ALAGAPPA UNIVERSITY

(A State University Established in 1985)

Karaikudi - 630003. Tamil Nadu, India

FACULTY OF SCIENCE
DEPARTMENT OF PHYSICS

M.Phil., PHYSICS

REGULATIONS AND SYLLABUS

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

DEPARTMENT OF PHYSICS

M.PHIL. PHYSICS

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 andGraded as Category-I University by MHRD-UGC)

Karaikudi - 630003, Tamil Nadu

ALAGAPPA UNIVERSITY
DEPARTMENT OF PHYSICS
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: Department of Physics
Name of the Subject Discipline: PHYSICS
Programme of Level: M.Phil.
Duration for the Course: Full Time (One Year)

About the Department

Department of Physics was started in the year 1985 during the inception of Alagappa University. In a short span of time, the Department of Physics has established as Centre of Excellence in research. Since its inception, the Department has strong commitment towards teaching programmes at the postgraduate level (M.Sc. and M.Phil.) and research programmes at doctoral level Ph.D (Full time and Part time modes). The department has flexibility in framing courses and conducting tests and examinations. The teaching component of this department has been recognized as one of the best in the country. The department has an excellent library, sophisticated characterization tools, smart class rooms with ICT facility, well furnished M.Sc. practical lab and internet lab with wifi facility. Thrust area research activities are being pursued intensively in the Department of Physics which includes crystal growth of nonlinear, ferroelectric and semiconducting materials, organic conducting polymers for rechargeable batteries, electrodes for Lithium, Sodium and Sulfur batteries, Biodiesel synthesis, electrodes for Fuel cells, thin film semiconductor for solar cells, layered compound semiconductor for photoelectrochemical solar cells, oxide thin films for smart materials and MEMS. Many prototype devices have been designed and fabricated from the materials developed in this department.

During the span of 37 years, the Department has published more than 1442 research articles in internationally reputed scientific journals. The department has produced about 133 Ph.D Scholars, 337 M.Phil. and 1073 M.Sc. students. The department has organized plenty of international and national meetings in different areas of Physics. Several research funding agencies such as DAE, DST, UGC, CSIR, DRDO, AICTE, BRNS etc. have sponsored research projects to our Department. The member faculties of the Department are visiting and collaborating with many highly reputed national and international institutions. Several awards and recognitions at the national and international levels have also been received by the department faculty members. The Department has been sponsored by UGC-SAP (DRS Level I, II, III) and by DST-FIST (Level I and II). So far, the department has earned Rs.1232 lakh through various funding agencies including Rs.144 lakh through characterization consultancy. The faculty members are extending their knowledge to provide consultancy services to small scale industries. Six patents have been filed from the faculty members and also four patents were already granted to the department. In addition, new method of crystal growth was invented and it has been recognized by the researchers worldwide. The total scopus citation of the Department of Physics is 22020 along with h-index of 66, and the Web of Science citation is 18308 with h-index of 62.

I. Name of the Programme

The programme is named as Master of Philosophy (M.Phil.) in Physics. This programme is offered under Choice Based Credit System (CBCS). The CBCS enables the students to select variety of subjects as per his/her interest and requirement. Acquiring knowledge in the related fields is advantageous to the students. Fast learners can earn more credits than the stipulated minimum of 24 credits. The programme is structured in such a way to impart more knowledge in science, in particular in Physics.

II. Programme General Objectives

- Physics is the natural science that involves the study of matter and its motion through space and time along with the related concepts such as energy and force. It is one of the most fundamental scientific disciplines.
- The main goal of Physics is to understand how the universe behaves. Physics explains the natural phenomena in the universe and often considered to be the most fundamental science.
- It provides a basis for all other sciences - without Physics, we could not have Biology, Chemistry, or anything else. Physics also makes significant contributions through advances in new technologies.
- One academic Programme is necessary to create awareness to students in the emerging field and also it should teach basic concepts and developments of Physics to students to make them as scientist or technologists in this field.
- Hence our task is to introduce M.Phil. programme in Physics to educate the postgraduate students in the fascinating fields. Rigorous and comprehensive in approach, this syllabus presents essential contents in a detailed, clear and direct way.

III. Eligibility for Admission

A candidate who has passed M.Sc. Degree Examination with Physics, Applied Physics, Electronics as subject of study of any University or any of the M.Sc. Degree Examination with specialization such as Nanoscience, Applied Physics, Electronics, Nuclear Physics, Biophysics 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.Phil. Degree in Physics of this University after a course of study of one academic year.

For securing admission to the M.Phil. programme, candidates must have secured 55% of marks in the respective P.G. Degree Programme or any equivalent programme in the case of inter-disciplinary subjects. However, the minimum marks for the SC/ST candidates would be 50%. For all the candidates, who have completed their P.G. Degree on or before 1991, the minimum eligible marks for admission to M.Phil. would be 50%.

IV. Duration of the Programme

The Programme for the degree of M.Phil. in Physics shall consist of one academic year divided in to two semesters. Each semester consists of 90 working days.

V. Courses of Study

M.Phil. Physics

CBCS - Structure of the Programme

Sl. No.	Course Code No.	Title of the Course	No. of Credit	Marks		Total
				Internal	External	
I SEMESTER						
1.	581101	Research Methodology and Programming	4	25	75	100
2.	581102	Advanced Physics	4	25	75	100
3.	581103	General Skills in Science	4	25	75	100
		Total	**12**			**300**
II SEMESTER						
4.	581201	Materials Science of Thin Films	4	25	75	100
5.	581202	Solid State Ionics				
6.	581203	Crystal Growth and Characterization				
7.	581204	Advancement in Nanoscience				
		Any One Course				
8.	581999	Dissertation & Viva-voce	8	50	150 (100+50)	200
		Total	**12**			**300**
Grand Total (I & II SEMESTER)			**24**			**600**

VI. Teaching Methodologies

The classroom teaching would be through conventional lectures and use of OHP and Power Point presentations. The lecture would be in such a way that the student should participate actively in the discussion. Student seminars shall be conducted and scientific discussions shall be arranged to improve their communicative skill. In the laboratory, instruction shall be given for the experiments followed by demonstration and finally the students have to do the experiments individually. Periodic tests shall be conducted and special attention would be given to the slow learning students.

VII. Examinations

The examination shall be three hours duration to each course at the end of each semester. The candidate failing in any course(s) will be permitted to appear for each failed course(s) in the subsequent examination.

At the end of second semester, viva-voce will be conducted on the basis of the Dissertation report submitted by the student. One internal and one external examiner (Head of the Department (HOD)) will conduct the viva-voce jointly.

VIII. Question Paper Pattern

M.Phil. Physics
581XXX: Course title
(2022-23 onwards)

Time: 3 Hours   Max. Marks - 75

Answer all questions. All questions carry equal marks. (5 × 15 = 75 marks)

1. either or type question from UNIT I
2. either or type question from UNIT II
3. either or type question from UNIT III
4. either or type question from UNIT IV
5. either or type question from UNIT V

IX. Dissertation Work:

External Evaluation of the dissertation	-	100
Internal (Research Guide)	-	50
Viva-Voce	-	50
Total		**200 marks**

(a) Plan of Work:

The student should prepare plan of work for the dissertation, get the approval of the guide and should be submitted to the University during the second semester of his/her study. In case the student wants to avail the facility from other University/laboratory, they will undertake the work with the permission of the guide and HOD and acknowledge the alien facilities utilized by them.

The duration of the dissertation work shall be a minimum of three months in the second semester.

(b) Dissertation Work outside the Department:

In case the student stays away for work from the Department for more than one month, specific approval of the University should be obtained.

(c) No. of copies/distribution of dissertation work:

The students should prepare four copies of dissertation and submit the same for the evaluation by Examiners. After evaluation one copy is to be retained in the Department library and one copy is to be submitted to the University (Controller of Examinations) and one copy for guide and one copy can be held by the student.

(d) Format to be followed:

The format/certificate for dissertation to be submitted by the students is given below:

Format for the preparation of dissertation work:

(a) Title page
(b) Bonafide Certificate
(c) Acknowledgement
(d) Table of contents

CONTENTS

Chapter No.	TITLE	Page No.
1.	Introduction	
2.	Review of Literature	
3.	Materials and Methods	
4.	Results and Discussion	
5.	Summary	
6.	References	

Format of the Title Page:

TITLE OF THE DISSERTATION

Dissertation submitted in partial fulfillment of the requirement for the Degree of Master of Philosophy in PHYSICS to the Alagappa University, Karaikudi - 630 003.

By
Student's Name
Register Number
Under the Guidance of
(Faculty's Name)
University Emblem
Department of Physics
Alagappa University
Karaikudi
Month and Year

Format of certificates

Certificate – (Guide)

This is to certify that the Dissertation/Project entitled "--" submitted to Alagappa University, Karaikudi - 630003 in partial fulfillment for the award of the degree of Master of Philosophy in PHYSICS by Mr/Ms --------------------- (Reg No:--------------) under my supervision. This is based on the results of studies carried out by him/her in the Department of Physics, Alagappa University, Karaikudi - 630003. 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: Karaikudi Research Supervisor
Date: _________

Certificate - (HOD)

This is to certify that the Dissertation/Project entitled "--" submitted by Mr/Ms -----------------(Reg No: --------------) to the Alagappa University, in partial fulfilment for the award of the degree of Master of Philosophy in Physics is a bonafide record of research work done under the supervision of Dr.------------------, Assistant Professor, Department of Physics, 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 any degree, diploma, fellowship, or any other similar title of any University or Institution.

Place: Karaikudi
Date:_________ Head of the Department

Declaration - (Student)

I hereby declare that the Dissertation/Project entitled "-------------------------------------" submitted to the Alagappa University for the award of the degree of Master of Philosophy in Physics has been carried out by me under the guidance of Dr. -----------------, Assistant Professor, Department of Physics, 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: _________ (Student)

Guidelines for approval of M.Phil. Physics guides for guiding students in their research for submitting project work:

1. M.Phil. Physics (Partial fulfillment) Guide:

a) A person seeking for recognition as guide should have:
A Ph.D. Degree in Science discipline
(or)
b) M.Phil. degree in Science with first class/second class should have 3 years of active teaching/research experience

They should have published at least one research paper in a National/International Journal authored solely or jointly.

2. Procedure for submitting application for approval as guides:
(i) The University shall on request give prescribed application form.
(ii) The filled in applications should be submitted before the close of said date by the University.
(iii) All such applications should be routed through the HOD with specific recommendations.
(iv) All relevant proofs should be submitted along with the applications.

3. Approval:

The committee constituted for the purpose will scrutinize the applications and recommend for approval/rejection. Orders will then be passed by the authority of the University and communicated to each member individually through the HOD.

X. Passing Minimum

The candidate shall be declared to have passed the examination if the candidate secures a minimum of 50% in the University external examination and 50% of the total (Int+Ext) marks.

For the dissertation work and viva-voce, a candidate should secure 50% of the total marks for pass. The candidate should compulsorily attend viva-voce examination to secure pass in that course.

Candidate who does not obtain the required minimum marks for a pass in a course/dissertation report shall be required to reappear and pass the same at a subsequent appearance.

XI. Classification of Successful Candidates

Candidates who secure 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.

Candidates who obtain 75% of the marks in the aggregate shall be deemed to have passed the examination in First class with Distinction provided they pass all the examinations prescribed for the course at the first appearance.

Candidates who pass all the examinations prescribed for the programme in the first instance and within a period of one academic year from the year of admission to the programme only are eligible for University Ranking.

A candidate is deemed to have secured first rank provided he/she
(i) should have passed all the papers in first attempt itself
(ii) should have secured the highest over all grade point average (OGPA)

XII. Maximum Duration for the Completion of the Course

The maximum duration for completion of M.Phil. Degree in Physics Programme shall not exceed ten semesters.

XIII. Commencement of this Regulation

These regulations shall take effect from the academic year 2022-23 i.e., for students who are to be admitted in the first year of the programme during the academic year 2022-23 and thereafter.

XIV. Transitory Provision

Candidates who were admitted to the M.Phil. Physics Programme of study before 2022-23 shall be permitted to appear for the examinations under those regulations for a period of three years i.e., up to and inclusive of the examination of April/May 2025. Thereafter, they will be permitted to appear for the examination only under the regulations then in force.

XV. Syllabus

SEMESTER – I

Course code: 581101	**Research methodology and programming**	**Credits: 4**
Objectives	➢ To impart the knowledge on methodology of research. ➢ To impart the knowledge on the computer programming to the students. ➢ To impart the knowledge on logical and systematic thinking ➢ To impart the knowledge on techniques and tools to collect, process and analyze the data. ➢ To impart the knowledge for deriving crucial findings for solving problems.	
UNIT - I	**Principles of Scientific Research:** Identification of problem – Determining the mode of attack – Literature survey – References – Awareness of current status – Abstract of a research paper – Possible ways of getting oneself abreast of current literature – Internet and its applications – E-mail – WWW – Web browsing – Assessing the status of the problem – Guidance from the supervisor – Actual investigation - Preparation of manuscript – Presenting a paper in scientific seminar – Thesis writing.	
UNIT - II	**Best Research Practices:** Research ethics, writing skills – own sentence making – plagiarism – constituents – online, offline plagiarisms – Critical analysis and review of research paper: Structure of paper – Writing methodology – Conclusion – Acknowledgments – Preparation of figures for publication quality – Abstract – Reference management system.	
UNIT - III	**Numerical Methods:** Curve fitting – Least square method – Solutions of equations – Graphical method – Newton-Raphson method – Interpolation – Lagrange method – Numerical integration – Trapezoidal method – Simpson's method – Numerical differentiation – First order, second order Euler's method – Runge-kutta method – Second order, Third order and Fourth order – Taylor's series solutions.	
UNIT - IV	Simulation studies – Labview and Mathematica: Introduction to LABVIEW tools palette – Controls & functions palette –Data types, conversion – Front panel, block diagram construction – Create indicators/ controls/ constant math operations, Booleans, arrays – For loops –Paths, graphing, timed loops, signal generation/processing, waveform types. Basics – structure of mathematica – symbolic calculations – numerical calculations – graphics – programming mathematical tools – co-ordinates – Scalars – Vectors – kinematics – Velocity – Acceleration – kinematic examples.	
UNIT - V	**C- programming and MATLAB:** C-language: operators and expressions – various operators – library functions – data input – output – Getchar, Scanf, printf, gets and puts function – control statements – functions: defining a function, accessing for, passing arguments – programming structure – arrays – data files. MATLAB environment- working with data sets – data input/output – logical variables and operators – array and x-y plotting – simple graphics – data types matrix, string, cell and structure – file input and output – matlab files – simple programs.	

Suggested Readings: Gottfried, B. S. (2018). *Programming with C*. New York: McGraw – Hill publishing company. Scarborough, J.V. (2017). *Numerical mathematical analysis*. Oxford and IBH Jovitha Jerome. (2010). *Virtual instrumentation using LABVIEW*. New Delhi: PHI learning Pvt. Ltd. LabVIEW Basics I course manual, national instruments corporation. Rudra Pratap. (2010). *Getting started with MATLAB: A quick introduction for scientist and engineers*, Oxford university press. Gerdbaumann. (2005). *Mathematica for theoretical physics: Classical mechanics & NLD*. Springer.(VOL. I). SergiyButenko, Panos M Pardalos. (2014). *Numerical methods and optimization an introduction (Chapman & Hall/CRC Numerical analysis and scientific computing series) 1st edition*, university of Florida, Gainesville, USA.	
Outcomes	On successful completion of the course, a student will be able to ❖ Design, execute and interpret experiments to test their own hypotheses. ❖ Expertise in research through several repeated experiments. ❖ Demonstrate the ability to choose appropriate methods to research aims and objectives. ❖ Demonstrate capacity to lead and manage change through collaboration with others. ❖ Describe the intellectual skills, and understand the concepts, rules and procedures for the findings.

Name of the Course Teachers
Dr. K. Sankaranarayanan
Dr. M. Sivakumar
Dr. M. Ramesh Prabhu

ALAGAPPA UNIVERSITY

Course Code: 581102	ADVANCED PHYSICS	Credits: 4
Objectives	➢ To impart knowledge in the field of quantum mechanics with the physical concepts. ➢ To understand atomic and molecular structure and properties and chemical reactivity in the field of quantum chemistry. ➢ To impart knowledge in the field of Laser and Fiber optic communications. ➢ To gain the knowledge in fundamental and microscopic characterizations. ➢ To develop critical thinking and quantitative reasoning skills in instrumentation and data analysis	
UNIT I	**Quantum Mechanics:** Relativistic wave equations- Klein-Gordon equation- Dirac equation - Elements of field quantization - Lagrangian theory - Non-relativistic fields - Relativistic fields - Klein- Gordon field - Dirac field , Bosons and fermions, Electromagnetic field - Interacting field.	
UNIT II	**Quantum Chemistry:** Bonds - Localised Bonds - Valence Bond theory , Molecular orbital theory - Non-localized bonds - Huckel molecular orbital theory - Hybridization - sp^3 - sp^2 - sp hybridization with examples - Benzene - Butadiene - Structures - Feynman diagrams - Applications. Self-Consistent field techniques - Elementary ideas of Hartree method and Hartree and Fock method - Correlations.	
UNIT III	**Lasers:** Production of giant pulse - Q-Switching – Laser amplifiers – Mode locking – Hole burning - Solid state lasers – Gas lasers – Semiconductor lasers – Hetro-junction lasers – Liquid dye lasers and chemical lasers - Free electron laser - Application of Lasers in Materials processing and biological Systems – Fiber optic communications.	
UNIT IV	**Instrumentation and Data Analysis – I:** Infrared spectrophotometry - Fourier transform interferometer – Ultraviolet–Visible Spectrophotometer - Photoluminescence spectrometer- Raman spectrometer – X-ray powder diffractometer - Continuous wave NMR spectrometer – Electron spin resonance	
UNIT V	**Instrumentation and Data Analysis - II** Secondary ion mass spectrometry - Auger emission spectrometry - Electron spectroscopy for chemical analysis - Mass spectrometer -Differential thermal analysis - Differential scanning calorimeter – Scanning electron microscope (SEM) - Atomic force microscope	

Suggested Readings:-	
1. Ossi, Paolo, M. (2018). *Advances in the Application of Lasers in Materials Science*, Springer International Publishing. 2. Aruldhas, G. (2016). *Quantum Mechanics*, IInd edition, PHI Learning Private Limited, New Delhi. 3. James Keeler. (2013). *Understanding NMR Spectroscopy*, 2nd edition, Wiley India Pvt. Ltd. 4. Duer, J. (2005). *Introduction to Solid-State NMR Spectroscopy*, 1st Edition, Melinda Wiley-Blackwell. 5. Willard, H.H, Merritt, L.L, Dean, J.A, Settle, F.A. (1986). *Instrumental methods of Analysis*, 6th Edn. CBS Publishers & Distributors, India.	
Outcomes	On successful completion of the course, a student will be able to ❖ Gain the basic knowledge in the advanced physics subjects. ❖ Gain the basic knowledge in quantum mechanics and quantum chemistry. ❖ Understand the principles and applications of fiber-optic communication. ❖ Gain the basic knowledge in instrumentation and data analysis. ❖ Gain the basic knowledge in fundamental and microscopic characterization techniques.

Name of the Course Teachers
Dr. G. Ravi
Dr. N. Anandhan
Dr. R. Subadevi

Course Code: 581103	GENERAL SKILLS IN SCIENCE	Credits: 4
Objectives	➢ To impart the knowledge in computer operating skills and communication skills in English. ➢ To understand the basic structure of MS office, Lab view, JCPDS and Pixar manager ➢ To understand telephone, interview and presentation skills to the students. ➢ To study the basic qualification of science teacher and prepare curriculum development skill to the students. ➢ To understand the oretical and practical skill to the students.	
UNIT-I	**Introduction to computers:** - Computer Hardware: input devices and media – Magnetic device and media – Output devices and media – Storage device and media - Computer architecture – System software: types, operating system, and translators – Application software: types of language – Application packages – Integrated software - Introduction to operating system - Working with windows and office programs – Internet, Website and Email for data collection.	
UNIT-II	**Computer operating skills: -** Starting a program and opening a document – Saving and naming the document - Create file and folders – Deleting and un-deleting a document – Closing a document – Renaming and moving a document – Finding a document- MS office: Word, Excel, Access, Power point, Outlook and Integrated office applications – Software for data analysis: Origin, WSxM, LabVIEW, JCPDS and Pixar manager - C programming – Principles, classes and structure of C^{++} Programming.	
UNIT-III	**Communication skills in English: -** Understanding communication – Greeting and introducing – Making requests – Asking for getting permission – Offering help – Giving instruction and directions - Art of small talk – Participating in conversation – Making a short formal speech –Describing the people, place, events and things - Telephone skill: understanding, handling calls, leaving message and making request - Written communication: report writing, note making - Career skills: curriculum vitae and cover letters - Facing an interview and presentation skills – Academic listening.	
UNIT-IV	**Pedagogical skill for science teachers: -** Science Teacher: Skills, teacher competencies and professional growth - Theory and models of curriculum development: Concept and Technical scientific models of curriculum development - Planning a science library – Handling of practical classes - Educational technology and classroom pedagogy: Educational Technology – Concept, Emerging technologies- New technologies on methodology of teaching, learning experiences and curriculum development - Uses of Micro-teaching.	

UNIT-V	**Practical training: -** Preparation of smart board, charts and models for handling classes of science teacher - Creating management documents e.g., Curriculum Plan, Timetable scheduling, Evaluation- Strategies etc – Learning to write and draw on the blackboard - Preparation of over head projector presentations - Preparation of power point/LCD presentations – Preparation of teaching materials – Preparation of seminar classes and assignment for PG students -

Suggested Readings:-

Joseph, W. Habraken, (2004). *Microsoft office 2003*, All in one, Que publishing.

Benny, R. Smith, F.C. (2003). *Fundamentals of computer- aided engineering*, John Wiley & sons.

Harry, C. (2001). *Communication skills for scientific and technical professional*, Perseus.

Rosenblatt, L. (2010). *Rethinking the Way We Teach Science: The Interplay of Content, Pedagogy, and the Nature of Science*, Published by Taylor & Francis.

Alan, B. (2000). *Improve your communication skills* Kogan page.

Outcomes	On successful completion of the course, a student will be able to ❖ Explore their skills in operating computers for research and extension activities. ❖ Enhance more skills in operating computer and photographical skills to improve their educational technology. ❖ Explore their skills in telephone interaction and communication activities. ❖ Understanding practical classes, micro-teaching, interview and presentation skills. ❖ Explore their skills in handling smart board, charts, models, power point presentation and other activities.

Name of the Course Teachers
Dr. R. Yuvakkumar
Dr. S. Sudhahar
Dr. R. Sivakumar

SEMESTER - II

Course Code: 581201	MATERIALS SCIENCE OF THIN FILMS	Credits: 4
Objectives	➢ The syllabus focuses the students to learn thin film processes, characterization and applications in various fields of microelectronics and optoelectronics. ➢ The syllabus also imparts knowledge to the students on technologically oriented diversified areas e.g., coating of all kinds of optical, decorative, environmental and wear resistant, biotechnology and the generation and conservation of energy. ➢ The syllabus aims to acquire knowledge in chemical vapor deposition method. ➢ The syllabus plans to know the mechanical techniques and preparation of thin films and thickness measurements in thin films. ➢ The syllabus focuses to give knowledge in chemical characterizations.	
UNIT I	**Thin Film Structure:** Introduction – Structural, morphology of deposited films and coatings - Structure zone models for evaporated and sputtered coatings - Columnar grain structure - The tangent rule - Film density - Computational simulation of film structure: scope, Monte Carlo simulations, molecular dynamics simulations - Grain growth - Texture and microstructure control in thin films - Grain growth in thin film - Film texture - Thin film microtexture.	
UNIT II	**Thermal Evaporation Processes:** Introduction - The physics and chemistry of evaporation - Evaporation rate - Vapor pressure of the elements - Evaporation of multi-element materials - Deposition geometry - Film thickness uniformity - Film purity - Evaporation hardware - Electrically heated evaporation sources - Electron beam evaporation - Deposition techniques - Evaporation processes and applications - Pulsed laser deposition - Web coating - Ion beam assisted evaporation.	
UNIT III	**Chemical Vapor Deposition:** Introduction - Reaction types: pyrolysis, reduction, oxidation, compound formation, disportionation, reversible transfer - Thermodynamics of CVD: reaction feasibility, conditions of equilibrium, Gas transport: close spaced vapor transport - Film growth kinetics: axial growth uniformity, influence of thermodynamics - Thermal CVD processes: atmospheric pressure CVD, low pressure CVD, metal organic CVD(MOCVD) processes, laser enhanced CVD deposition, plasma enhanced CVD processes.	
UNIT IV	**Characterization of Thin Films – I:** Introduction - Film thickness: Optical methods for measuring film thickness – Interferometer – Ellipsometry - Mechanical technique: Profilometry - Quartz crystal microbalance - Structural characterization of films and surfaces: Scanning electron microscopy (SEM) -Transmission electron microscopy (TEM) - X-ray diffraction (XRD).	

<table>
<tr><td>UNIT V</td><td>Characterization of Thin Films – II: Chemical characterization of surfaces and films: Fingerprinting atoms through electron transition - X-ray energy dispersive analysis (EDX) - Auger electron spectroscopy (AES) - X-ray photoelectron spectroscopy (XPS).</td></tr>
<tr><td colspan="2">Suggested Readings:-
Cullity and Stock, (2014). Elements of X-Ray Diffraction, 3rd edition, Low Price Edition, 2014.
Milton Ohring, Shefford P. Baker, (2016). Materials Science of Thin Films Deposition and Structure, Academic Press.
Meissel, L.T, Glang, R. (2015). Handbook of Thin Film Technology, McGraw Hill, 2015.
Hartmut Frey, Hamid R. Khan, (2015). Handbook of Thin Film Technology, Springer Science & Business Media.
Zexian Cao, (2016). Thin Film Growth: Physics, Materials Science and Applications, Woodhead Publishing, 2016.</td></tr>
<tr><td>Outcomes</td><td>On successful completion of the course, a student will be able to
❖ Understand the nucleation and growth of thin film at the atomic scale and learn non elemental and elemental characterization of thin film and coatings.
❖ Have insights in possibilities and the importance of different thin film coatings for variety of industrial applications.
❖ Recognize the comparisons between different fundamental physical and chemical vacuum-based deposition techniques.
❖ Understand the Optical methods and Structural characterization of thin film surfaces.
❖ Perceive knowledge in chemical characterization analysis.</td></tr>
</table>

Name of the Course Teachers
Dr. G. Ravi
Dr. N. Anandhan

Course code: 581202	SOLID STATE IONICS	Credits: 4
Objectives	➢ To understand the knowledge on the basic and advanced sources of solid-state Ionics. ➢ To know the complicated mechanism of lithium-ion battery as well as energy storage devices. ➢ To describe operation of various solid state Ionics applications including open circuit cells, cells using current and cells generating current. ➢ To inculcate the knowledge about the appropriate measurement techniques for investigating solid state electrochemical material/ device. ➢ To select materials for different functions within the devices and to use appropriate resources for finding up to date information on solid state Ionics.	
UNIT I	**SUPERIONIC MATERIALS:** Basics of ionic and covalent materials - Super ionic materials - Crystalline anionic and cationic conductors – Mixed ionic and electronic conductivity – Structural factors responsible for high ionic conductivity. **SOLID STATE BATTERIES:** Solid state batteries – Mass transport and reactions in solid state batteries – Battery performance and electrode kinetics – Double layer and other polarization effects at solid/solid interface.	
UNIT II	**BATTERY MATERIALS – ELECTROLYTES AND INTERFACES:** Liquid and Polymer electrolytes: Lithium transport in Lithium batteries – Polymer electrolytes in Lithium batteries - Mobility: ionic/electronic, mechanisms of charge migration. SEI Formation: Introduction – Principles and routes of the SEI formation – Structure of the SEI.	
UNIT III	**BATTERY MATERIALS – ELECTRODES:** Anode Materials: An Overview: Introduction Lithium metal, carbon-based materials and hard carbon – Composites Sn, Sb, Metal oxides.Cathode Materials: Trends in cathode materials - Methods of synthesis - Effect of particle size and morphology on cathode behavior –Manganese spinals, Layered Li_xMnO_2 and similar cathodes – special case: $LiFePO_4$ - Sodium ion batteries: spinel, layered and olivine cathode materials. **SUPERCAPACITOR MATERIALS:** origin – capacitors – types – materials: carbon materials – pseudo capacitive materials – hybrid materials – Applications.	
UNIT IV	**ENERGY CONVERSION DEVICES:** Introduction to fuel cell - Oxygen evolution reaction(OER) and Hydrogen evolution reaction(HER) mechanisms - Types of fuel cells and applications. Redox flow batteries: introduction – types – Anolyte, catholyte: organic materials – inorganic materials - cell configuration – flow field– difference between Fuel cells and redox flow batteries– Applications.	

<table>
<tr><td>UNIT V</td><td>ANAYTICAL TECHNIQUES: X-ray and Neutron scattering – Transport Kinetics – Ion dynamics (Microscopic properties) – Spectroscopic techniques: Analysis of super ionic materials– Electrochemical Analysis: Cyclic voltammetry (CV), Galvanostatic charge-discharge (GCD) and Impedance spectroscopy of the super ionic material.</td></tr>
<tr><td colspan="2">Suggested Readings:-
Perla B Balbuena, Yi Xuan Wang, (2004), Lithium-ion Batteries: solid-electrolyte interphase. University of South Carolina, Imperial college Press.
Helena Berg, (2015), Batteries for electric vehicles: Materials and electrochemistry, Cambridge University Press.
Christian Julien, Alain Mauger, Ashok Vijh, Karim Zaghib, (2016), Lithium Batteries Science and Technology, international Publishing Switzerland.
PieroZanello, (2003), Inorganic electrochemistry theory, practice and application, The Royal Society of Chemistry.
Aiping Yu, Victor Chabot Author, Jiujun Zhang, Electrochemical Supercapacitors for Energy Storage and Delivery: Fundamentals and Applications, CRC Press; 1st edition (2017)</td></tr>
<tr><td>Outcome</td><td>On successful completion of the course, a student will be able to
❖ Learn the components and mechanisms in batteries: separators, binder, electrolytes, ion insertion/de-insertion, SEI formation.
❖ Know the concepts of Li-ion battery development and safety issues and to well-known the characterization methods involve in batteries.
❖ Learn about the techniques of cell and electrode design, impedance spectroscopy, stoichiometric polarization etc.,
❖ Understand the mechanism of battery materials, membranes, fuel and electrolysis cells etc.,
❖ Know the in-depth analyzes of materials for electrolytes, electrodes and super ionic conductors.</td></tr>
</table>

Name of the Course Teachers
Dr. M. Sivakumar
Dr. R. Subadevi
Dr.M.Ramesh Prabhu

Course code: 581203	CRYSTAL GROWTH AND CHARACTERISATION	Credits: 4
Objectives	➢ To impart knowledge about Crystal structures, various crystal growth methods and some of the essential characterization techniques. ➢ To study the basic concepts of crystal systems, crystal symmetry, nucleation and types of crystal growth ➢ To understand growth parameters like material purification, crystalline perfection and seed preparation etc., ➢ To study about Miers TC diagram, solution growth and gel growth method ➢ To study about the melt, hydrothermal, flux and vapor growth techniques.	
UNIT I	**Introduction to Crystal Growth:** Crystal growth importance – Crystal symmetry – Space lattice – Crystal planes – Bragg's law – Classification of crystal growth – Nucleation – Critical size – Crystal defects, Grain boundary and Dislocation – Surface energy – Diffusion, Kinds of liquid crystalline order.	
UNIT II	**Growth Parameters:** Material purification – Solvent selection – Solution preparation and crystal growth – Seed preparation – Agitation – Crystal habit – Cooling rate –– Crystalline perfection - Distillation, Sublimation, Precipitation - Liquid – Liquid extraction, Optimization of pH – Viscosity.	
UNIT III	**Solution and Gel Growth:** Solution and solubility – Measurement of supersaturation – Mier's solubility diagram – Slow cooling, slow evaporation and temperature gradient methods – Gel growth – Principle - Properties of gel – Structure of gel – Importance of gel - Synergies – U tube and straight tube methods.	
UNIT IV	**Melt and Vapour Growth:** Purification by Zone refining and Zone melting – Impurity dislocations – Growth techniques – Bridgman – Czochralski – LEC – Convection in melt – Kyrupoulos – Hydrothermal method - Flux growth – Phases of matter – Principles of flux growth – Choice of flux – Different flux growth techniques - Vapour phase crystallization in a closed system – Chemical vapour deposition – Physical vapour deposition.	
UNIT V	**Crystal Characterization:** Crystallographic – Orientation and plane - Orientation of crystals by optical and X-ray methods - Crystal cutting and polishing - Observation of defects in crystals (Optical microscopy and Etching) - Thermal, optical and mechanical properties of crystals (qualitative study).	
Suggested Readings:- Benz Klaus-Werner. (2014). *Introduction to Crystal Growth and Characterization*, Wiley-VCH Verlag Faraday. (2007). *Crystal Growth and Nucleation*. RSC Publishing. Muller, G. Jacques Metois, J. Rudolph, P. (2004). *Crystal growth-from fundamentals to technology*, Elsevier publication. Markov, I.V. (2003). *Crystal growth for beginners*, Second edition, World Scientific Publishing Co. Hans J. Scheel & Tsuguo Fukuda. (2003). *Crystal Growth Technology*, John Wiley & Sons, Ltd.		

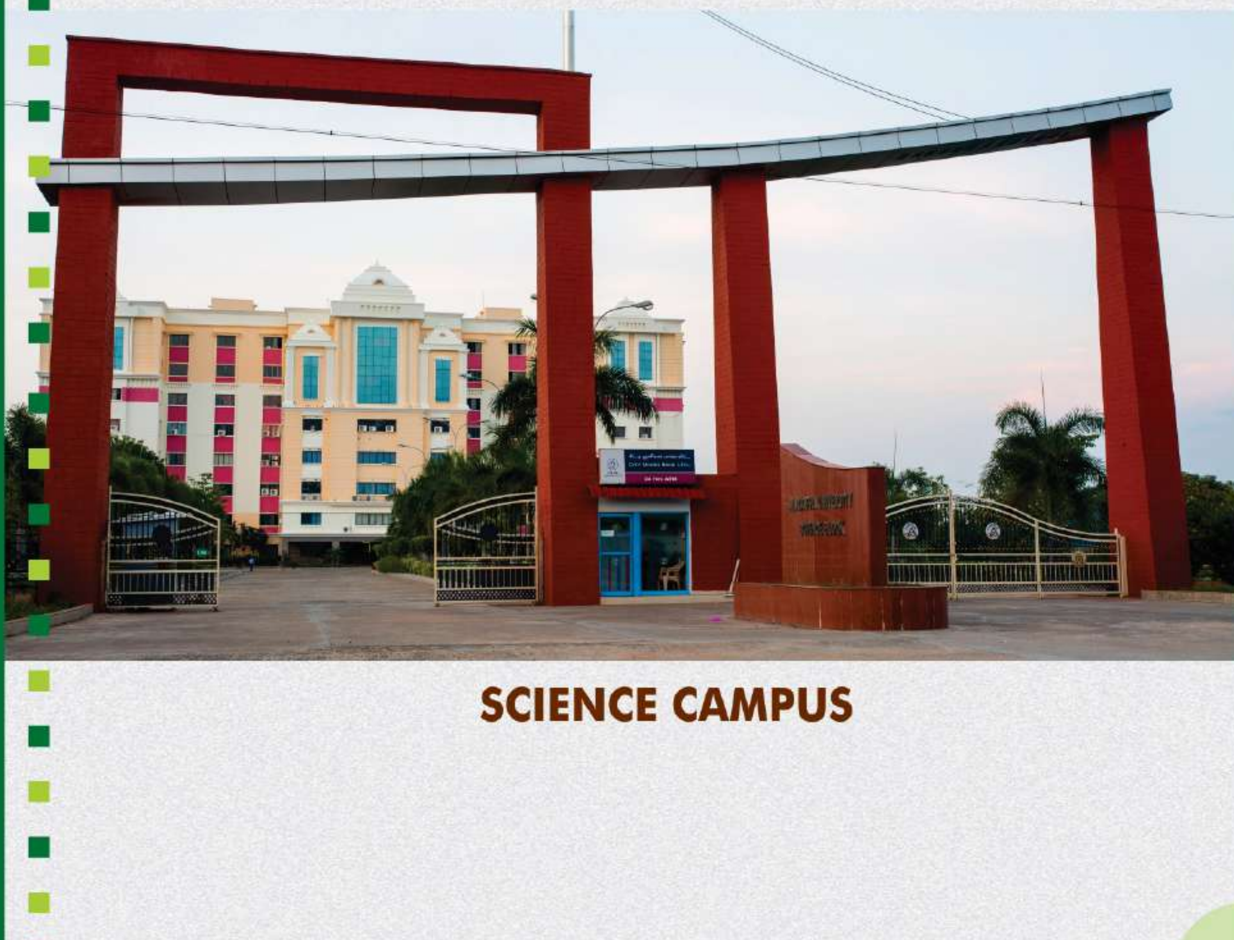
Outcomes	On successful completion of the course, a student will be able to ❖ Give an introduction to elementary crystal growth principles, various crystal growth techniques that allows them to prepare for a M.Phil or Ph.D. project in this field. ❖ Explain the crystal symmetry, nucleation, Bragg's law and Mier's TC diagram ❖ Understand solution, gel, melt and vapor growth techniques ❖ Understanding the basic concept and working principles of structural and spectral analyses. ❖ Understanding the basic concept and applications of optical, thermal and mechanical analyses

Name of the Course Teachers
Dr. G. Ravi
Dr. K. Sankaranarayanan
Dr. S. Sudhahar

<table>
<tr><td>Course code: 581204</td><td colspan="2">ADVANCEMENT IN NANOSCIENCE</td><td>Credits: 4</td></tr>
<tr><td>Objectives</td><td colspan="3">➢ To gain knowledge, creation, manipulation and applications of materials at nanometer scale.
➢ To impart the basic knowledge on Nanoscience and Technology and to understand the various process techniques available for the processing of nanostructured materials.
➢ To obtain knowledge in synthesis and processing of nanomaterials at the atomic, molecular levels.
➢ To obtain thorough knowledge in 2D and 3D nanostructures of materials.
➢ To impart fundamental knowledge in physical and chemical properties and to provide an adequate scientific background to undertake research.</td></tr>
<tr><td>UNIT I</td><td colspan="3">Introduction: Nanoscience & Nanotechnology - Classification of nanomaterials: Definition of – Zero, one and two dimension nano structures – Examples - Classification of Top down and bottom up methods - Surface energy – Chemical potential as a function of surface curvature – Electrostatic stabilization - Steric stabilization – DLVO theory- Quantum Confinement - Atomic structure molecules and phase Energy-Molecular and Atomic size - Surfaces and dimensional space.</td></tr>
<tr><td>UNIT II</td><td colspan="3">Nanomaterial Synthesis Methods: Introduction to Nano scale materials - Catalysis – Synthesis and processing - Method of nano structured materials preparation – Mechanical grinding - Wet chemical synthesis – Sol-gel processing - Gas phase synthesis - Gas condensation processing - Chemical vapor condensation – Nano composite synthesis – Processing.</td></tr>
<tr><td>UNIT III</td><td colspan="3">Nanomaterial Properties: 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>UNIT IV</td><td colspan="3">Quantum Dots And Nanotubes: Quantum dots - Nano wires - Nano tubes 2D and 3D films - Nano and mesopores – Micelles – Bilayers – Vesicles - Bio-nano machines - Biological membranes.</td></tr>
<tr><td>UNIT V</td><td colspan="3">Physical Properties of Nanostructured Materials: 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 nanotubes - Magnetic behavior of single domain particles and nanostructures - Surface chemistry of tailored monolayer - Self assembling.</td></tr>
<tr><td colspan="4">Suggested Readings:-
Wilson, M, Kannangara, K, Smilt, G, Simmons, M & Raguse, B. (2005). Nanotechnology Basic Science and Emerging technologies. Overseas Press.
Charles P. Poole & Frank J. Owens. (2003). Introduction to Nanotechnology. Wiley Interscience.
Mark A. Ratner & Daniel Ratner. (2002). Nanotechnology: A gentle introduction to the next Big Idea (1st ed). Prentice Hall P7R.</td></tr>
</table>

	Cao, *Nanostructures and Nanomaterials: Synthesis, Properties and Applications*, World Scientific Publishing Company; 2nd edition (2011) Wen Lu , Jong-Beom Baek, Liming Dai, Carbon Nanomaterials for Advanced Energy Systems: Advances in Materials Synthesis and Device Applications, Wiley 1st edition (2015)
Outcomes	On successful completion of the course, a student will be able to ➢ Gain noteworthy knowledge in CMOS technology to molecular electronics, spintronics, nanophotonics and quantum computations and understand the various process techniques available for the processing of nanostructured materials. ➢ Understand creation, manipulation and applications of materials at nanometer scale. ➢ Proficiency in development and synthesis process of engineered nanomaterials. ➢ Gain significant knowledge on nanomaterial properties, Quantum Dots and Nanotubes. ➢ Expertise in interpreting this knowledge into useful advance technological applications.

Name of the Course Teachers
Dr. N. Anandhan
Dr. R. Yuvakkumar



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