0	0	0	3	3		3				
3	23NS5102	Physics of Nanotechnology	3	1	0	0	4	3	2	3				
4	23NS5103	Chemistry of Nanotechnology	3	1	0	0	4	3	3	3	3		3	3
5	23NS5104	Synthesis and characterizations of Nano Materials-1	3	0	6	0	6	3	3					
6	23ns5105	Nano Photonics	4	0	0	0	4		3	3	3			
7	23NS5206	Synthesis and Characterization of Nanomaterials-2	3	0	0	12	6	3	3					
8	23NS5207	Emerging applications of nanotechnology	4	0	0	0	4		3		3			
9	23NS6108	Advanced Nanomaterials	4	0	0	0	4	2	2	2				
10	23NS6109	Advanced Nanobiotechnology	4	0	0	0	4			3				
11	23NS6110	Micro and Nano Electronics Devices	4	0	0	0	4	2	2			2		
12	23NS6121	Nano-Electronics	2	0	0	0	2			2				
13	23NS6122	Artificial Intelligence Integration with Nanotechnology	2	0	0	0	2	3						
14	23NS52E1	Biology of Nanotechnology	3	0	0	0	3	3	2					
15	23NS52E2	Bio Chemistry	3	0	0	0	3	3						

16	23NS52E3	Nanomagnetic Materials and Devices	3	0	0	0	3	3						
17	23NS52E4	Societal Impacts of Nanotechnology	3	0	0	0	3					3	3	
18	23NS61E5	Nanotechnology for Renewable Energy Materials	3	0	0	0	3	3						
19	23NS61E6	Nanotechnology in Health Care	3	0	0	0	3	3						
20	OENS0001	Material Science and Engineering	1	1	0	0	2	2						
21	OENS0002	Experimental Physics	0	0	4	0	2	3						
22	**23IE5201**	Essentials of Research Design	0	0	32	0	16	3	3					
23	23IE6104	Term Paper	2	0	0	0	0		3				3	3
24	23IE6205	Dissertation	1	1	0	0	2		3				3	3
25	23CC5201	Value Added Course	0	0	4	0	2							

Course Articulation Matrix

	K L UNIVERSITY
	DEPARTMENT OF PHYSICS
	2023-2024 M.Sc Nanoscience and TechnologyBATCH Course Outcomes vs Program Outcomes
	Course Articulation Matrix

S No	Course Code	Course Title	LTPS	Credits	CO NO	Description of the Course Outcome	Program Outcomes						
							1	2	3	4	5	6	7
1	23UC5201	Professional communication Skills	0-0-4-0	0	CO1	To develop the skill of contextual Vocabulary and Critical Reading					3		
					CO2	To demonstrate different types of personal and professional skills and apply them for growth in professional zone.					3		
					CO3	Apply the concepts of Mathematical Principles to solve problems on Arithmetic, Algebra & Geometry to improve problem solving ability.	3						

					CO4	Apply the concepts and using Logical thinking to solve problems on verbal & Non-Verbal Reasoning to develop Logical thinking skills.	3						
2	23NS5101	Fundamentals of Nanoscience & Nanotechnology	3-0-0-0	3	CO1	Understanding the basic concepts, Background, scientific revolutions of nanoscience and technology and understanding multifunction materials	2						
					CO2	Understanding the uniqueness of nanomaterial properties by comparing bulk materials with nanomaterials and applying to size dependent properties and challenges in nanotechnology.			3				
					CO3	Apply the concepts of dimensionality and size dependent phenomena to nanoscale materials and to observe size dependent variation in basic properties.	3						
					CO4	Apply the concepts and properties to advanced and recent special Nanomaterials like CNT, nano composites, carbon fullerenes and study their specific applications.			3				

3	23NS5102	Physics of Nanotechnology	3-1-0-0	4	CO1	Apply the concepts of various concepts of quantum mechanics to solve the problems related to the motion of electrons in microscopic level	3						
					CO2	Understand the fundamental concepts of wave optics, electromagnetic waves, interference and polarization of light		2					
					CO3	Apply the spin and orbital motion of electrons in determining magnetic properties of materials and identifies their role in classification soft & hard magnetic materials having specific engineering applications.			3				
					CO4	Apply the knowledge of crystal structures and understand the electrical properties of semiconductors			3				
4	23NS5103	Chemistry of Nanotechnology	3-1-0-0	4	CO1	Apply a working knowledge of the basic concept of Chemistry for Nanotechnology and chemical and physical properties changes.	3		3				
						Analyse several synthetic methods for the	3	3					3

					CO2	fabrication of nanoparticles.							
					CO3	Apply the links between the structure and catalytical activity of the nanomaterials.	3			3		3	
					CO4	Illustrate the application and prospects of Chemistry for Nanotechnology	3					3	3
5	23NS5104	Synthesis and characterizations of Nano Materials-1	3-1-6-0	7	CO1	Apply the principles of different Physical and chemical routes to synthesis as per the required application and properties	3						
					CO2	Apply the knowledge of structural characterization methods to analyze the performance of materials for required applications.		3					
					CO3	Apply the knowledge of spectroscopic characterization methods to analyze the performance of materials for required applications		3					
					CO4	Apply the knowledge of surface and thermal characterization methods to analyze the performance of materials for required applications.		3					

					CO5	Apply the knowledge of synthesis and characterization of nanomaterials to perform experiments and analyze the samples.		4					
6	23NS5105	Nano Photonics	4-0-0-0	4	CO1	Apply the concept of fundamental in Nano Photonics for optical devices			3				
					CO2	Apply nonlinear optics principles to analyze and design optical devices				3			
					CO3	Demonstrate the application of photonic crystals in real-world scenarios		3					
					CO4	Apply the principles of nano photonics to design the simple photonic devices			3				
7	23NS5206	Synthesis and Characterization of Nanomaterials-2	3-0-0-12	6	CO1	Apply the principles of different Physical and chemical routes to synthesis as per the required application and properties	3						
					CO2	Apply the knowledge of structural characterization methods to analyze the material surface defects and their performance for required applications.	3						
					CO3	Apply the knowledge of magnetic and electrical characterization methods to	3						

						analyze the performance of materials for required applications							
					CO4	Apply the knowledge of Bio-materials characterization methods to analyze the performance of materials for bio-medical applications.	3						
					CO5	Apply the knowledge of synthesis and characterization of nanomaterials to perform experiments and analyze the samples		4					
8	23NS5207	Emerging applications of nanotechnology	4-0-0-0	4	CO1	Understanding the principles of Nanotechnology and explaining its applications in the biomedical field with the intersection of nanotechnology and biomedicine.		2					
					CO2	Describe the Nanotechnology in Agriculture through precision and conventional farming methods and current developments in Nano-based agriculture systems.		3					
					CO3	Evaluate the impact of Nanotechnology on food processing, food quality, and ethical implications on food products.		3		3			

					CO4	Apply Nanoscale techniques to demonstrate the nanomaterial-biomolecular interactions and toxicity associated with using nanomaterials in biological systems.		3					
9	23NS6108	Advanced nanomaterials	3-0-0-0	3	CO1	Gain in-depth knowledge in the concepts of magnetism at nanoscale.	2						
					CO2	Gain good knowledge in Thermoelectric Materials and the advanced tools to study.		2					
					CO3	Understanding the various one dimensional semiconductors behaviours.			2				
					CO4	Understanding the structure properties of polymeric nanomaterials and applications.			2				
10	23NS6109	Advanced Nanobiotechnology			CO1	Understand the structure and properties of nanomaterials used in Nano technological applications			2				
					CO2	Understand the role of nanostructure assembly and impact of nanomaterials on biological processes			2				
					CO3	Apply the knowledge of nanotechnology in			3				

						detecting various diseases using nano biosensors.								
					CO4	Apply the knowledge of nanotechnology in Agriculture and Food technologies			3					
11	23NS6110	Micro and Nano Electronic Devices	4-0-0-0	4	CO1	Understand the Basic Electronic devices and nano electronic devices, Mechanical Molecular Nano robotics Nano devices and Nano computers: Theoretical Models	2							
					CO2	Understand the Molecular scale electronics - Molecular materials for electronics – Carbon materials: Fullerene and CNTs.		2						
					CO3	Understand the Micro and Nano electrical Systems: - Overview		2						
					CO4	Understand the Future Nano systems -Nano machines, nano robots, electronics based on CNT, molecular Electronics.					2			
12	23NS6121	Flexi Core Course Nano Electronics	2-0-0-0	2	CO1	Understanding of the principles, limitations, and applications of nano electronics.			2					
					CO2	Understanding of the nano scale effects, techniques for nanoscale transistor fabrication, industrial CMOS technology, and non-classical elements of nano			2					

						MOSFETs.							
					CO3	Understanding of the introduction to nanostructures, the fabrication and patterning techniques used to create nanostructures, and the characterization techniques.			2				
					CO4	Understanding of nano sensors, nano actuators, memory devices, photovoltaic cells, and their applications in communication, industry, commercial settings, agriculture, biomedical fields, and the Internet of Things (IoT).			2				
13	23NS6122	Artificial Intelligence Integration with Nanotechnology	2-0-0-0	2	CO1	Gain the in-depth knowledge in the concepts Artificial Intelligence, Machine Learning, and Deep Learning	3						
					CO2	Gain and apply good knowledge of artificial intelligence in the nanotechnology.	3						
					CO3	Applying the artificial intelligence in nanoscale simulations	3						

					CO4	Apply the knowledge of artificial intelligence in Nano-Computing and High-Performance Computing.	3						
14	23NS52E1	Biology of Nanotechnology	3-0-0-0	3	CO1	Understand the concepts of Biomolecules used in Biotechnological processes	2						
					CO2	Understand the interaction between Biomolecules, immune components and applications of recombinant DNA Technology		2					
					CO3	Apply the principles of in-silico technology in designing drugs and concepts of Biosafety and bioethics	3						
					CO4	Apply the concepts of analytical techniques to characterize the bioanalytes used in various Pharma and Biotechnological industries.	3						
15	23NS52E2	Biochemistry	3-0-0-0	3	CO1	Understand the functions and properties of Proteins in biological systems	2						
					CO2	Understand the functions of Enzymes and kinetics in physiological systems	2						
					CO3	Understand the structure, Functions and	2						

						classification of Carbohydrates, Nucleic acids and Lipids in Biological system								
					CO4	Apply the importance of Metabolic pathways in Biotechnology sector.	3							
16	23NS52E3	Nanomagnetic Materials and Devices	3-0-0-0	3	CO1	Apply in-depth knowledge in the concepts of magnetism at both micro and nanoscale.	3							
					CO2	Apply good knowledge in Nanomagnetism and the advanced tools to study.	3							
					CO3	Applying the various imaging techniques to study the magnetic behaviors.	3							
					CO4	Apply the suitable applications of the magnetic materials based on the functional Properties in nano magnetic in data storage and biomedicine.	3							
17	23NS52E4	Societal Impacts of Nanotechnology	3-0-0-0	3	CO1	Understand the societal impacts of nanotechnology					2			
					CO2	Apply the economic impact of nanotechnology						3		
						Apply the ethics and laws related to					3			

					CO3	nanotechnology								
					CO4	Understand the societal impacts of nanotechnology							2	
18	23NS61E5	Nanotechnology for Renewable Energy Materials	3-0-0-0	3	CO1	Apply the basic concepts of energy conversion systems.	3							
					CO2	Appraise the working of fuel cells current status and future trends	3							
					CO3	Apply the knowledge of photovoltaic cells and energy conversion systems to improve their performance.	3							
					CO4	Apply the knowledge of photovoltaic systems to understand the working of Solar cells.	3							
19	23NS61E6	Nanotechnology in Health Care	3-0-0-0	3	CO1	Understand the recent advancements in the field of Nanotechnology for diagnostic applications	3							
					CO2	Understand the knowledge of nanotechnology in detecting various diseases using nano biosensors.	2							

					CO3	Understand the concepts of nanotechnology in drug development applications	2						
					CO4	Apply the novel techniques in diagnosing various diseases using nano devices	3						
20	OENS0001	Material Science and Engineering	2-0-0-0	2	CO1	Understands structure of crystalline solids, kinds of crystal imperfections and appreciates structure-property relationship in crystals.	2						
					CO2	Understands spin and orbital motion of electrons in determining magnetic properties of materials and identifies their role in classification soft & hard magnetic materials having specific engineering applications.	2						
					CO3	Understands role of molecular level vibrations in determining thermal properties of materials, heat treatment methods for changing the microstructure of materials and micro and macro level responses of materials subjected to load, for identification of materials having specific engineering	2						

						applications.							
					CO4	Understands the role of electronic energy band structures of solids in governing various electrical and optical properties of materials.	2						
21	OENS0002	Experimental Physics	2-0-0-0	2	CO1	- Understanding the basic concepts, Background, scientific revolutions of nanoscience and technology and understanding multifunction materials	2						
					CO2	Apply the principles of different chemical routes to synthesis as per the required application and properties.	3						
					CO3	- Understanding the basic difference between nano and bulk materials properties.	3						
					CO4	Apply the knowledge of structural characterization methods to analyze the performance of materials for required applications.	3						

22	23IE5201	Essentials of Research Design	1-1-0-0	2	CO1	Illustrate Research objects, steps involved in research and articulate appropriate Research Questions	3						
					CO2	Perform Literature Review in a Scholarly style and apply appropriate methods for Data collection	3	3					
					CO3	Represent the data in tabular/Graphical form and prepare data for analysis	3						
					CO4	Perform statistical modelling and analysis to optimize the data, prepare the data for publishing.	4	4					
23	23IE6104	Term Paper	0-0-8-0	4	CO1	Discovery of new insights, theories, or empirical findings that advance the existing knowledge base		3				3	4
24	23IE6205	Dissertation	0-0-32-0	16	CO 5	Discovery of new insights, theories, or empirical findings that advance the existing knowledge base		3				3	4
25	23CC5201	Value Added Course	2-0-0-0	0									

CHAPTER 13: SYLLABUS

PROFESSIONAL COMMUNICATION SKILLS (PCS)

COURSE CODE	23UC5201	MODE	R	LTPS	0-0-4-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	To develop and demonstrate principles of listening, speaking, reading and writing in various functional contexts	3	PO5
CO2	To demonstrate different types of personal and professional skills and apply them for growth in professional zone.	3	PO5
CO3	Apply the concepts of Mathematical Principles to solve problems on Arithmetic, Algebra & Geometry to improve problem solving ability.	3	PO5
CO4	Apply the concepts and using Logical thinking to solve problems on verbal & Non-Verbal Reasoning to develop Logical thinking skills.	3	PO5

Syllabus

Module 1	A) Vocabulary: Synonyms, Antonyms and One-word substitutes, (B)Reading comprehension, Critical reading, (C) Writing skills: Email writing, report writing and paragraph writing (D) Listening/Speaking Skills: listen & speak, Functional grammar.
Module 2	Personal Skills: Intra & Interpersonal skills (B) Assertiveness (C) Group Discussion (D) Resume writing (E) Video resumes (F) Interview skills

Module 3	Simple Equations, Ratio & Partnership, Averages, Percentages, Profit & Loss, Simple & Compound Interest, Numbers, Quadratic Equations & Inequalities, Time & Work, Time, Speed & Distance, Permutations & Combinations, Probability, Mensuration, Data Interpretation.
Module 4	Syllogism, Logical Venn Diagrams, Cubes & Dice, Number& letter series, Number, letter & word Analogy, Odd Man Out, Coding & Decoding, Blood Relations, Directions, clocks, calendars, Number, ranking & Time sequence test, Seating Arrangements, Data Sufficiency.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Business Student's Handbook: Skills for Study and Employment	Fisher, Julie and Bailey, Peter	Cengage Learning	2017
2	The Complete Guide to mastering soft skills for workplace success	Adams, John	Adams media	2019
3	Writing Tools: 55 Essential Strategies for Every Writer	Roy Peter Clark	Little, Brown and Company	2006
4	Quantitative Aptitude	R. S. Agarwal	SCHAND	
5	A Modern Approach to Verbal Reasoning	R. S. Agarwal	SCHAND	

FUNDAMENTALS OF NANOSCIENCE AND NANOTECHNOLOGY (FNN)

COURSE CODE	23NS5101	MODE	L	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understanding the basic concepts, Background, scientific revolutions of nanoscience and technology and understanding multifunction materials	2	PO1
CO2	Understanding the uniqueness of nanomaterial properties by comparing bulk materials with nanomaterials and applying to size dependent properties and challenges in nanotechnology.	3	PO3
CO3	Apply the concepts of dimensionality and size dependent phenomena to nanoscale materials and to observe size dependent variation in basic properties.	3	PO1
CO4	Apply the concepts and properties to advanced and recent special Nanomaterials like CNT, nano composites, carbon fullerenes and study their specific applications.	3	PO3

Syllabus

Module 1	**Basics of Nanoscience and Nanotechnology:** Background to Nanoscience and Nanotechnology, Feynman predictions on Nanotechnology - scientific revolutions - nanosized effects- surface to volume ratio nanoscience-Nanotechnology-Nano materials-Nano composites- Multifunctional nano materials-definitions with examples, Definition of Nanotechnology, Moore's law.

Module 2	**Comparison Bulk and Nanomaterials**: Nanostructured materials-metal semiconductor-ceramics and composites- size dependent properties - uniqueness in these properties compared to bulk and microscopic solids- nanomaterials and nanostructures in nature- super-hydrophobicity, self-cleaning-antifogging, Difference between Nanoscience and Nanotechnology, challenges in Nanotechnology.
Module 3	**Basics Properties**: Definition of a nano system - classification of nanocrystals - dimensionality and size dependent phenomena; Quantum dots, Nanowires and Nanotubes, 2D films; Nano & mesopores – Top Down and Bottom Up-Differences, Misconception of Nanotechnology- Importance of the nanoscale materials and their devices -size dependent variation in mechanical, physical, chemical, magnetic, electronic, transport, etc.
Module 4	**Advanced and Recent Special Nanomaterials**: Carbon Nano structures and types of Carbon Nano tubes, growth mechanisms Mechanical reinforcements, Solid Disordered carbon Nanostructures, Nano structured crystals. Graphene, Carbon nano-fibres. Electrical, Vibrational, Mechanical Properties of CNTs, optical properties; Carbon nanotubes, nano composites, carbon fullerenes-An overview over preparation, properties, applications

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Nanostructures & Nanomaterials: Synthesis, Properties & Applications	G. Cao	Imperial College Press	2004
2	Nanomaterials, Nanotechnologies and Design: An introduction for engineers and Architects	Michael F. Ashby, P.J. Ferreira, D.L. Schodek.	Oxford	2009
3	Fundamentals of Nanotechnology	Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep	CRC Press	2009

Physics of Nanotechnology (PoN)

COURSE CODE	23NS5102	MODE	R	LTPS	3-1-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the concepts of various concepts of quantum mechanics to solve the problems related to the motion of electrons in microscopic level	3	PO1
CO2	Understand the fundamental concepts of wave optics, electromagnetic waves, interference and polarization of light	2	PO2
CO3	Apply the spin and orbital motion of electrons in determining magnetic properties of materials and identifies their role in classification soft & hard magnetic materials having specific engineering applications.	3	PO2
CO4	Apply the knowledge of crystal structures and understand the electrical properties of semiconductors	3	PO2

Syllabus

Module 1	QUANTUM MECHANICS: De-Broglie wavelength: in terms of energy and potential – Schrödinger time dependent equation – Time independent equation – Applications of Schrödinger wave equation – One dimensional harmonic oscillator: Eigen values of the total energy – Particle in a one dimensional box.

Module 2	Wave optics: Electromagnetic waves and their characteristics – Theories of light – Wave, Electromagnetic and Quantum – Scattering of light: Rayleigh's and Tyndal scattering – Huygen's principle – Interference – Diffraction – Polarization of light waves.
Module 3	MAGNETISM: m Fundamental Concepts of Magnetism– Magnetic Materials – Dia, Para, Ferro, Anti ferro and ferrimagnetism–Magnetic Susecptibility – Curie Temperature – Hysteresis – Remanence – Coercivity – Saturation Magnetization – Small Particle Magnetism.
Module 4	ELECTRONICS: Classification of Solids, Crystal structure, Energy Levels, Intrinsic and Extrinsic Semiconductor, Conduction in Metals and Semiconductors. Diode Under Forward and Reverse Bias - Transistor Basics, Working Principles – Current-Voltage Characteristics.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Solid State Physics	S.O. Pillai	New Age International Publishers	2022
2	Introduction to Solid-State Physics	C. Kittel	Wiley	1986
3	Magnetic Materials: Fundamentals and Applications	Nicola A. Spaldin,	Cambridge University Press, 2nd Edition	2014

CHEMISTRY OF NANOTECHNOLOGY (CNT)

COURSE CODE	23NS5103	MODE	R	LTPS	3-1-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understanding the basic Classification and Nomenclature of Nanomaterials	2	PO 1
CO2	Demonstrate of different types of chemical method to Synthesis of Nanomaterials.	3	PO 2
CO3	Understanding the concepts of Structure and Morphology of Nanoparticles	2	PO 2
CO4	Demonstrate the Novel Properties of Nanomaterials	3	PO 2

Syllabus

Module 1	Classification and Nomenclature of Nanomaterials: Nanosized metals and alloys, semiconductors, ceramics – a comparison with respective bulk materials; Organic semiconductors, carbon materials; Zero-, one-, two- and three-dimensional nanostructures – quantum dots, quantum wells, quantum rods, quantum wires, quantum rings; bulk nanostructured, nanocomposites, Nanomachines and Devices.
Module 2	Synthesis of Nanomaterials: Nucleation and growth of nanosystems; self-assembly, mechanical milling, laser ablation, sputtering and microwave plasma, chemical reduction and oxidation, hydrothermal, micelles, sol-gel processes, photolysis, radiolysis, and metallo-organic chemical vapor deposition; designing of advanced

	integrated nanocomposites, functional nanomaterials and nanostructured thin films.
Module 3	Structure and Morphology of Nanoparticles: Fundamental Properties - size effects on structure and morphology of free or supported nanoparticles, size and confinement effects. Fraction of surface atoms - specific surface energy and surface stress, effect on the lattice parameter. Nanoparticle morphology - Equilibrium shape of a macroscopic crystal and nanometric crystals, morphology of supported particles.
Module 4	Novel Properties of Nanomaterials: Size and shape dependent optical, emission, electronic, transport, photonic, refractive index, dielectric, mechanical, magnetic, non-linear optical properties; Transition metal sols, origin of plasmon band, Mie theory, influence of various factors on the plasmon absorption. quantum confinement in semiconductors – particle in a box like model for quantum dots; origin of charge on colloidal sols, zeta potential, catalytic and photocatalytic properties, Mechanical properties.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Nanoscale Materials in Chemistry	Klabunde, K.J. (Ed.)	John Wiley & Sons Inc	2021
2	Nanoparticles	Schmid, G.	Wiley	2018
3	Nanochemistry	Sergeev, G.B.	Elsevier B.V. 2010	2010
4	Chemistry of Nanomaterials	Rao, C.N.R., Müller, A. and Cheentham, A.K.	Wiley	
5	Nanoscience and Nanotechnology: Fundamentals of Frontiers	Shubra Singh M.S. Ramachandra Rao	Wiley	2013

Synthesis and Characterization of Nanomaterials-1 (SCNM-1)

COURSE CODE	23NS5104	MODE		LTPS	3-0-6-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the principles of different Physical and chemical routes to synthesis as per the required application and properties	3	PO-1
CO2	Apply the knowledge of structural characterization methods to analyse the performance of materials for required applications.	3	PO-2
CO3	Apply the knowledge of spectroscopic characterization methods to analyze the performance of materials for required applications	3	PO-2
CO4	Apply the knowledge of surface and thermal characterization methods to analyze the performance of materials for required applications.	3	PO-2
CO5	Apply the knowledge of synthesis and characterization of nanomaterials to perform experiments and analyze the samples	4	PO-2

Syllabus

Module 1	Physical and Chemical routes for synthesis of nanomaterials: High Energy Ball Milling, Solid State method, Inert gas condensation, Role of inert gases- Post oxidation process; Chemical precipitation and co-precipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Microemulsions or reverse micelles, Solvo-thermal synthesis
Module 2	Structural Characterization methods: X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and EDAX analysis, Atomic force Microscopy (AFM), Scanning Probe Microscopy.

Module 3	Spectroscopic Characterization: Raman spectroscopy Basic concepts of spectroscopy, operational principle and application for analysis of nanomaterials, Fourier Transform Infrared Spectroscopy (FTIR), UV-VIS-IR Spectrophotometers, Photoluminescence (PL), Principle of operation and application for band gap measurement.
Module 4	Surface & Thermal Characterization: X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, BET Analysis - Electron Spin Resonance (ESR), Ferromagnetic Resonance (FMR), Nuclear Magnetic Resonance (NMR), Mossbauer Spectroscopy, DTA, TGA, DSC (Principle and Applications).

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Nanostructures & Nanomaterials: Synthesis, Properties & Applications	G. Cao	Imperial College Press	2004
2	characterization of materials	Elton N. Kaufmann	Wiley Inter science	2003
3	Materials Characterisation: Introduction to Microscopic and Spectroscopic Methods	Y. Leng	John Wiley & Sons (Asia)	2008

Nano Photonics (NPHT)

COURSE CODE	23NS5105	MODE	OFFLINE	LTPS	**4-0-0- 0**	PRE-REQUISITE	PNT

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Apply the concept of fundamental in Nano Photonics for optical devices	3	PO3
CO2	Apply nonlinear optics principles to analyze and design optical devices	3	PO4
CO3	Demonstrate the application of photonic crystals in real-world scenarios	2	PO2
CO4	Apply the principles of nano photonics to design the simple photonic devices	3	PO3

Syllabus

Module 1	**Mathematical Methods in Nano photonics:** Algebraic techniques - solid-state quantum mechanics - linear algebra and eigen systems, group theory, Bloch's theorem and conservation laws, optical phenomena to nonlinear filters. Waveguides; Photonic crystals fibres and filter.
Module 2	**Nano-Plasmonic biosensors,** Basics of Plasmonics, Metallic nanoparticles, nanorods and nano shells, local field enhancement. Collective modes in nanoparticle arrays, particle chains and arrays. suface plasmons and waveguides. Applications of Metallic Nanostructures - Fabrication Adiabatic nanofabrication – Regulating the size and position of nanoparticles using size dependent resonance.
Module 3	**Nano photonics devices:** Basis of Nanophotonics - Optical near fields and effective - interactions as a base for nanophononics – Principles of operations of nanophotonic devices - using optical near fields – Principles of nanofabrication using optical near fields - Spontaneous emission control, Application of microcavities
Module 4	**Medical Sensors:** Classical contrast mechanisms: bright field, dark field – Fluorescence contrast mechanism – Nonlinear microscopy based on second harmonic generation - coherent anti-Stokes Raman scattering –Stimulated emission depletion - nanoscale electronic energy transfer. Cooperative emissions.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Principles of Nanophotonics	Motoichi Ohtsu, Kiyoshi Kobayashi, Tadashi Kawazoe, Takashi Yatsui and Makoto Naruse	CRC Press-Taylor & Francis Group	2020.
2	Nanophotonics	P N Prasad	John Wiley & Sons	2020
3	Photonic Crystals: Towards Nanoscale Photonic Devices	Jean Michel Lourtioz,	Springer	2006
4	Photonic Crystals	John D Joannopoulos	Princeton University Press	2008
5	The Handbook of Photonics	Mool Chand Gupta, John Ballato	Boca Raton CRC Press	2022

Synthesis and Characterization of Nanomaterials-2 (SCNM-2)

COURSE CODE	23NS5206	MODE-R	LTPS	3-0-0-12	PRE-REQUISITE	SCNM-1

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Apply the principles of different Physical and chemical routes to synthesis as per the required application and properties	3	PO1
CO2	Apply the knowledge of structural characterization methods to analyze the material surface defects and their performance for required applications.	3	PO1
CO3	Apply the knowledge of magnetic and electrical characterization methods to analyze the performance of materials for required applications	3	PO1
CO4	Apply the knowledge of Bio-materials characterization methods to analyze the performance of materials for bio-medical applications.	3	PO1
CO5	Apply the knowledge of synthesis and characterization of nanomaterials to perform experiments and analyze the samples	4	PO2

Syllabus

Module 1	Physical and Chemical routes for synthesis of nanomaterials: Different types of Sputtering processes – Pulsed laser deposition – Rapid solidification – Arc discharge method- Fabrication of Nanostructures Microfabrication using Etching-Lithography; Thermolysis routes, Microwave heating synthesis; Sono-chemical synthesis; Electrochemical synthesis; Photochemical synthesis, Supercritical fluid nano materials synthesis.

Module 2	Materials defects studies: Scanning Tunnelling Microscopy(STM), Atomic Force Microscopy AFM)-Non-contact, contact- Tapping- conducting mode-.Near Field Scanning Optical Microscopy; Scanning Capacitance Microscopy- Magnetic Force Microscopes MFM)- Chemical Force Microscope (CFM) - Applications for analysis of nanomaterials.
Module 3	Magnetic and electrical characterization: Vibration Sample Magnetometer (VSM), Semiconducting Quantum Interference Device (SQUID), Impedance Spectroscopy- Four probe method, PPMS
Module 4	Bio-materials characterization New Advances and challenges in biological and biomedical materials characterizations- Dynamic light scattering spectroscopy. Confocal Microscopes- Confocal Raman – Application in Nano-biotechnology. Fluorescence Microscope.
Module 5	1. Synthesis of Fe2O3 Nano fibres using electrospinning. 2. Preparation of WO3 nanostructures using microwave synthesis. 3. Synthesis of ZnFe2O4 Nanoparticles by sol-gel Method. 4. SEM demo characterization of nanomaterials for size and surface morphology. 5. Fabrication of Thin Film by using Spin coating technique. 6. Photocatalytic activity of nanomaterials. 7. Gas Sensor Setup Demo Class 8. Electrochemical workstation demo class 9. Performing photolithography experiments and using a scanning electron microscope. https://www.uvu.edu/physics/nanotech/practice/vr_lab.html 10. Preparation of Sols: https://csc-iiith.vlabs.ac.in/List%20of%20experiments.html 11. Preparation of Gels: https://csc-iiith.vlabs.ac.in/List%20of%20experiments.html

Reference Books:

Sl No	Title	Author(s)	Publisher	Year

1	Nanoparticles – Nanocomposites – Nanomaterials An Introduction for beginners	Dieter Vollath	Wiley 2013	2013
2	Concise Encyclopedia of Materials Characterization: Advances in Materials Sciences and Engineering	R.W. Cahn, E.M. Lifshitz	Elsevier, 2016	2016
3	Materials Characterization: Introduction to Microscopic and Spectroscopic Methods	Yang Leng	John Wiley & Sons, 2013	2013
4	Handbook of Nanoceramics and their Based Nanodevices (Vol. 2)	Tseung-Yuen Tseng and Hari Singh Nalwa	American Scientific Publishers	2005

Emerging Applications of Nanotechnology (EANT)

COURSE CODE	23NS5207	MODE	Theory	LTPS	4-0-0-0	PRE-REQUISITE	No Need

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Student can understand the Basic Electronic devices and nano electronic devices, Mechanical Molecular Nano robotics Nano devices and Nano computers: Theoretical Models	2	PO-1
CO2	Student can understand the Molecular scale electronics - Molecular materials for electronics – Carbon materials: Fullerene and CNTs.	2	PO-2
CO3	Student can understand the Micro and Nano electrical Systems: - Overview	2	PO-2
CO4	Student can understand the Future Nanosystems -Nano machines, nano robots, electronics based on CNT, molecular Electronics.	2	PO-5

Syllabus

Module 1	**CO1:** Semiconductor Nanodevices-I: Single Electron devices- Nano scale MOSFET – Resonant Tunnelling Transistor – Single Electron Transistors manipulation Single Electron Dynamics Mechanical Molecular Nano robotics Nano devices and Nano computers: Theoretical Models
Module 2	**CO2:** Molecular Electronics: - Molecular scale electronics -Molecular materials for electronics – Carbon materials: Fullerene and CNTs, Graphene and RGO - Carbon Nanotubes, Structure and Unique Properties of Carbon Nanotubes – types

	of Carbon Nanotubes - Applications of Carbon Nanotubes–CNTs in field Emission, Shielding, Field-Effect Transistor and logic gates.
Module 3	**CO3:** Micro and Nano electrical Systems: - Overview- Micro and Nano-Electromechanical systems - Fundamental concepts - fabrication process- choice of materials, calculations - the performance of different structures - Nanoelectronics Devices - Approaches to Nanoelectronics - advantages and disadvantages of different approaches, thermal sensors, radiation sensors, magnetic sensors, chemical sensors, mechanical sensors
Module 4	**CO4:** Future Nano systems -Nano machines, nano robots, electronics based on CNT, molecular Electronics. Quantum Computation: Future of Meso/ Nano electronics -Interfacing with the Brain, towards molecular medicine, Lab-on-Bio Chips- Guided evolution for challenges and the solutions in Nano Manufacturing technology.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	MICROELECTRONICS Paperback	Jacob Millman (Author), Arvin Grabel (Author)	**McGraw Hill Education**	**1 July 2017**
2	Microelectronics, 2ed	Behzad Razavi (Author)	**Wiley**	**1 January 2017**
3	Nanotechnology for Electronic Materials And Devices Paperback	Korkin Anatoli Et. Al (Author)	**Springer Nature (SIE)**	**1 January 2011**

Advanced Nanomaterials ANM

COURSE CODE	23NS6108	MODE		LTPS	4-0-0-0	PRE-REQUISITE	Fundamentals of Nanoscience and Nanotechnology

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	To gain in-depth knowledge in the concepts of magnetism at nanoscale.	3	1
CO2	Gain good knowledge in Thermoelectric Materials and the advanced tools to study.	3	1
CO3	Understanding the various one dimensional semiconductors behavior.	3	1
CO4	Understanding the structure properties of polymeric nanomaterials and applications.	3	1

Syllabus

Module 1	Nanostructured Magnetism: Nanostructure magnetism, Effect Bulk Nano structuring of magnetic property, Giant and colossal magnetic resistance, Nanomagnetic materials, Paramagnetism in metallic nanoparticles, semiconducting quantum dots.
Module 2	Thermoelectric Materials: Concept of phonon, Thermal conductivity specific heat, exothermic and endothermic processes, Different types of thermoelectric materials, Bulk properties, One dimensional and composite thermoelectric materials, Applications.
Module 3	One dimensional semiconductors: Fabrication strategies, quantum conductance effects in semiconductor nanowires, porous Silicon, nanobelts, nanoribbons, nanosprings.

Module 4	Structure properties of Polymeric Nanomaterials and Applications: Structure-property relationship, stress-strain behaviour, crystalline melting point, effect of chain flexibility and other steric factors, entropy and heat of fusion, glass transition temperature, relationship between Tm and Tg. Effect of molecular weight, property requirements and its utilization. Synthetic procedure commercial polymers, Fire retarding and biomedical polymers.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Semiconductor for solar cells	H J Moller, Artech House Inc, MA, USA.	Wiley	2010
2	Solis state electronic device	Ben G Streetman, Prentice Hall of India Pvt Ltd.,	Wiley	2004
3	Organic Photovoltaics – Materials, Device Physics and Manufacturing Technologies,	C. Brabec, V. Dyakonov, U. Scherf	Wiley	2003
4	Text Book of Polymer Science	F.W. Billmeyer Jr	Wiley	2010
5	Polymer Science	V.R. Gowariker, N.V. Viswanathan and J. Sreedhar	Wiley	2009

Advanced Nano B**iotechnology** (ANBT)

COURSE CODE	23NS6109	MODE	OFFLINE	LTPS	**4-0-0-0**	PRE-REQUISITE	PNT

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Apply the basic concepts of energy conversion systems.	3	PO3
CO2	Appraise the working of fuel cells current status and future trends	3	PO3
CO3	Apply the knowledge of photovoltaic cells and energy conversion systems to improve their performance.	3	PO3
CO4	Apply the knowledge of photovoltaic systems to understand the working of Solar cells.	3	PO3

Syllabus

Module 1	Functional Principles of Nanobiotechnology- - Historical perspective of Integration of biology, chemistry, and material science. Opportunities and Promises of nanobiotechnology. Structure and functional properties of Biomaterials, Bimolecular sensing, Molecular recognition and Flexibility of biomaterials. - Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers of biomolecular recognition events. Microbial production of inorganic nanoparticles – Magnetosomes. DNA based nanostructures – Topographic and Electrostatic properties of DNA and proteins – Hybrid conjugates of gold nanoparticles – DNA oligomers.

Module 2	Nanomaterials used in Biotechnology - Nanoparticles, carbon nanotubes, quantum dots and buckyballs interface with biological macromolecules. Biological perspectives of nanomaterials – impact of nanomaterials in biological processes – tolerance by immune systems and toxicity. Nucleic acid Engineering- Modifications of DNA for nano-technological applications. Nanostruture assembly using DNA.
Module 3	Nanotechnology in Biomedical and Pharmaceutical Industry - Nanoparticles in bone substitutes and dentistry – Implants and Prosthesis - Reconstructive Intervention and Surgery – Nanorobotics in Surgery – Photodynamic Therapy – Nano sensors in Diagnosis. Design and types of nano-biosensors. DNA aptamers for nano-biosensing and drug discovery.
Module 4	Nanotechnology in Agriculture and Food technology - Insecticides development using nanotechnology and Nanofertilizers. Nanotechnology in food processing, food safety and biosecurity, toxin and contaminant detection, Smart packaging.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact‖,	Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer,	Wiley – VCH.	
2	, Bionanotechnology: Lessons from Nature,	D.S. Goodsell	Wiley Press.	
3	Nanobiotechnology: Concepts, Applications and Perspectives,	C. M. Niemeyer and C. A. Mirkin-(Editor),	Wiley Press.	

Micro and Nano Electronic Devices (M&NED)

COURSE CODE	23NS6110	MODE	Theory	LTPS	4-0-0-0	PRE-REQUISITE	No Need

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the Basic Electronic devices and nano electronic devices, Mechanical Molecular Nano robotics Nano devices and Nano computers: Theoretical Models	2	PO-1
CO2	Understand the Molecular scale electronics -Molecular materials for electronics – Carbon materials: Fullerene and CNTs.	2	PO-2
CO3	Understand the Micro and Nano electrical Systems: - Overview	2	PO-2
CO4	Understand the Future Nano systems -Nano machines, nano robots, electronics based on CNT, molecular Electronics.	3	PO-5

Syllabus

Module 1	**CO1:** Semiconductor Nano devices-I: Single Electron devices- Nano scale MOSFET – Resonant Tunneling Transistor – Single Electron Transistors manipulation Single Electron Dynamics Mechanical Molecular Nano robotics Nano devices and Nano computers: Theoretical Models
Module 2	**CO2:** Molecular Electronics: - Molecular scale electronics -Molecular materials for electronics – Carbon materials: Fullerene and CNTs, Graphene and RGO - Carbon Nanotubes, Structure and Unique Properties of Carbon Nanotubes – types of Carbon Nanotubes - Applications of Carbon Nanotubes–CNTs in field Emission, Shielding, Field-Effect Transistor and logic gates.
Module 3	**CO3:** Micro and Nano electrical Systems: - Overview- Micro and Nano-Electromechanical systems - Fundamental concepts - fabrication process- choice of materials, calculations - the performance of different structures - Nanoelectronics Devices - Approaches to Nanoelectronics - advantages and disadvantages of different approaches, thermal sensors, radiation sensors, magnetic sensors, chemical sensors, mechanical sensors
Module 4	**CO4:** Future Nanosystems -Nano machines, nano robots, electronics based on CNT, molecular Electronics. Quantum Computation: Future of Meso/Nanoelectronics -Interfacing with the Brain, towards molecular medicine, Lab-on-Bio Chips- Guided evolution for challenges and the solutions in Nano Manufacturing technology.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	MICROELECTRONICS Paperback	Jacob Millman (Author), Arvin Grabel (Author)	**McGraw Hill Education**	**1 July 2017**
2	Microelectronics, 2ed	Behzad Razavi (Author)	**Wiley**	**1 January 2017**
3	Nanotechnology for Electronic Materials And Devices Paperback	Korkin Anatoli Et. Al (Author)	**Springer Nature (SIE)**	**1 January 2011**

Nano-Electronics (NE)

COURSE CODE	23NS6121	MODE	Offline	LTPS	2-0-0-0	PRE-REQUISITE	MNED

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understanding of the principles, limitations, and applications of nano electronics.	2	PO3
CO2	Understanding of the nano scale effects, techniques for nanoscale transistor fabrication, industrial CMOS technology, and non-classical elements of nano MOSFETs.	2	PO3
CO3	Understanding of the introduction to nanostructures, the fabrication and patterning techniques used to create nanostructures, and the characterization techniques.	2	PO3
CO4	Understanding of nano sensors, nano actuators, memory devices, photovoltaic cells, and their applications in communication, industry, commercial settings, agriculture, biomedical fields, and the Internet of Things (IoT).	2	PO3

Syllabus

Module 1	Overview of Nano Electronics: Introduction to nano electronics, Development of Micro-Electronics, Limitation of Micro-Electronics, Micro-Electronics to Nano Electronics, Examples of Nano Devices, Application of Nano Devices in Electronics.
Module 2	Scaling Theory: Nano scale effects, Techniques for Nano Scale Transistor, Industrial CMOS Technology, Non-classical Elements of Nano MOSFET.

Module 3	Nanofabrication Techniques: Introduction to nano structures (Thin films, Nano wire, Nano rods, CNT), Fabrication/Patterning of nano structure (CVD, AFM, Lithography), Characterization techniques of nanostructures (SEM, TEM).
Module 4	Smart Nano Devices/Materials: Nano Sensors, nano actuators and bio sensor, memory devices (Fin FET), photo voltaic cell. Applications: Communication, Industry, Commercial, Agriculture and bio medical, IOT.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Fundamentals of Modern VLSI Devices	Y. Taur and T. Ning	Cambridge University Press.	2009
2	Silicon VLSI Technology	Plummer, Deal, Griffin	Pearson Education India	2000
3	Nanotechnology and Nanoelectronics: Materials, Devices, Measurement Techniques	W.R. Fahrner	Springer	2010

ARTIFICIAL INTELLIGENCE INTEGRATION WITH NANOTECHNOLOG (AIIN)

COURSE CODE	**23NS6122**	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Gain the in-depth knowledge in the concepts Artificial Intelligence, Machine Learning, and Deep Learning	3	PO-1
CO2	Gain and apply good knowledge of artificial intelligence in the nanotechnology.	3	PO-1
CO3	Applying the artificial intelligence in nanoscale simulations	3	PO-1
CO4	Apply the knowledge of artificial intelligence in Nano-Computing and High-Performance Computing.	3	PO-1

Syllabus

Module 1	What is Artificial Intelligence, Machine Learning, and Deep Learning?
Module 2	Artificial Intelligence's Application in Nanotechnology, The Application of AI in Atomic Force Microscopy (AFM)
Module 3	Artificial Intelligence in Nanoscale Simulations
Module 4	Artificial Intelligence and Nano-Computing, Artificial Intelligence and High-Performance Computing.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	There's Plenty of Room at the Bottom	Feynman R	Journal of Microelectromechanical Systems	1992

2	Artificial Intelligence Versus Human Intelligence: A New Technological Race	Zohuri B, Mossavar FR	Acta Scientific Pharmaceutical Sciences	2020
3	Neural Network Driven Artificial Intelligence: Decision Making Based on Fuzzy Logic	Zohuri B, Moghaddam M	Science Publishers, Inc.	2017
4	A Model to Forecast Future Paradigms: Volume 1: Introduction to Knowledge Is Power in Four Dimensions	Zohuri B, Mossavar FR	Apple Academic Press	2003

Biology of Nanotechnology (BNT)

COURSE CODE	23NS52E1	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understand the concepts of Biomolecules used in Biotechnological processes	2	PO-1
CO2	Understand the interaction between Biomolecules, immune components and applications of recombinant DNA Technology	2	PO-2
CO3	Apply the principles of in-silico technology in designing drugs and concepts of Biosafety and bioethics	3	PO-1
CO4	Apply the concepts of analytical techniques to characterize the bioanalytes used in various Pharma and Biotechnological industries.	3	PO-1

Syllabus

Module 1	Introduction Basic unit of life; macromolecules; prokaryotes; eukaryotes; cell com J)onents- sub-cellular organelles. Microbial life and fermentation process: Bacteria, fungi and viruses; basic concept of microbial growth, bioprocess technology and enzymes.
Module 2	Molecular biology concepts: Central dogma of molecular biology-replication, transcription and translation; recombinant DNA technology; basic concept of immune system, vaccines, GMOs

Module 3	Medical Biotechnology: Introduction to biopharmaceuticals, herbal medicines, gene therapy, nanobiotechnology, bioinformatics and drug design, biosafety and bioethics.
Module 4	Molecular techniques in Biotechnology: Introduction to microscopy, spectroscopy, electrophoresis, chromatography, centrifugation, , radioisotope technique, PCR, northern blotting southern blotting, western blotting.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"Molecular Biology and Biotechnology	Walker, J.M. and Gingold, E.B.	The Royal Society of Chemistry UK.	
2	Principles and Techniques of Practical Biochemistry	Wilson, K. and Walker, J	5th edition, Cambridge University Press	
3	., "Molecular Biotechnology : Principles and Recombinant DNA	Bernard R. G., Jack J. P	", ASM Press 4th Edition.	

Biochemistry (BC)

COURSE CODE	**23NS52E2**	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Understand the functions and properties of Proteins in biological systems	2	PO-1
CO2	Understand the functions of Enzymes and kinetics in physiological systems	2	PO-1
CO3	Understand the structure, Functions and classification of Carbohydrates, Nucleic acids and Lipids in Biological system	2	PO-1
CO4	Apply the importance of Metabolic pathways in Biotechnology sector.	3	PO-1

Syllabus

Module 1	Chemical basis of life; Water-properties of water, acid and base, pH, buffers, 5 physiological buffers; Non-covalent interactions; Macromolecular assemblies. Proteins-classification, structure, function, dynamics, specificity, and basics of 9 protein purification and analysis;
Module 2	nctional and structural proteins-Hemoglobin, - myoglobin, collagen. Enzymes-introduction, classification, kinetics and catalysis; Enzyme inhibitors; 8 Enzyme mechanisms and regulation.
Module 3	ucleic acids-structure and properties of DNA and RNA, DNA double helical 5 structure, A, B & Z DNA; Carbohydrates-Mono! di and polysaccharides, glycoproteins and glycolipids; Lipids-Classification, structure, function, lipid bilayer.

Module 4	Metabolism- basic concepts and design; Metabolism of carbohydrates-glycolysis & 11 gluconeogenesis, citric acid cycle, electron transport chain and oxidative phospborylation; Metabolism ofli pid amino acid and nucleotides. Integration of metabolism, coordinated control and regulation.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"Biochemistry"	Stryer, L.	7th edition, W. H. Freeman	2010
2	Principles of Biochemistry	Horton, H.R., Moran, L.A., Ochs R.A., Rawn, J. D. and Scrimgeor, R.S.,	"3rd edition Prentice Hall,.	2001
3	Biochemistry	Voet D. and Voet, J. G.,	3rd edition, John Wiley and Sons	2004

NANOMAGNETIC MATERIALS AND DEVICES (NMD)

COURSE CODE	**23NS52E3**	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Gain and Apply in-depth knowledge in the concepts of magnetism at both micro and nanoscale.	3	PO-1
CO2	Gain and apply good knowledge in nanomagnetism and the advanced tools to study.	3	PO-1
CO3	Applying the various imaging techniques to study the magnetic behaviors.	3	PO-1
CO4	Identiy and apply the suitable applications of the magnetic materials based on the functional Properties in nanomagnetic in data storageand biomedicine.	3	PO-1

Syllabus

Module 1	Fundamentals of magnetism – classification of magnetic materials - Antiferromagnetic materials – Domains and the magnetization process– Coercivity of fine particles - Super paramagnetism in fine particles – Exchange anisotropy - Induced anisotropy in thin films - Electron transport in magnetic multi-layers – Spin polarized electron tunneling - Interlayer exchange coupling - Spin relaxation in magnetic metallic layers and multi-layers - Nonequilibrium spin dynamics in laterally defined magnetic structures.
Module 2	Two-spin channel model - Two terminal spin electronics – Three terminal spin electronics - Spin tunneling - Study of ferromagnetic and antiferromagnet

	interfaces – Photoemission Electron Microscopy - X-ray Absorption Spectroscopy - X-ray Magnetic Linear Dichroism (XMLD) - X-ray Magnetic Circular Dichroism (XMCD) - Temperature dependence of X-ray Magnetic Dichroism
Module 3	Molecular Nano magnets – Mesoscopic magnetism - Particulate nanomagnets – Geometrical nanomagnets – Fabrication techniques scaling – Characterization using various techniques – Imaging magnetic microspectroscopy – Optical Imaging – Lorentz Microscopy – Electron Holography of Magnetic Nanostructures –Magnetic Force Microscopy.
Module 4	Magnetic sensors and Giant Magnetoresistance - Optically transparent materials - Soft ferrites- Nanocomposite magnets- Magnetic refrigerant – High TC superconductor – Ferro/biofluids– Biomedical applications of magnetic nanoparticles - Diagnostic applications - Therapeutic applications - Physiological aspects - Toxic effects.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Magnetic Microscopy of Nanostructures	Hans .P.O, and Hopster. H	Springer	2010
2	Ultra thin Magnetic Structures III – Fundamentals of Nanomagnetism	Bland. J.A.C, and B. Heinrich. B,	Springer	2005
3	Magnetic Materials: Fundamentals and Device Applications	Nicola. A.	Cambridge, University Press	2003
4	Magnetism and Magnetic Materials	J. M. D. Coey,	Pearson Education	2003

Societal Impacts of Nanotechnology (SINT)

COURSE CODE	23NS52E4	MODE		LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the economic and societal impacts of nanotechnology	2	PO4
CO2	Apply the economical and societal impacts of nanotechnology in society	3	PO4
CO3	Apply the ethics, laws and governance related to nanotechnology	3	PO5
CO4	Apply the public perception, societal implications of nanotechnology	3	PO5

Syllabus

Module 1	**Protection and Regulation for Nanotechnology Patentability** requirements-riding the patent office pony-infringement issues-nanotech patents outside the united states-copyright requirements-nanotech creation as artist Works-Delegation of power of Agencies-Examples of regulation of nanotechnology environmental regulations-regulation of exports-political and judicial control over agency action. The applications of civil &criminal laws-civil liability, Health and safety issues.
Module 2	Economic Impacts and Commercialization of Nanotechnology and Social Scenarios Introduction -Socio-Economic Impact of Nanoscale Science: Initial Results and Nanobank-Managing the Nanotechnology Revolution: Consider the Malcolm Baldrige National Quality Criteria -The Emerging NanoEconomy: Key Drivers, Challenges, and Opportunities-Transcending Moore's Law with Molecular

	Electronics and Nanotechnology- Navigating Nanotechnology Through Society - Nanotechnology, Surveillance, and Society: Methodological Issues and Innovations for Social Research-Nanotechnology: Societal Implications: Individual Perspectives Nanotechnology and Social Trends-Five Nanotech
Module 3	**Ethics, Law and Governance:** Ethics and Law-Ethical Issues in Nanoscience and Nanotechnology: Reflections and Suggestions-Ethics and Nano: A Survey-Law in a New Frontier- An Exploration of Patent Matters Associated with Nanotechnology - The Ethics of Ethics -Negotiations over Quality of Life in the Nanotechnology Initiative, Governance of Nanotechnology and problems.
Module 4	**Public Perceptions and Education** Public Perceptions-Societal Implications of Nanoscience: An Agenda for Public Interaction Research -Communicating Nano technological Risks- A Proposal to Advance Understanding of Nanotechnology's Social Impacts -Nanotechnology in the Media: A Preliminary Analysis-Public Engagement with Nanoscale Science and Engineering -Nanotechnology: Moving Beyond Risk-Communication Streams and Nanotechnology: The (Re)Interpretation of a New Technology-Nanotechnology: Societal Implications Nanotechnology.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Nanotechnology: Societal Implications II-Individual Perspectives	Mihail C Roco and William Sims	Springer	2007
2	Nanotechnology: Risk, Ethics and Law	Geoffrey Hunt and Michael D Mehta	James & James Publication	2006
3	Nanotechnology: Global Strategies, Industry Trends and Applications	Jurgen Schulte	Wiley & Sons LTD	2005
4	Environmental Nanotechnology applications and impact of nanomaterial	Mark R Weisner	The Mc Graw Hill	2007

Nanotechnology for Renewable Energy Materials (NREM)

COURSE CODE	23NS61E5	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the basic concepts of energy conversion systems.	3	PO-1
CO2	Appraise the working of fuel cells current status and future trends	3	PO-1
CO3	Apply the knowledge of photovoltaic cells and energy conversion systems to improve their performance.	3	PO-1
CO4	Apply the knowledge of photovoltaic systems to understand the working of Solar cells.	3	PO-1

Syllabus

Module 1	Fundamental Concepts in Electrochemistry Electrochemical Cell, Faraday's laws, Electrode Potentials, Thermodynamics of electrochemical cells, Polarization losses in electrochemical cells, Electrode process and kinetics, Electrical double layer, Photo-electrochemical cell, thermoelectric effect.
Module 2	Energy Conversion Systems Issues and Challenges of functional Nanostructured Materials for electrochemical Energy, Conversion Systems, Fuel Cells, Principles and nanomaterials design for; Proton exchange membrane fuel cells (PEMFC); Direct methanol fuel cells (DMFC); Solid-oxide fuel cells (SOFC), Current status and future trends
Module 3	Photovoltaic Systems Principles of photovoltaic energy conversion (PV), Types of photovoltaic Cells, Physics of photovoltaic cells, Organic photovoltaic cell cells, thin-film Dye-Sensitized Solar Cells, Quantum dot (QD) Sensitized Solar Cells

	(QD-SSC), Organic-Inorganic Hybrid Bulk Hetero junction (BHJ-SC) Solar cells, Current status and future trends
Module 4	Energy Storage System - Batteries Issues and Challenges of functional Nanostructured Materials for electrochemical Energy Storage Systems, Primary and Secondary Batteries (Lithium-ion Batteries), Cathode and anode materials, Nanostructured Carbon-based materials, Nano-Oxides, Novel hybrid electrode materials, Current status and future trends

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Nanofabrication and its Application in Renewable Energy	Gang Zhang; Navin Manjooran, Prof. Dr Gang Zhang	Royal Society of Chemistry	2014
2	Nanoenergy Nanotechnology Applied for Energy Production	Flavio Leandro de Souza, Edson Roberto Leite	Springer Berlin, Heidelberg	2013
3	Nanotechnology for Electronics, Photonics, and Renewable Energy	Anatoli Korkin, Predrag S. Krstić, Jack C. Wells	Springer New York, NY	2010

Nanotechnology in Health Care (NHSC)

COURSE CODE	23NS61E6	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	To be introduced to recent advancements in nano medicine.	3	PO-1
CO2	learn developments in nanostructured materials used for medical implants	3	PO-1
CO3	learn about nano diagnostics and understand the harmful effects of nanoparticles.	3	PO-1
CO4	understand need of nanotechnology in health care	3	PO-1

Syllabus

Module 1	Nano molecular Diagnostics - Array and Chips Introduction - Nano diagnostics - Rationale of Nanotechnology for Molecular Diagnostics -Nano arrays for Molecular Diagnostics. Nano ProTM System - Nano fluidic/Nano array Devices to Detect a Single Molecule of DNA-Self-Assembling Protein Nano arrays -Fullerene Photodetectors for Chemi-luminescence Detection on Micro Fluidic Chips - Nano bio chip Nanoparticles for Molecular Diagnostics -Gold Nanoparticles - Applications of Nano pore Technology for Molecular Diagnostics DNA–Protein and DNA–Nanoparticle Conjugates
Module 2	Nano machines and Nano barcodes, Nano biosensor :DNA Nano machines for Molecular Diagnostics -Nano barcodes Technology -Nano barcode Particle Technology for SNP Genotyping -Qdot Nano barcode for Multiplexed Gene Expression Profiling-Biobarcode Assay for Proteins Single-Molecule Barcoding

	System for DNA Analysis Nanoparticle-Based Colorimetric DNA Detection Method Cantilevers as Biosensors for Molecular .
Module 3	NANOPHARMACEUTICALS : Introduction -Nano-biotechnology for Drug Discovery -Gold Nanoparticles for Drug Discovery - Use of Quantum Dots for Drug Discovery –Nano-lasers for Drug Discovery -Cells Targeting by Nanoparticles with Attached Small Molecules -Role of AFM for Study of Bio-molecular Interactions for Drug Discovery Nanoscale Devices for Drug Discovery - Nanotechnology Enables Drug Design at Cellular Level Nano-biotechnology-Based Drug Development -Dendrimers as Drugs- Fullerenes as Drug Candidates -Nano-bodies Nano-biotechnology in Drug Delivery -Nanoscale Delivery of Therapeutics.
Module 4	Application in Cancer Therapy & Nano-medicine: Introduction and Rationale for Nanotechnology in Cancer Therapy - Passive Targeting of Solid Tumors: Pathophysiological Principles and Physicochemical Aspects of Delivery Systems -Active Targeting Strategies in Cancer with a Focus on\Potential Nanotechnology Applications-Pharmacokinetics of Nanocarrier-Mediated Drug and Gene Delivery - Multifunctional Nanoparticles for Cancer Therapy- Neutron Capture Therapy of Cancer

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	The Handbook of Nanomedicine"	Kewal. K, Jain,	Humana Press	2008
2	Nanomedicine: A Systems Engineering Approach	Zhang,	Pan Stanford Publishing,	2005.
3	.Nanomedicine Volume IIA: Biocompatibility	Robert. A, Freitas Jr.	Landes, Bioscience Publishers,	2000

Material Science and Engineering (MSE)

COURSE CODE	OENS0001	MODE	R	LTPS	2-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understands structure of crystalline solids, kinds of crystal imperfections and appreciates structure-property relationship in crystals.	2	PO-1
CO2	Understands spin and orbital motion of electrons in determining magnetic properties of materials and identifies their role in classification soft & hard magnetic materials having specific engineering applications.	2	PO-1
CO3	Understands role of molecular level vibrations in determining thermal properties of materials, heat treatment methods for changing the microstructure of materials and micro and macro level responses of materials subjected to load, for identification of materials having specific engineering applications.	2	PO-1
CO4	Understands the role of electronic energy band structures of solids in governing various electrical properties of materials.	2	PO-1

Syllabus

Module 1	**Crystallography:** Bonding in materials, Space lattice, basis, unit cell, Seven Crystal systems, Bravais lattice system, Reciprocal lattice, Crystal directions, Miller Indices, problems, Diffraction of Crystals, Bragg's Law, XRD, Laue, Rotating Crystal and powder XRD Techniques, Problems. **Crystal Imperfections:** Point Defects, Line Defects, Surface Defects, Volume

	Defects, and Effects of Defects on Crystalline Properties.
Module 2	**Magnetic properties:** Origin of Magnetic Moment, Dia, Para, Ferro, Antiferro and Ferri Magnetism, Domain theory and Hysteresis Effect of Ferro and Ferri Magnetism, Soft and Hard Magnetic Materials.
Module 3	**Thermal properties:** Iron-Carbon Diagram, Heat capacity, Thermal Expansion and Thermal Conductivity in Metals, Ceramics and Polymers, Heat treatment of Materials, Hardening, Tempering, Quenching and Nitriding. **Mechanical Properties:** Stress, Strain, Hooke's Law, Elasticity, Plasticity, Creep, Ductility, Brittle, Hardness, Strength, Modulus of Elasticity, Fracture, Fatigue, Stress- Strain Behavior of Ductile and Brittle Materials, Hardness Tests- Vickers, Rockwell and Brinell.
Module 4	**Electrical Properties:** Energy band theory, Band structures in Conductors, Semi conductors and Insulators, Electrical properties of conductors- Ohms, Mathiessen rule, conductivity, Mobility, Electrical properties of Semi conductors, Factors effecting the carrier concentration, Conductivity and Mobility of charge carriers. Electric properties of Insulator-Dielectrics- Types of Dielectrics, Dielectric Constant, Polarization, Types of Polarizations, Frequency Dependence of Polarization, Ferro, Piezo Electrics.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Materials Science and Engineering: An Introduction	William D. Callister,Jr.	Wiley India Pvt.Ltd. 6th edition	, 2007
2	*"Solid State Physics"*	Adrianus J. Dekker,	1st Edition Macmillan India Ltd.	2002
3	S"Solid state physics"	. O. Pillai,	Revised 6th edition, New Age International Publishers.	

Experimental Physics (EXP)

COURSE CODE	OENS0002	MODE		LTPS	2-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understanding the basic concepts, Background, scientific revolutions of nanoscience and technology and understanding multifunction materials.	2	PO-1
CO2	Apply the principles of different chemical routes to synthesis as per the required application and properties.	3	PO-1
CO3	Understanding the basic difference between nano and bulk materials properties.	2	PO-1
CO4	Apply the knowledge of structural characterization methods to analyse the performance of materials for required applications.	3	PO-1

Syllabus

Module 1	Basics of Nanoscience and Nanotechnology: Background to Nanoscience and Nanotechnology, Feynman predictions on Nanotechnology - scientific revolutions – nano sized effects- surface to volume ratio Nanoscience-Nanotechnology-Nano Materials-Nano composites- Multifunctional nano materials-definitions with examples, Definition of Nanotechnology.
Module 2	Physical and Chemical routes for synthesis of nanomaterials: Sol-gel method, Hydrothermal method, co–precipitation method and electrospinning method – thin film technique.
Module 3	Properties of Nanomaterials: Magnetic properties, electrical properties, mechanical properties and optical properties of nanomaterials.

Module 4	Structural Characterization methods: X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM) and EDAX analysis, Atomic force Microscopy (AFM), Scanning Probe Microscopy.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Nanostructures & Nanomaterials: Synthesis, Properties & Applications	G. Cao	Imperial College Press	2004
2	characterization of materials	Elton N. Kaufmann	Wiley Inter science	2003
3	Materials Characterization: Introduction to Microscopic and Spectroscopic Methods	Y. Leng	John Wiley & Sons (Asia)	2008