ALAGAPPA UNIVERSITY

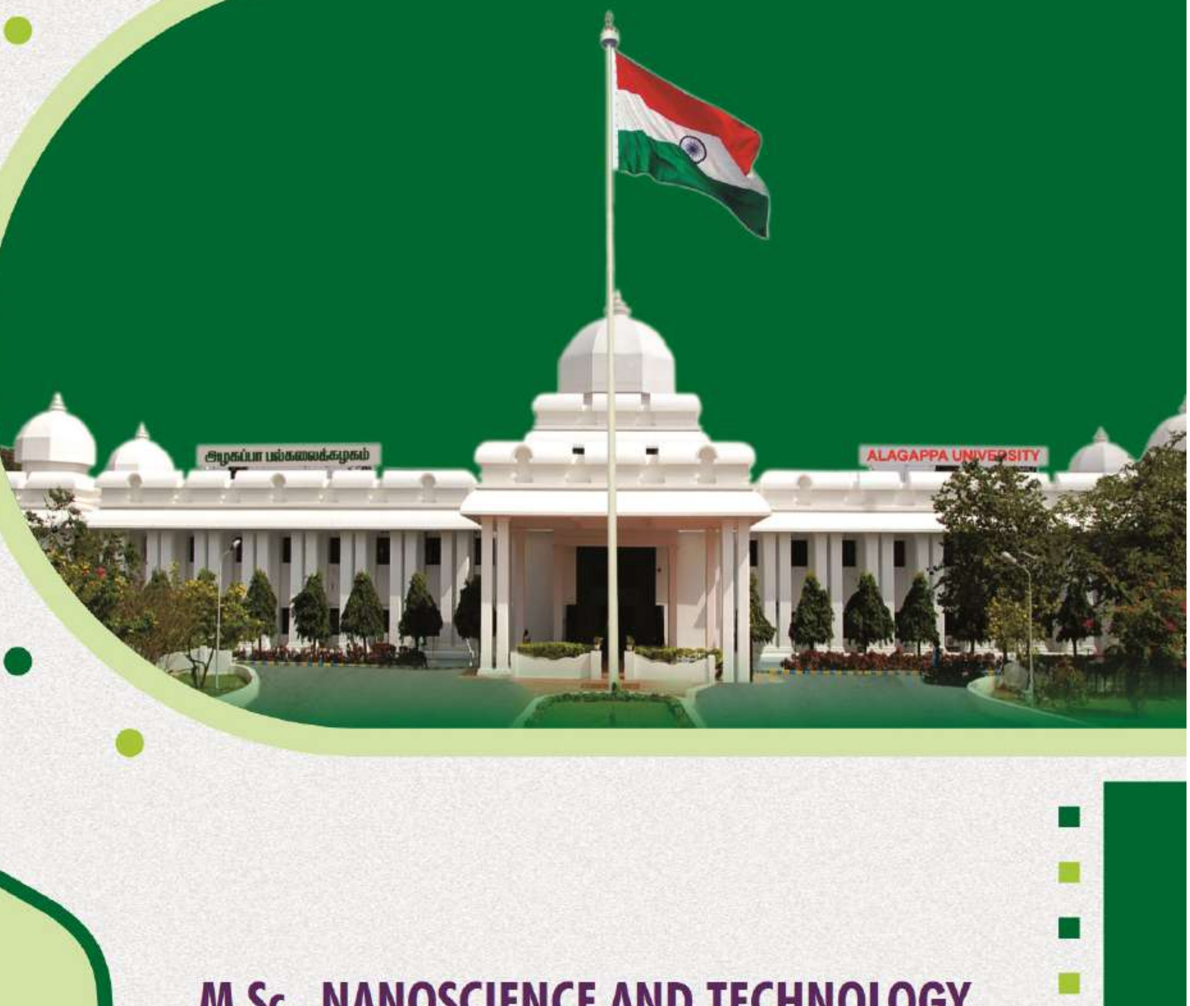
(A State University Established in 1985)

Karaikudi - 630003. Tamil Nadu, India

2017 Accredited with A+ Grade by NAAC (CGPA : 3.64) | 2018 MHRD Graded as Category - I Granted Autonomy | 2018 MHRD Swachh Campus Rank : 4 | 2021 nirf Rank : 33 | 2021 QS University Rankings Asia Rank : 199

FACULTY OF SCIENCE

DEPARTMENT OF NANOSCIENCE AND TECHNOLOGY



M.Sc., NANOSCIENCE AND TECHNOLOGY

REGULATIONS AND SYLLABUS

(For the candidates admitted from the
Academic Year 2022 - 2023)

DEPARTMENT OF NANOSCIENCE AND TECHNOLOGY
M.Sc., Nanoscience and Technology

REGULATIONS AND SYLLABUS
[For the candidates admitted from the Academic Year 2022 – 2023 onwards]

ALAGAPPA UNIVERSITY

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the Third Cycle and Graded as Category-I University by MHRD-UGC)
Karaikudi -630003, Tamil Nadu.

The panel of Members-Broad Based Board of Studies

Chairperson:

Name : Dr. K. Gurunathan,

Designation : Dean, Faculty of Science,

Department : Head, Department of Nanoscience & Technology,

University : Science campus, Alagappa University, Karaikudi-630003

Teaching Experience: 17, Research Experience: 34,

Area of Research: Hydrogen production, Nanomaterials, Gas sensors, Photocatalysis, Electrochemical sensing, Conducting Polymer Nanocomposites

Foreign Expert:

Name : Dr. M. Ashokkumar

Designation: Professor & Assistant Deputy Vice Chancellor International

Department : School of Chemistry

University : University of Melbourne, Australia

Teaching Experience: 25, Research Experience: 35,

Area of Research: The fundamental and applied aspects of acoustic cavitation, Hydrogen Energy, Photocatalysis

Indian Expert:

Name : Dr. R. Ilangovan

Designation : Professor

Department : National Centre for Nanoscience & Technology

University : University of Madras, Chennai

Teaching Experience:17, Research Experience: 25

Area of Research: Piezoelectric, Gas sensors

Indian Expert:

Name : Dr. G. Annadurai

Designation : Professor, Co-ordinator for UGC Innovative Programme in Nanoscience

Department : Department of Environmental Biotechnology

University : Sri Paramakalyani Centre for Excellence in Environmental Sciences

Teaching Experience: 18, Research Experience: 26

Area of Research: Nanoscience and Nanotechnology, Environmental Science, Adsorption Studies, Nanocomposite

Industry Expert:

Name : Dr. N. Anbananthan

Designation : Senior Vice President

Company name and address: Ion Exchange (INDIA) Ltd, Ion Hourse, Dr.E.Moses Road, Mahalakshmi Mumbai – 400 011, MH

Experience : 33

Area : Water treatment Industry, Petrochemical/Fertilizer Industry and Pharma Industry.

Members (All Department faculty)

Name : Dr. K. Gurunathan, Designation : Dean, Faculty of Science, Department : Head, Department of Nanoscience & Technology, University : Science campus, Alagappa University, Karaikudi-630003 Teaching Experience: 17, Research Experience: 34, Area of Research: Hydrogen production, Nanomaterials, Gas sensors, Photocatalysis, Electrochemical sensing, Conducting Polymer Nanocomposites	
Name : Dr. P. Shakkthivel Designation : Professor Department : Department of Nanoscience & Technology, University : Science campus, Alagappa University, Karaikudi Teaching Experience: 15, Research Experience: 23, Area of Research: Li-ion Batteries, Supercapacitor,Magnetic Nanoparticles & Targeted drug Delivery Modified electrodes & Bio-molecule diagnosis	
Name : Dr. C. Balalakshmi Designation : Assistant Professor Department : Department of Nanoscience & Technology, University : Science campus, Alagappa University, Karaikudi Teaching Experience: 6, Research Experience: 9, Area of Research: Nano marine biotechnology, Nano anti coating food packaging application, Nano medical biotechnology	
Name : Dr. G. Ramalingam Designation : Assistant Professor Department : Department of Nanoscience & Technology, University : Science campus, Alagappa University, Karaikudi Teaching Experience: 10, Research Experience: 10 Area of Research: Nanomaterials, QDs, Energy materials, Solar cell Environmental application	
Name : Dr. N. Suganthy Designation : Assistant Professor Department : Department of Nanoscience & Technology, University : Science campus, Alagappa University, Karaikudi Teaching Experience: 9, Research Experience: 11, Area of Research: Nanotoxicology, Nanopharmacology, Targeted drug delivery, MOF for biological applications	

Alumnus/Alumna: Name :Dr.T.M.Amarnath Current position : Guest Researcher Type of Profession: Guest Researcher Professional address: Department of Nanoscience & Technology, Science campus, Alagappa University, Karaikudi	

ALAGAPPA UNIVERSITY
DEPARTMENT OF NANOSCIENCE AND TECHNOLOGY
Karaikudi -630003, Tamil Nadu.

REGULATIONS AND SYLLABUS-(CBCS-University Department)
[For the candidates admitted from the Academic Year 2022 – 2023 onwards]

Name of the Department	**:** Nanoscience and Technology
Name of the Programme	: M.Sc., Nanoscience and Technology
Duration of the Programme	**:** Full Time (Two Years)

Choice-Based Credit System

A choice-Based Credit System is a flexible system of learning. This system allows students to gain knowledge at their own tempo. Students shall decide on electives from a wide range of elective courses offered by the University Departments in consultation with the Department committee. Students undergo additional courses and acquire more than the required numberof credits. They can also adopt an inter-disciplinary and intra-disciplinary approach to learning, and make the best use of the expertise of available faculty.

Programme

Programme" means a course of study leading to the award of a degree in a discipline.

Courses

'Course' is a component (a paper) of a programme. Each course offered by the Department is identified by a unique course code. A course contains lectures/ tutorials/laboratory /seminar/project / practical training/report writing /Viva-voce, etc or a combination of these, to meet effectively the teaching and learning needs.

Credits

The term "Credit" refers to the weightage given to a course, usually in relation to the instructional hours assigned to it. Normally in each of the courses credits will be assigned on the basis of the number of lectures/tutorial/laboratory and other forms of learning required to complete the course contents in a 15-week schedule. One credit is equal to one hour of lecture per week. For laboratory/field work one credit is equal to two hours.

Semesters

An Academic year is divided into two **Semesters.** In each semester, courses are offered in 15 teaching weeks and the remaining 5 weeks are to be utilized for conduct of examination and evaluation purposes. Each week has 30 working hours spread over 5 / 6 days a week.

Medium of Instruction

Medium of Instruction for the Programme is English

Departmental Committee

The Departmental Committee consists of the faculty of the Department. The Departmental Committee shall be responsible for admission to all the programmes offered by the Department including the conduct of entrance tests, verification of records, admission, and evaluation. The Departmental Committee determine the deliberation of courses and specifies the allocation of credits semester-wise and course-wise. For each course, it will also identify the number of credits for lectures, tutorials, practicals, seminars etc. The courses (Core/Discipline Specific Elective/Non-Major Elective) are designed by teachers and approved by the Departmental Committees. Courses approved by the Departmental Committees shall be approved by the Board of Studies/Broad Based Board of Studies. A teacher offering a course will also be responsible for maintaining attendance and performance sheets (CIA -I, CIA-II, assignments and seminar) of all the students registered for the course. The Non-major elective programme, MOOCs coordinator and Internship Mentor are responsible for submitting the performance sheet to the Head of the department. The Head of the Department consolidates all such performance sheets of courses pertaining to the programmes offered by the department. Then forward the same to be Controller of Examinations.

Programme Educational Objectives (PEO)

PEO-1	Excelling societal problem solving through miniaturization technologies by developing dynamic younger generations
PEO-2	Inculcating in-depth knowledge in basic science concepts
PEO-3	Concepts architecturing fundamental nanoscience and technology knowledge to develop novel nanomaterials
PEO-4	Developing innovative nano-products as a solution for industrial and real-life problems
PEO-5	Creating professionalism in fabrication of reliable and reproducible nanomaterials
PEO-6	Articulating skills in developing scientific content and sustainable team-work
PEO-7	Mastering experimental tools and techniques for analyzing nanomaterials
PEO-8	Interpreting experimental data for characterization and evaluation of nanomaterials
PEO-9	Contributing cost-effective, eco-friendly, societal need products for the betterment of environment
PEO-10	Associating various disciplines of industry and society for the socio-economic growth of the country

Programme Specific Objectives-(PSO)

PSO-1	To foster the transfer of new technologies and novel products particularly, atomically designed applications
PSO-2	To inculcate knowledge on novel strategies to synthesis nanomaterials effectively and their specialized application.
PSO-3	To provide insight on green chemistry and Biomimicry
PSO-4	To provide in depth knowledge on electronic, energy and medical devices
PSO-5	To provide exposure on designing nanomaterials for specific applications

Programme Outcomes-(PO)

PO-1	Expertize in the use of advanced nanoscience and technology in various applications.	**Knowledge**
PO-2	Bridging the basic science knowledge in the field of nanoscience.	
PO-3	Capable of designing nanomaterials with various dimensions.	
PO-4	Proficient in developing innovative nano-products for day-to-day life	
PO-5	Ability to innovate traditional research to advanced cutting edge technologies for device development	**Skill**
PO-6	Able to comprehend scientific ideas, design and documentation	
PO-7	Capable to use modern techniques and research tools for nanomaterials characterisation	
PO-8	Acquiring skills in computing the analytical data	
PO-9	Entrepreneur in developing nano-engineering materials for social needs	**Attitude**
PO-10	Develop industry-institute linkage to enhance service to society	

Programme Specific Outcomes- (PSO)

PSO- 1	Nano-engineered advanced techniques for the fabrication of Next-generation energy storage devices	**Knowledge**
PSO-2	Fabrication of nanomaterials for biomedical and sensor applications	
PSO-3	Biologically-derived greener nanomaterials for drug-delivery applications	**Skill**
PSO-4	Acquiring skills in the energy harvesting, storage of large-scale fabrication	
PSO-5	Introducing start-ups in the field of renewable energy, bio-medical and sensing applications	**Attitude**

Eligibility for admission

A candidate who has passed B.Sc., Degree Examination with Mathematics, Physics, Chemistry and Biology as main subject of study of any university or any of the B.Sc., degree examination with specialization such as Mathematics, Applied Mathematics, Applied Physics, Electronics, Nuclear Physics, Biophysics, Industrial chemistry, Polymer Chemistry, Applied Chemistry, Pharmaceutical Chemistry, Biotechnology, Nanoscience, Nanobiotechnology, Biochemistry and Micro-biology or any other specialization in Mathematics, Physics, Chemistry and Biology and B.E/B.Tech in ECE,EEE, Chemical Engg., Petrochemical Engg., Mater.Sci. & Engg., Nanotechnology, Biotechnology and Bioinformatics of some other university accepted by the syndicate as equivalent thereto, subject to such condition as may be prescribed therefore shall be permitted to appear and qualify for the M.Sc. Degree in Nanoscience and Technology of this University after a course of study of two academic years.

Minimum Duration of Programme

The programme is for a period of two years. Each year shall consist of two semesters viz. Odd and Even semesters. Odd semesters shall be from June / July to October / November and even semesters shall be from November / December to April / May. Each semester there shall be not less than 90 working days consisting of 5 teaching hours per working day which shall comprise 450 teaching clock hours for each semester (exclusive of the days for the conduct of the University end- semester examination).

Components

A PG programme consists of a number of courses. The term “course” is applied to indicate a logicalpart of the subject matter of the programme and is invariably equivalent to the subject matter of a “paper” in the conventional sense. The following are the various categories of the courses suggestedfor the PG programmes:

A. Core courses (CC)- “Core Papers” means “the core courses” related to the programme concerned including practicals and project work offered under the programme and shall cover core competency, critical thinking, analytical reasoning, and research skill.

B. Discipline-Specific Electives (DSE) means the courses offered under the programme relatedto the major but are to be selected by the students, shall cover additional academic knowledge, critical thinking, and analytical reasoning.

C. Non-Major Electives (NME)- Exposure beyond the discipline

- All PG programme students have to undergo a total of two Non Major Elective courses with 2 credits offered by other departments (one in II Semester another in III Semester).
- A uniform time frame of 3 hours on a common day (Tuesday) shall be allocated for the Non-Major Electives.

- Non Major Elective courses offered by the departments pertaining to a semester should be announced before the end of previous semester and the same shall be submitted to the Curriculum Design and Development Cell and posted in the University websites.
- Registration process: Students have to register for the Non-Major Elective course within 15 days from the commencement of the semester either in the department or online. The list of registered candidates shall be submitted to Director, Curriculum Design and Development Cell.

D. Self Learning Courses from MOOCs platforms.

- MOOCs shall be on voluntary for the students.
- All PG programmes students have to undergo a total of 2 Self Learning Courses (MOOCs) one in II semester and another in III semester.
- The actual credits earned through MOOCs shall be transferred to the credit plan of programmes as extra credits.
- If the Self Learning Course (MOOCs) is without credit, 2 credits/course be given and transferred as extra credit
- While selecting the MOOCs, preference shall be given to the course related to employability skills.

E. Projects / Dissertation /Internships (Maximum Marks: 200**)**

The duration of the Project/Dissertation/internship shall be a minimum of three months in the fourth semester.

- **Plan of work**

Project/Dissertation

The candidate shall undergo Project/Dissertation Work during the final semester. The candidate should prepare a scheme of work for the dissertation/project and should get approval from the guide. The candidate, after completing the dissertation /project work, shall be allowed to submit it to the university departments at the end of the finalsemester. If the candidate is desirous of availing the facility from other departments/universities/laboratories/organizations they will be permitted only after getting approval from the guide and HOD. In such a case, the candidate shall acknowledge the same in their dissertation/project work.

Internship

The students who have opted for an Internship must undergo industrial training in the reputed organizations to accrue industrial knowledge in the final semester. The student has to find industry related to their discipline (Public limited/Private Limited/owner/NGOs etc.,) in consultation with the faculty in charge/Mentor and get approval from the head of the department and Departmental Committee before going for an internship.

- **No. of copies of the dissertation/project report/internship report**

The candidate should prepare three copies of the dissertation/project/report and submit the same for the evaluation of examiners. After evaluation, one copy will be retained in the department library, one copy will be retained by the guide and the student shall hold one copy.

- **Format to be followed for dissertation/project report**

The format /certificate for thesis to be followed by the student are given below

- Title page
- Certificate
- Acknowledgment
- Content as follows:

Chapter No	Title	Page number
1	Introduction	
2	Aim and objectives	
3	Review of literature	
4	Materials and methods	
5	Result	
6	Discussion	
7	Summary	
8	References	

- **Format of the title page**

Title of Dissertation/Project work

Dissertation/Project submitted in partial fulfilment of the requirement for the degree of Master of Science to the Alagappa University, Karaikudi -630003.

By

(Student Name)

(Register Number)

University Logo

Department of ---

Alagappa University

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the Third Cycle and Graded as Category-I University by MHRD-UGC, 2019: QS ASIA Rank-216, QS BRICS Rank-104,QS India Rank-20)

Karaikudi - 630003

(Year)

- **Format of certificates**

Certificate -Guide

This is to certify that the **Dissertation/Project** entitled "---" submitted to Alagappa University, Karaikudi-630 003 in partial fulfilment for the degree of Master of Science in ----------- by Mr/Mis ---------------------(Reg No---------------)under my supervision. This is based on the results of studies carried out by him/her in the Department of--------------------------, Alagappa University, Karaikudi-630 003. This dissertation/Project or any part of this work has not been submitted elsewhere for any other degree, diploma, fellowship, or any other similar titles or record of any University or Institution.

Place: Date:

Karaikudi Research Supervisor

Certificate - (HOD)

This is to certify that the thesis entitled **"---------------- "** submitted by Mr/Mis -----------------(Reg No: --------------) to the Alagappa University, inpartial fulfilment for the award of the degree of Master of --------in is a bonafide record of research work done under the supervision of Dr.------------------, AssistantProfessor, Department of ---------- , Alagappa University. This is to further certify that the thesis or any part thereof has not formed the basis of the award to the student of anydegree, diploma, fellowship, or any other similar title of any University or Institution.

Place: Karaikudi Head of the Department

Date:

Declaration (student)

I hereby declare that the dissertation entitled **"--------------- "** submitted to the Alagappa University for the award of the degree of Master of -------- in ------has been carried out by me under the guidance of Dr. **-----------------**, Assistant Professor, Department of , Alagappa University, Karaikudi – 630 003. This is my original and independent work and has not previously formed the basis of the award of any degree, diploma, associateship, fellowship, or any other similar title of any University or Institution.

Place: Karaikudi **(--------------)**

Date:

Internship

- **Format to be followed for Internship report**

The format /certificate for internship report to be followed by the student are given below

- Title page -**Format of the title page**

Title of internship report

Internship report submitted in partial fulfilment of the requirement for the Master of degree in to the Alagappa University, Karaikudi -630003.

By (Student Name)

(Register Number)

University Logo

Department of ---

Alagappa University

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the Third Cycle and Graded as Category-I University by MHRD-UGC, 2019: QS ASIA Rank-216, QS BRICS Rank-104,QS India Rank-20)

Karaikudi – 630003

(Year)

- Certificate-(**Format of certificate – faculty in-charge)**

This is to certify that the report entitled "---------------- " submitted to Alagappa University, Karaikudi-630 003 in partial fulfilment for the Master ofScience in ----------- by Mr/Mis------------ (Reg No) under my supervision. This is based on the work carried out by him/her in the organization M/S --. This Internship report or any part of this work has not been submitted elsewhere for any otherdegree, diploma, fellowship, or any other similar record of any University or Institution.

Place: Research Supervisor

Date:_

<u>Certificate (HOD)</u>

This is to certify that the Internship report entitled **"**---------------- **"** submitted by Mr/Mis**.-----------------(Reg No)** to the Alagappa University, in partial fulfilment for the award of the Master of Science in **-------** is a bonafide record of Internship report done under the supervision of , Assistant Professor, Department of ----------------------, Alagappa University and the work carried out by him/her in the organization M/S -------------------------. This is to further certify that the thesis or any part thereof has not formed the basis of the award to the student of any degree, diploma, fellowship, or any other similar title of any University or Institution.

Place: Karaikudi

Date:

Declaration (student)

I hereby declare that the Internship Report entitled "__________" submitted to the Alagappa University for the award of the **Master of Science in** has been carried out by me under the supervision of , Assistant Professor, Department of------------------------, Alagappa University, Karaikudi – 630 003. This is my original and independent work carried out by me in the organization M/S ------------------------- for theperiod of three months or and has not previously formed the basis of the award of any degree, diploma, associateship, fellowship, or any other similar title of any University orInstitution.

Place: Karaikudi Head of the Department
Date:
(--------------)

- Certificate-(**Format of certificate – Company supervisor or Head of the Organization)**

  This is to certify that the Internship report entitled "--" submitted to Alagappa University, Karaikudi-630 003 in partial fulfilment for the Master of Science in ----------------------by Mr/Mis------------ (Reg No:------------) under my supervision. This is based on the work carried out by him/her in our organization M/S ---------for the period of three months or ------. This Internship report or any part of this work has not been submitted elsewhere for any other degree, diploma, fellowship, or any other similar record of any University or Institution.

Place:
Date: Supervisor or in charge

- Acknowledgment
- Content as follows

Chapter No	**Title**	**Page number**
1	Introduction	
2	Aim and objectives	
3	Organization profile /details	
4	Methods / Work	
5	Observation and knowledge gained	
6	Summary and outcome of the Internship study	
7	References	

Teaching methods:

The classroom teaching would be through conventional lectures and use of OHP and Power Point presentations. The lecture would be such that the student should participate actively in the discussion. Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skill.

In the laboratory, instruction would be given for the experiments followed by demonstration and finally the students have to do the experiments individually.

Periodic tests would be conducted and for the students of slow learners would be given special attention.

Attendance

Students must have earned 75% of attendance in each course for appearing for the examination. Students who have earned 74% to 70% of attendance need to apply for condonation in the prescribed form with the prescribed fee. Students who have earned 69% to 60% of attendance need to apply for condonation in the prescribed form with the prescribed fee along with the Medical Certificate. Students who have below 60% of attendance are not eligible to appear for the End Semester Examination (ESE). They shall re-do the semester(s) after completion of the programme

Examination

The examinations shall be conducted separately for theory and practical's to assess (remembering, understanding, applying, analysing, evaluating, and creating) the knowledge required during the study. There shall be two systems of examinations viz., internal and external examinations. The internal examinations shall be conducted as Continuous Internal Assessment tests I and II (CIA Test I & II).

Internal Assessment

The internal assessment shall comprise a maximum of 25 marks for each subject. The following procedure shall be followed for awarding internal marks.

Theory -25 marks

Sr.No	**Content**	**Marks**
1	Average marks of two CIA test	15
2	Seminar/group discussion/quiz	5
3	Assignment/field trip report/case study report	5
Total		**25 Marks**

Practical -25 Marks

Sr.No	**Content**	**Marks**
1	Major Experiment	10 marks
2	Minor Experiment	5 marks
3	Spotter (2x 5/ 4 x4) or any other mode	10 marks
Total		**25 Marks**

Project/Dissertation/internship-50 Marks (assess by Guide/incharge/HOD/supervisor)

Sr.No	**Content**	**Marks**
1	Two presentations (mid-term)	30 Marks
2	Progress report	20 Marks
Total		**50 Marks**

External Examination

- There shall be examinations at the end of each semester, for odd semesters in the month of October / November; for even semesters in April / May.
- A candidate who does not pass the examination in any course(s) may be permitted to appear in such failed course(s) in the subsequent examinations to be held in October / November or April / May. However, candidates who have arrears in Practical shall be permitted to take their arrear Practical examination only along with Regular Practical examination in the respective semester.
- A candidate should get registered for the first semester examination. If registration is not possible owing to shortage of attendance beyond condonation limit / regulation prescribed OR belated joining OR on medical grounds, the candidates are permitted to move to the next semester. Such candidates shall re-do the missed semester after completion of the programme.
- For the Project Report/ Dissertation Work / internship the maximum marks will be 100 marks for project report evaluation and for the Viva-Voce it is 50 marks (if in some programmes, if the project is equivalent to more than one course, the project marks would be in proportion to the number of equivalent courses).
- Viva-Voce: Each candidate shall be required to appear for Viva-Voce Examination (in defense of the Dissertation Work /Project/ internship).

Scheme of External Examination (Question Paper Pattern)

Theory - Maximum 75 Marks

Section A	10 questions. All questions carry equal marks. (Objective type questions).	10 x 1 = 10 Marks	10 questions – 2 each from every unit
Section B	5 questions Either / or type like 1.a (or) b. All questions carry equal marks.	5 x 5 = 25 Marks	5 questions – 1 each from every unit
Section C	5 questions Either / or type like 1.a (or) b. All questions carry equal marks	5 x8 = 40 Marks	5 question –1 each from every unit

Practical –Maximum 75 Marks

Section A	Major experiment	15 Marks
Section B	Minor experiment	10 Marks
Section C	Experimental setup	5 Marks
Section D	Spotters (5 x 5 marks)	25 Marks
Section E	Record note	10 Marks
Section F	Vivo voce	10 Marks

Dissertation /Project report/Internship report Scheme of evaluation

Dissertation /Project report/Internship report	100 Marks
Vivo voce	50 Marks

Results

The results of all the examinations will be published through the Department where thestudent underwent the course as well as through University Website.

Passing minimum

- A candidate shall be declared to have passed in each course if he/she secures not less than 40% marks in the End Semester Examinations and 40% marks in the Internal Assessment and not less than 50% in the aggregate, taking Continuous assessment and End Semester Examinations marks together.
- The candidates not obtained 50% in the Internal Assessment are permitted to improve their Internal Assessment marks in the subsequent semesters (2 chances will be given) by writing the CIA tests and by submitting assignments.
- Candidates, who have secured the pass marks in the End-Semester Examination and in the CIA but failed to secure the aggregate minimum pass mark (E.S.E + C I.A), are permitted to improve their Internal Assessment mark in the following semester and/or in University examinations.
- A candidate shall be declared to have passed in the Project / Dissertation / Internship if he /she gets not less than 40% in each of the Project / Dissertation / Internship Report and Viva-Voce and not less than 50% in the aggregate of both the marks for Project Report and Viva-Voce.
- A candidate who gets less than 50% in the Project / Dissertation / Internship Report must resubmit the thesis. Such candidates need to take again the Viva-Voce on the resubmitted Project report.

Grading of the Courses

Once the marks of the CIA and ESE for each of the courses are available, they will be added.The marks, thus obtained will then be graded as per the scheme provided in the following.

MARKS	GRADE POINT	LETTER GRADE
96 and above	**10**	**S+**
91 – 95	**9.5**	**S**
86 – 90	**9.0**	**D++**
81 – 85	**8.5**	**D+**
76 – 80	**8.0**	**D**
71 – 75	**7.5**	**A++**
66 – 70	**7.0**	**A+**
61 – 65	**6.5**	**A**
56 – 60	**6.0**	**B**
50 – 55	**5.5**	**C**
Below 50	**0**	**RA**

From the second semester onwards the total performance within a semester and continuous performance starting from the first semester are indicated respectively by **Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA).** These two are calculatedby the following formulate

$$\text{GPA} = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

Where '**Ci**' is the Credit earned for Course i in any semester; '**Gi'** is the Grade Point obtained by the student for Course i and 'n' is the number of Courses **passed** in that semester.

CGPA (Cumulative Grade Point Average) = Average Grade Point of all the Courses passed starting from the first semester to the current semester.

Classification of the successful candidate

A candidate who secured not less than 60% of the aggregate marks in the whole examination shall be declared to have passed the examination in First class. All other successful candidates shall be declared to have passed in the Second class. The candidate who obtains 76% of marks in the aggregate shall be deemed to have passed the examination in first class with distinction provided they should have passed all the examinations at the first appearance.Candidates who passed all the examinations prescribed for the course in the first instance and within two academic years from the year of admission to the course are alone eligible for university ranking.

A candidate is deemed to have secured the first rank provided if he/she should have passed all the papers in the first attempt itself and should have secured the highest Cumulative grade point average (CGPA).

Each student should have taken --- credits as a core course**, -- credits as a major elective; --- credits as non-major elective, ---- credits as dissertation / project work / internship, in addition, MOOCs courses as extra credits, thus totaling at least 90 credits are required to complete PG degree programme.**

Classification of the final result

The final result of the candidate shall be based only on the CGPA earned by the candidate.

a) Successful candidates passing the examinations and earning CGPA between 6.01 and 7.50 shall be declared to have passed in First Class and those who earned CGPA between 5.00 and 6.00 shall be declared to have passed in Second Class.
b) Candidates earning CGPA between 7.51 and 9.00 in the first appearance within the prescribed duration of the programme shall be declared to have passed in First Class with Distinction and those who earned CGPA 9.01 and above in the first appearance within the prescribed duration of the programme shall be declared to have passed in First Class – Exemplary in the respective Programmes.
c) Absence from an examination shall not be taken as an attempt.

Final result

CGPA	Letter Grade	Classification of Final Results
9.51 and above	**S+**	First class – Exemplary
9.01 – 9.50	**S**	
8.50 – 9.00	**D++**	First class – Distinction
8.01 – 8.50	**D+**	
7.50 – 8.00	**D**	
7.01 – 7.50	**A++**	First Class
6.51 – 7.00	**A+**	
6.01 – 6.50	**A**	
5.51 – 6.00	**B**	Second Class
5.00 – 5.50	**C**	
Below 5.00	**RA**	Reappear

Maximum duration of the completion of the programme

The maximum period for completion of M.Sc., programme in shall not exceed eight semesters continuing from the first semester.

Conferment of the Master's Degree

A candidate shall be eligible for the conferment of the Degree only after he/ she has earned the minimum required credits for the Programme prescribed therefor (i.e. 90 credits). Programme).

Village Extension Programme

The Sivaganga and Ramnad districts are very backward districts where a majority of people Lives in poverty. The rural mass is economically and educationally backward. Thus the aimof the introduction of this Village Extension Programme is to extend out to reach environmental awareness, social activities, hygiene, and health to the rural people of this region. The students in their third semester have to visit any one of the adopted villages within the jurisdiction of Alagappa University and can arrange various programs to educate the rural mass in the following areas for three day based on the theme.1. Environmental awareness 2. Hygiene and Health. A minimum of two faculty members can accompany the students and guide them.

M.Sc., Nanoscience and Technology

Programme structure

S. No	Course Code	Core	Title of the paper	T/P	Credits	Hours/ Week	Marks		
I Semester							**I**	**E**	**Total**
1	533101	Core 1	Introduction to Quantum Physics	T	4	4	25	75	100
2	533102	Core 2	Basics of Materials Science	T	5	5	25	75	100
3	533103	Core 3	Basic Biotechnology	T	4	4	25	75	100
4	533104	Core 4	Introduction to Nanoscience	T	4	4	25	75	100
5	533107	Core 5	Nano Science and Technology Lab-I (Nanophysics Experiments)	P	4	8	25	75	100
6	533501/ 533502	DSE*1	Thin Film Technology and Characteristics/ Condensed Matter Physics	T	3	3	25	75	100
			Library / Yoga/ counseling/Field trip	-	-	2	-	-	-
					24	**30**	**150**	**450**	**600**
II Semester									
7	533201	Core 6	Synthesis of Nanomaterials	T	5	5	25	75	100
8	533202	Core 7	Characterization of Nanomaterials	T	4	4	25	75	100
9	533203	Core 8	Applications of Nanomaterials	T	5	5	25	75	100
10	533207	Core 9	Nano Science and Technology Lab – II (Nano-chemistry Experiments)	P	5	10	25	75	100
11	533503/ 533504	DSE*2	Information Storage Materials and Devices/ Computer Simulation and Modelling	T	3	3	25	75	100
12	-	NME	Non-Major Elective**	T	2	3	25	75	100
13			Self-learning course (SLC) –MOOCs***	-	Extra credit				
					24	**30**	**175**	**525**	**700**
III Semester									
14	533301	Core 10	Nano Biotechnology and Nano Medicine	T	4	4	25	75	100
15	533302	Core 11	Nanoelectronics and Nanodevice	T	4	4	25	75	100
16	533303	Core 12	Nanoengineering	T	4	4	25	75	100
17	533304	Core 13	Microsystem Technology	T	4	4	25	75	100
18	533307	Core 14	Nano Science and Technology Lab –III (Nano-biotechnology Experiments)	P	4	8	25	75	100
19	533505/ 533506	DSE*3	Polymer Nanocomposites / Nanobiomaterials and Nanobiotechnology for Tissue Engineering	T	3	3	25	75	100
20	-	NME	Non-Major Elective**	T	2	3	25	75	100
21	-		Self-learning course (SLC) –MOOCs***	---	Extra credit				
					25	**30**	**175**	**525**	**700**
IV Semester									
22	533401	Core 15	Nanotoxicology	T	4	4	25	75	100
23	533999	Core 16	****Dissertation Work or Internship Programme	P	13	26	50	150	200
					17	**30**	**50**	**150**	**200**
Total					**90**	**120**	**550**	**1650**	**2200**

Discipline Specific Elective Courses (DSE)								
1	533501	Thin Film Technologies and Characteristics	3	3	25	75	100
2	533502	Condensed Matter Physics	3	3	25	75	100
3	533503	Information Storage Materials and Devices	3	3	25	75	100
4	533504	Computer Simulation and Modelling	3	3	25	75	100
5	533505	Polymer Nanocomposites	3	3	25	75	100
6	533506	Nanobiomaterials and nano biotechnology fortissue engineering	3	3	25	75	100

Non-Major Elective Courses (NME)**							
1.	-	Introduction to Nano Scale in Science andTechnology	2	3	25	75	100
2.	-	Nanotechnology and Advanced drug deliverySystem	2	3	25	75	100

*DSE – Discipline Specific Elective -Student Choice and it may be conducted by parallel sections.
** NME –Non Major Elective -Student have to select courses offered by other (Faculty) departments.
*** SLC- Self Learning Courses -Voluntary basis
**** Dissertation / internship report –Marks -Vivo-voce (50) + thesis (100) + internal (50) =200

T-Theory
P-Practical

<table>
<tr><td colspan="7">Semester - I</td></tr>
<tr><td>Core</td><td>Course code 533101</td><td colspan="2">Introduction to Quantum Physics</td><td>T</td><td>Credits: 4</td><td>Hours: 4</td></tr>
<tr><td colspan="7">Unit –I</td></tr>
<tr><td>Objective 1</td><td colspan="6">To achieve an understanding of the theory of quantum mechanics, and an ability to apply the quantum theory to important physical systems</td></tr>
<tr><td colspan="7">Vector & Special Function: Vector space, linear transformation - Inverse transformation, - Determination of Eigen values and Eigen vectors. Beta and Gamma functions, Legender's, Hermite and Laguerre polynomials and Bessel functions.</td></tr>
<tr><td>Outcome 1</td><td colspan="5">The students should be able to understand the basic and advanced concepts to analyze the Quantum Mechanics and mathematical physics.</td><td>K2</td></tr>
<tr><td colspan="7">Unit-II</td></tr>
<tr><td>Objective 2</td><td colspan="6">To make them understand the basis and basics of Quantum Mechanics</td></tr>
<tr><td colspan="7">The Physical Basis of Quantum Mechanics: - Limitation of classical physics – Plank's Quantum hypothesis- Einstein's Photoelectric effect- wave nature of particle Wave-particle duality, Schrödinger time depended independent wave equations and expectation values, Uncertainty principle.</td></tr>
<tr><td>Outcome 2</td><td colspan="5">Scientifically improvement of new applications of quantum physics in computation</td><td>K2</td></tr>
<tr><td colspan="7">Unit III</td></tr>
<tr><td>Objective 3</td><td colspan="6">To teach the theoretical and conceptual aspects of Quantum tunneling</td></tr>
<tr><td colspan="7">Bound States & Quantum Tunneling: - Free particle - Momentum eigen functions, Energy levels of a particle – Infinite square well in one(1D), two (2D), and three dimensions(3D) - Density of states – Confined carriers - Electron wave propagation in devices - Quantum confinement - Penetration of a barrier – Tunnel effect.</td></tr>
<tr><td>Outcome 3</td><td colspan="5">Students understand the necessity for quantum methods in the analysis of physical systems of atomic and solid-state physics.</td><td>K3</td></tr>
<tr><td colspan="7">Unit IV</td></tr>
<tr><td>Objective 4</td><td colspan="6">To introduce the optical behavior of quantum particles and the various effects associated with it</td></tr>
<tr><td colspan="7">Optical properties and interactions of nanoscale materials: - Size-dependent optical properties: Absorption and emission, Basic quantum mechanics of linear optical transitions, General concept of excitons, Wannier excitons, Size effects in high-dielectric-constant materials, Size effects in Π-conjugated systems, strongly interacting Π -conjugated systems: A molecular dimer, Size-dependent electromagnetic interactions: Particle–particle Forster resonant energy transfer (FRET).</td></tr>
<tr><td>Outcome 4</td><td colspan="5">Student analyze able to interpret certain basic and fundamental behavior of quantum particles</td><td>K5</td></tr>
<tr><td colspan="7">Unit V</td></tr>
<tr><td>Objective 5</td><td colspan="6">To become aware of the necessity for quantum methods in the analysis of physical systems of atomic and solid-state physics</td></tr>
<tr><td colspan="7">Semiconductor Band-Gap Engineering: - Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level and quasi-Fermi levels, p-n junctions, Schottky junction and Ohmic contacts. Semiconductor optoelectronic materials, Bandgap modification.</td></tr>
</table>

Outcome 5	**Student have opportunity to create the applications of quantum mechanics in physics, engineering, and related fields**	**K3**

Suggested Readings:-

Vaughn, M. T. (2008). *Introduction to mathematical physics*. Weinheim: Wiley-VCH.
Aruldhass. G(2004), Quantum Mechanics**,** Printice hall of India Pvt Ltd. New Delhi.
Dass, H. K., & Bhārmā, R. (2015). *Mathematical Physics:* Rama Nagar, New Delhi: S. Chand & Company Pvt.
Griffiths, D. J. (2017). *Introduction to quantum mechanics*. Cambridge: Cambridge University Press.
Bhattacharya, P. (2009). *Semiconductor optoelectronic devices*. New Delhi: Prentice Hall India.
Vaughn, M. T. (2008). *Introduction to mathematical physics*. Weinheim: Wiley-VCH.
Tsurumi, T. (2010). *Nanoscale physics for materials science*. Boca Raton, FL: CRC Press.
Singh, J. (1995). *Semiconductor optoelectronics: Physics and technology*. New York: McGraw-Hill.

Online Resources

https://epgp.inflibnet.ac.in/view_search.php?&category=19026&ft=et
http://simons.hec.utah.edu/NewUndergradBook/Chapter1.pdf
https://epgp.inflibnet.ac.in/view_f.php?category=1852
https://www.cl.cam.ac.uk/teaching/0910/QuantComp/notes.pdf
https://indico.cern.ch/event/870515/attachments/2217802/3755127/HGrayQCLecture1.pdf

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course designed by **Dr. G. Ramalingam, Assistant Professor**

Course Outcome Vs Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	L(1)	M(2)	S(3)	M(2)	S(3)	L(1)	S(3)	M(2)	L(1)
CO2	S(3)	S(3)	M(2)	L(1)	S(3)	M(2)	M(2)	S(3)	S(3)	S(3)
CO3	L(1)	S(3)	M(2)	S(3)	M(2)	L(1)	L(1)	S(3)	M(2)	L(1)
CO4	S(3)	M(2)	S(3)	S(3)	L(1)	S(3)	M(2)	S(3)	M(2)	(-)
CO5	M(2)	S(3)	L(1)	M(2)	M(2)	S(3)	M(2)	M(2)	M(2)	-
W.AV	2.2	2.4	2	2.4	2	2.4	2	2.8	2.2	1

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	L(1)	L(1)	M(2)	L(1)	L(1)
CO2	L(1)	M(2)	L(1)	M(2)	S(3)
CO3	M(2)	M(2)	S(3)	M(2)	L(1)
CO4	M(2)	S(3)	-	L(1)	L(1)
CO5	S(3)	L(1)	L(1)	L(1)	-
W.AV	1.8	1.8	1.4	1.4	1.2

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester – I</td></tr>
<tr><td>Core</td><td>Course code 533102</td><td>Basics of Materials Science</td><td>T</td><td>Credits: 5</td><td>Hours: 5</td></tr>
<tr><td colspan="6">Unit - I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To make the student understand the crystal structure arrangement</td></tr>
<tr><td colspan="6">Crystal Symmetry and Structure Determination: - The Growth and form of crystal - Crystal system - Space lattices and Unit cell - Crystal Symmetry-planes and Miller indices – Statistical thermodynamic of crystals - symmetry distribution of crystals – Scherrer's equation-crystalline size determination -Imperfections in Crystal-Schottky and Frenkel defects.</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Understanding the crystallite basics and defective structures</td><td>K1</td></tr>
<tr><td colspan="6">Unit-II</td></tr>
<tr><td>Objective 2</td><td colspan="5">To make them understand the various physical and chemical properties of solid materials</td></tr>
<tr><td colspan="6">Structure of Solids: - The crystalline - Noncrystalline states – Classification of Solids – Amorphous Solids, Crystalline Solids – Properties of Solids - Mechanical properties, Electrical properties, Optical Properties, Magnetic properties , Energy Bonding Structures in solid, low energy excitations: phonons, plasmons, Magnons, Polarons, Polaritons-Inorganic solids-Covalent solids, Metal and alloys, Ionic solids, Molecular solids, Structure of silica and silicates.</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Familiarize with various solid structures and physical properties</td><td>K2</td></tr>
<tr><td colspan="6">Unit - III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To acquire basic principles of Metals, Semiconductors and their functionalities</td></tr>
<tr><td colspan="6">Metals, Semiconductors and Dielectric materials: - Metals - Atomic Structure - physical and electronic properties, thermal conductivity - Electrical conductivity, non-metals - Semiconductors - energy gap in solids – band structures-excitons, types of Semiconductors, Semiconductor devices.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Capable to distinguish the materials in term of energy bonds</td><td>K4</td></tr>
<tr><td colspan="6">Unit - IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">To facilitate the students to obtain polymeric materials characteristics.</td></tr>
<tr><td colspan="6">Polymeric materials: - Polymeric Materials - Electrical Properties of Polymers - Classification of polymers – Polymer Crystallinity - Mechanical-Dynamic-Tensile – Flexural properties, Heat-thermal – Gas barrier – ionic conductivity - optical transparency - Biodegradability behavior, structure of long chain polymers, Crystallinity of long chain polymers. Stress strain behavior – macroscopic deformation - viscoelastic deformation – deformation of semi crystalline polymers</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Remembering the of polymers physical chemical and bio degradable properties</td><td>K2</td></tr>
</table>

Unit - V		
Objective 5	**To obtain the knowledge on important defects in the materials**	
Crystals and defects: - Defects in solid structures – point defects – extended defects – Planar Defects – dislocations – grain boundaries – role of the defects on the properties of solids – grain boundary volume in microscopic and nanocrystals – defects in microscopic and nanocrystals – surface effects on the properties - defects due to severe plastic deformation – stacking faults – Hall Petch behavior –deformation in FEE and HCP nanostructures.		
Outcome 5	**Analysing the defects in the solids and the micro structural de formation principles**	**K2**

Suggested Readings:-

Atkins, P. W., Paula, J. D., & Keeler, J. (2019). *Atkins physical chemistry*. Oxford: OxfordUniversity Press.

Barnham, K., & Vvedensky, D. D. (2001). *Low-dimensional semiconductor structures: fundamentals and device applications*. New York: Cambridge University Press.

Byrappa, K., & Ohachi, T. (2003). *Crystal growth technology*. Norwich, NY: William Andrew Pub.(2003). *Materials science and technology*. Washington, D.C.: National Academies Press.

CallisterW, D. (2006). *Materials science and engineering an introduction*. La Habana: EditorialFélix Varela.

Chung, Y.-wah. (2007). *Introduction to materials science and engineering*. Boca Raton: CRC/Taylor & Francis.

Fischer, T. E. (2009). *Materials science for engineering students*. Amsterdam: Elsevier/AcademicPress.

Goddard, W. A. (2002). *Handbook of nanoscience, engineering, and technology*. Boca Raton, FL: CRC. Karas, G. V. (2005). *New developments in crystal growth research*. New York: Nova SciencePublishers.

Lu, G. Q., & Zhao, X. S. (2006). *Nanoporous materials: science and engineering*. London:Imperial College Press.

Markov, I. V. (2017). *Crystal growth for beginners: fundamentals of nucleation, crystal growth,and epitaxy*. New Jersey: World Scientific.

Narayan, R. (1983). *An introduction to metallic corrosion and its prevention*. New Delhi: Oxford& IBH.

Pillai, S. O. (2018). *Solid state physics*. London, UK: New Academic Science, an imprint of NewAge International (UK) Ltd.

Raghavan, V. (2015). *Materials science and engineering: a first course*. Delhi: PHI LearningPrivate Limited.

Raghavan, Y. S. (2010). *Nanostructures and nanomaterials: synthesis, properties andapplications*. New Delhi: Arise Publishers & Distributors.

Shackelford, J. F. (2016). *Introduction to materials science for engineers*. Pearson Education:Harlow.

Wasa, K., Kitabatake, M., & Adachi, H. (2011). *Thin films material technology: sputtering ofcompound materials*. Berlin: Springer.

Rethwisch, David G., and Callister, William D. (2020*) Materials Science and Engineering: An Introduction, WileyPLUS Card with Loose-leaf Set. Wiley.*

Sutton, Adrian P. (, 2021). *Concepts of Materials Science. United Kingdom, OUP Oxford*
Online Resources
https://epgp.inflibnet.ac.in/view_f.php?category=1640
https://epgp.inflibnet.ac.in/view_f.php?category=1673

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***
Course designed by **Dr. P. Shakkthivel, Professor**					

Course Outcome Vs Programme Outcomes

	PG1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M(2)	L(1)	S(3)	M(2)	M(2)	S(3)	L(1)	L(1)	M(2)	L(1)
CO2	S(3)	S(3)	M(2)	L(1)	S(3)	L(1)	M(2)	L(1)	M(2)	M(2)
CO3	M(2)	S(3)	M(2)	L(1)	M(2)	M(2)	S(3)	S(3)	S(3)	L(1)
CO4	M(2)	M(2)	M(2)	L(1)	L(1)	L(1)	L(1)	L(1)	M(2)	M(2)
CO5	S(3)	M(2)	M(2)	M(2)	M(2)	L(1)	M(2)	L(1)	M(2)	S(3)
W.AV	2.4	2.2	2.2	1.4	2	1.4	1.8	1.4	2.2	1.8

S- Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Program Specific Outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	L(1)	S(3)	S(3)	S(3)	S(3)
CO2	M(2)	M(2)	M(2)	S(3)	M(2)
CO3	S(3)	M(2)	M(2)	M(2)	M(2)
CO4	M(2)	L(1)	S(3)	S(3)	S(3)
CO5	M(2)	M(2)	M(2)	M(2)	S(3)
W.AV	2	2	2.4	2.6	2.6

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester – I</td></tr>
<tr><td>Core</td><td>Course code 533103</td><td>Basic Biotechnology</td><td>T</td><td>Credits: 4</td><td>Hours: 4</td></tr>
<tr><td colspan="6">Unit -I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To learn about the structure and function of biomolecules in living system</td></tr>
<tr><td colspan="6">Biotechnology: - Basic concepts of Biotechnology - Structure of atom and molecules, Bonding in biological system, Buffers in biological system; Structure and function of cells – prokaryotes and eukaryotes, Structure and organization of membrane, membrane transport; Structure, classification and biological importance of carbohydrates, amino acids, Protein, nucleic acid and lipids; Enzymes – classification, kinetics and application.</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Learners acquire basic knowledge on the building blocks of the macromolecules, its chemical properties and their importance in living system</td><td>K1</td></tr>
<tr><td colspan="6">Unit II</td></tr>
<tr><td>Objective 2</td><td colspan="5">To strengthen the knowledge on various cloning and expression vectors</td></tr>
<tr><td colspan="6">Genetic Engineering: - Scope and Milestones in Genetic Engineering– Gene Expression; Molecular tools used in Genetic Engineering - DNA modifying enzymes, vectors and host system; Gene cloning - ethical issues, Merits and Demerits of cloning; - Gene Therapy; Biotechnological applications of rDNA technology.</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Students will attain in depth knowledge on central dogma of life, genetic engineering and gene therapy</td><td>K2</td></tr>
<tr><td colspan="6">Unit III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To make the students understand the concepts of transgenic plants and its application.</td></tr>
<tr><td colspan="6">Plant Biotechnology: - Plant cell and Tissue culture – In vitro culture methodologies - Callus Culture, Cell Suspension Culture, Organ Micro-culture, plant micro-propagation, Somatic Embryogenesis; Applications of Plant Genetic Engineering in crop improvement- green house technology, plants as bioreactors, transgenic plants and its application.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Learners will apply the knowledge of cell culture techniques for micro and macro level manipulations of plants for environmental monitoring and health care applications</td><td>K3</td></tr>
<tr><td colspan="6">Unit IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">To provide insight on animal cell culture and its application in the development of transgenic animals</td></tr>
<tr><td colspan="6">Animal Biotechnology: - Scope of animal biotechnology - Techniques of animal cell and tissue culture- Culture media, growth factors, characteristics of cells in culture - Primary culture, immortal cells, cell lines, Maintenance of cell lines in the laboratory; application of animal cell culture; Transgenic animal production – Methods of gene transfer, Transgenic animal model for human disorders.</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Students will apply their knowledge on animal cell culture for the development of transgenic animals and vaccines for the betterment of society</td><td>K3</td></tr>
</table>

Unit V

Objective 5	**To impart knowledge on use of microbes for bioremediation purpose and energy production.**	

Microbial Biotechnology: - Environmental pollution – Types, Causes, Effects and Control measures; Bio remediation -concepts, bioremediation of toxic metal ions, phytoremediation, Microbial leaching mechanism; Bioactive metabolites - Primary metabolites, Secondary metabolites, Enzyme Technology, Single cell protein, Biomass and Bio-energy, Bio-gas production.

Outcome 5	**Learners will acquire knowledge on mechanism of microbial based bioremediation leading to development of technology to combat environmental pollution and sustainable energy production**	**K6**

Suggested Readings:-

Voet, D., & Voet, J. G. (2021). *Biochemistry*. J. Wiley & Sons.

Nelson D.L., Cox, M.M. (2021*). Lehninger Principles of Biochemistry* (8th ed), Macmillan Learning

Kennelly, P., Botham, K., McGuinness, O., Rodwell, V., Anthony Weil, P. (2022). *Harper's Illustrated Biochemistry*. (32nd ed.) McGraw Hill / Medical.

Primrose, S. (2014). *Principles of Gene manipulation and genomics* (Seventh Edition ed.). Blackwell.

Al-Rubeai, (2014). *Animal Cell culture*. Springer International Publishing.

Zahoorullah, S.(2015). *A Text book of Biotechnology*. SM online LLC

Gayatri, (2015). *Plant Tissue Culture: Protocols in Plant Biotechnology*. Alpha Science International.

Brown, T. (2006). *Gene cloning and DNA analysis* (Fifth edition ed.). Blackwell.

Freshney, R. I. (2015). *Culture of Animal cells: A Manual of Basic technique and Specialised Application* (Seventh Edition ed.). Wiley Blackwell.

Godbey, W. (2014). *An Introduction to Biotechnology: The Science technology and medicalapplications*. Academic Press, Elseiver.

Sambrook, J. (2007). *A Laboratory Manual, Cold spring harbour laboratory press*. Cold spring harbour laboratory press.

Smith, R. (2013). *Plant tissue culture experiment and techniques* (Third edition ed.). Academic Press, Elseiver.

Stewart, C. N. (2016). *Plant Biotechnology and genetics: Principles, Techniques and Applications* (Second Edition ed.). John Wiley and Sons

Online Resources

https://epgp.inflibnet.ac.in/view_f.php?category=1826

https://epgp.inflibnet.ac.in/view_f.php?category=1038

https://epgp.inflibnet.ac.in/loaddata.php?action=loadpaperlist1&maincat=3

https://epgp.inflibnet.ac.in/ahl.php?csrno=5.https://nptel.ac.in/courses/102105034/

https://nptel.ac.in/courses/10210301/

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course designed by **Dr. N. Suganthy, Assistant Professor**

Course Outcome Vs Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	S(3)	M(2)	M(2)	S (3)	M(2)	L(1)	L(1)	M(2)	L(1)
CO2	M (2)	S (3)	S (3)	S (3)	M(2)	M(2)	L(1)	L(1)	M(2)	M (2)
CO3	S (3)	S (3)	S (3)	S (3)	M(2)	M(2)	M(2)	M(2)	M(2)	S (3)
CO4	S (3)	S (3)	S (3)	S (3)	M(2)	S (3)	M(2)	M(2)	S (3)	S (3)
CO5	S (3)	S (3)	S (3)	S (3)	S (3)	M(2)	M(2)	M(2)	S (3)	S (3)
W.AV	2.6	3	2.8	2.8	2.4	2.2	1.6	1.6	2.4	2.4

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Program Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	S(3)	S (3)	M (2)	M (2)
CO2	M (2)	S (3)	S (3)	M (2)	M (2)
CO3	S (3)	S (3)	S (3)	M (2)	M (2)
CO4	S (3)	S (3)	L(1)	S (3)	S (3)
CO5	S (3)	S (3)	S (3)	S (3)	S (3)
W.AV	2.8	3	2.6	2.4	2.4

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester -I</td></tr>
<tr><td>Core</td><td>Course Code 533104</td><td>Introduction to Nanoscience</td><td>T</td><td>Credits: 4</td><td>Hours: 4</td></tr>
<tr><td colspan="6">Unit -I</td></tr>
<tr><td>Objective 1</td><td colspan="5">Apply key concepts in materials science, chemistry, physics, biology and engineering to the field of nanotechnology.</td></tr>
<tr><td colspan="6">Introduction and History channel: - Background of Nanoscience and Technology, Implications for Physics, Chemistry, Biology and Engineering-Significance of Nanoscale: Different types of Nanomaterials-metals, semiconductors, composite materials, Ceramics, Alloys, And Polymers.</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Gained a knowledge on historical perspective of physics , chemistry , biology and nanoengineering and technology</td><td>K2</td></tr>
<tr><td colspan="6">Unit - II</td></tr>
<tr><td>Objective 2</td><td colspan="5">Identify current nanotechnology solutions in design , engineering and manufacturing.</td></tr>
<tr><td colspan="6">Evolution and growth: - Fundamentals of nucleation growth – Nanoparticles morphology -atomic structure – molecules & phases – energy at the nanoscale molecular and atomic size-dimensionality and size dependent phenomena, Nanowires and Nanotubes, 2D films.</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Mastering in design a nanoparticle morphology and engineering tools</td><td>K3</td></tr>
<tr><td colspan="6">Unit - III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To analyze the nanocrystals and classified the different dimensional nanomaterials</td></tr>
<tr><td colspan="6">Nanomaterials: - Types of Nanocrystals – zero dimensional – one dimensional – two dimensional – three dimensional Nano structured materials – metals – semiconductors –ceramics and composites– size dependent properties–mechanical , physical and chemical - Uniqueness in these properties compared to bulk and microscopic solids .Biological Nanomaterials.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Learners developed the different dimensional structures of nano particles , nanocrystals and nanomaterials</td><td>K6</td></tr>
<tr><td colspan="6">Unit - IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">Identify the interatomic and intermolecular potential energies and forces</td></tr>
<tr><td colspan="6">Laws governing Nanomaterials: - Forces between atoms and molecules, particles and grain boundaries, surfaces – strong intermolecular forces -similaritiesanddifferencesbetweenintermolecularandinterparticleforces</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Expertise to nanosystems intermolecular and interatomic forces and potentials</td><td>K4</td></tr>
<tr><td colspan="6">Unit - V</td></tr>
<tr><td>Objective 5</td><td colspan="5">Apply to study the manufacturing processes , healthcare products including paints, filters , CNT , fullerenes , and forensic applications</td></tr>
<tr><td colspan="6">Advanced Nano Materials- Nanomaterials and nanostructures in nature- superhydrophobicity, self-cleaning – antifogging-Surface immobilized protein Nano structures Forensic Applications: Collection and analysis of evidence of different types of crime scenes including drugs - blood splattering, serology and Toxicology- Food and Cosmetic applications, Textiles, Paints, Catalysis, Drug delivery and its applications, Biochips- analytical devices CNTs, Fullerenes.</td></tr>
<tr><td>Outcome 5</td><td colspan="4">Acquired a knowledge in advance nanomaterials applications in modern society</td><td>K3</td></tr>
</table>

Suggested Readings:-

Malhotra, B. D., & Ali, M. A. (2018). Nanomaterials in biosensors: Fundamentals and applications. Nanomaterials for biosensors, 1..

Schodek, D. L., Ferreira, P., & Ashby, M. F. (2009). Nanomaterials, nanotechnologies and design: an introduction for engineers and architects. Butterworth-Heinemann.

Binns, C. (2021). Introduction to nanoscience and nanotechnology. John Wiley & Sons.

Klabunde, K. J., & Richards, R. M. (Eds.). (2009). Nanoscale materials in chemistry. John Wiley & Sons.

Kontogeorgis, G. M., &Kiil, S. (2016). Introduction to applied colloid and surface chemistry. John Wiley & Sons.

Poole, C. P., & Owens, F. J. (2003). Introduction to Nanotechnology John Wiley & Sons. Inc., Hoboken, New Jersey.

Tsurumi, T., Hirayama, H., Vacha, M., &Taniyama, T. (2009). Nanoscale physics for materials science. CrcPress.

Online Resources

https://epgp.inflibnet.ac.in/view_f.php?category=1852

https://epgp.inflibnet.ac.in/loaddata.php?action=loadpaperlist1&maincat=831

https://nptel.ac.in/courses/118102003/

https://nptel.ac.in/courses/103103033/module9/lecture1.pdf

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by

Dr. C. Balalakshmi, Assistant Professor/

Dr. K. Gurunathan, professor & Head

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	S (3)	M (2)	M (2)	L (1)	M (2)	M (2)	L (1)	M (2)	M(2)
CO2	S(3)	S(3)	S(3)	S(3)	M(2)	M(2)	S(3)	M(2)	M(2)	L(1)
CO3	M(2)	M(2)	S(3)	S(3)	M(2)	S(3)	S(3)	L(1)	L(1)	M(2)
CO4	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)
CO5	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	M(2)	M(2)	S(3)	S(3)
W.AV	2.8	2.8	2.6	2.8	1.8	2.6	2.6	1.8	2	2.2

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Program Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	L(1)	L(1)	L(1)	M(2)	-
CO2	M(2)	M(2)	S(3)	S(3)	M(2)
CO3	S(3)	S(3)	S(3)	S(3)	M(2)
CO4	S(3)	M(2)	S(3)	S(3)	S(3)
CO5	S(3)	S(3)	S(3)	L(1)	M(2)
W.AV	2.4	2.2	2.6	2.4	1.8

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="7">Semester I</td></tr>
<tr><td>Core</td><td>Course code
533107</td><td colspan="2">Nanoscience and Technology
Lab – I
(Nano-Physics Experiments)</td><td>P</td><td>Credits: 4</td><td>Hours: 8</td></tr>
<tr><td colspan="7">UNIT-I</td></tr>
<tr><td>Objective 1</td><td colspan="6">To understand the resistivity behavior of nanomaterials</td></tr>
<tr><td colspan="7">Measurement of resistivity of a given Silicon nano material by Four probe method.
Measurement of resistivity of a given Alumina nanomaterial by Four probe method.
Measurement of Magnetoresistance of a given semiconducting nano material.</td></tr>
<tr><td>Outcome 1</td><td colspan="5">Obtained through knowledge on the nanomaterials</td><td>K2</td></tr>
<tr><td colspan="7">UNIT-II</td></tr>
<tr><td>Objective 2</td><td colspan="6">To gain knowledge hall effete and temperature coefficient</td></tr>
<tr><td colspan="7">Study of Hall Effect.
Study of the dependence of Hall coefficient on temperature</td></tr>
<tr><td>Outcome 2</td><td colspan="5">Attained the hands on training hall effect measurement</td><td>K3</td></tr>
<tr><td colspan="7">UNIT-III</td></tr>
<tr><td>Objective 3</td><td colspan="6">To understand the characteristic of PN junction diode</td></tr>
<tr><td colspan="7">Study of P-N junction characteristics- Temperature coefficient and Energy band gap
Study of P-N junction characteristics-Reverse saturation current and Material constant</td></tr>
<tr><td>Outcome 3</td><td colspan="5">Experienced in learning and doing action</td><td>K2</td></tr>
<tr><td colspan="7">UNIT-IV</td></tr>
<tr><td>Objective 4</td><td colspan="6">To study spin coating & find application in solar cell</td></tr>
<tr><td colspan="7">Thin film spray and spin nanocoating.
Study of solar cell I-V Characteristics</td></tr>
<tr><td>Outcome 4</td><td colspan="5">Effect of thin film coating technology</td><td>K4</td></tr>
<tr><td colspan="7">UNIT-V</td></tr>
<tr><td>Objective 5</td><td colspan="6">To evaluation skill in finding nanosize</td></tr>
<tr><td colspan="7">Characteristics of Zener Diode- Zener diode as voltage regulator.
Particle size analysis using image -J software.</td></tr>
<tr><td>Outcome 5</td><td colspan="5">Real time experience on nanosize</td><td>K5</td></tr>
<tr><td>K1-Remember</td><td>K2-Understand</td><td>K3- Apply</td><td>K4-Analyze</td><td colspan="2">K5-Evaluate</td><td>K6-Create</td></tr>
<tr><td colspan="7">Course designed by Dr.G.Ramalingam, Assistant Professor</td></tr>
</table>

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	M(2)	L(1)	L(1)	L(1)
CO2	S(3)	-	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	-
CO3	S(3)	M(2)	-	S(3)	M(2)	M(2)	-	M(2)	M(2)	S(3)
CO4	S(3)	L(1)	-	S(3)	M(2)	S(3)	M(2)	-	L(1)	S(3)
CO5	L(1)	-	S(3)	S(3)	S(3)	-	M(2)	S(3)	-	L(1)
W.AV	2.6	1.2	1.6	2.8	2.6	2.2	1..6	1.8	2.4	1.6

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

CO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	M(2)	L(1)	M(2)	S(3)
CO2	L(1)	S(3)	S(3)	L(1)	L(1)
CO3	M(2)	L(1)	M(2)	L(1)	M(2)
CO4	S(3)	S(3)	S(3)	S(3)	L(1)
CO5	L(1)	M(2)	M(2)	M(2)	-
W.AV	1.8	2.2	2.2	1.8	1.4

S- Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester- I</td></tr>
<tr><td>DSE</td><td>Course code 533501</td><td>Thin Film Technologies and Characteristics</td><td>T</td><td>Credits: 3</td><td>Hours: 3</td></tr>
<tr><td colspan="6">Unit I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To understand the basic definition and the various techniques in thin film formation</td></tr>
<tr><td colspan="6">Thin Film Technology: - Role of Thin films and Nanostructures in Technology and Devices; Vacuum evaporation-Hertz- Knudsen equation, evaporation from a source and film thickness uniformity. Glow discharge and plasmas-Plasma structure, DC, RF and microwave excitation; Sputtering processes-Mechanism and sputtering yield, Sputtering of alloys; Reactive sputtering.</td></tr>
<tr><td>Outcome1</td><td colspan="4">Learners familiarize with the principles and equipment of different deposition techniques</td><td>K1</td></tr>
<tr><td colspan="6">Unit-II</td></tr>
<tr><td>Objective 2</td><td colspan="5">To explain the mechanism of thin film formation with aid of relevant mathematical and theoretical explanations</td></tr>
<tr><td colspan="6">Nucleation and Growth: - Nucleation and Growth: Adsorption, Surface diffusion, models for 3D and 2D nucleation, coalescence and depletion, grain structure and microstructure and its dependence on deposition parameters. Role of energy enhancement in nucleation; Self-assembly: mechanisms and controls for nanostructures of 0 and 1 dimension.</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Understand the phenomena and concepts involved in thin film</td><td>K2</td></tr>
<tr><td colspan="6">Unit-III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To inculcate knowledge about the factors that influence the process of nucleation and growth</td></tr>
<tr><td colspan="6">Deposition Technology: - Adsorption, Surface diffusion, Nucleation, Surface energy, Texturing, Structure Development, Interfaces, Stress, Adhesion, Temperature Control, agglomeration, aggregation, Semiconductor devices , Growth Monitoring , Composition Control, Lattice Mismatch Surface Morphology.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Capable to elucidate the factors that are involved in thin film technology</td><td>K2</td></tr>
<tr><td colspan="6">Unit -IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">A basic coverage of the important topics under ‘epitaxial growth’</td></tr>
<tr><td colspan="6">Epitaxial Technology : -Epitaxy: Structural aspects of epitaxy, homo- and hetero-epitaxy, lattice misfit and imperfections; epitaxy of compound semiconductor, theories of epitaxy, Role of interfacial layer, Artificial semiconductors, Band-gap engineering, Superlattice structures; Strained layer epitaxy,</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Understand the fabrication methods for engineering of thin film</td><td>K2</td></tr>
<tr><td colspan="6">Unit- V</td></tr>
<tr><td>Objective 5</td><td colspan="5">To guide the students in understanding the various properties and characteristics of thin films</td></tr>
<tr><td colspan="6">Characteristics of Thin Films: - Mechanical, Electrical, Magnetic and Optical Properties of Thin Film, Analysis of thin films –Interface phenomena- Multilayer films.</td></tr>
<tr><td>Outcome 5</td><td colspan="4">Learners acquire knowledge on thin film properties for various industrial applications</td><td>K5</td></tr>
</table>

Suggested Readings:-

Bunshah, R. F. (2001). *Handbook of hard coatings: Deposition technologies properties and applications*.Estados Unidos: Noyes Publications.

Callister, W. D., & Rethwisch, D. G. (2018). *Materials science and engineering: An introduction*.Hoboken, NJ: Wiley.

Chopra, K. L. (1985). *Thin film phenomena*. Malabar, FL: R.E. Krieger.

Frey, H. (2015). *Handbook of Thin-Film technology*. Berlin: Springer.

Ohring, M. (2006). *The materials science of thin films*. San Diego, Calif: Academic Press.

Pandalai, S. G. (2003). *Recent research developments in vacuum science & technology*. Trivandrum:Transworld research network.

Seshan, K. (2012). *Handbook of thin film deposition: Techniques, processes, and technologies*.Amsterdam: Elsevier.

Online Resources

https://epgp.inflibnet.ac.in/ahl.php?csr
no=831
https://nanohub.org/tags/thinfilms
https://nanohub.org/resources/26056
https://nanohub.org/resources/11949

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by
Dr. K. Gurunathan, Professor & Head

Course Outcome Vs Programme Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S (3)	S (3)	S (3)	S (3)	S (3)	L(1)	L(1)	-	M(2)	L(1)
CO2	M(2)	S (3)	M(2)	L(1)	M(2)	M(2)	S (3)	L(1)	S (3)	S (3)
CO3	S (3)	S (3)	S (3)	M(2)	S (3)	M(2)	S (3)	M(2)	M(2)	L(1)
CO4	M(2)	S (3)	S (3)	M(2)	M(2)	L(1)	M(2)	L(1)	L(1)	L(1)
CO5	S (3)	S (3)	S (3)	S (3)	S (3)	M(2)	S (3)	S (3)	S (3)	S (3)
W.Av	2.6	3	2.8	2.2	2.6	1.6	2.4	1.4	2.2	1.8

S-Strong (3), M-Medium (2), L- Low (1)

Course Outcome Vs Program Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	S(3)	L(1)	S(3)	M(2)
CO2	L(1)	M(2)	L(1)	S(3)	L(1)
CO3	M(2)	S(3)	M(2)	S(3)	S(3)
CO4	M(2)	M(2)	L(1)	S(3)	S(3)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)
W.AV	**2**	**2.6**	**1.6**	3	**2.4**

S-Strong (3), M-Medium (2), L- `Low (1)

Semester- I					
DSE	**Course code 533502**	**Condensed Matter Physics**	**T**	**Credits: 3**	**Hours: 3**
Unit -I					
Objective 1	**To introduce the basics of atoms , crystals and lattices and related concepts**				
Crystalline Matter: - Atoms in crystals – types of lattices-Cubic- Close packed structure - Atomic planes –reciprocal lattice- Brillouin zones-structure factor- Binding in crystals –types					
Outcome 1	**Learnes acquire with basic and important concepts in solid state physics**				**K2**
Unit-II					
Objective 2	**To make them understand some key theories and concepts in crystals**				
Properties: - Lattice vibration in crystals – Optical properties in IR – Phonons – Electrical properties of metals – Free electron theory – Fermi energy – Brillouin zones – Semiconductor – Band theory- Kronig Penny Model – Effective mass – Impurity levels – Hall effect – Fermi energy of pure and doped semi conductor					
Outcome 2	**Student discuss the properties of materials from physics point of view**				**K1**
Unit III					
Objective 3	**To introduce them to basic concepts in dielectrics and ferroelectrics**				
Dielectrics and Ferroelectrics: - Depolarisation field E1, Lorentz field E2, Dielectric Constant and Polarisability – Clausius – Mosotti relation – Electronic polarisability, Ferroelectric crystals, Classification of ferroelectric crystals, soft optical phonon, Landau theory of phase transition, second order transition.					
Outcome 3	**Student analysis the clear in concepts of dielectrics and ferroelectrics**				**K4**
Unit IV					
Objective 4	**To get them acquainted with magnetism properties of magnetic materials**				
Magnetism: - Quantum theory of paramagnetism – Ferromagnetism- Ferromagnetic domains – Ferro and Anti-ferro magnetic materials - spin waves – Hard and Soft magnetic materials.					
Outcome 4	**Learnes remember the basic concepts of magnetism**				**K1**
Unit V					
Objective 5	**To study the concept, theories and types under superconductivity**				
Superconductivity: - Meissner effect – Type I & II super conductors – London equation – Thermodynamic properties – BCS theory - Super conducting tunneling – DC & AC Josephson effect – SQUID – High temperature super conductivity.					
Outcome 5	**Oppurtunity for learners to equip them with applied concepts of superconductivity**				**K3**

Suggested Readings:-					
Azároff Leonid V. (1986). *Introduction to solids*. Bombay: Tata McGraw-Hill. Kittel, C., & McEuen, P. (2018). *Introduction to solid state physics*. Hoboken, NJ: Wiley.Phillips, P. (2015). *Advanced solid state physics*. Westview Press Pillai, S. O. (2018). *Solid state physics*. London, UK: New Academic Science, an imprint of NewAge International (UK) Ltd. Robertson, C. (1980). *The solid state*. London: Polytechnic of North London. S., N. G. B., & S., N. G. B. (n.d.). *Material science and Processes*. Khanna Pub.Publ.					
K1-Remember	***K2-Understand***	***K3-Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***
Course designed by:**Prof.K Gurunathan/Dr. G. Ramalingam**					

Course Outcome Vs Program Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S(3)	M(2)	L(1)	L (1)	L (1)	M(2)	M(2)	M(2)	S (3)	L (1)
CO2	L (1)	-	S (3)	S (3)	M 2)	S (3)	L (1)	M(2)	M(2)	-
CO3	S (3)	M(2)	L (1)	M(2)	L (1)	L (1)	S (3)	L (1)	L (1)	S (3)
CO4	L (1)	M(2)	M(2)	L (1)	L (1)	M(2)	S (3)	M(2)	S (3)	M (2)
CO5	M(2)	M(2)	-	S (3)	-	S (3)	M(2)	S (3)	S (3)	L (1)
W.AV	1.8	1.6	1.4	2	1	2.2	2.2	2	2.4	1.4

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Program Specific Outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	M(2)	L(1)	L(1)	-	M(2)
CO2	M (2)	-	L (1)	M (2)	S(3)
CO3	L (1)	L (1)	L (1)	M (2)	M (2)
CO4	L (1)	L (1)	-	M (2)	-
CO5	L (1)	L (1)	M (2)	M (2)	L (1)
W.AV	1.4	0.8	1	1.6	1.6

S-Strong(3), M-Medium(2), L- Low

<table>
<tr><th colspan="6">Semester – II</th></tr>
<tr><td>Core</td><td>Course code 533201</td><td>Synthesis of Nanomaterials</td><td>T</td><td>Credits: 5</td><td>Hours: 5</td></tr>
<tr><td colspan="6">Unit I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To provide basic knowledge on various physical approaches for nanomaterial synthesis</td></tr>
<tr><td colspan="6">Physical methods: - Inert gas condensation, Arc discharge, RF- plasma, Plasma arc technique, Ion sputtering - RF/DC magnetron sputtering, Laser ablation, Laser pyrolysis, microwave plasma evaporation , Thermal evaporation Electron beam evaporation, Transferred Arc Plasma Reactor.</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Acquire knowledge on various physical methods for synthesis, based on the properties and behaviors of the nanomaterials</td><td>K3</td></tr>
<tr><td colspan="6">Unit II</td></tr>
<tr><td>Objective 2</td><td colspan="5">To introduce students to bottom up approaches for the synthesis nanomaterials</td></tr>
<tr><td colspan="6">Chemical Methods: - Solvothermal synthesis- Photochemical synthesis-Electrochemical synthesis, Sol-gel technique – control of grain size – co-precipitation hydrolysis – sonochemical method combustion technique – colloidal precipitation – template process – Micellar route-growth of nanorods – solid-state sintering – grain growth.</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Acquire information on chemical route of nanomaterial synthesis.</td><td>K3</td></tr>
<tr><td colspan="6">Unit III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To impart knowledge on synthesis of nanomaterial of various dimensions by hydrothermal approach</td></tr>
<tr><td colspan="6">Hydrothermal methods: - Principle, 3D nanostructures – carbon nanotube – Inorganic nanotubes and nanorods – Nanoflowers- nanocrystals, Nano-rings – chemical routes for 1D nanotubes and nanorods – Schlenk synthesis of Quantum dots.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Students will be able to fabricate nanomaterial of various dimension and morphology based on applications</td><td>K4</td></tr>
<tr><td colspan="6">Unit IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">To provide insight on the synthesis of nanomaterials by top down approach</td></tr>
<tr><td colspan="6">Mechanical methods: Grinding – high energy ball milling, types of balls, WC and ZrO_2, material-ball ratio, medium for grinding, limitations in getting required grain size for low melting point materials, typical systems, severe plastic deformation, melt quenching and annealing.</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Attain knowledge in optimizing the synthesis methodology by mechanical approach to fabricate novel devices in nano architectures</td><td>K3</td></tr>
<tr><td colspan="6">Unit V</td></tr>
<tr><td>Objective 5</td><td colspan="5">To make the students understand concepts of Nano-Biomimetics</td></tr>
<tr><td colspan="6">Biological Methods: - Biologically synthesized nanoparticles - Phytosynthesis, phycosynthesis and mycosynthesis, bioproduct mediated synthesis of nanoparticles, Protein Based Nanostructure Formation, DNA Templated Nanostructure Formation.</td></tr>
</table>

Outcome 5	**Students will use concept of biomimetics to create novel bio inspired nanomaterials for biomedical applications**	**K6**

Suggested Readings:-

Abdullaeva, Z. (n.d.). *Synthesis of Nanoparticles and Nanomaterials: Biological Approaches*. SpringerNature.

Basiuk, V. (2015). *Green Processes for Nanotechnology: From inorganic to bioinspriednanomaterials*. Springer.

Grumezescu, A. (2015). *Fabrication and self assembly of nanobiomaterials: Application ofNanobiomaterials*(Vol. 1). William Andrew, Elseiver.

Grumezescu, A. (2016). *Nanomaterials in Antimicrobial therapy: Application of Nanobiomaterials*. William Andrew, Elseiver.

Horikoshi,S.(2013). *Microwaves in Nanoparticle Synthesis: Fundamentals and Application*. Wiley-VCH.

Kulkarni, S. (2014). *Nanotechnology: Principles and Practices*(Third edition ed.). SpringerInternational Publishing.

Rao, (n.d.). *The Chemistry of Nanomaterials*(Second Edition ed.). John Wiley and Sons. Sengupta, A. (2015). *Introduction to Nano: Basics to nanoscience and nanotechnology*. Springer.

Singh, (2015). *Bio-Nanoparticles: Biosynthesis and Sustainable Biotechnological implication*. WileyBlackwell.

Venetti, A. (2007). *Progress in Materials Science Research*. Nova Science

Online Resource

https://epgp.inflibnet.ac.in/view_f.php?category=1852

https://nptel.ac.in/courses/102107058/3

https://nptel.ac.in/courses/103103033/module9/lecture2.pdf

https://nptel.ac.in/courses/118102003/ https://www.slideshare.net/RamalingamGopal/sol-gel-synthesis-of-nanoparticles

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by:**Dr. N. Suganthy, Assistant Professor /Dr. K Gurunathan, Professor& Head**

Course Outcome Vs Programme Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S (3)	S (3)	S (3)	S (3)	S (3)	M(2)	S (3)	L(1)	S (3)	S (3)
CO2	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	M(2)	S (3)	S (3)
CO3	M(2)	S (3)	S (3)	M(2)	M(2)	S (3)	M(2)	M(2)	S (3)	M (2)
CO4	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	M(2)	S (3)	M (2)
CO5	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	M(2)	M(2)	S (3)	S (3)
W.AV	2.8	3	3	2.8	2.8	2.8	2.6	1.8	3	2.6

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Program Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S (3)	M (2)	M (2)	S (3)
CO2	M (2)	S (3)	S (3)	M (2)	S (3)
CO3	S (3)	S (3)	M (2)	S (3)	S (3)
CO4	S (3)	S (3)	M (2)	S (3)	S (3)
CO5	M(2)	S (3)	S (3)	S (3)	S (3)
W.AV	2.6	3	2.4	2.6	3

S-Strong(3), M-Medium(2), L- Low(1)

Semester – II					
Core	**Course code 533202**	**Characterization of Nanomaterials**	**T**	**Credits: 4**	**Hours:4**

Unit - I		
Objective 1	**To explore various mechanical properties and characterization techniques for nanoscale materials**.	
Mechanical Characterization: -Hardness and elastic modulus of NPs-Micro hardness – nanoindensation – fatigue – failure stress and strain toughness – abrasion and wear resistance – fracture toughness – elasticity of nanomaterials – superplasticity – plastic nature of nanoceramics – nanomembranes – inter connected pores – plastic deformation of nanomaterials- Adhesion and friction of NPs		
Outcome 1	**Gained knowledge on the importance of the material mechanical properties and to determining**	**K2**
Unit - II		
Objective 2	**To gain deep knowledge on the electrical characterization of nanomaterials**	
Electrical Characterization: -DC electrical conductivity as a function of temperature - Hall effect – types of charge carriers – charge carrier density – impedance spectroscopy – dc electrical resistivity – activation energy – bulk and grain boundary capacitances – relaxation times of dipoles.		
Outcome 2	**Influence of various affecting factors in conductivity and their analysis.**	**K3**
Unit - III		
Objective 3	**To obtain detailed methods of morphological and structural studies of nanomaterials**	
Spectroscopic and Microscopic characterization **Optical spectroscopy: -**Optical absorption spectroscopy (OAS) - UV-Vis spectroscopy-photoluminescence (PL) - Fourier Transform Infrared Spectroscopy (FTIR) - Raman spectroscopy - X-ray diffraction (XRD) - *Electron Spectroscopy:* X- ray Photoelectron Spectroscopy (XPS) - Electron microscopy: - Scanning Electron Microscopy (SEM)-Transmission Electron Microscopy (TEM)/ High Resolution (HR)TEM with Selected Area Electron Diffraction (SAED) Atomic Force Microscopy (AFM).		
Outcome 3	**Deep knowledge on utilizing advanced optical and electron spectroscopy techniques**	**K1**
Unit - IV		
Objective 4	**1. To lean and gain magnetic studies and properties.**	
Magnetic Characterization: - Concepts of dia-para-ferro and ferri magnetism – exchange correlation - exchange interaction – Hysteresis loop – coercivity – change of coercivity – grain size – soft magnets – hard magnets – spring exchange magnets– magnetic measurements using VSM – function of temperature - ferromagnetic resonance – magnetic force microscopy – NMR – Introduction – Experimental Techniques – Chemical shift, dipolar interaction, spin - spin interaction – Applications – ESR –Principles and Applications of ESR Spectroscopy.		
Outcome4	**Recent advanced principles in magnetism and latest magnetic measurement techniques learning**	**K4**

Unit - V		
Objective 5	**To understand the basics of electrochemical studies for the characterization of nanomaterials**	
Electrochemical Characterization: - **Fundamental Principle***:* Electrochemical cell - ion/ion interaction and Stokes- Einstein equation - electrode/electrolyte interface - kinetics of electrode reactions -Butler-Volmer equation - Electroanalytical techniques: irrversible - quasi-reversible voltammetry - linear scan and cyclic voltammetry - Electrochemical impedance spectroscopy - Galvanostatic charge- discharge - chronopotentiometry chronoamperometry.		
Outcome 5	**Sound understanding of electrochemical principles and various techniques**	**K6**

Suggested Readings:-

Barsoukov, E., & Macdonald, J. R. (2005). *Impedance spectroscopy theory, experiment, andapplications.* Hoboken, NJ: Wiley-Interscience.

Bashir, R., &Wereley, S. (2006). *Biomolecular sensing, processing and analysis*. New York:Springer.

Bhagyaraj, S. M., Oluwafemi, O. S., Kalarikkal, N., & Thomas, S. (2018*). Characterization ofnanomaterials: advances and key technologies*. Duxford: Woodhead Publishing, an imprint of Elsevier.

Desai, T., & Bhatia, S. (2006). *Therapeutic micro/nanotechnology*. Berlin: Springer.

Fujita, H. (2012*). Micromachines as tools for nanotechnology.* Springer-verlag Berlin And Hei. Hosford, W. F. (2010*). Physical metallurgy.* Boca Raton: CRC Press. http://shodhganga.inflibnet.ac.in/bitstream/10603/118051/11/11_chapter%204.pdf https://epgp.inflibnet.ac.in/view_f.php?category=1639

Ishiwara, H., Arimoto, Y., Ishiwara, H., &Okuyama, M. (2004*). Ferroelectric Random AccessMemories.* Berlin, Heidelberg: Springer Berlin Heidelberg.

Kaupp, G. (2011). *Atomic force microscopy, scanning nearfield optical microscopy andnanoscratching: application to rough and natural surfaces.* Berlin: Springer.

Micromachines as tools for nanotechnology. (2013). Place of publication not identified: Springer. Parthasarathy, B. K. (2007). *Challenges and opportunities in nanotechnology.* New Delhi: Isha Books.

Pecharsky, V. K., &Zavalij, P. Y. (2009). *Fundamentals of powder diffraction and structuralcharacterization of material.* New York, NY: Springer.

Ramesh, K. T. (2009). *Nanomaterials: Mechanics and mechanisms.* New York: SpringerScience.

Thomas, S., Thomas, R., Zachariah, A. K., & Mishra, R. K. (2017). *Spectroscopic methods fornanomaterials characterization.* Amsterdam, Netherlands: Elsevier.

Tominaga, J., & Tsai, D. P. (2003). *Optical nanotechnologies: The manipulation of surface andlocal plasmons.* Berlin: Springer.

Zhang, J. Z. (2009). *Optical properties and spectroscopy of nanomaterials.* New Jersey: World Scientific.

Vasile-Dan Hodoroaba., Wolfgang E.S. Unger., Alexander G Shard. (2019). *Characterization of Nanoparticles: Measurement Processes for Nanoparticles.* Netherlands, Elsevier Science.

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by **Dr. P. Shakkthivel, Professor**

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L(1)	M(2)	S(3)	M(2)	M(2)	M(2)	M(2)	L(1)	M(2)	M(2)
CO2	M(2)	S(3)	S(3)	M(2)	M(2)	M(2)	M(2)	M(2)	M(2)	M(2)
CO3	S(3)	M(2)	M(2)	M(2)	M(2)	M(2)	M(2)	M(2)	M(2)	M(2)
CO4	S(3)	M(2)	S(3)	S(3)	M(2)	S(3)	S(3)	L(1)	M(2)	S(3)
CO5	L(1)	S(3)	S(3)	M(2)	M(2)	M(2)	M(2)	L(1)	M(2)	L(1)
W.AV	2	2.4	2.8	2.2	2	2.2	2.4	1.4	2	2

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	S(3)	S(3)	M(2)	S(3)
CO2	S(3)	M(2)	S(3)	M(2)	S(3)
CO3	S(3)	M(2)	S(3)	M(2)	S(3)
CO4	M(2)	S(3)	M(2)	S(3)	M(2)
CO5	M(2)	M(2)	S(3)	S(3)	M(2)
W.AV	2.4	2.4	2.8	2.4	2.6

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester-II</td></tr>
<tr><td>Core</td><td>Course Code 533203</td><td>Applications of Nanomaterials</td><td>T</td><td>Credits : 5</td><td>Hours: 5</td></tr>
<tr><td colspan="6">Unit -I</td></tr>
<tr><td>Objective 1</td><td colspan="5">Explain the applications of nanomaterials in electronics which increase the capabilities of electronic devices, enhance the density of memory chips, etc.</td></tr>
<tr><td colspan="6">Electronic Applications:-Microelectronics–Photolithography - Molecularelectronics–Nanoelectronics–memories–LEDs–Nanotransistors-photonics -carbon nanotubes (CNT) in electronic applications – CNT based MOSFET– MEMS and NEMSCMOS technology</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Gained knowledge on the general physics and applications in electronic devices</td><td>K3</td></tr>
<tr><td colspan="6">Unit - II</td></tr>
<tr><td>Objective 2</td><td colspan="5">Understand the magnetic nanoparticles have shown promise in a number of magnetic devices</td></tr>
<tr><td colspan="6">Magnetic Applications: - Soft magnets for high speed memories – hard magnets – high density memories-High Energy Density Batteries-High-Power Magnets –biological applications.</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Excelling the processing techniques for designing magnetic devices using Nano materials</td><td>K3</td></tr>
<tr><td colspan="6">Unit - III</td></tr>
<tr><td>Objective 3</td><td colspan="5">Illustrate the Nanocomposites are materials that incorporate nanosized particles into a matrix of standard ceramics material and its applications</td></tr>
<tr><td colspan="6">Applications of Nanoceramics and Nanocomposites: - Near net shaped components –membranes for purification of water – blood and air, catalysis – tooth and bone substitutes –hydroxyappetites–inductive bone –replacements–ceramic valves -Aerospace Components With Enhanced Performance Characteristics</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Learners expertise to fabricate nanocomposites for waste water purification and nanoceramics for tooth and bone substitutes</td><td>K6</td></tr>
<tr><td colspan="6">Unit - IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">Explain the nanotechnological products, and environmental detoxification of organic and inorganic pollutants</td></tr>
<tr><td colspan="6">Environmental applications: – Organic dye degradation – textile and leather industries – removal of bacteria and microbes – water resistant composites for walls resistance to fungal attack–sensors for gases – pressure– temperature-lighteningarrestors–Detoxificationoforganic/inorganicpollutants.</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Analyzing the environmental detoxification of organic and inorganic pollutants</td><td>K4</td></tr>
<tr><td colspan="6">Unit - V</td></tr>
<tr><td>Objective 5</td><td colspan="5">Apply key concepts is to highlight the biological and biomedical applications of nanomaterials</td></tr>
<tr><td colspan="6">Biologicalapplications:-Bio-functionalization of CNT and biological applications- Nanobiosensor-Longer-LastingMedical Implants. glucose detection,artificial nanostructures: – sensory physiology and muscle physiology - Trends in nanobiotechnology- New generations of prosthetic and medical implants-artificial organs and implants- artificial scaffolds or biosynthetic coatings-retinal, cochlear, and neural implants, repair of damaged nerve cells, and replacements of damaged skin, tissue, or bone.</td></tr>
</table>

Outcome 5	**Mastering the design and nanodevice for biological and biomedical applications of nanomaterials**	**K6**

Suggested Readings:-

AndrzejWieckowski&et.al,(2003)*CatalysisandElectrocatalysisat Nanoparticle*.

Kumar, C. S. (Ed.). (2006). *Nanomaterials: toxicity, health and environmental issues* (Vol. 5). St. Martin's Press.

Nalwa, H. S. (2007). *Handbook Of Nanostructured Biomaterials And Their Applications In Nanobiotechnology. Volume 1: Biomaterials*. American Scientific Publishers.

Mirsky, V. M. (Ed.). (2013). *Ultrathin electrochemical chemo-and biosensors: technology and performance* (Vol. 2). Springer Science & Business Media.

Greco, R. S., Prinz, F. B., & Smith, R. L. (Eds.). (2004). *Nanoscale technology in biological systems*. CRC Press

Theodore, L., & Kunz, R. G. (2005). *Nanotechnology: environmental implications and solutions*. John Wiley & Sons.

Online Resource

https://swayam.gov.in/nd1_noc19_mm21/preview

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course designed by

Dr. C. Balalakshmi Assistant Professor

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	S(3)	L(1)	M(2)	L(1)	M(2)	L(1)	M(2)	S(3)	L(1)
CO2	S(3)	M(2)	M(2)	-	S(3)	M(2)	M(2)	L(1)	M(2)	L(1)
CO3	S(3)	L(1)	S(3)	M(2)	L(1)	L(1)	M(2)	L(1)	M(2)	M(2)
CO4	L(1)	L(1)	M(2)	S(3)	L(1)	L(1)	M(2)	L(1)	S(3)	M(2)
CO5	S(3)	M(2)	M(2)	L(1)	L(1)	M(2)	L(1)	M(2)	S(3)	M(2)
W.AV	2.4	1.8	2	1.6	1.4	1.6	1.6	1.4	2.6	1.6

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	L(1)	M(2)	S(3)	L(1)
CO2	L(1)	M(2)	-	M(2)	M(2)
CO3	L(1)	M(2)	L(1)	L(1)	-
CO4	-	L(1)	M(2)	S(3)	M(2)
CO5	M(2)	L(1)	S(3)	M(2)	M(2)
W.AV	1.2	1.4	1.6	2.2	1.4

S-Strong(3), M-Medium(2), L- Low(1)

Semester II					
Core	Course code 533207	Nanoscience and Technology Lab – II (Nano-chemistry Experiments)	P	Credits: 5	Hours: 10

UNIT-I

Objective 1	**To understand the nanoparticle synthesis**	
1. Synthesis of Iron oxide nanoparticles by Co-precipitation method. 2. Synthesis of ZnO nanoparticles by chemical method. 3. Synthesis of SnO_2 nanoparticles by Chemical sol-gel method. **4.** Synthesis of TiO_2 nanoparticles by Chemical sol-gel method		
Outcome 1	**Obtained through knowledge on the formation principles of iron oxide and zno nanoparticles**	**K2**

UNIT-II

Objective 2	**To gain knowledge on the Au, Ag and polymer process with examples**	
1. Synthesis of colloidal nanocmaterials of Au and Ag nanoparticles 2. Preparation of polymer nanocomposites		
Outcome 2	**Attained the hands on training of synthesis of nanoparticles though sol-gel method**	**K3**

UNIT-III

Objective 3	**To understand the nanoparticle formation by spectroscopic techniques**	
1. Studies on bulk and nanoparticles through UV-Vis spectroscopy and calculate the band gap of materials. 2. Raman spectroscopy studies on nanomaterials		
Outcome 3	**Preparation of Au, Ag and polymer nanocomposites and the stabilization are inculcated**	**K2**

UNIT-IV

Objective 4	**To get topography and concluding properties of nanocomposites**	
1. Demo Thin film characterization through AFM. 2. Conductivity studies of polymer-nanocomposite material by Four probe method		
Outcome 4	**Effect of nanostructures on the spectroscopic interactions have been taugh**	**K4**

UNIT-V

Objective 5	**To verify the structural and morphological characterizes of nanostructures**	
1. XRD demo studies for calculating the size of the nanoparticles and nanocomposites by Scherrer's formula and mass approximation method 2. SEM demo characterization of nanomaterials. for size and surface morphology by using known SEM images		
Outcome 5	**Chemical structural and morphological characteristies of nanomaterials**	**K5**

K1-Remember	***K2-Understand***	***K3-Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by **Dr. P. Shakkthivel, Professor**

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	S(3)	S(3)	S(3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)
CO2	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)
CO3	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)
CO4	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)
CO5	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)
W.AV	3	3	3	3	3	3	3	3	3	3

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	S(3)	S(3)	S(3)
CO2	S(3)	S(3)	S(3)	S(3)	S(3)
CO3	S(3)	S(3)	S(3)	S(3)	S(3)
CO4	S(3)	S(3)	S(3)	S(3)	S(3)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)
W.AV	3	3	3	3	3

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester – II</td></tr>
<tr><td>DSE</td><td>Course code
533503</td><td>INFORMATION STORAGE
MATERIALS AND DEVICES</td><td>T</td><td>Credits: 3</td><td>Hours: 3</td></tr>
<tr><td colspan="6">Unit - I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To understand the essential principles of semiconductor device and Electron transport properties.</td></tr>
<tr><td colspan="6">Overview of Information Storage and Nanotechnology Different types of information storage materials, solid state memory, optical memory, magnetic recording, emerging technologies, role of nanotechnology in data storage.</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Students familiarizing them with basics of Information Storage on use of Nanotechnology</td><td>K1</td></tr>
<tr><td colspan="6">Unit - II</td></tr>
<tr><td>Objective 2</td><td colspan="5">Become proficient in magnetic and optical properties of materials and Nano-electronic devices</td></tr>
<tr><td colspan="6">Optical Data Storage Write and read techniques (signal modulation, disk format, data reproduction), read and write principles (read-only, write-once, phase-change, magnetooptic disks), optical pickup heads (key components, diffraction-limited laser spot, focusing and tracking error signals, servo-loop design, actuator), optical media, near field optical recording, holographic data storage</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Acquired knowledge on magnetic properties of materials and their applications in data storage</td><td>K2</td></tr>
<tr><td colspan="6">Unit - III</td></tr>
<tr><td>Objective 3</td><td colspan="5">Acquire knowledge about different types of electronic devices and about some storage materials</td></tr>
<tr><td colspan="6">Basics of Magnetism for Magnetic Data Storage Magnetic field, magnetic moment, spin, exchange coupling, ferromagnetic and anti-ferromagnetic materials, magnetic anisotropy, demagnetisation field, magnetic domain, magnetic hysteresis, super paramagnetism</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Learner understanding on the functioning of optical materials for optoelectronics</td><td>K2</td></tr>
<tr><td colspan="6">Unit - IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">Understand the selection process which will be used in industries</td></tr>
<tr><td colspan="6">Magnetic Media Inductive read and write head, AMR head, GMR effect, spin-valve sensor, magnetic tunnelling junction, GMR head, ultra-small head design. Longitudinal recording media, media design, thin film technology, media noise, superparamagnetic limit.</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Student evaluate basics of quantum structures and their applications in magnetic media storage</td><td>K5</td></tr>
<tr><td colspan="6">Unit - V</td></tr>
<tr><td>Objective 5</td><td colspan="5">Create various electronic and optoelectronic devices using suitable materials</td></tr>
<tr><td colspan="6">Solid state Memory Charge, spin and phase change based memories (DRAM, SRAM, Flash, FeRAM, MRAM, CRAM, RRAM, NVFDRAM). Probe storage, molecular memory, atomic memory and quantum information storage.</td></tr>
<tr><td>Outcome 5</td><td colspan="4">Students able to analyze different type of storage system</td><td>K4</td></tr>
</table>

Suggested Readings:-

Erwin R. Meinders , Matthias Wuttig, Liesbeth Van Pieterson, Andrei V.Mijiritskii, *Optical Data Storage* Springer, 2006.

Seth Lloyd and Y. Jack Ng., November 2004 *Black Hole Computers, Scientific American Magazine.*

Information in the Holographic Universe, Scientific American Magazine, August, Jacob D. Bekenstein, 2003

Wu YH, "*Nano Spintronics for Data Storage*", Encyclopedia for Nanoscience and Nanotechnology, vol.7, American Scientific Publishers, 2003

Mechanics and Reliability of Flexible Magnetic Media, Bharat Bhushan, 2000, Springer.

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by: **Dr. G. Ramalingam, Assistant Professor**

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	S(3)	S(3)	L(1)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)
CO2	M(2)	M(2)	S(3)	M(2)	L(1)	L(1)	L(1)	L(1)	S(3)	S(3)
CO3	S(3)	-	S(3)	L(1)	M(2)	M(2)	M(2)	M(2)	L(1)	M(2)
CO4	-	M(2)	L(1)	M(2)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO5	M(2)	L(1)	L(1)	S(3)	L(1)	S(3)	S(3)	M(2)	S(3)	M(2)
W.AV	2	1.6	2.2	1.8	2	2.4	2.2	2	2.4	2.6

S-Strong (3), M-Medium (2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	M(2)	M(2)	L(1)	L(1)
CO2	M(2)	-	M(2)	L(1)	L(1)
CO3	L(1)	-	M(2)	L(1)	-
CO4	M(2)	L(1)	S(3)	M(2)	M(2)
CO5	M(2)	M(2)	M(2)	M(2)	S(3)
W,AV	1.8	1	2.2	1.4	1.4

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester – II</td></tr>
<tr><td>DSE</td><td>Course Code 533504</td><td>Computer Simulation and Modelling</td><td>T</td><td>Credits: 3</td><td>Hours: 3</td></tr>
<tr><td colspan="6">Unit - I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To acquire the knowledge of solving system of linear equations using an appropriate numerical methods</td></tr>
<tr><td colspan="6">Molecular Dynamics Simulations Introduction to Molecular Dynamics Simulations; Molecular Dynamics Programs, Trajectory, coordinates and acceleration; Newton's equation; Lennard-Jones Potential; Free Energy Calculations; Thermodynamics Integration; Chemical Potentials; Umbrella Sampling; Application of Molecular Dynamics Simulations.</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Students understand the scientific problems represented in mathematical forms such as differential equations and integral equations.</td><td>K2</td></tr>
<tr><td colspan="6">Unit - II</td></tr>
<tr><td>Objective 2</td><td colspan="5">Approximate the functions using polynomial interpolation numerical differentiation and integration using interpolating polynomials</td></tr>
<tr><td colspan="6">Characteristics of Molecular dynamics Molecular Dynamics Simulation Methods: Molecular Dynamics using simple models; Molecular Dynamics with continuous potentials; Constraint Dynamics; Time-dependent properties; Molecular Dynamics at Constant Temperature (The Anderson Thermostat and Nose-Hoover Thermostat); Molecular Dynamics at Constant Pressure; Conformational changes from Molecular Dynamics Simulations.</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Learners skilled with Numerical methods in order to solve scientific problems</td><td>K4</td></tr>
<tr><td colspan="6">Unit - III</td></tr>
<tr><td>Objective 3</td><td colspan="5">Acquire the knowledge of numerical solution of ordinary differential equation by single and multi step methods.</td></tr>
<tr><td colspan="6">Modelling Introduction to modeling -Importance of dynamic modeling-data model and process model-Molecular workbench model-computational engine-Molecular dynamic engine, Quantum dynamic engine-modeling and authoring system-delivery system and assessment system.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Students able to apply how to simulate nanotechnological materials systems with the aid of computation and simulation</td><td>K3</td></tr>
<tr><td colspan="6">Unit - IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">To obtain the solution of boundary value problems in partial differential equations using finite differences.</td></tr>
<tr><td colspan="6">Computer simulation Introduction to simulations- Janus –Faced character of simulations: simulation in Nanoscience, Epistemic status of simulations, experimental practice with theoretical instruments-.</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Students able to remember all branches including biology can understand and do simulations</td><td>K1</td></tr>
<tr><td colspan="6">Unit - V</td></tr>
<tr><td>Objective 5</td><td colspan="5">To Study simulation and monte-carlo methods and their applications</td></tr>
<tr><td colspan="6">Computational Nanoscience Introduction to computational analysis- Computation in Nanoscience- Density functional theory (DFT)- Band Structure and Some In-Class Simulation: DFT for Solids- Monte Carlo simulation: Quantum Monte carlo, computational chemistry and biology.</td></tr>
<tr><td>Outcome 5</td><td colspan="4">Students create mathematical and computational skill will be development and able to computations for making crystals and carbon nanotubes</td><td>K6</td></tr>
</table>

Suggested Readings:-

Andrew R. Leach (2001) "*Molecular Modeling – Principles and Applications*"; Second Edition, Prentice Hall, USA.

Daan Frenkel, Berend Smit (2002) "*Understanding Molecular Simulation: From Algorithms to Applications*"; Second Edition , Academic Press, USA.

Tavan, P., Carstens, H. and Mathias, G. (2008) *Molecular Dynamics Simulations of Proteins and Peptides*: Problems, Achievements, and Perspectives, in Protein Folding Handbook (eds J. Buchner and T. Kiefhaber, Wiley-VCH Verlag GmbH, Weinheim, Germany.

Charles Xie and Amy Pallant *The Molecular Workbench Software: An Innova-tive Dynamic Modeling Tool for Nanoscience Education*, USA.

Johannes LENHARD, D. Baird, A. Nordmann & J. Schummer (eds.*) Nanoscience and the Janus-Faced Character of Simulations,Discovering the Nanoscale* Amsterdam: IOS Press, 2004.

K1-Remember	*K2-Understand*	*K3-Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by

Dr. G. Ramalingam, Assistant Professor

Course Outcome Vs Programme Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S(3)	M(2)	M(2)	L(1)	M(2)	S(3)	S(3)	L(1)	M(2)	M(2)
CO2	L(1)	L(1)	-	S(3)	M(2)	M(2)	L(1)	S(3)	M(2)	S(3)
CO3	L(1)	L(1)	L(1)	M(2)	S(3)	L(1)	S(3)	M(2)	S(3)	S(3)
CO4	L(1)	M(2)	S(3)	S(3)	M(2)	L(1)	L(1)	M(2)	S(3)	S(3)
CO5	S(3)	M(2)	-	L(1)	L(1)	S(3)	M(2)	L(1)	M(2)	-
W.AV	1.8	1.6	1.2	2	2	2	2	1.8	2.4	2.2

S-S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	-	-	S(3)	L(1)
CO2	L(1)	-	M(2)	L(1)	S(3)
CO3	L(1)	M(2)	S(3)	-	M(2)
CO4	M(2)	S(3)	S(3)	M(2)	-
CO5	S(3)	(3)	L(1)	L(1)	L(1)
W.AV	1.8	1.6	1.8	1.4	1.4

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester – III</td></tr>
<tr><td>Core</td><td>Course code 533301</td><td>Nanobiotechnology and Nanomedicine</td><td>T</td><td>Credits: 4</td><td>Hours: 4</td></tr>
<tr><td colspan="6">Unit -I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To make the students understand the principles behind nanomedicine and its application.</td></tr>
<tr><td colspan="6">Concept of Nanobiotechnology & Nanomedicine: - Background, Tools of Nanotechnology in Biomedical applications. Different types of Nanomaterials used in Nanobiotechnology & Nanomedicine – organic nanomaterials: carbon and natural polymers-based nanomaterials; Inorganic nanomaterials: metal and metal oxide based nanomaterials and Hybrid nanomaterials: organic – organic, Inorganic – inorganic and organic – inorganic nanocomposites used for biological and pharmaceutical applications.</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Understand the concepts of nanotechnology which will help in tailoring nanomaterials for biomedical applications.</td><td>K2</td></tr>
<tr><td colspan="6">Unit II</td></tr>
<tr><td>Objective 2</td><td colspan="5">To provide insight on the role of nanotechnology in sustainable agriculture</td></tr>
<tr><td colspan="6">Nanotechnology in Agriculture: Nano-fertilizers efficient alternative to conventional fertilizers, pesticides and fungicides. Methods adapted for the application of nano-fertilizers on agricultural field – irrigation and foliar spray approach. Mechanism behind enhanced nutritional intake, nitrogen fixation and photosynthesis of plants using nano-fertilizers. Advantage of nano-fertilizers on plant environmental system for the protection from bacteria, fungal, pest factors and nutritional deficiency. Commercially available nano-fertilizers in the market - Fe_2O_3, $CaCO_3$ and ZnO nanoparticles.</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Fabricate nanofertilizers and nanobiosensors for sustainable agriculture</td><td>K6</td></tr>
<tr><td colspan="6">Unit III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To apprehend the recent updates on bionanomaterials for analysis and sensing techniques.</td></tr>
<tr><td colspan="6">Nanotechnology in Bioimaging and Diagnosis - Fluorophores and Quantum dots – Labeling and functionalization for bioimaging. Carbon based nanomaterials for bioimaging. Biocompatible quantum dots. Nano-biosensors –working principle, fabrication and types. Nano-biosensors for the detection of biomarkers in biofluids- glucose, urea, albumin, enzymes, DNA, antigens and neurotransmitters, detection of pathogenic microorganisms in agro and food products.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Develop smart and remote assessable sensors for biomedical application</td><td>K6</td></tr>
<tr><td colspan="6">Unit IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">To impart knowledge on principles of drug delivery systems and control of varied parameters for effective drug delivery</td></tr>
<tr><td colspan="6">Nanotechnology for Drug Delivery System: Physicochemical characteristics of nanocarriers - Size, dispersity, morphology, porosity and surface charge of nanoparticles. Types: Viral nanocarriers, Polymeric nanocarrier, lipid nanocarrier, carbon nanostructures, dendrimers, silica nanoparticles, antibody based nanocarriers. Basic fundamentals of drug delivery systems – drug loading, cellular uptake, diffusion, swelling ratio, controlled release and bioavailability of drugs. Kinetic parameters</td></tr>
</table>

involved in targeted drug release – pH, temperature and electrostatic interaction. Routes of drug administration using nanocarriers.		
Outcome 4	**Explore the possibility of applying and analyzing varied nanoparticles based targeted drug delivery**	**K4**
Unit V		
Objective 5	**To update the recent advancement in nanotechnology in the field biomedicine and regenerative medicine**	
Advanced applications of Nanomaterials in biomedical applications: Nanomedicine for cancer, cardiovascular disorders, neurodegeneration, microbial infections and wound healing applications. Nanomaterials for tissue engineering, dental and bone implants. Antioxidant, anti-inflammatory and Antithrombotic potential of nanomaterials. Advanced tools used in nanomedicine - regenerative medicines, nanorobots.		
Outcome 5	**Understand recent updates on nanotheranostics agents available for cancer treatment, orthopedics and neurological disorders**	**K5**

Suggested Readings:-

Logothetidis, S. (2014). *Nanomedicine and Nanobiotechnology*. Springer-Verlag.

Kalia, S., & Haldorai, Y. (2015). *Organic-inorganic hybrid nanomaterials*. Springer International Publishing.

Visakh, P. M., (2016). *Nanomaterials and nanocomposites: Zero to three dimensional materials and their composits*. Wiley-VCH.

Bawa, R. (2016). *Handbook of Clinical Nanomedicine: Nanoparticles, Imaging, Therapy, and clinical application*. CRC Press.

Panpatte, D. G., & Jhala, Y. K. (2019). *Nanotechnology for agriculture: Crop Production & Protection*. Springer.

Rai, M. (2015). *Nanotechnology in Diagnosis, Treatment and Prophylaxis of Infectious Diseases*. Academic Press.

Thakur, V. K. (2015). *Ecofriendly polymer nanocmposites: Chemistry and Applications*. Springer, India.

Thomas, S. (2015). *Nanotechnology Applications for Tissue Engineering*. Elsevier, USA.

Jogaiah, S. (2020). *Advances in nano-fertilizers and nano-pesticides in agriculture.* Elsevier.

Berezin, M. Y. (2015). *Nanotechnology for Biomedical Imaging and diagnostics: From Nanoparticle Design to Clinical Applications*. Wiley.

Vestergaard, M. C., Kerman, K., Hsing, I.-M., & Tamiya, E. (2015). *Nanobiosensors and nanobioanalyses*. Springer.

Grumezescu, A. M. (2017). *Nanobiosensors*. Elsevier.

Logothetidis, S. (2014). *Nanomedicine and Nanobiotechnology*. Springer-Verlag.

Siepmann Jürgen, Siegel, R. A., & Rathbone, M. J. (2012). *Fundamentals and applications of controlled release drug delivery*. Springer.

Hillery, A. M., & Park, K. (2017). *Drug delivery: Fundamentals and applications*. CRC Press.

Grumezescu, A. M. (2016). *Nanobiomaterials in soft tissue engineering*. WA, William Andrew, an imprint of Elsevier.

Chen, X. (2014). *Cancer Thernostics*. Academic press, Elseiver.

Ge, Y. (2014). *Nanomedicine: Principles and Perspectives*. Springer, Newyork.

Howard, 8. A. (2016). *Nanomedicine*. Springer Nature.
Lourtioz, J. (2014). *Nanosciences and Nanotechnology: Evolution or Revolution*. Springer, New York.
Mirkin, C. (2015). *Nanotechnology-Based Precision Tools for the Detection and Treatment of Cancer*. Springer International.
Pathak, Y. (2016). *Drug Delivery Nanoparticles Formulation and Characterization*. Informa Healthcare, USA.

Online Resources

https://epgp.inflibnet.ac.in/ahl.php?csrno=6https://nptel.ac.in/courses/118102003/
https://nptel.ac.in/courses/118107015/
https://onlinecourses.nptel.ac.in/noc17_bt17/preview
https://nptel.ac.in/courses/102104069

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course designed by
Dr. N. Suganthy, Assistant Professor

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)
CO2	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)
CO3	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
CO4	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)
W.AV	3	2.8	3	3	3	3	3	2.4	3	2.6

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	S(3)	M(2)	S(3)
CO2	S(3)	M(2)	L(1)	S(3)	S(3)
CO3	S(3)	S(3)	M(2)	M(2)	S(3)
CO4	L(1)	S(3)	S(3)	S(3)	S(3)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)
W.AV	2.6	2.8	2.4	2.6	3

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester – III</td></tr>
<tr><td>Core</td><td>Course code 533302</td><td>Nanoelectronics and Nano Devices</td><td>T</td><td>Credits: 4</td><td>Hours: 4</td></tr>
<tr><td colspan="6">Unit -I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To understand the basic concepts, involve in this technology for device architecture and interface engineering at atomic</td></tr>
<tr><td colspan="6">Basic of Nanoelectronics: - Basics of nanoelectronics – capabilities of nano electronics – physical fundamentals of nano electronics – basics of information theory – the tools for micro and nano fabrication – basics of lithographic techniques for nanoelectronics</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Learners remember different types of conventional and novel nanoelectronics devices for different applications</td><td>K1</td></tr>
<tr><td colspan="6">Unit-II</td></tr>
<tr><td>Objective 2</td><td colspan="5">To elaborate on the various application where nanoelectronics revolutionize fields promoting technology growth</td></tr>
<tr><td colspan="6">Memory Devices and Sensors: - Nano ferroelectrics – ferroelectrics random access memories – introduction – FeRAM circuit design – ferroelectric thin film properties and integration – Types of sensors- calorimetric sensors – electrochemical cells – surface and bulk acoustic devices – gas-sensitive FETs – resistive semiconductor gas sensors – Identification of hazardous solvents and gases – semiconductor sensor array.</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Students analysis significance of tunneling effect in nanoelectronics devices</td><td>K4</td></tr>
<tr><td colspan="6">Unit III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To enable them to grasp the principle and working mechanism of such nanoelectronic systems</td></tr>
<tr><td colspan="6">Spintronics: - Diffusive spin-dependent transport, spin-dependent scattering, GMR effect, spin-dependent tunneling, ballistic spin transport, Landau-Lifshitz Gilbert equation, micromagnetics (brief), spin transfer/torque.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Student understand the concepts of coulomb blockade and electron transport</td><td>K2</td></tr>
<tr><td colspan="6">Unit IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">To demonstrate how simulation can facilitate learning of fabrication process and device designing</td></tr>
<tr><td colspan="6">Semiconductor Nanodevices: - Single - Electron Devices; Nano scale MOSFET - Resonant Tunneling Transistor - Single Electron Transistors; Single-Electron Dynamics; Nanorobotics and Nanomanipulation; Mechanical Molecular Nanodevices; Nanotechnology and Nano computing - Augmented and Virtual Reality (AR/VR).</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Evaluation of electronic property of materials in mesoscopic level</td><td>K5</td></tr>
<tr><td colspan="6">Unit V</td></tr>
<tr><td>Objective 5</td><td colspan="5">To understand the limitations of silicon electronics and progress of nanoelectronics</td></tr>
<tr><td colspan="6">Electronic and Photonic Molecular Materials: - Preparation- Electroluminescent Organic materials- Laser Diodes – Quantum well lasers:- Quantum cascade lasers - Cascade surface – emitting photonic crystal laser – Quantum dots lasers – Quantum wire lasers:- White LEDs – LEDs based on nanowires, nanotubes and nanorods High Efficiency Materials for OLEDs – Quantum well infrared photo detectors-electronic properties of carbon based nanomaterials.</td></tr>
</table>

Outcome 5	Learners had create the underlying physical process governing to the operation of nanodevices	K6

Suggested Readings:-

Wilson, M. A., Raguse, B., Kannangara, K., Smith, G., & Simmons, M. (2014). *Nanotechnology: Basic science and emerging technologies*. Strawberry Hills,

Goser, K., Glösekötter, P., & Dienstuhl, J. (2004). *Nanoelectronics and nanosystems: From transistors to molecular and quantum devices*. Berlin: Springer.

Waser, R. (2012). Nanoelectronics and information technology: Advanced electronic materials and novel devices. Weinheim: Wiley-VCH.

Awschalom, D. (2004). Spin electronics. Dordrecht: Kluwer Academic.

Bloor, D., Bryce, M. R., & Petty, M. C. (1995). Introduction to molecular electronics: London: Arnold.

Botti, S. (2007). Physical Properties of Carbon Nanotubes. Trivandrum.

Shul, R. J. (2001). Wide-bandgap electronic devices. Warrendale, PA: Materials Research Society.

Kasap, S., & Capper, P. (2017). Springer handbook of electronic and photonic materials. Cham, Switzerland: Springer.

Online Resource

http://www.circuitstoday.com/nanoelectronics

https://link.springer.com/chapter/10.1007/978-94-015-9576-6_6

https://nptel.ac.in/courses/117108047/

https://nanohub.org/

https://www.researchgate.net/publication/320631898_Nanotechnology_and_Nano_computing

http://msl.cs.uiuc.edu/vr/vrch1.pdf

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course designed by

Dr. G. Ramalingam, Assistant Professor

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	S(3)	M(2)	L(1)	S(3)	L(1)	M(2)	M(2)	M(2)	M(2)
CO2	L(1)	S(3)	S(3)	L(1)	S(3)	S(3)	L(1)	S(3)	M(2)	S(3)
CO3	L(1)	S(3)	M(2)	M(2)	-	S(3)	S(3)	S(3)	L(1)	S(3)
CO4	M(2)	M(2)	M(2)	M(2)	S(3)	S(3)	M(2)	L(1)	M(2)	S(3)
CO5	S(3)	L(1)	M(2)	M(2)	L(1)	S(3)	M(2)	M(2)	M(2)	M(2)
W.AV	1.8	2.4	2.2	1.6	2	2.6	2	2.2	1.8	2.6

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	M(2)	S(3)	S(3)	-
CO2	M(2)	S(3)	M(2)	S(3)	M(2)
CO3	-	L(1)	-	S(3)	M(2)
CO4	L(1)	S(3)	M(2)	S(3)	(1)
CO5	M(2)	-	M(2)	S(3)	L(1)
W.AV	1.6	1.6	2	3	1.2

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester – III</td></tr>
<tr><td>Core</td><td>Course code 533303</td><td>Nano Engineering</td><td>T</td><td>Credits: 4</td><td>Hours :4</td></tr>
<tr><td colspan="6">Unit - I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To educate the new generation nanotechnologist to participate in, and indeed seed for new industrial revolution by understanding semiconductor nanostructures</td></tr>
<tr><td colspan="6">Semiconductor Nanostructures: - Overview- semiconductor physics, Fabrication techniques, Electronic structure and physical processes in semiconductor nanostructures, Optical Imaging -Lorentz Microscopy -Electron Holography of Magnetic Nanostructures -Magnetic Force Microscopy -Magnetic Data Storage -Introduction - Magnetic Media - Properties -Materials Used -Write Heads -Read Heads.</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Knowledge on semiconductor nanoengineering can make the nanotechnologist in future industrialist-fabrication and imaging techniques</td><td>K2</td></tr>
<tr><td colspan="6">Unit - II</td></tr>
<tr><td>Objective 2</td><td colspan="5">To them to the revolutionalizing field of molecular electronics</td></tr>
<tr><td colspan="6">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 logicgates.</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Various superior and common nanomaterials pertaining the improved performance of C-based nanoelectronic components</td><td>K3</td></tr>
<tr><td colspan="6">Unit - III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To enable students to develop a range of professional to enhance employment opportunities in a wide range of industrial and governmental institutions.</td></tr>
<tr><td colspan="6">Micro and Nanoelectrical Systems: - Overview- Micro and Nano-Electromechanical systems - Fundamental concepts - fabrication process- choice of materials, calculations - the performance of different structures - Nanoelectronic Devices - Approaches to Nanoelectronics - advantages and disadvantages of different approaches, thermal sensors, radiation sensors, magnetic sensors, chemical sensors, mechanical sensors, Micro actuators - Extension to the Nanoscale, Micro component assembly and packing.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Novel advanced micro and nano electronics application</td><td>K2</td></tr>
<tr><td colspan="6">Unit - IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">To prepare the students more knowledge for the workplace through NEMS and MEMS nanoscale engineering and to multidisciplinary teams</td></tr>
<tr><td colspan="6">Nanoscale Materials and Devices: - Electron Transport in Magnetic Multi-layers -Spintronics -Spin Polarized Electron Tunneling - The Datta-Das spin field effect transistor - Concept of the Datta–Das transistor - Interface tunnel barriers - Gate-induced spin rotation: The Rashba effect - Spin relaxation and spin dephasing - Interlayer Exchange Coupling -Spin Relaxation in Magnetic Metallic layers and Multi-layers -Non-Equilibrium Spin Dynamics in Laterally Defined Magnetic Structures.</td></tr>
</table>

Outcome 4	**Knowing various effect and phenomenon that are the principle behind the working of these nanoelectronic systems**	**K2**
	Unit - V	
Objective 5	**To form strong nano and photonic materials device technologist**	

Electronic and Photonic Molecular Materials and Devices: - Definitions, examples, hybridisation, conjugation, excitations, Molecular crystals, conducting vs semi conducting polymers, Electroluminescence from an Electrochemical Cell - injection, transport, Exciton formation, light emission, Influence of supramolecular order: excimers, H- and J-aggregates, liquid crystallinity.

Outcome 5	**Ideas on photoni smake the students suitable for nano technology industries**	**K1**

Suggested Readings:-

Bloor, D., Bryce, M. R., & Petty, M. C. (1995). *Introduction to molecular electronics:*. London: Arnold.

Current opinion in solid state & materials science. (n.d.). London, UK: Current Science. Diwan, P., & Bharadwaj, A. (2006). *Nanorobotics*. New Delhi: Pentagon Press.

Diwan, P., & Bharadwaj, A. (2006). *Nanorobotics*. New Delhi: Pentagon Press.

Duzer, T. V., & Turner, C. W. (1999). *Principles of superconductive devices and circuits*. Upper SaddleRiver, NJ: Prentice Hall PTR.

Feng, D., &Jin, G. (2005). *Introduction to condensed matter physics*. Singapore: World Scientific.

Goser, K., Glösekö tter, P., &Dienstuhl, J. (2004). *Nanoelectronics and nanosystems: From transistorstomolecular and quantum devices*. Berlin: Springer.

Hadziioannou, G., &Malliaras, G. G. (2007). *Semiconducting polymers: Chemistry, physics andengineering*. Weinheim: Wiley-VCH.

Heinzel, T. (2010). *Mesoscopic electronics in solid state nanostructures*. Weinheim: Wiley-VCH. Lu, G. Q., & Zhao, X. S. (2006). *Nanoporous materials: Science and engineering*. London: Imperial College Press.

Marder, M. P. (2015). *Condensed matter physics*. New York: John Wiley and Sons.

OHandley, R. C. (2000). *Modern magnetic materials: Principles and applications*. New York: Wiley. Verdeyen, J. T. (2003). *Laser electronics*. Taipei: Pearson Education Taiwan.

Wise, D. L., Wnek, G. E., &Trantolo, D. J. (1998). *Electrical and optical polymer systems: Fundamentals, methods and applications*. New York: Dekker.

Zhou, B., Hermans, S., &Somorjai, G. A. (2004). *Nanotechnology in catalysis*. New York: Springer.

Majumder, Manoj Kumar . (, 2020). *Introduction to Microelectronics to Nanoelectronics: Design and Technology*. United Kingdom, CRC Press.

Suvardhan Kanchi,. Deepali Sharma. (2020).*Nanomaterials in Diagnostic Tools and Devices.* Netherlands, Elsevier Science.

Online Resource

https://nptel.ac.in/downloads/115106076/

https://nptel.ac.in/syllabus/syllabus_pdf/115106076.pdf

nptel.ac.in/syllabus/syllabus_pdf/115104044.pdf *https://nptel.ac.in/courses/115106076/14*

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course designed by

Dr. P.Shakkthivel Professor

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	S (3)	S (3)	M(2)	M(2)	S (3)	S (3)	M(1)	S (3)	M(2)
CO2	S (3)	S (3)	S (3)	S (3)	S (3)	S (3)	M(2)	L(1)	S (3)	M(2)
CO3	S (3)	S (3)	S (3)	M(2)	S (3)	S (3)	S (3)	L(1)	S (3)	M(2)
CO4	S (3)	S (3)	M(2)	S (3)	S (3)	S (3)	M(2)	L(1)	M(2)	S (3)
CO5	S (3)	S (3)	M(2)	S (3)	S (3)	S (3)	S (3)	M(2)	S (3)	S (3)
W.AV	3	3	2.6	2.6	2.8	3	2.6	1.2	2.8	2.4

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	S(3)	S(3)	M(2)	S(3)
CO2	S(3)	M(2)	S(3)	M(2)	S(3)
CO3	S(3)	S(3)	M(2)	S(3)	M(2)
CO4	M(2)	S(3)	S(3)	M(2)	S(3)
CO5	S(3)	M(2)	M(2)	S(3)	M(2)
W.AV	2.6	2.6	2.6	2.4	2.6

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><th colspan="6">Semester- III</th></tr>
<tr><td>Core</td><td>Course code 533304</td><td>Microsystem Technology</td><td>T</td><td>Credits: 4</td><td>Hours: 4</td></tr>
<tr><td colspan="6">Unit-I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To learn about modern chip manufacturing, with the main focus to design MEMS devices</td></tr>
<tr><td colspan="6">Design and Process Methods: -Basics of electronic design- Electronic Design Automation (EDA), Design for Manufacturing (DFM) - Processing of substrate materials- Thin film deposition methods: Physical Vapor Deposition (Sputtering, evaporation, MBE, PLD etc), Fabrication-Patterning approaches-Thin film sensors, Pattern transfer-rapid prototyping and micro ECM and EDM..</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Students learn the basics and manufacturing process of microsystem devices</td><td>K2</td></tr>
<tr><td colspan="6">Unit-II</td></tr>
<tr><td>Objective 2</td><td colspan="5">To know about various fabrication methods for devices.</td></tr>
<tr><td colspan="6">Fabrication Process: - Silicon fabrication processes. Silicon micromachining (wet), Dr etching technologies for metals, semiconductors and insulators, Microsystems fabrication techniques- MEMS packaging hierarchy</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Learners able to create electronic devices</td><td>K6</td></tr>
<tr><td colspan="6">Unit- III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To construct the knowledge about concepts involving lithographic techniques</td></tr>
<tr><td colspan="6">Lithography: - Silicon MEMS fabrication technology, Advanced lithography (e-beam lithography, radiation for imaging (UV, X-rays, synchrotron, masking issues), Lithographically induced self-construction (LISC), Nano imprint lithography.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Acquire knowledge for the design of semiconductor devices through lithography techniques</td><td>K2</td></tr>
<tr><td colspan="6">Unit- IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">To educate the students about MEMS based sensor and its applications</td></tr>
<tr><td colspan="6">MEMS Packaging & Sensors: Types & controls - Technologies- Packaging of MEMS devices by anodic/fusion bonding, Pressure sensors and packaging, MEMS performance and evaluation. Bionanosensor devices- communicable disease and biological threat detection.</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Able to explore the Sensors fabrication, assembling, and function</td><td>K4</td></tr>
<tr><td colspan="6">Unit- V</td></tr>
<tr><td>Objective 5</td><td colspan="5">To apply knowledge on Development of device or chip designing protocols</td></tr>
<tr><td colspan="6">Industries Application: - System on chips (SOC)- System on package (SOP)- Non-silicon MEMS and related fabrication techniques- Si carbide MEMS- Biomedical MEMS -Integration of Microsystems with electronics including RF MEMS and the exploitation of Microsystems.</td></tr>
<tr><td>Outcome 5</td><td colspan="4">Learners will have Capability to fabricate MEMS devices for Practical application</td><td>K3</td></tr>
</table>

Suggested Readings:-

Dieter, G. E. (1991). *Engineering design: A materials and processing approach*. McGraw-Hill.

Beeby, S. (2004). *MEMS mechanical sensors*. Boston: Artech House.

CERAMIC MATERIALS FOR ELECTRONICS. (2019). S.l.: CRC PRESS.

Implications of emerging micro- and nanotechnologies. (2002). Washington, D.C.: National Acad. Press. Meisami, E., & Timiras, P. S. (1988). *Handbook of human growth and developmental biology*. BocaRaton, FL: CRC Press.

Harper, C. A. (2000). *Electronic Packaging and Interconnection Handbook*. McGraw-Hill. Pileni, M. P. (2005). *Nanocrystals forming mesoscopic structures*. Chichester: John Wiley distributor.

Tay, F. E. (2002). *Materials & process integration for MEMS:*. Boston: Kluwer Acad. Publ.

Online Resource

https://epgp.inflibnet.ac.in/ahl.php?csrno=6

https://epgp.inflibnet.ac.in/ahl.php?csrno=831

http://www.owlnet.rice.edu/~phys534/notes/week07_lectures.pdf

http://www.cense.iisc.ac.in/research/mems-and-nems-sensors

http://faculty.uml.edu/zgu/Teaching/documents/Lecture04-24-13.pdf

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by **Dr. K. Gurunathan,Professor & Head**

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	M(2)	M(2)	M(2)	M(2)	M(2)	L(1)	L(1)	M(2)	M(2)
CO2	M(2)	M(2)	M(2)	S(3)	M(2)	S(3)	S(3)	L(1)	S(3)	M(2)
CO3	S(3)	S(3)	M(2)	M(2)	S(3)	S(3)	L(1)	L(1)	S(3)	M(2)
CO4	S(3)	S(3)	S(3)	M(2)	M(2)	M(2)	M(2)	M(2)	S(3)	M(2)
CO5	S(3)	M(2)	M(2)	S(3)	M(2)	S(3)	L(1)	M(2)	S(3)	S(3)
W.AV	2.8	2.4	2.2	2.4	2.2	2.6	1.6	1.4	2.8	2.2

S-Strong (3), M-Medium (2), L- Low (1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	M(2)	S(3)	S(3)	M(2)
CO2	S(3)	L(1)	M(2)	S(3)	S(3)
CO3	S(3)	S(3)	S(3)	M(2)	S(3)
CO4	S(3)	S(3)	M(2)	M(2)	M(2)
CO5	S(3)	S(3)	L(1)	M(2)	S(3)
W.AV	2.8	2.4	2.2	2.4	2.6

S-Strong (3), M-Medium (2), L- Low (1)

Semester-III					
Core	**Course code 533307**	**Nano science and Technology-lab III (Nano-biotechnology Experiments)**	**P**	**Credits:4**	**Hours: 8**

	Unit -I	
Objective 1	**Teach students about safe and good laboratory practice to be followed in microbiology, biochemistry and nanotechnology lab.**	
	1. Introduction to Nanobiology Laboratory - Instrumentation, Good Laboratory Practices, Demonstration of bio-safety measures, Autoclaving and sterilization of culture media 2. Handling biological samples and BSL Facilities (Plant origin, Animal Origin, Microbiological) 3. Preparation of buffers and Ph measurement	
Outcome 1	**Students will acquire basic knowledge on handling instruments**	**K1**
	Unit -II	
Objective 2	**To cater the students on techniques for isolation and culturing of microorganism**	
	1. Handling and culturing of microorganisms: Plate pouring, streaking and inoculation 2. Bacterialcharacterizationbystainingtechniquesandbiochemicaltests. 3. Measurement of growth-Growth curve 4. Preservation and maintenance of microbial cultures. 5. Isolation and quantification of DNA and Protein from microbial source- Agarose Gel Electrophoresis and (ii) SDS – PAGE Electrophoresis 6. Estimation of Protein – Bardford Method/Lowry method	
Outcome 2	**Learners will obtain knowledge in handling microbial and molecular biology techniques**	**K2**
	Unit - III	
Objective 3	**Developtheskillsingreensynthesisofnanoparticlesandassessitsantimicrobialactivity**	
	1. Microbial synthesis of nanoparticles from bacteria and fungi–Metal (Ag, Pd), metal oxide (CuO, TiO2, Fe_2O3) 2. Phytomediated synthesis of nanoparticles – ZnO, MgO. 3. Techniques for nanoparticle separation – Centrifugation, Sedimentation 4. Characterization of synthesized nanoparticles	
Outcome 3	**Apply the knowledge on biomimetics for biogenic route synthesis of nanoparticles and apply it in the field of biological research.**	**K3**
	Unit IV	
Objective 4	**Decipher the knowledge of interaction of nanoparticle with the living system**	
	1. Assessment of antimicrobial activity of synthesized nanoparticles. 2. Immobilization of synthesized nanoparticles. 3. Evaluating the biological activity of immobilized nanoparticles 4. Bioconjugation of nanomaterials with DNA and Protein.	
Outcome 4	**Proficient in synthesizing and characterizing nanoparticles that finds applications in biomedical and industrial set ups**	**K5**

Unit V		
Objective 5	**To provide basic insights on the toxicity evaluation of nanomaterials**	
1. Assessment of toxic effect of nanomaterials under *in vitro* conditions 2. Assessment of hemolytic effect of nanomaterials under *in vitro* conditions 3. Toxicity evaluation of nanomaterials under *in vivo* conditions using *Artemia salina*, Zebra fish as model system.		
Outcome 5	**Design and conduct experiments to evaluate the toxicity of fabricated nanomaterials**	**K6**

Suggested Readings:-

Green, M. R., & Sambrook, J. (2012). Molecular cloning. *A Laboratory Manual 4th*..
Bergey, D. H. (1994). *Bergey's manual of determinative bacteriology*. Lippincott Williams &Wilkins..Kannan,N.(2002).*LaboratoryManualin GeneralMicrobiology*. Panima.
Katoch, P. (2016). *Analytical techniques in Biochemistry and Molecular Biology*. Springer New York.Katoch, R. (2011). *Analytical techniques in Biochemistry and Molecular Biology*. Springer New York.Poinern, G. E. J. (2014). *A laboratory course in nanoscience and nanotechnology*. CRC Press.
Singh,O.V.(2015).*Bio-Nanoparticles:BiosynthesisandSustainableBiotechnologicalImplications*,. Wiley-Blackwell.

Online Resource

https://vlab.amrita.edu/?sub=3&brch=73

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by
Dr. N. Suganthy, Assistant Professor

Course Outcome Vs Programme Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M(2)	M(2)	L(1)	M(2)	S(3)	M(2)	S(3)	S(3)	L(1)	M(2)
CO2	M(2)	M(2)	L(1)	L(1)	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)
CO3	M(2)	M(2)	L(1)	S(3)	S(3)	M(2)	S(3)	S(3)	M(2)	L(1)
CO4	S(3)	L(1)	L(1)	M(2)	M(3)	M(2)	S(3)	S(3)	S(3)	M(2)
CO5	S(3)	M(2)	M(2)	S(3)	S(3)	S(3)	M(2)	M(2)	S(3)	S(3)
W.AV	2.6	1.8	1.2	2.2	3	2.2	2.8	2.8	2.2	2.4

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	M(2)	L(1)	S(3)	M(2)	L(1)
CO2	L(1)	M(2)	S(3)	M(2)	L(1)
CO3	L(1)	S(3)	M(2)	L(1)	M(2)
CO4	M(2)	M(2)	M(2)	S(3)	L(1)
CO5	S(3)	M(2)	M(2)	S(3)	L(1)
W.AV	1.8	2	2.4	2.2	1.2

S-Strong(3), M-Medium(2), L- Low

Semester – III					
DSE	**Course code 533505**	**POLYMER NANOCOMPOSITES**	**T**	**Credits: 2**	**Hours: 3**
Unit - I					
Objective 1	**To introduce students to the classification of nanocomposites**				
Nanocomposite Classification Classification – Hydrolysis – synthesis – mechanical analysis – polyphosphazene nanocomposite – Nanocomposite applications – polymer nanocomposites – processing polymer nanocomposites – clay containing polymeric nanocomposites (CPNC) – synthetic processing of clay based nanocomposites.					
Outcome 1	**Learned basic and fundamental aspects of polymer nanocomposites and their properties**	**K2**			
Unit - II					
Objective 2	**To obtain knowledge on various biodegradable polymers and their properties**				
Biodegradable polymers Definition and categories – properties and drawbacks – polymer / layered silicate nanocomposite technology – techniques used for the characterization of nanocomposites – biodegradable polymers and their nanocomposites - biodegradability – foam processing of biodegradable nanocomposites					
Outcome 2	**Familiarize the students various techniques preparation methods of biodegradable polymers**	**K1**			
Unit - III					
Objective 3	**To acquire details about rubber clay nanocomposites and their various types.**				
Rubber clay nanocomposites Overview of rubber - natural rubber – synthetic polyisoprene - styrene butadiene rubber – butyl rubber – polybutadiene – ethylene propylene rubber – silicone rubbers- nitrile rubber – Rubber crosslinking systems – types of rubber clay nanocomposite – preparation – structure – silicon rubber clay nanocomposites.					
Outcome 3	Enable them to discern the use of rubber materials for appropriate applications	**K4**			
Unit - IV					
Objective 4	**To enable them to be aware of the magnetic polymer nanocomposites covering areas of preparation and characterization**				
Magnetic polymer nanocomposite Introduction – classification of magnetic polymer nanocomposites – Powders and suspensions – fibers – films – synthesis – precipitation of the magnetic component – mixing of the polymer and the magnetic component – In situ polymerization – In situ precipitation – characterization – transition electron microscopy – high resolution electron microscopy – electron energy loss spectroscopy – mapping magnetic and electric fields – magnetic properties – single domain particles – superparamagnetism.					
Outcome 4	**Aware of the importance of polymer magnetic nanocomposite in the field of research and their interest around the world**	**K3**			
Unit - V					
Objective 5	**To emphasize on the property of wear resistance of polymer nanocomposites**				
Wear resisting polymer nanocomposites Introduction – surface treatment – physical methods – chemical methods – wear performance and mechanisms – effect of size and content of the nano fillers – Tribochemistry - effect of surface treatment of the nano fillers.					

Outcome 5	How polymer composites enhance variety of properties in variety of application fields	K6

Suggested Readings:-

Yiu-Wing Mai and Zhong-Zhen Yu, Polymer nanocomposites, -. CRC Press Boca Raton Boston New york Washing ton, DC. and Woodhead publishing ltd, England, 2006.

Parag Diwan and Ashish Bharadwaj, Nanocomposites, Pentagon Press.

Pulickel M. Ajayan , Linda S. Schadler, Paul V Braun, Nanocomposite Science and Technology,Wiley-VCH,2006.

Gero Decher, Joe Schlenoff, Multilayer Thin Films, Wiley-VCH, 2006.

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course designed by

Dr. P. Shakkthivel, Professor

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S(3)	S(3)	M(2)	M(2)	M(2)	M(2)	L(1)	L(1)	M(2)	M(2)
CO2	S(3)	S(3)	S(3)	M(2)	S(3)	L(1)	M(2)	L(1)	S(3)	L(1)
CO3	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	L(1)	S(3)	S(3)
CO4	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	L(1)	S(3)	S(3)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	S(3)
W.AV	3	3	2.8	2.4	2.8	1.8	2.4	1.2	2.8	2.4

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	M(2)	S(3)	M(2)	S(3)
CO2	M(2)	S(3)	M(2)	S(3)	M(2)
CO3	S(3)	M(2)	S(3)	S(3)	S(3)
CO4	M(2)	S(3)	S(3)	M(2)	M(2)
CO5	S(3)	M(2)	M(2)	M(2)	S(3)
W.AV	2.6	2.4	2.6	2.4	2.6

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester – III</td></tr>
<tr><td>DSE</td><td>Course code 533506</td><td>NANO BIOMATERIALS AND NANOBIOTECHNOLOGY FOR TISSUE ENGINEERING</td><td>T</td><td>Credits: 2</td><td>Hours: 3</td></tr>
<tr><td colspan="6">Unit I</td></tr>
<tr><td>Objective1</td><td colspan="5">To understand the material classifications in orthodontic and dental implants and their limitations</td></tr>
<tr><td colspan="6">Orthopedic Orthopedic implants-materials used- modes of failure - wear debris; stress and strain imbalances at the tissue implant interface. Dental: Dental materials used- modes of dental implants failure –debris: stress and strain imbalances at the tissue implant interface.</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Attain knowledge for optimizing nanomaterials in tissue engineering</td><td>K3</td></tr>
<tr><td colspan="6">Unit II</td></tr>
<tr><td>Objective 2</td><td colspan="5">To gain the knowledge about the materials used in the chondrocyte and vascular grafts</td></tr>
<tr><td colspan="6">Cartilage Cartilage materials used-modes of cartilage implant failure –wear debris : stress and strain imbalances at the tissue implant interface; Vascular: vascular materials used –modes of vascular implant failure - wear debris stress and strain imbalances at the tissue implant interface.</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Exposure gained from the subject to be useful for the advanced medical inventions in the field of stomatology</td><td>K3</td></tr>
<tr><td colspan="6">Unit III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To impart detailed knowledge about the need and challenges of cartilage transplants in the body</td></tr>
<tr><td colspan="6">Bladder Bladder implant materials used –modes of cartilage implant failure - stress and strain imbalances at the tissue implant interface.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Gain insight on interaction of nanomaterials with the biological cells providing source of information for the new inventions</td><td>K4</td></tr>
<tr><td colspan="6">Unit IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">To understand the pharmacodynamics of nano-implants in the body</td></tr>
<tr><td colspan="6">Implantation Advantages of Nanomaterials use as implants – biological response of implanted materials – desirable and undesirable reactions of the body with implanted materials</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Basic information obtained from this subject provides the opportunity in the nanotechnology-based tissue engineering research</td><td>K5</td></tr>
<tr><td colspan="6">Unit V</td></tr>
<tr><td>Objective 5</td><td colspan="5">To provide information on mode of interactions of the nanomaterials with biological molecules</td></tr>
<tr><td colspan="6">Applications of Implantation Protein interactions with implanted materials : -Cellular recognition of Proteins Absorbed on materials surfaces – adhesion - migration differentiation- Cellular Extra cellular matrix deposition leading to tissue regeneration – foreign body response – inflammatory response</td></tr>
</table>

Outcome 5	**Students will develop innovative ideas and approaches for the construction of bio-transplants with nanosized materials**	**K6**

Suggested Readings:-

Jon J.Kellar, Functional fillers and nanoscale minerals; new markets / new horizons; SME science,2006.

Chellakumar, Tissue, Cell and Organ Engineering, Wiley-VCH, 2006.

R.Haffman and E.D.Zanjani, Stem Cell Transplantation, Wiley-VCH, 2005.

Richard S.Silberglit, Philip S.Anton, James Schneider, The global technology revolution: bio/nano/materials trends and their synergies with information; Rand Corporation; 2001.

Joachim Schnmmer, Davis Barid, Nanotechnology Challenges: implications for Philosophy - Ethics and Society; World Scientific; 2006.

Davis Baird, Alfred Nordmann, Joachim Schummer, Discovering the nanoscale - IOP press; 2004.

William A. Goddard, Sergey, Edward Lyshevski, Donald W.Brenner, Hand book of nanoscience, Engineering and technology , CRC press; 2003.

Mark A.Ratner, Daniel Ratner, A gentle introduction to next big idea - Nanotechnology: Prentice Hall PTR; 2003.

William Sims Bainbridge, Mihail C.Roco, Societal implication of Nanoscience and Nanotechnology , Springer; 2001.

B.C.Cradall, Molecular speculations on global abundance - Nanotechnology: MIT press;1996.

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by
Dr. N. Suganthy, Assistant Professor

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	M(2)	M(2)	M(2)
CO2	S(3)	S(3)	S(3)	M(2)	M(2)	S(3)	M(2)	M(2)	M(2)	M(2)
CO3	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	M(2)	M(2)
CO4	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)
W.AV	2.8	3	3	2.8	2.8	3	2.6	2.2	2.2	2.4

Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	L(1)	S(3)	S(3)	M(2)	M(2)
CO2	M(2)	S(3)	S(3)	S(3)	M(2)
CO3	M(2)	M(2)	M(2)	S(3)	L(1)
CO4	M(2)	M(2)	M(2)	S(3)	M(2)
CO5	M(2)	S(3)	S(3)	S(3)	S(3)
W.AV	1.8	2.6	2.6	2.8	2

Strong(3), M-Medium(2), L- Low(1)

Semester- IV					
Core	**Course code 533401**	**Nanotoxicology**	**T**	**Credits: 4**	**Hours: 4**

Unit - I		
Objective 1	**To impart knowledge on diverse dimensions of nanomaterials and its interaction with environment**	
Introduction: - Nanopollution – Natural source, anthropogenic source, Environmental and occupational exposure, Aerosol, Entry routes into the human body – Lungs, intestinal tract, skin, Physicochemical characteristics of nanomaterials – Effect of size, shape, surface charge, solubility and surface coatings		
Outcome 1	**Acquire knowledge on routes of entry of nanomaterials, its physiochemical properties and its impact in environmental pollution**	**K1**
Unit II		
Objective 2	**To provide insight on mechanism of interaction of nanomaterials in cellular system**	
Mechanism of cellular interaction: - Interactions of Nanoparticles with Cells and their Cellular Nanotoxicology – Cellular uptake, Reactive oxygen species mediated toxicity - Oxidative stress, inflammation, genotoxicity, hemolytic activity and Immunotoxicity.		
Outcome 2	**Understand the mode of cellular entry of nanoparticles and its mechanism of action**.	**K2**
Unit III		
Objective 3	**To create awareness regarding the toxic effect of nanomaterial to human health**	
Human exposure to Nano sized Materials: - Nanoparticles interaction with biological membrane, Disposition of NSPs in the respiratory tract, Studies of neuronal translocation of UFPs from respiratory tract, Neuronal uptake and translocation, Translocation to the circulatory and lymphatic system, Translocation of NSPs in the liver, spleen and kidney, Exposure via GI Tract and Skin, toxicity of nanoparticles in the eye.		
Outcome 3	**Relate properties of nanomaterials with their transport, uptake, reactivity and toxicity in human system**	**K2**
Unit IV		
Objective 4	**To introduce students to various tests and model systems available for toxicity evaluation**	
Assessment of nanotoxicity: Toxicity assessment- Laboratory rodent studies, Ecotoxicologic studies, Methodology for Nanotoxicology: *in vitro* toxicity studies - Cell viability (MTT assay, lactate dehydrogenase release), ROS generation, genotoxicity (Comet assay and DNA fragmentation assay), mutagenicity (Ames test), and Hemolytic assay. *In vivo* toxicity testing – Zebra fish and Mice/Rat as model system: Acute and subacute toxicity studies, LD 50 and LD90 determination.		
Outcome 4	**Learners critically evaluate the toxicity of nanomaterials using various model system**	**K5**

Unit V		
Objective 5	**To emphasize the ethical agenda to be followed while using nanomaterials**	
Dosimetry, Risk Assessment and Execution: - Inhaled nanoparticle dosimetry, Risk assessment – Understanding the social impact of nanotechnology, Ethical, Legal and Social Implications, Development of Test Protocols for Nanomaterials – Regulation of Engineered Nanomaterials, Exploration of patent matters associated with nanotechnology, nanomedicine and nanopharmacology		
Outcome 5	**Learners acquire information on ethics laws and regulation of nanomaterials to comprehend the challenges and risk involved in nanotechnology**	**K3**

Suggested Readings

Duran, N. (2014). *Nanotoxicology: Materials, Methodologies, and Assessments*. Springer, Newyork.

Gatti, (2015). *Case Studies in Nanotoxicology and Particle Toxicology*. Academic Press.

Kumar, V. (2018). *Nanotoxicology: Toxicity Evaluation, Risk Assessment and Management*. CRC press.

Monteiro-Riviere (2014). *Nanotoxicology: Progress towards Nanomedicine*. CRC Press, Taylor and Franscis.

Njuguna, J. (2014). *Health and Environmental Safety of Nanomaterials: Polymer Nan0composites and other material containing nanoparticles*, Woodhead Publishing, Elsevier, UK.

Otsuki, T. (2016). *Biological Effects of Fibrous and Particulate Substances*. Springer, Japan. Ramachandran, G. (2011). *Assessing Nanoparticle Risks to Human Health*. Elsevier, USA. Salem, (2015). *Inhalation Toxicology*., CRC Press, London.

Sutariya, V. (2014). *Biointeractions of Nanomaterials*. CRC press.

Nancy A. Monteiro-Riviere, C. Lang Tran, *Nanotoxicology: Progress towards Nanomedicine*, Second edition, CRC Press, Taylor and Franscis, Boca Raton, 2014.

G. Ramachandran, *Assessing Nanoparticle Risks to Human Health*, William Andrew, Elsevier, USA, 2011

J. Njuguna, K. Pielichowski, H. Zhu, *Health and Environmental Safety of Nanomaterials: Polymer Nancomposites and other material containing nanoparticles*, Woodhead Publishing, Elsevier, UK, 2014.

Online Resource

http://textofvideo.nptel.ac.in/102107058/lec20.pdf
http://www.nitttrc.edu.in/nptel/courses/video/102108077/L63.html
http://www.digimat.in/nptel/courses/video/102107058/L20.html
https://www.slideshare.net/rijuchandran/nanotoxicology

K1-Remember	K2-Understand	K3- Apply	K4-Analyze	K5-Evaluate	K6-Create

Course designed by
Dr. N. Suganthy, Assistant Professor

Course Outcome Vs Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	S(3)	M(2)	M(2)	M(2)	M(2)	M(2)	M(2)	S(3)	S(3)
CO2	S(3)	S(3)	M(2)	M(2)	M(2)	S(3)	M(2)	M(2)	S(3)	M(2)
CO3	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)	M(2)	M(2)	S(3)	M(2)
CO4	S(3)	S(3)	M(2)	S(3)	M(2)	M(2)	M(2)	M(2)	S(3)	M(2)
CO5	S(3)	S(3)	S(3)	S(3)	M(2)	M(2)	M(2)	M(2)	M(2)	M(2)
W.AV	2.8	3	2.2	2.6	2	2.2	2	2	2.8	2.2

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	S(3)	S(3)	S(3)	M(2)
CO2	M(2)	S(3)	M(2)	S(3)	M(2)
CO3	M(2)	S(3)	S(3)	S(3)	M(2)
CO4	M(2)	S(3)	S(3)	S(3)	M(2)
CO5	M(2)	S(3)	S(3)	S(3)	M(2)
W.AV	2.2	3	2.8	3	2

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><th colspan="6">Semester-II</th></tr>
<tr><th>NME</th><th>Course code</th><th>Introduction to Nano Scale in Science and Technology</th><th>T</th><th>Credits: 2</th><th>Hours: 3</th></tr>
<tr><td colspan="6">Unit -I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To introduce students to the history and basic of origin of Nanotechnology</td></tr>
<tr><td colspan="6">Scientific Revolutions: - Types of Nanomachines and Nanotechnology-Periodic table- Atomic structure molecules and phase energy-Molecular and atomic size-Surfaces and dimensional space-Top down and bottom up.</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Basics of nanotechnology in physical and chemical points of view</td><td>K1</td></tr>
<tr><td colspan="6">Unit-II</td></tr>
<tr><td>Objective 2</td><td colspan="5">To introduce students to the various forces of bonding and how they dominate the regime at nanoscale. To teach the various synthesis of such nanomateirals</td></tr>
<tr><td colspan="6">Chemical bonding: - Forces between atoms and molecule particles and grain boundaries surfaces-Strong inter molecular forces-Electrostatic and Vander Waals forces between surfaces-Similarities and differences between intermolecular and inter particle forces- covalent and coulomb interactions-Basic principles of Nano Scale materials, Synthesis, processing, Mechanical grainding,wet chemical synthesis- Sol-gel processing</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Be well-versed in the common yet widely used methods of synthesis of nanomaterials</td><td>K2</td></tr>
<tr><td colspan="6">Unit III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To study the band structures at nanoscale</td></tr>
<tr><td colspan="6">Band structure: - Opportunity at the nano scale-length and time scale in structures- energy landscapes-Inter dynamic aspects of inter molecular forces-Evolution of band structure and Fermi surface.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Familiarize the concept of quantum dots and their unique behavioral attributes</td><td>K4</td></tr>
<tr><td colspan="6">Unit IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">To introduce them to the fundamentals of quantum scale and biological membranes</td></tr>
<tr><td colspan="6">Quantum scale and biological membranes: - Quantum dots - Nano wires - Nano tube2D and 3D films Nano and mesopores, miscelles bilayers, vesides-binano machines- biological membranes.</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Well – equipped in the basic of nanomaterials in biological membranes</td><td>K3</td></tr>
</table>

Unit V		
Objective 5	**To introspect the various fascinating properties of nanomaterials explained with appropriate examples**	
Properties: - Influence of nano structuring on Mechanical, optical, electronic, magnetic and chemical properties-Grain size effects on strength of metals optical properties of quantum dots and quantum wires-electronic transport in quantum wires and carbon nano tubes-magnetic behavior of single domain particles and nanostructures –surface chemistry of tailored monolayer-self assembling.		
Outcome 5	**Be acquainted with unique examples to understand nanomaterial's various fascinating properties that finds application in various technologies we rely on**	**K5**

Suggested Readings:

Hornyak, G. L. (2009). *Fundamentals of nanotechnology*. Boca Raton: CRC Press.

Fiorani, D. (1994). *Fundamental properties of nanostructured materials: National School of the Condensed Matter Group, Rimini, Italy, September 20-25, 1993*. Singapore: World Scientific.

Goddard, W. A. (2007). *Handbook of nanoscience, engineering, and technology*. Boca Raton, FL: CRCPress.

Poole, C. P., & Owens, F. J. (2010). *Introduction to nanotechnology*. New Delhi: Wiley India.

Ratner, M. A., & Ratner, D. (2008). *Nanotechnology: a gentle introduction to the next big idea*. UpperSaddle River, NJ: Prentice Hall Professional Technical Reference.

Timp, G. (1998). *Nanotechnology*. New York: AIP Press.

K1-Remember	***K2-Understand***	***K3- Apply***	***K4-Analyze***	***K5-Evaluate***	***K6-Create***

Course Designed by

Prof. K. Gurunathan/Dr. G. Ramalingam, Assistant Professor

Course Outcome Vs Programme Outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M(2)	S(3)	S(3)	L(1)	M(2)	M(2)	M(2)	M(2)	M(2)	L(1)
CO2	S(3)	S(3)	S(3)	M(2)	M(2)	L(1)	S(3)	L(1)	S(3)	S(3)
CO3	M(2)	M(2)	S(3)	S(3)	S(3)	L(1)	S(3)	L(1)	M(2)	M(2)
CO4	M(2)	M(2)	L(1)	M(2)	L(1)	M(2)	S(3)	M(2)	M(2)	M(2)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	M(2)
W.AV	2.4	2.6	2.6	2.2	2.2	1.8	2.8	1.8	2.4	1.8

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	S(3)	M(2)	M(2)	S(3)	M(2)
CO2	M(2)	S(3)	M(2)	S(3)	S(3)
CO3	S(3)	M(2)	M(2)	M(2)	M(2)
CO4	M(2)	M(2)	S(3)	S(3)	M(2)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)
W.AV	2.6	2.4	2.4	2.8	2.4

S-Strong(3), M-Medium(2), L- Low(1)

<table>
<tr><td colspan="6">Semester - III</td></tr>
<tr><td>NME</td><td>Course code</td><td>Nanotechnology and Advanced Drug Delivery System</td><td>T</td><td>Credits: 2</td><td>Hours:3</td></tr>
<tr><td colspan="6">Unit I</td></tr>
<tr><td>Objective 1</td><td colspan="5">To provide an over view on the unique characteristic features of nanomaterials, its synthesis and characterization.</td></tr>
<tr><td colspan="6">Basic concepts of Nano-science and technology: Properties and technological advantages of Nanomaterials - Quantum wire, Quantum well, Quantum dots and Carbon nanotubes: Synthesis – Top down and bottom up approaches; Characterization - Spectroscopic techniques and Microscopic observations.</td></tr>
<tr><td>Outcome 1</td><td colspan="4">Understand the basic concepts on fabrication of nanomaterials for biomedical application</td><td>K1</td></tr>
<tr><td colspan="6">Unit II</td></tr>
<tr><td>Objective 2</td><td colspan="5">To provide insight on various nanocarriers for effective drug and gene delivery.</td></tr>
<tr><td colspan="6">Fundamentals and types of Nanocarriers: Types - Viral nanocarriers, Polymeric nanocarrier, lipid nanocarrier, carbon nanostructures, dendrimers, silica nanoparticles, Microbes and antibody based nanocarriers; Physicochemical properties - Size, Surface, Magnetic and Optical Properties</td></tr>
<tr><td>Outcome 2</td><td colspan="4">Gain a broad understanding on nanocarriers and its applications in the field of biomedicine</td><td>K2</td></tr>
<tr><td colspan="6">Unit III</td></tr>
<tr><td>Objective 3</td><td colspan="5">To understand the principles of drug delivery systems and control of varied parameters for effective drug delivery</td></tr>
<tr><td colspan="6">Nanotechnology for Drug Targeting: - Drug targeting – Targeted (Microneedles, Micropumps, microvalves, Implantable microchips), non-targeted delivery, controlled drug release; Nanoparticle surface modification – bioconjugation, peglyation, antibodies cell-surface targeting, diseased tissue destruction using nanoparticles, drug encapsulation strategies.</td></tr>
<tr><td>Outcome 3</td><td colspan="4">Apply the concept of nanobased drug delivery system for targeted drug delivery</td><td>K3</td></tr>
<tr><td colspan="6">Unit IV</td></tr>
<tr><td>Objective 4</td><td colspan="5">To update the advancement of nanomaterials in bioimaging and biosensors</td></tr>
<tr><td colspan="6">Nanotechnology for Imaging and Detection: - Fluorophores and Quantum dots - Labeling and functionalization, Image analysis, Imaging facilitating surgical approaches; Nanoparticles for bioanalytical applications – Biosensors - DNA and Protein based biosensors – materials for biosensor applications- fabrication of biosensors. Use of nanoparticles for MRI, X Ray, Ultrasonography Drug Delivery.</td></tr>
<tr><td>Outcome 4</td><td colspan="4">Apply the knowledge for the development of nano-drug delivery systems for the sensing, diagnosis and therapy</td><td>K4</td></tr>
</table>

Unit V		
Objective 5	**To impart knowledge on recent development in nanotechnology in cancer therapy and regenerative medicine**	
Nanomedicine: - Nanotechnology in Cancer Therapy - Passive and Active Targeting Strategies in Cancer with a Focus on Nanotechnology Applications, Multifunctional Nanoparticles for Cancer Therapy - Neutron Capture Therapy of Cancer, Nanoneurology – Nano cardiology - Nano-Orthopedics - Nano-Ophthalmology.		
Outcome 5	**Critically evaluate the recent trends in nanomedicine and apply in focused clinical area**	**K6**

Suggested Readings: -

Bulte, J. W., & Modo, M. M. (2016). *Design and Applications of Nanoparticles in Biomedical Imaging*. Spinger. doi:10.1007/978-3-319-42169-8

Kumar, P., & Srivastava, R. (2016). *Nanomedicine for Cancer Therapy: From Chemotherapeutic to Hyperthermia-Based Therapy*. Springer International Publishing. doi:10.1007/978-3-319-45826-7

Malhotra, B., & Ali, M. A. (2017). *Nanomaterials for Biosensors (1st ed.).* Elsevier.

Mishra, V., Kesharwani, P., Amin, M., & Iyer, A. (2017). *Nanotechnology-Based Approaches forTargeting and Delivery of Drugs and Genes*. Academic Press.

Mohapatra, S., Ranjan, S., Dasgupta, N., & Mishra, R. (2019). *Nanocarriers for drug delivery,Nanoscience and Nanotechnology in drug delivery*. Amsterdam: Elseiver.

Nikolelis, D., & Nikoleli, G. (2018). *Nanotechnology and Biosensors*. Amsterdam: Elseiver.

Jain, K. K. (2017). *The Handbook of Nanomedicine* (Third ed.). Humana Press.

Shah, M. M., Imran, M., & Ullah, S. (2017). *Delivery and Diagnosis (1st ed.).* William Andrew.

Slevin. (2012). *Current Advances in the Medical Application of Nanotechnology (1st ed.).*Manchester:Bentham Press. doi:10.2174/97816080513111120101

Tuan, V. D. (2015). *Nanotechnology in biology and medicine methods, devices and Applications* (Second ed.). San Fransico: CRC press.

Varghese, T., & Balakrishna, K. (2012). *Nanotechnology: An Introduction to Synthesis, Properties andApplications of Nanomaterials*. Atlantic & Distributors

Online Resource

http://www.nanomedicinecenter.com

https://nptel.ac.in/courses/118107015/module4/lecture7/lecture7.pdf

https://nptel.ac.in/courses/102107058/

https://nptel.ac.in/courses/118106019/Module%209/Lecture%203/Lecture%203.pdf

http://www.imm.org/Reports/rep048.pdf .

K1-Remember	*K2-Understand*	*K3- Apply*	*K4-Analyze*	*K5-Evaluate*	*K6-Create*

Course Designed by

Dr. N. Suganthy, Assistant Professor

Course Outcome Vs Programme Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M(2)	S(3)	M(2)	M(2)	M(2)	S(3)	M(2)	M(2)	M(2)	M(2)
CO2	S(3)	S(3)	M(2)	S(3)	M(2)	S(3)	S(3)	M(2)	S(3)	M(2)
CO3	M(2)	S(3)	M(2)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)	S(3)
CO4	S(3)	S(3)	M(2)	S(3)	S(3)	S(3)	M(2)	M(2)	S(3)	S(3)
CO5	S(3)	S(3)	S(3)	M(2)	S(3)	S(3)	M(2)	M(2)	S(3)	M(2)
W.AV	2.6	3	2.2	2.6	2.6	3	2.4	2.4	2.8	2.4

S-Strong(3), M-Medium(2), L- Low(1)

Course Outcome Vs Programme Specific Outcomes

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	S(3)	M(2)	S(3)	M(2)	M(2)
CO2	S(3)	S(3)	S(3)	S(3)	M(2)
CO3	S(3)	S(3)	S(3)	S(3)	S(3)
CO4	M(2)	S(3)	S(3)	S(3)	S(3)
CO5	S(3)	S(3)	S(3)	S(3)	S(3)
W.AV	2.8	2.8	3	2.8	2.6

S-Strong(3), M-Medium(2), L- Low(1)

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