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 Govt. of India; UGC University Grants Commission — Graded as Category - 1 & Granted Autonomy

2018 — MHRD GOVERNMENT OF INDIA — Swachh Campus Rank : 4

2019 — nirf NATIONAL INSTITUTIONAL RANKING FRAMEWORK — Rank : 28

2019 — QS — India Rank : 20; BRICS Rank : 104; Asia Rank : 216

DEPARTMENT OF NANOSCIENCE AND TECHNOLOGY

M.Sc.,CHEMISTRY (SPECIALIZATION NANOSCIENCE & TECHNOLOGY)

[Choice Based Credit System (CBCS)]

[For the candidates admitted from the academic year 2019-2020]

CONTENTS

I. NAME OF THE PROGRAMME

The programme is named **Branch IV (b) - M.Sc. Chemistry-Specialization in Nanoscience and Technology** . The syllabus for this programme is framed under the rules of the Choice Based Credit Semester System (CBCS) of this University and both Core- and Elective courses were incorporated as its components. The CBCS enables the students to select variety of subjects as per their 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 90 credits.

II. OBJECTIVES OF THE PROGRAMME

All basic life forms on Earth depend greatly on chemistry for their survival, including us. Chemistry is a big part of your everyday life. We find chemistry in daily life in the foods we eat, the air we breathe, our soap, our emotions and literally every object we can see or touch. Without chemistry it would be extremely hard for us to live. We need chemistry and chemicals for everything we do.

Chemistry is a pervasive subject. All the branches of science need chemistry. It is an experimental science and students need to train in practicals to get expertise in doing fine experiments and handle sophisticated instruments. Along with the data obtained its statistical analysis is also required to establish authenticity in the fields like environmental science, space chemistry and biotechnology. There are immense potentialities for chemistry and post graduates to undertake advanced research or in Industries as skilled chemists. It is important for the educators to provide a platform for the student community to study in detail the basics and advancements in chemistry. Hence our goal in floating the M.Sc programme in Chemistry-Specialization in Nanoscience and Technology is to educate the undergraduate students of chemistry in the fascinating fields of chemistry in an effective manner. This syllabus presents essential contents in a detailed, clear and direct way.

The major objectives of M.Sc. Chemistry-Specialization in Nanoscience and Technology are:

- To provide, thorough well designed studies of theoretical and experimental chemistry, a worthwhile educational experience for all students
- To acquire deep knowledge in fundamental aspects of all branches of chemistry
- To acquire basic knowledge in the specialized thrust areas like Photoelectrochemistry, Materials Chemistry, Chemistry in Nanoscience and Technology etc. and
- To develop abilities and skills that:
  - are relevant to the study and practice of science,
  - are useful in everyday life,
  - are encouraging efficient and safe practice and effective communication.

- To develop attitudes relevant to science such as:
  - Concern for accuracy and precision,
  - Objectivity,
  - Integrity,
  - Enquiry,
  - Initiative and
  - Inventiveness.

III. ELIGIBILITY FOR ADMISSION

A candidate who is a B.Sc. graduate of this University or any recognized University in the main subject/subjects as given below or who has passed an examination accepted by the Syndicate as equivalent there to is eligible for admission to M.Sc. Chemistry- Specialization in Nanoscience and Technology programme.

M.Sc. Chemistry-Specialization in Nanoscience and Technology	:	B.Sc., Degree Examination with Chemistry / Special Chemistry / Industrial Chemistry / Textile Chemistry / Electrochemistry / Applied Chemistry / any other specialization in Chemistry as main subject of study and any two of Mathematics, Physics, Botany, Zoology, Computer Application, Microbiology, Textile Chemistry, Electrochemistry, Applied Chemistry as ancillary subjects

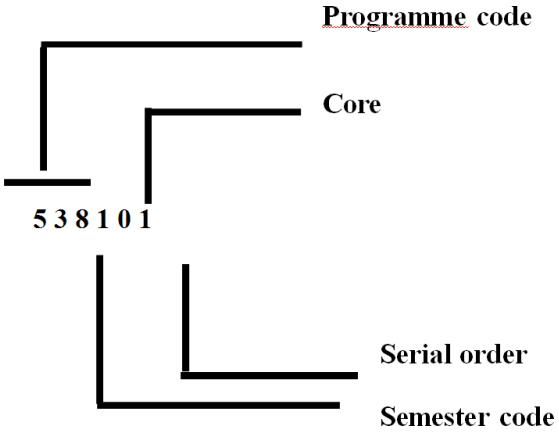
The admission is subject to the prevailing rules and regulations for PG admission of this University. The candidate has to undergo this programme in the Department of Nanoscience and Technology, Alagappa University and complete all the examinations prescribed under the four semesters to qualify for this degree.

IV. DURATION OF THE 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 July to November and even semesters shall be from December to April. There shall be 90 working days which shall comprise 540 teaching clock hours for each semester (exclusive of the days for the conduct of University end semester examination).

V. COURSES IN THE PROGRAMME

M.Sc. Chemistry-Specialization in Nanoscience and Technology programme consists of number of courses. The term 'course' is applied to indicate a logical part of the subject matter of the programme and invariably equivalent to the subject matter of a "paper" in the conventional sense.



For elective, the fourth digit is '5'.

M.Sc. CHEMISTRY-SPECIALIZATION IN NANOSCIENCE AND TECHNOLOGY

Sem	Course Code	Course Title	Credit	Hrs /W	CIA Marks	ESE Marks	Total Marks
I	538101	Inorganic Chemistry -I	5	5	25	75	100
	538102	Organic Chemistry -I	5	5	25	75	100
	538103	Physical Chemistry -I	5	5	25	75	100
	538107	Inorganic Chemistry Practical	4	8	25	75	100
		Major Elective -I	4	4	25	75	100
		Library /MOOCs	*	03			
		Total	**23**	**30**	**125**	**375**	**500**
II	538201	Inorganic Chemistry-II	5	5	25	75	100
	538202	Organic Chemistry -II	5	5	25	75	100
	538203	Physical Chemistry -II	5	5	25	75	100
	538207	Organic Chemistry Practical	4	8	25	75	100
		Major Elective- II	4	4	25	75	100
		Non-major Elective- **I**	2	3	100	-	100
		Total	**25**	**30**	**125**	**375**	**600**
III	538301	Inorganic Chemistry –III	5	5	25	75	100
	538302	Organic Chemistry -III	5	5	25	75	100
	538303	Physical Chemistry -III	5	5	25	75	100
	538307	Physical Chemistry Practical	4	8	25	75	100
	540703	Non-major Elective- **II**	2	3	25	75	100
	538506	**Major Elective- III**	4	4	25	75	100
		Library /MOOCs/Career guidance		*			
		Total	**25**	**30**	**125**	**375**	**600**
IV	538507	**Major Elective- IV**	4	4	25	75	100
	538999	Project Work -Report & Viva-voce	13	26	25	75	100
		Total	**17**	**30**	**75**	**225**	**200**
		GRAND TOTAL	**90**	**120**	**450**	**1425**	**1900**

ELECTIVE COURSES

Course Code	Course Title
538501	Introduction to Nanoscience and Technology
538502	Environmental Green Chemistry
538503	Synthesis and Characterization Techniques of nanomaterials
538507	Nanocomposites
538506	Application of Nanotechnology

***Extra hours and extra credit**

SUPPORTIVE COURSES FOR OTHER DEPARTMENTS*

Sl. No.	Course Code	Course Title	Credit	Hours/ week	CIA Marks	ESE Marks	Total
1.	538701	Physics and Chemistry of Nanomaterials	2	3	25	75	100
2.	538702	Application of Spectroscopy in Materials Chemistry	2	3	25	75	100

*****Depending upon the requirement, any one of the above courses will be floated in a semester.

VI. PROJECT

Each candidate shall be required to take up a Project Work and submit the report at the end of the second year. The Head of the Department shall assign the Guide who in turn will suggest the Project Work to the student in the beginning of the second year. One typed copy of the Project Report shall be submitted to the University through Head of the Department on or before the date fixed by the University.

The project report will be evaluated by an Internal Examiner and an External, nominated by the University. The candidate concerned will have to defend his project in a Viva-Voce examination.

VII. SEMESTERS

An Academic year is divided into two **semesters.** In each semester, courses are offered in 18 teaching weeks including the duration of conduct of internal examination. Each week has 30 working hours spread over 5 days a week.

VIII. CREDITS

The term "Credit" refers to the weightage given to a course, usually in relation to the instructional hours assigned to it. For instance, a four hour course is assigned four credits, three hour course is assigned three credits. However, in no instance the credits of a course can be greater that the hours allotted it. The total minimum credits, required for completing a PG programme is 90. The details of credits for individual components are given in Table 1.

Table 1. Details on the number of courses and credits per course

Study Components	Number of courses	Credit per Courses	Total Credits	Total marks
1. Core Courses - Theory	9	5	45	900
2. Core Courses - Practicals	3	4	12	300
4. Project work (Core)	1	9	9	100
5. Elective Courses	4	4	16	400
6. Supporting course (IDC)	2	2	4	200
7. MOOCs/career guidance etc				
Total	19	24	90	1900

IX. TEACHING METHODOLOGIES

The classroom teaching would be through conventional lectures and use of Power Point presentations and smart classroom facilities. 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.

X. EXAMINATIONS

i) 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.

ii) 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.

iii) 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 course.

iv) Viva-Voce: Each candidate shall be required to appear for Viva-Voce Examination (in defending the Project only).

v) For the Project Report, the maximum marks will be 150 for project report evaluation and for the Viva-voce it is 50. At the end of fourth semester viva-voce will be conducted on the basis of the Dissertation/Project report submitted by the student. HOD and external examiner will conduct the viva-voce jointly in the presence of Guide.

vi) The results of all the examination will be published through the University Department where the student underwent the programme as well as through University Website.

vii) Practical examination for M.Sc. Chemistry-Specialization in Nanoscience and Technology programme shall be conducted at the end of each semester.

XI. CONDONATION

Studentmust have earned 75% of attendance in each course for appearing for the examination. Students who have earned 74% to 70% of attendance to be applied for condonation in the prescribed form with prescribed fee. Students who have earned 69% to 60% of attendance are to apply for condonation in the prescribed form with the prescribed fee along with the Medical Certificate. Students who have attended below 60% are not eligible to appear for the examination and they shall

re-do the semester after completion of the programme, with the prior permission of the Registrar of the University.

XII. QUESTION PAPER PATTERN

(For all theory courses)

Max. Marks: 75 Time**: 3 Hours**

PART-A: 10x2=20

(Answer all questions)

(Two questions from each unit)

Q.No. 1 – 10

PART-B: 5x5=25

(Answer all questions)

(One question from each unit with internal choice)

11. a) or b)

12. a) or b)

13. a) or b)

14. a) or b)

15. a) or b)

PART-C: 3x10=30

(Answer any three questions)

(One question from each unit)

Q.No. 16 – 20

XIII. EVALUATION

The performance of a student in each course is evaluated in terms of percentage of marks with a provision for conversion to grade points. Evaluation for each course shall be done by continuous internal assessment by the concerned Course Teacher as well as by an end semester examination and will be consolidated at the end of the course. The components for continuous internal assessment are:

Two tests	- 15marks (Third /repeat tests for genuine candidates/absentees)
Seminar/Quiz	- 05 marks
Assignment	- 05 marks
	25 marks

Attendance need not be taken as a component for continuous assessment, although the student should put in a minimum of 75% attendance in each course. In addition to continuous evaluation component, the end semester examination, which will be a written examination of at least 3 hours duration, would also form an integral component of the evaluation. The ratio of marks to be allotted to continuous internal assessment and to end semester examination is 25:75. The evaluation of laboratory component, wherever applicable, will also be based on continuous internal assessment for 25 marks and on end-semester practical examination 75 marks.

Distribution of marks for practical examinations

(CIA marks 25 + ESE Marks 75 marks)

ESE mark distribution	
Quantitative/ Qualitative analysis	50 marks
Viva – Voce in practical	15 marks
Record Note	10 marks
Total	75 marks

Project Work (PW)

Project report evaluation	150 marks
Viva-Voce examination	50 marks
Total	200 marks

(a) Topic:

The topic of the dissertation shall be assigned to the candidate before the end of first semester and a copy of the same should be submitted to the HOD.

(b) Plan of Work:

The student should prepare plan of work for the dissertation well in advance and get the approval of the guide during the first week of third semester of their study. In case the student wants to avail the facility or to carryout part of the work from other University/Research Institute/Laboratories in Industry, they can undertake the work with the permission of the guide and HOD and acknowledge the alien facilities/co-supervisor. The duration of the dissertation research shall be a minimum of three months in the fourth semester. In case the student stays away for work from the Department for more than one month, specific approval of the HOD should be obtained.

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

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, one copy can be given to the guide and one copy can be held by the student.

(f)Format to be followed:

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

Format for the preparation of project work:

(a) Title page

(b) Bonafide Certificate

(c) Acknowledgement

(d) Table of contents

CONTENTS

Format of the Title Page:

TITLE OF THE DISSERTATION Dissertation Submitted in part fulfillment of the requirement for the Degree of Master of Science in Chemistry (CBCS) to the Alagappa University, Karaikudi. By Students Name: Register Number: Under the Guidance of (Faculty Name) **University Emblem**
Department of Nanoscience and Technology Alagappa University (Reaccredited with "A" Grade by NAAC) Karaikudi - 630003
Year:

Format of the Certificate:

CERTIFICATE

This is to certify that the dissertation entitled ..... ---------- submitted in part fulfillment of the requirement of the degree of Master of Science in Chemistry (CBCS) to the Alagappa University, Karaikudi is a record of bonafide research work carried out by ---------- under my supervision and guidance and that no part of the dissertation has been submitted for the award of any degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journals or magazines.

Date:

Place: Signature of the Guide

XIV. PASSING MINIMUM

A candidate shall be declared to have passed in each course if he/she secures not less than 50% marks in the University ESE and not less than 50% in the aggregate, taking continuous assessment and University Examination marks together.

Candidates, who have secured the pass marks in the end-semester examination (ESE) but failed to secure the aggregate minimum pass mark (50%) are permitted to improve their CIA mark in the following semester and/or in University examinations.

A candidate shall be declared to have passed in the Project work if he/she gets not less than 50% in each of the Project Report and Viva-voce but not less that 50% in the aggregate of both the marks for Project Report and Viva-voce.

A candidate who gets less than 50% in the Project Report must resubmit the Project Report. Such candidates need take again the Viva-Voce on the resubmitted Project.

Improvement of marks – Norms for the Improvement marks

a) Candidates willing to improve his/her performance of marks in the University Examination (other than Practical /Project work) in Theory course shall be permitted to re-appear again in the succeeding semester examination for the theory course(s) in which he/she has passed in the first appearance.

b) Improvement of performance of marks is allowed only once of a (theory course) course.

c) If the candidate shows no improvement in such appearance, marks secured by him/her in the first appearance will remain. No fresh marks statement will be issued in such cases.

d) If the candidate shows improvement, a revised mark statement will be issued on production of the original mark statement issued to him/her.

e) On improvement of performance, if a candidate becomes eligible for a higher class/ GPA and CGPA it shall be incorporated/awarded in the mark statement/provisional certificate/degree certificate on an application made by the candidate (along with the original Mark Statemen/Provisional Certificate/Degree Certificate) already issued (as the case may be)

together with a fee prescribed for the purpose. However, he/she is not eligible for Revision of Rank of for the award of Prize.

f) Candidates willing to appear for the examination for improvement of marks at his/her last semester examination may await for the result of his/her latest appearance and re-appear twice in the immediately succeeding examination session.

g) The fee for permission re-appear for improvement of marks is to be paid in addition to the examination fee for each course for which he/she is appearing for.

h) The application for permission of re-appearance must be sent separately to the Controller of Examination in the prescribed form duly recommended by the HOD of the College on or before the last date for receipt of application for registration.

i) Fees paid once by these candidates will not be refunded or adjusted under any circumstances.

XV. GRADING

Once the marks of the CIA and end-semester examination 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 Table 2.

Table 2 Grading of the Courses

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	F

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

$$\mathbf{GPA} = \sum_{i=1}^{n} \mathbf{Ci}$$

$$\mathbf{GPA} = \frac{\sum_{i=1}^{n} \mathbf{CiGi}}{\sum_{i=1}^{n} \mathbf{Ci}}$$

Where ‘Ci’ is the Credit earned for the course i in any semester; ‘Gi’ is the Grade Point obtained by the student for the 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 starting

from the first semester to the current semester.

XVI. 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 therefore (i,e. 90 credits).

XVII. RANKING: UNIVERSITY RANK EXAMINATION

Candidates who pass all the examinations prescribed for the programme in the first instance and within a period two academic years 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 (CGPA)

Rank certificate will be issued for a programme as follows:

a) Only THREE ranks if the students strength is below 20.
b) Only FIVE ranks if the student strength is above 20 but below 50.
c) Only TEN ranks if the student strength is above 50 but below 100

XVIII. GRIEVANCE REDRESSAL COMMITTEE

The Department shall form a Grievance Redressal Committee for each course with the course Teacher and the HOD as the members. This committee shall solve all grievances relating to the internal Assessment marks of the students.

XIX. TRANSFER OF CREDITS

Students are permitted to transfer their programme credits from Directorate of Distance Education (DDE) of Alagappa University to Regular Stream and Vice-versa, if the PG degree programme is same.

XX. REVISION OF REGULATIONS AND CURRICULUM

The University may from time to time revise, amend and change the regulation and the curriculum, if found necessary.

XXI. COMMENCEMENT OF THIS REGULATION

These regulations shall take effect from the academic year 2016-17 i.e., for students who are to be admitted to the first year of the programme during the academic year 2016-17 and thereafter.

XXII. TRANSITORY PROVISION

Candidates who were admitted to the M.Sc. Chemistry-Specialization in Nanoscience and Technology programme of study from or after 2016-2017 shall be permitted to appear for the examinations under the above regulations for a period of four years. Thereafter, they will be permitted to appear for the examination only under the regulations then in force

Programme general objectives

Chemistry is a pervasive subject. All the branches of science need chemistry. It is an experimental science and students need to train in practicals to get expertise in doing fine experiments and handle sophisticated instruments. Along with the data obtained its statistical analysis is also required to establish authenticity in the fields like environmental science, space chemistry and biotechnology. There are immense potentialities for chemistry and post graduates to undertake advanced research or in Industries as skilled chemists. It is important for the educators to provide a platform for the student community to study in detail the basics and advancements in chemistry. Hence our goal in floating the M.Sc programme in Chemistry-Specialization in Nanoscience and Technology is to educate the undergraduate students of chemistry in the fascinating fields of chemistry in an effective manner.

Programme specific objectives

1. To provide, thorough well designed studies of theoretical and experimental chemistry, a worthwhile educational experience for all students
2. To acquire deep knowledge in fundamental aspects of all branches of chemistry
3. To acquire basic knowledge in the specialized thrust areas like Photoelectrochemistry, Materials Chemistry, Chemistry in Nanoscience and Technology etc.

Programme outcome

On successful completion of the programme

1. The students will be able to engage in noteworthy, self-govering, and creative research in chemistry.
2. The skill-based courses support the student to develop entrepreneurship in the field of chemistry.
3. The student acquired significant knowledge to clear the competitive examinations.

Semester – I			
Course code: 538101	**Inorganic Chemistry - I**	**Credits: 5**	**Hours : 5**
Objectives	➢ Understanding fundamental and advance level concepts of inorganic chemistry ➢ Determine the Styx code of borane compounds ➢ Understanding the relationship between properties and structures/bonding. ➢ To explain different types of nuclear reactions. ➢ To study the different types of metal clusters.		
Unit – I	**Structure and Bonding: -** VB Theory: Hybridisation – Sigma and pi bonding- concept of hybridization - VSEPR theory. MO theory. Application of MOT to homonuclear diatomic molecules like He_2, Li_2, N_2,O_2 and heteronuclear diatomic molecules like HF, NO and CO. Bond length, bond angles, bond order, bond energies - Intermolecular forces - Dipole moment - Lattice energy –Born Land equation - Born Haber cycle. Covalent character in ionic compounds – Fajan's rule.		
Unit – II	**Cages and Metal Clusters: -** Inorganic chains - rings - cages and clusters - catenation - heterocatenation - intercalation chemistry - Isopoly, Heteropoly acids and their anions, Silicates, phosphazenes - phosphazene polymers; sulphur nitrogen compounds. sulphur halides, oxo acids of sulpur; Boranes: Structure and bonding in polyhedral boranes and carboranes, styx notation; Wade's rule; electron count in polyhedral boranes; isolobal analogy; borazine: synthesis and structure. Metal clusters - dinuclear clusters - trinuclear clusters - tetra nuclear clusters - hexanuclear cluster.		
Unit – III	**Solid State Chemistry** : - Packing of ions in HCP, FCC and BCC structure – determination of packing fraction in SC, BCC, FCC and HCP structure-density of cubic crystals-structure of ionic crystals - AB type of crystals -Sodium chloride, Zinc blende, Wurtzite and Caesium chloride - AB_2 type of crystals- Fluorite, Rutile and Calcium carbide; A_2B type of crystals - Anti-fluorite; structure of covalent crystals - graphite and diamond - Electrical conductivity and super conductivity – High temperature super conductors –semi conductor types and applications – semi conductors in solar energy conversions		
Unit – IV	**Nuclear Chemistry: -** Properties of nucleus – nuclear stability, factors affecting the nuclear stability; Mode of decay - alpha, beta, gamma and orbital electron capture; Q value - threshold energy- reaction cross section; isobars- nuclear isomerism, Classification of nuclear reactions - spontaneous, transmutation, capture reactions, spallation reactions, - nuclear fission reaction-characteristic of fission reaction; theory of fission-liquid drop model; types of fission reaction-chain reaction; nuclear fusion - conditions necessary - energy released in fusion - steller energy; usage of radioisotopes in neutron activation analysis and isotopic dilution analysis; dating methods-radio-carbon dating method and rock-dating method.		
Unit – V	**Chemistry of Lanthanides and Actinides: -** Lanthanides- occurrence, extraction and separation techniques (fractional crystalization, precipitation, ion-exchange, solvent-extraction and thermal decomposition, selective reduction and oxidation) - position in the periodic table - electronic configuation - oxidation states - size relationships - lanthanide contraction - spectral and magnetic properties - condition compounds of lanthanides - uses of lanthanides and their compounds. Actinides: Synthesis of elements - position in the periodic table, electronic configuration and oxidation states - spectral and magnetic properties - comparative account of lanthanides and actinides.		

Reference and Textbooks:-

Arnikar, H. J. (1995). *Essentials of nuclear chemistry*. New Delhi: New Age International.

Arora, A. (2005). *Text book of inorganic chemistry*. New Delhi: Discovery Publishing House.

Arora, M. G., & Singh, M. (1998). *Nuclear chemistry*. New Delhi: Anmol Publications.

Cotton, F. A. (2008). *Advanced inorganic chemistry*. India: Wiley

Cotton, F. A. (2008). *Advanced inorganic chemistry*. India: Wiley.

Emeléus, H. J., & Anderson, J. S. (1952). *Modern aspects of inorganic chemistry, by H.J. Emeléus, ... and J.S. Anderson, ...* London: Routledge and Kegan Paul.

Emeléus, H. J., & Sharpe, A. G. (1983). *Advances in inorganic chemistry and radiochemistry*. New York: Academic Press.

Huheey, J. E., Keiter, E. A., Keiter, R. L., & Medhi, O. K. (2013). *Inorganic chemistry: Principles of structure and reactivity*. New Delhi: Pearson.

Jolly, W. J. (1985). *Modern inorganic chemistry*. New York: McGraw-Hill.

Malik, W. U., Tuli, G. D., & Madan, R. D. (2009). *Selected topics in inorganic chemistry*. New Delhi: S. Chand & Company.

Prakash, S. (2003). *Advanced inorganic chemistry*. Delhi: S. Chand

Outcomes	➢ Will be able to study the knowledge of general inorganic chemistry concepts. ➢ Will be able to analyse the structure and bonding of inorganic compounds. ➢ Will be able to catch innovative idea for mini project work. ➢ Will be able to supply broad theoretical and applied background. ➢ Will be able to understand the various metal clusters. ➢ Will be able to identify the different types of nuclear reactions. ➢ Will be able to know the chemistry of the Lanthanides and the Actinides

Name of the Course Teacher

Dr. S. Sangeetha/ Prof. K. Gurunathan

Semester – I			
Course code: 538102	**Organic Chemistry - I**	**Credits: 5**	**Hours : 5**
Objectives	➢ To understand the important features of reaction mechanism. ➢ To make the students to understand the mechanism of aliphatic substitution and elimination reactions. ➢ Impart knowledge about aromatic character in organic compounds . ➢ To explain the Optical isomerism and conformational analysis through stereochemistry.		
Unit - I	**Introduction to Reaction Mechanism: -** Reaction intermediates – free radicals, carbenes, nitrenes, carbanions, carbocations – formation and stability of reaction intermediates – principle of microscopic reversibility – Energy profile diagram – Hammond postulate - methods of determining reaction mechanism – kinetic methods – primary and secondary kinetic isotopic effect – non kinetic methods – isotope labeling, crossover experiment, trapping of intermediates, stereochemical studies		
Unit - II	**Aliphatic Substitution and Elimination Reactions: -** **Aliphatic Nucleophilic substitution:** Nucleophilicity and basicity. Types of nucleophiles. S_N1 and S_N2 mechanisms – Effect of substrate structure – Effect of the attacking nucleophile – Effect of the leaving group – Effect of the solvent. Neighbouring group participation. SNimechanism. **Aliphatic electrophilic substitution:** Mechanism of aliphatic electrophilic substitution reactions – S_E1, S_E2 and S_Ei mechanisms. **Elimination:** E_1, E_2 and E_1cB mechanism – orientation effects in elimination reactions –Hoffmann's,and Zaitsev's rule – Competition between elimination and substitution - Bredts rule.		
Unit - III	**Aromaticity : -** Aromatic character in benzene, five, six, seven and eight membered rings – other systems with aromatic sextets – Huckel's rule – Aromaticity concept of compounds with 2, 6, 10, 14, 18 and 22π electrons. Chemistry of cyclopentadienyl cation and anion. NMR as a tool for aromaticity of Annulenes. Concept of Homoaromaticity. Antiaromaticity of compounds with 4 and 8π electrons. Alternant and nonalternant hydrocarbons.		
Unit - IV	**Stereochemistry: -** Concept of chirality, necessary and sufficient conditions for chirality– Prochirality and prosteroisomerism - enantiotopic and diastereotopic ligands and faces – NMR distinction of enantiotopic/diastereotopic ligands - pro-R and pro-S and Re and Si faces. Stereospecfic and stereoselective reactions. Asymmetric synthesis; Cram rule. Optical isomerism due to axial chirality – biphenyl, Allenes and spiranes – RS notation -Stereochemistry of ansa compounds. Geometrical isomerism: E-Z nomenclature – determination of geometrical isomers using physical and chemical methods.		
Unit - V	**Conformational analysis: -** Configuration and Conformation. Conformational analysis of acyclic systems: Ethane propane, ,n-butane and ethylene glycol.Conformational analysis of cyclic systems: cyclohexane and mono, di-substituted cyclohexanes. Fused and bridged bicyclic systems: Decalins. Conformation, reactivity and stereoelectronic factors of cyclic systems.		

Reference and Textbooks:-

Carey, F. A., & Sundberg, R. J. (2007). *Advanced organic chemistry*. New York: Springer.

Eliel, E. L. (1975). *Stereochemistry of carbon compounds*. New Delhi: Tata McGraw-Hill Pub.

Finar, I. L. (2003). *Organic chemistry: Volume 1: The Fundamental Principles*. India: Pearson eduation.

Kalsi, P. S. (1990). *Stereochemistry: Conformation and mechanism*. New York: Wiley.

Mukherji, S. M., & Singh, S. P. (1984). *Reaction mechanism in organic chemistry*. New Delhi: Macmillan.

Nasipuri, D. (2012). *Stereochemistry of organic compounds: Principles and applications*. Tunbridge Wells, Kent, UK: New Academic Science..

Norman, R. O., & Coxon, J. M. (1995). *Principles of organic synthesis*. London: ELBS with Chapman and Hall.

Smith, M., & March, J. (2007). **Marchs advanced organic chemistry: Reactions, mechanisms, and structure*. Hoboken, NJ: John Wiley & Sons.

Sykes, P. (1986). Guidebook *to Mechanism in Organic Chemistry*. Harlow: Longman.

Outcomes	➢ Graphically visualize organic reactions with correct reaction mechanisms ➢ Use the concepts nucleophile and electrophile in order to explain the reactivity ➢ Will be able to analyze some common and important organic reactions such as SN2, E2, SN1 and E1 with mechanism ➢ Will know the nature and stability of aromatic compounds ➢ From stereochemistry the three dimensional atoms arrangement of organic compounds will be understood ➢ Will be able to understand the flexible nature of organic compounds through carbon-carbon bond rotation

Name of the Course Teacher

Dr. K. Radhakrishnan/Prof. K. Gurunathan

Semester – I			
Course code: 538103	**Physical Chemistry-I**	**Credits: 5**	**Hours : 5**
Objectives	➢ Understand the essential of quantum theory and its mechanics that are converging to create the new area of quantum chemistry. ➢ To make the students understand the principles of different models of double layer in the field of electrochemistry and various types of over potentials. ➢ Employ theories of reaction rates, unimolecular reaction, and elementary reactions in solutions. ➢ Impart knowledge about basic concept of thermodynamics and thermodynamics of ideal and non-ideal solutions. ➢ Apprehend and explain the principles of photochemistry and solar energy conversion.		
Unit - I	**Quantum Chemistry – I: -** **Quantum Theory: -** Inadequacy of classical mechanics, Black-body radiation, Planck's distribution, Photoelectric effect, Wave-particle duality of material particles and de Broglie's hypothesis, Dynamics of microscopic systems: Born interpretation of the wave function, Normalization, Quantization, Probability density and Uncertainty principle. **Quantum mechanics: -** Schrodinger equations, Operator algebra: Operators, linear and hermitian, Eigen functions and Eigen values, Angular momentum		
Unit - II	**Electrochemistry: -** Polarizable and Non-polarizable interfaces, Lippman Equation–Relating charge density and interfacial tension, Different models of double layer–Born model, Helmholtz-Perrin model, Gouy-Chapmann diffuse charge model and Stern model. Derivation of Butler-Volmer equation, Tafel equations. Types of electrode reaction, various types of over potentials.		
Unit - III	**Chemical Kinetics -I: -** Theories of Reaction Rates: Rate laws and rate constants, reaction order, determination of rate law, reactions approaching equilibrium, temperature dependence of reaction rates, Arrhenius parameters, consecutive elementary reactions, steady-state approximation, Kinetic isotope effect. **Unimolecular reactions:** Lindemann- Hinshelwood mechanism and activation energy of a composite reaction. **Elementary Reactions in Solutions:** Activated complex theory; Bronsted-Bjerrum equation - Primary and secondary salt effects, Eyring equation and potential energy surfaces.		
Unit - IV	**Classical Thermodynamics: -** **Thermodynamics concept: -** Second law of thermodynamics Need – Statements - Concept of entropy, reversible and irreversible processes, Free energies. Fundamental equations for open systems, Partial molar quantities, partial molar volume and chemical potential, Gibbs-Duhem equation, Real gases and Fugacity - activity and activity co-efficient – determination. **Thermodynamics of ideal and non-ideal solutions: -** Liquid-liquid solutions, liquid-solid solutions, muticomponent systems and mean ionic activity coefficients. Strong electrolytes, Debye-Huckel limiting law and its extensions, Applications of Debye-Huckel Theory. Phase behavior of one and two components systems and classification of phase transitions		

Unit - V	**Photochemistry and Solar Energy Conversion: -** **Photochemistry:** - Jablonski diagram, Photophysical process in electronically excited molecules by different types of pathways, Resonance energy transfer rates, Fluorescence quenching kinetics in solution phase, Quantum yield. Photosensitization, Chemiluminences, Lasers. **Solar energy conversion: -** Basic concept of photocatalysis, visible light water splitting, Photovoltaic cells, Perovskites solar cell, Dye sensitized solar cells, efficiency and measurements**.**

Referene and Text books:-

Allis, W. P. (1964). *Thermodynamics and statistical mechanics*. Taipei: Reprinted by Hsin Yueh

Atkins, P. W., & Paula, J. D. (2010). *Physical chemistry*. New York: W.H. Freeman.

Bockris, J. O., & Reddy, A. K. (2004). *Modern electrochemistry*. New York: Kluwer Academic.

Chandra, A. K. (1994). *Introductory quantum chemistry*. New Dehli: Tata McGraw-Hill.

Glasstone, S. (2007). *Thermodynamics for chemists*. New York: Narahari Press.

Gupta, K. S. (1992). *Chemical kinetics & reaction mechanism*. Jaipur, India: RBSA.

Gurtu, J. N., & Gurtu, A. (2010). *Physical chemistry Vol. I*. Meerut, India: Pragati Prakashan.

Houston, P. L. (2001). *Chemical kinetics and reaction dynamics students solutions manual*. Boston: McGraw-Hill.

Klein, S. A., & Nellis, G. (2012). *Thermodynamics*. New York: Cambridge University Press.

Laidler, K. J. (n.d.). *Chemical kinetics*. New York, NY: HarperCollins.

Levine, I. N. (2014). *Quantum chemistry*. Boston: Pearson.

Mordechay Schlesinger, Modern Aspects of*Electrochemistry:* Issue 43, Springer, Netherlands, 2009.

Oldham, K. B., Bond, A. M., & Myland, J. C. (2013). *Electrochemical science and technology: Fundamentals and applications*. Chichester: Wiley.

Prasad, R. K. (2010). *Quantum chemistry*. Tunbridge Wells: New age Science.

Rajaram, J. (1986). *Thermodynamics for students of chemistry*. Jalandhar: Shobhan Lal Nagin Chand.

Silbey, R. J., Alberty, R. A., & Bawendi, M. G. (2017). *Physical chemistry*. Hoboken, NJ: Wiley.

Outcomes	➢ Understand how operators play a major role in quantum mechanics. ➢ Realize the difference between different models of double layer in the field of electrochemistry. ➢ Understand how rate law is different from rate constant? and how order of reaction is different from one another? ➢ Recognize the need of second law of thermodynamics ➢ Realize the future research possibilities in the area of water splitting and dye sensitized solar cells.

Name of the Course Teacher

R.M. Jeyam/ Dr. P. Shakkthivel

Semester – I			
Course code: 538107	**Inorganic Chemistry Practical**	**Credits: 4**	**Hours : 8**

Objectives	➢ To enable the students, to apply the principle in the semi-micro analysis of an inorganic salt mixture ➢ To understand the different types of EDTA and redox titrations. ➢ To motivate the students to understand Preparation and Analysis of Co-Ordination Complexes. ➢ To practice the estimation of metal ions present in the given solution.
Unit - I	**1. Quantitative Analysis: -** a) EDTA titrations : i) Ca ii) Mg iii) Ni iv) Zn b) Redox titrations : Fe(II) vs. Ce(IV) , Fe(II) vs. dichromate NO^{2-} vs. Ce(IV)
Unit - II	**2. Semi-micro qualitative analysis:** Analysis of mixtures containing two ions: Less familiar cations : W, Mo, Zr, Ti, V, Li, Se and Te
Unit - III	3. **Preparation and Analysis of Co-Ordination Complexes: -** Preparation of co-ordination complexes by single/double stage method

Reference and Textbooks:- (APA format)

Grindley, D. N. (1964). *An advanced course in practical inorganic chemistry*. London: Butterworths.

Palmer, W. G. (1970). *Experimental inorganic chemistry / William George Palmer*. Cambridge: University.

Vogel, A. I. (1983). *A text-book of quantitative inorganic analysis including elementary instrumental analysis*. London: Longman.

Williams, R. P. (2012). *Laboratory manual of inorganic chemistry*. Place of publication not identified: Rarebooksclub Com.

Outcomes	➢ Will be able to acquire knowledge about in-organic chemistry practical ➢ Will be able to understand the how to do experimental work. ➢ Will be able to acquire knowledge in different types of titrations. ➢ Will be able to gain knowledge about the preparation and analysis of Co-Ordination Complexes

Name of the Course Teacher

Dr. S. Sangeetha/Prof. K. Gurunathan

Semester - II			
Course code: 538201	**Inorganic Chemistry - II**	**Credits: 5**	**Hours : 5**
Objectives	➢ Understanding fundamental and advance level concepts of inorganic chemistry ➢ Determine the basic concepts of coordination compounds ➢ Understanding the relationship between properties and structures/bonding. ➢ To explain how to use the inorganic chemistry for different aspects. ➢ To study the principle and importance of organometallic compounds.		
Unit - I	**Theories of Coordination Compounds : -** Valence Bond Theory-octahedral, square planar and tetrahedral complexes - limitations of VBT; Crystal Field Theory - splitting of d-orbitals in octahedral, tetrahedral complexes - factors affecting the magnitude of 10 Dq, spectrochemical series, crystal field stabilization energy of octahedral and tetrahedral complexes - distortion of octahedral complexes - Jahn-Teller distortion, applications of CFT; Spinels - structure, classification and site selection; Molecular Orbital Theory – sigma and pi bonding in octahedral complexes. Comparison of VBT, CFT and MOT.		
Unit - II	**Reaction Mechanism in Complexes: -** Conjugate base mechanism, anation reactions, Reactions of coordinated ligands, substitution reactions in square planar complexes - Trans effect –uses; theories of trans effect- electrostatic polarization theory - pi bonding theory; mechanism of substitution reactions- factors affecting the rate of substitution reactions- isomerisation in planar complexes; electron transfer reactions in coordination compounds - inner sphere mechanisms -outer sphere mechanisms - complementary - non-complementary electron transfer reaction mechanism.		
Unit - III	**Organometallic Chemistry - I : -** Review of formalisms such as oxidation state, 18-electron rule, classes of ligands, Valence electron count (16/18 electron rules); Metal carbon bond types- Structure and bonding in mono and polynuclear metal carbonyls; substituted metal carbonyls and related compounds; reactivity of metal carbonyls; vibrational spectra of metal carbonyls; dinitrogen and dioxygen as ligands in organometallic compounds. Nitrosyls: terminal bridging and bent cyclopentadienyl complexes- bonding with transition metals- metallocenes- ferrocene; Metal arene complexes- synthesis and reactivity.		
Unit - IV	**Organometallic Chemistry-II: -** Reaction mechanisms of organometallic complexes, ligand substitution, oxidative addition, reductive elimination, migratory insertion and hydride elimination, transmetallation, Reactions of coordinated ligands in organometallics. Fluxional molecules. Catalysis - Hydrogenation, Hydroformylation, hydrosilation, Monsanto process, Wacker process, alkene polymerization- Ziegler-Natta Polymerisation.		
Unit - V	B**ioinorganic Chemistry–I :-** Essential and trace metal ions in biology and their distribution, thermodynamic and kinetic factors for the presence of selected metal ions; bioligands - amino acids, proteins, nucleic acids, nucleotides and their potential metal - binding sites; molecular mechanism of ion transport across membranes - ionophores. sodium ion pump of *cis*-platin, radio-isotopes (e.g., Tc & I_2) and MRI agents. Toxicity of metals – Al, Cd, . Processes in Photosynthesis – Photosystems I and II. Metals in medicine - therapeutic applications Hg and Cr toxic effects with specific examples, detoxification by chelation. special ligands - porphyrins, chlorin and corrin.		

<table>
<tr><td colspan="2">Reference and Textbooks:-
Arora, A. (2005). Text book of inorganic chemistry. New Delhi: Discovery Publishing House.
Cotton, F. A. (2008). Advanced inorganic chemistry. India: Wiley
Graddon, D. P. (1968). An introduction to co-ordination chemistry. Oxford: Pergamon Press.
Huheey, J. E., Keiter, E. A., Keiter, R. L., & Medhi, O. K. (2013). Inorganic chemistry: Principles of structure and reactivity. New Delhi: Pearson.
Kettle, S. F. (1969). Co-ordination compounds. Nelson.
Prakash, S. (1945). Advanced inorganic chemistry. New Delhi: S. Chand & Company.
Sodhi, G. S. (2011). Textbook of inorganic chemistry. New Delhi, India: Viva Books.
Agarwala, S. K., & Lal, K. (2009). Advanced inorganic chemistry. Meerut: Pragati Prakashan.
Lewis, J. (1967). Modern coordination chemistry principles and methods. New York: Interscience Publ.
Gopalan, R. (2012). Textbook of inorganic chemistry. India: Universities Press (India) Private.
Lawrance, G. A. (2010). Introduction to coordination chemistry. Chichester: Wiley.
Sattler, K. D. (2011). Clusters and fullerenes. Boca Raton, FL: CRC Press.
Housecroft, C. E., & Sharpe, A. G. (2018). Inorganic chemistry. Harlow: Pearson Education.</td></tr>
<tr><td>Outcomes</td><td>➢ Will be able to how to use in-organic chemistry.
➢ Will be able to study the role of inorganic materials.
➢ Will be able to catch innovative idea for mini project work.
➢ Will be able to understand the reaction mechanism of inorganic complexes.
➢ Will be able to study the different type of catalysis reactions
➢ Will be able to identify which bond has occurred by analyzing the type of electron interactions in terms of transferring or sharing.
➢ Will be able to know the chemistry of the bioinorganic materials</td></tr>
</table>

Name of the Course Teacher

Dr. S. Sangeetha/ Prof. K. Gurunathan

Semester – II			
Course code: 538202	**Organic Chemistry - II**	**Credits: 5**	**Hours : 5**

Objectives	➢ To recognize the importance of oxidation and reduction reactions using various reagents. ➢ To understand the important features of reaction mechanisms and molecular rearrangements. ➢ To understand the substitution reactions in aromatic compounds. ➢ Apprehend knowledge about natural products. ➢ To know the uses of chromatographic techniques in organic chemistry.
Unit - I	**Oxidation and Reduction: -** Mechanism and application of stereochemical aspect of the following oxidation – reduction reactions: Oxidation reaction involving SeO_2, OsO_4, periodic acid, N-bromosuccinimide, Sharpless asymmetric epoxidation, Hydroboration-oxidation, Baeyer-Villiger oxidation, Woodward-Prevost reactions. Catalytic hydrogenation- Heterogeneous catalysts Pd/Pt/Rh/Ni. Homogeneous catalyst-Wilkinson catalyst. Reduction of various functional groups using lithium aluminium hydride and sodium borohydride. McMurry reaction- Birch reduction – Meerwein Pondorf Verley reduction – Wolff-Kishner reduction - Stereo/enantioselective reductions of Chiral Boranes.
Unit - II	**Name reactions and Molecular rearrangements: -** Mechanism of Aldol condensation – Perkin reaction – Knoevenagel reaction – Mannich reaction – Cannizaro reaction – Benzoin condensation – Claisen ester condensation – Darzen's reaction – Reformatsky reaction – Wittig reaction – Grignard reactons. **Mechanism of the following rearrangement reactions: -** Wagner – Meerwein, Pinacol, Beckmann, Hofmann, Curtius, Baeyer – Villeger, Sommelet – Hauser, Favorskii, Benzil – benzilic acid, Claisen, Fries, Dienone – phentol and di-pi methane.
Unit - III	**Aromatic substitution reactions: -**Aromatic electrophilic substitution– Mechanism of nitration, halogenation, Friedel-Craft's reaction, sulphonation and Gattermann – Koch Formylation - Reimer-Tiemann reaction - Vilsmeyer- Haack reaction - Kolbe-Schmidt reaction. Partial rate factors – ortho/para ratio – Quantitative treatment of reactivity of the electrophile (the selectivity relation). Aromatic nucleophilic substitution reactions (S_NAr). Unimolecular, bimolecular and benzyne mechanisms. Chichibabin reaction. Quantitative treatment of the effect of structure on reactivity - The Hammett relationship – significance of reaction and substituents constants.
Unit - IV	**Chemistry of Natural products: -**Steroids: synthesis of cholesterol, male sex harmones – androsterone and testosterone – female sex harmones – oestrone, equilenin and progesterone. Vitamins: Structures of A, B12, C, and K. Nucleic acids: Structures of nucleoside, nucleotide RNA and DNA, functions of nucleic acids.
Unit - V	**Chromatography: -** Basic principles of chromatography. Stationary phase, mobile phase, analyte, eluent. Types of chromatography: paper chromatography, Thin layer chromatography(TLC), column chromatography, ion-exchange chromatography, Gas chromatography(GC), High-pressure liquid chromatography(HPLC). Applications of chromatography.

Reference and Textbooks:

Carey, F. A. (2000). *Advanced organic chemistry*. New York: Springer

Clayden, J., Greeves, N., Warren, S., & Wothers, P. (2001). *Organic chemistry*. New York, NY: Oxford University Press.

Finar, I. L. (1985). *Organic Chemistry: Streochemistry and the Chemistry of Natural Products*. Harlow: Longman.

Finar, I. L. (2003). *Organic chemistry: Volume 1: The Fundamental Principles*. India: Pearson eduation.

Lundanes, E., Reubsaet, L., & Greibrokk, T. (2013). *Chromatography: Basic principles, sample preparations and related methods*. Weinheim, Germany: Wiley-VCH.

March, J. (2005). *Advanced organic chemistry: Reactions, mechanisms, and structure*. New York: Wiley

Mukherji, S. M., & Singh, S. P. (1984). *Reaction mechanism in organic chemistry*. New Delhi: Macmillan

Bansal, R. K., & Ahluwalia, V. K. (2012). *Organic Reaction Mechanisms*. Tunbridge Wells, Kent, UK: New Academic Science.

Bruice, P. Y. (2016). *Essential organic chemistry*. Upper Saddle River, NJ: Pearson.

Chatwal, G. R. (1981). *The chemistry of organic natural products*. Bombay: Himalaya Pub. House.

Miller, J. M. (2009). *Chromatography: Concepts and contrasts*. Hoboken: J. Wiley & Sons.

Mundy, B. P., Ellerd, M. G., & Favaloro, F. G. (2005). *Name reactions and reagents in organic synthesis*. Hoboken, NJ: John Wiley & Sons.

Outcomes	➢ Oxidation reduction concept using various reagents. ➢ Able to Explain the concept of reaction mechanism through organic name reactions and molecular rearrangement reactions ➢ aromatic electrophilic substitution reaction provides insight knowledge about aromatic compounds and their reactivity ➢ synthesis and stereochemistry of steroids will be understood ➢ properties and structure of vitamins and nucleic acids will be known ➢ able to know the application of chromatographic techniques in organic chemistry

Name of the Course Teacher

Dr. K. Radhakrishnan/Prof. K. Gurunathan

Semester – II			
Course code: 538203	**Physical Chemistry - II**	**Credits: 5**	**Hours : 5**
Objectives	➢ Understand the application of wave mechanics and John-teller effect, quantum numbers, zero-point energy, orthogonisation and normality, tunneling, perturbation theory. ➢ Explain the construction of Character Tables for C_{2V} and C_{3V} point group molecules, and Great orthogonality theorem and its proof ➢ To make the students understand the principles Spectroscopy application of group theory to IR spectral activity of vibrational modes of ammonia molecule, selection rules for vibrational IR and RAMAN spectra, ➢ To understand the Solution and gas phase kinetics, Enzymes, Fast reaction kinetics ➢ Impart knowledge about surface and interfaces, heterogeneous catalysis.		
Unit - I	**Quantum Chemistry – II : -** Application of wave mechanics: rigid rotor, harmonic oscillators, shapes of orbitals, shape quantization. Particle in a box: One and three-dimensional boxes, distortions, John-teller effect, quantum numbers, zero-point energy, orthogonisation and normality, tunnelling.		
Unit - II	**Group Theory- I : -** Symmetry elements and symmetry operations, Centre of symmetry, Plane and its types of Symmetry, Proper and Improper axis of Symmetry, Principal axis and subsidiary axes. The concept of groups, Assigning Point groups with illustrative examples, Symmetry operations and order of a group - Group theoretical rules (Group postulates), reducible and irreducible representations, matrix representations of symmetry operations, Construction of Character Tables for C_{2V} and C_{3V} point group molecules, and Great orthogonality theorem and its proof.		
Unit - III	**Group Theory - II : -**Direct product representation, Spectroscopy application of group theory to IR spectral activity of vibrational modes of ammonia molecule, selection rules for vibrational IR and RAMAN spectra, Mutual exclusion rule for molecules with center of symmetry, selection rules for rotational spectroscopy. Selection rules for n-π^* and π-π^* transitions in formaldehyde molecule. SALC procedure, Applications of SALC procedure to ethylene and butadiene molecules.		
Unit - IV	**Chemical Kinetics - II : -**Solution and gas phase kinetics: Chain reactions and its rate laws, Hydrogen-bromine reaction, chain-branching explosion reactions, Polymerization kinetics: stepwise and chain polymerizations. Homogeneous catalysis: Features of acid-base catalysis. **Enzymes: -** Michaelis-Menten mechanism of enzyme catalysis, catalytic efficiency of enzymes, mechanisms of enzyme inhibition. Fast reaction kinetics: Relaxation methods (T- and P-jump methods), Stopped flow methods, Shockwave technique, Flash photolysis.		
Unit - V	**Surface Chemistry and Heterogeneous Catalysis: -** Surface and interfaces: Surface tension, solid-liquid interfaces; contact angle and wetting; Solid-gas interface; Physisorption and chemisorptions, Freundlich, Gibbs, Langmuir, and BET adsorption isotherms; Surface area determinations. **Heterogeneous catalysis:** Kinetics of surface reactions involving adsorbed species, Langmuir-Hinshelwood mechanism, Langmuir-Rideal mechanism, Rideal-Eley mechanism, Basic aspects of semiconductor catalysis and applications.		

Reference and Textbooks:

Atkins, P., & Paula, J. D. (2017). *Elements of physical chemistry*. Oxford: Oxford University Press.

Birdi, K. S. (2016). *Handbook of surface and colloid chemistry*. Boca Raton: CRC Press/Taylor & Francis Group..

Castellan, G. (1972). *Physical chemistry*. Reading, MA: Addison Wesley.

Chandra, A. K. (1994). *Introductory quantum chemistry*. New Dehli: Tata McGraw-Hill.

COTTON, F. A. (2015). *CHEMICAL APPLICATIONS OF GROUP THEORY*. Place of publication not identified

F. Albert Cotton, Chemical Applications of Group Theory

Gupta, K. S. (1992). *Chemical kinetics & reaction mechanism*. Jaipur, India: RBSA.

Gurtu, J. N., & Gurtu, A. (2010). *Physical chemistry Vol. I*. Meerut, India: Pragati Prakashan.

Houston, P. L. (2001). *Chemical kinetics and reaction dynamics*. New York: McGraw-Hill

Kunju, A. S., & Krishnan, G. (2015). *Group theory and its applications in chemistry*. New Delhi: PHI Learning. .

Laidler, K. J. (1987). *Chemical kinetics*. New York, NY: Harper & Row.

Levine, I. N. (1991). *Quantum chemistry*. Englewood Cliffs, NJ: Prentice Hall.

Prasad, R. K. (2010). *Quantum chemistry*. Tunbridge Wells: New age Science.

Raman, K. V. (1994). *Group theory and its applications to chemistry*. New Delhi: Tata McGraw-Hill Publ.

Silbey, R. J., Alberty, R. A., & Bawendi, M. G. (2005). *Physical chemistry*. New York: J. Wiley.

Somorjai, G. A., & Li, Y. (2010). *Introduction to surface chemistry and catalysis*. Hoboken, NJ: Wiley.

Outcomes	➢ Understand application of wave mechanics. ➢ Realize the difference between different axis of symmetry and how to represent matrix ➢ Construct Character Tables for C_{2V} and C_{3V} point group molecules ➢ Realize the SALC procedure and application ➢ Recognize the Michaelis-Menten mechanism of enzyme catalysis, catalytic efficiency of enzymes, mechanisms of enzyme inhibition.

Name of the Course Teacher

R. M. Jeyam/Prof. P. Shakkthivel

Semester – II			
Course code: 538207	**Organic Chemistry Practical - I**	**Credits:4**	**Hours : 8**

Objectives	➢ Teach students safe and good laboratory practice to be followed in organic chemistry lab. ➢ Engage in safe laboratory practices by handling laboratory glassware, equipment and chemical reagents appropriately, using general guidelines and basic knowledge about the common hazards associated with them in an organic chemistry laboratory. ➢ Assemble glassware and perform the following techniques as a part of preparative procedures, aqueous workup, distillation, reflux , separation, isolation and crystallization. ➢ Predict the outcome of several common organic reaction types through a basic understanding of starting materials, functional groups, mechanism and typical reaction conditions. ➢ Characterize the prepared substances by UV and IR spectroscopic techniques.
Unit - I	**1. Qualitative analysis: -** Separation and Identification of components in a two component mixture and preparation of their derivatives. Determinations of boiling point/melting point for components and melting point for their derivatives.
Unit - II	**2. Double stage Organic preparation : -** (a) Benzanilide from benzophenone. (b) Eosin from phthalic anhydride (c) Methyl orange from Aniline (d) Benzoic acid from Aniline
Unit - III	**3. Quantitative estimations: -** (a) Aniline (b) Phenol (c) Glucose
Unit - IV	**4. Identification of functional groups of organic compounds prepared and extracted: -** (a) UV-VIS spectra of _, _ -unsaturated carbonyl systems (b) FT IR spectra of few organic compounds

Reference and Textbooks:

Bansal, R. K. (2009). *Laboratory manual of organic chemistry*. New Delhi: New Age International.

Furniss, B. S., & Vogel, A. I. (2007). *Vogels textbook of practical organic chemistry*. New Delhi: Pearson Education.

Vogel, A. I. (2000). *Elementary practical organic chemistry part 2: Qualitative organic analysis*. India: CBS..

Vogel, A. I. (2000). *Elementary practical organic chemistry: Quantitative organic analysis*. New Dehli: CBS

Outcomes	➢ Acquire basic knowledge on practical techniques and approaches commonly used in organic chemistry linked to chemistry ➢ Understand the separation and identification of organic molecules and preparation of organic compounds ➢ Gain knowledge on organic chemistry practical through UV and IR techniques

Name of the Course Teacher:**Dr. K. Radhakrishnan/Prof. K. Gurunathan**

Semester – III			
Course code: 538301	**Inorganic Chemistry - III**	**Credits: 5**	**Hours : 5**

Objectives	➢ Understanding fundamental and advance level concepts of inorganic chemistry ➢ Determine the application of IR, raman and mossbauer spectroscopy to the study of inorganic compounds ➢ Understanding the spectral and magnetic properties of complexes. ➢ To explain NMR Spectroscopy of Inorganic Compounds. ➢ To study the organic photochemistry, bioinorganic chemistry II
Unit - I	**Application of Ir, Raman and Mossbauer Spectroscopy to the study of Inorganic Compounds: -** Application of IR and Raman spectra in the study of coordination compounds – application to metal carbonyls, nitrosyls and sulphate – geometrical and linkage isomerism – detection of inter and intramolecular hydrogen bonding. **Mossbauer Spectroscopy:-** Mossbauer Effect – resonance absorption – Doppler effect – Doppler velocity – isomer shift –magnetic hyperfine splitting-application of Mossbauer spectroscopy in the study of iron and tin complexes.
Unit - II	**Spectral and Magnetic Properties of Complexes: - Electronic** spectra of coordination compounds - selection rules, band intensities and band widths; Term state for d ions in octahedral complexes, Characteristics of d-d transitions. Nephelauxetic effect, energy level diagrams of Orgel and Tanabe - Sugano diagram. Magnetic properties of coordination compounds - dia, para – ferro and antiferro – magnetism –Molecular magnets, magnetic susceptibility by Gouy balance.
Unit - III	**NMR Spectroscopy of Inorganic Compounds: -** NMR Spectroscopy: ^{31}P and ^{19}F and – NMR spectroscopy – Introduction – application in structural problem – evaluation of rate constants – monitoring the course of reaction – NMR of fluxional molecules – NMR of paramagnetic molecules – contact shifts and shift reagent**.**
Unit - IV	**Inorganic Photochemistry: -** Photochemistry of Cr(III), Co(III) and Ru(II) - coordination compounds – photoaquation – photoanation – photoisomerisation – photo redox reactions – charge transfer photo chemistry – photosensitisation – solar energy conversion – photogalvanic cell – splitting of water to evolve hydrogen and oxygen – photochemistry of Pt(II) and Pt(IV) complexes.
Unit - V	**Bioinorganic Chemistry II : -** Active-site structure and function of metalloproteins and metalloenzymes; structure and properties of haemoglobin, myoglobin, hemocynin and hemerythrin. Zinc containing enzymes-carboxypeptidase-A and carbonic anhydrase. Electron transfer proteins - active site structure and functions of ferredoxin, rubridoxin and cytochromes. Nitrogen fixation; Structure and properties of Chlorophyll.
	Reference and Textbooks: Arora, A. (2005). *Text book of inorganic chemistry*. New Delhi: Discovery Publishing House Das, A. K. (2013). *Bioinorganic Chemistry*. S.L.: Books & Allied Graddon, D. P. (1968). *An introduction to co-ordination chemistry*. Oxford: Pergamon Press. Huheey, J. E., Keiter, R. L., & Keiter, E. A. (1993). *Inorganic chemistry: Principles of structure and reactivity*. New York: Harper Collins. Kettle, S. F. (1969). *Co-ordination compounds*. Nelson. Mackay, K. M., Mackay, R. A., & Henderson, W. (1996). *Introduction to modern inorganic chemistry*. London: Blackie Academic & Professional.

Outcomes	➢ Will be able to study the basic ideas of IR and RAMAN spectroscopy ➢ Will be able to study the Mossbauer Spectroscopy. ➢ Will be able to catch innovative idea for mini project work ➢ Will be able to understand the magnetic properties of complexes. ➢ Will be able to understand the inorganic photochemistry ➢ Will be able to identify the different types of NMR spectroscopy ➢ Will be able to know the chemistry of bio-Inorganic Compounds

Name of the Course Teacher

Dr. S. Sangeetha/ Prof. K. Gurunathan

Semester – III			
Course code: 538302	**Organic Chemistry - III**	**Credits: 5**	**Hours : 5**
Objectives	➢ To understand the basic principle and types of reactions of photochemistry and pericyclic reactions. ➢ To know the principle and applications of UV, IR and Mass spectroscopy. ➢ To know the important concept of proton and ^{13}C NMR spectroscopy in organic reactions ➢ To gain knowledge about heterocyclic compounds ➢ To understand the concept of retrosynthetic analysis of organic compounds ➢ To understand the protection and deprotection of various functional groups		
Unit - I	**Photochemistry and Pericyclic Reactions: -** Basic principles of photochemistry- Norrish-I and Norrish-II type reactions – Paterno buchi reaction – photochemistry of olefins and dienes, cis – trans isomers– photosensitization – photoreduction. **Pericyclic Reactions:** Symmetry properties of Molecular Orbitals, Electrocyclic, Cycloaddition and sigmatropic reactions.		
Unit - II	**UV, IR and Mass Spectroscopy**: - **UV Spectroscopy:** Principle **–** absorption spectra of conjugated dienes – unsaturated carbonyl compounds – Woodward – Fieser rules. **IR Spectroscopy: -** Molecular vibrations – vibrational frequency – factors influencing group frequencies. **Mass Spectrometry: -** Principle – type of ions base peak – parent ion, metastable and Isotopic peaks – fragmentation – Mc Lafferty rearrangement – Retro Diels – Alder reaction		
Unit - III	**^{1}H NMR Spectroscopy**: - Origin of NMR spectra – chemical shift – spin – spin coupling – coupling constant – first and second order spectra – spin – spin splitting – Relaxation time – simplification of complex spectra – deuterium substitution – spin decoupling – double resonance – shift reagents – nuclear overhauser Effect – CIDNP – NMR concept of aromaticity – FT Technique. **^{13} C NMR Spectroscopy: -** Assignment of signals – off–resonance decoupling.		
Unit - IV	**Heterocycles: -** General aspects of heterocyclic compounds, nomenclature of Nitrogen, Oxygen and Sulpur heterocyclic compounds. Major classes of heterocycles. Synthesis of five and six member aromatic heterocycles: Knorr-pyrrole synthesis, Paal-Knorr Furan synthesis, Hinsberg Thiophene synthesis, Hantzsch pyridine synthesis, Fischer Indole synthesis, Skraup Quinoline synthesis, Bischler-Napieralski Isoquinoline synthesis.		
Unit - V	**Retrosynthesis and Functional Group Protection Retrosynthetic Analysis**: - Basic principles and terminology of retrosynthesis, synthesis of aromatic compounds, one group and two group C-X disconnections, one group C-C and two group C-C disconnections, amine and alkene synthesis, important strategies of retrosynthesis, functional group transposition, important functional group interconversions **Protecting groups: -** Protection and deprotection of hydroxy, carboxyl, carbonyl, carboxy amino groups. Chemo- and regioselective protection and deprotection; illustration of protection and deprotection in synthesis		

Reference and Textbooks:

Ahluwalia, V. K. (2013). *Heterocyclic chemistry*. Oxford: Alpha Science International.

Carey, F. A., & Sundberg, R. J. (2007). *Advanced organic chemistry*. New York: Springer.

Finar, I. L. (2003). *Organic chemistry: Volume 1: The Fundamental Principles*. India: Pearson eduation.

Kemp, W. (2008). *Organic spectroscopy*. Place of publication not identified: Palgrave Macmillan

March, J. (2005). *Advanced organic chemistry: Reactions, mechanisms, and structure*. New York: Wiley

Mukherji, S. M., & Singh, S. P. (1984). *Reaction mechanism in organic chemistry*. New Delhi: Macmillan

Parashar, R. K., & Negi, B. (2016). *Chemistry of Heterocyclic compounds*. New Delhi: Ane Books

Quin, L. D., & Tyrell, J. A. (2010). *Fundamentals of heterocyclic chemistry: Importance in nature and in the synthesis of pharmaceuticals*. Hobooken, NJ: Wiley.

Sharma, Y. R. (2013). *Elementary Organic Spectroscopy: Principles and chemical* applications. S.l.: S Chand & Co.

Silverstein, R. M., Webster, F. X., Kiemle, D. J., & Bryce, D. L. (2015). *Spectrometric identification of organic compounds*. Hoboken, NJ: Wiley.

Warren, S., & Wyatt, P. (2013). *Organic Synthesis The Disconnection Approach*. Hoboken: Wiley.

Outcomes	➢ Able to understand photochemistry of olefins and carbonyl compounds and various types of reactions ➢ Will have ability to explain the applications of various spectroscopic techniques in organic chemistry ➢ Will get the insight knowledge in heterocyclic compounds ➢ .able to explain the concepts behind the retrosynthesis and functional group protection and deprotection.

Name of the Course Teacher

Dr. K. Radhakrishnan/ Prof. K. Gurunathan

Semester – III			
Course code: 538303	**Physical Chemistry - III**	**Credits: 5**	**Hours :5**

Objectives	➢ Understand theAtomic orbital and their energies , Structure of Helium atom and Hydrogen molecule ➢ To know the Electronic transitions, Franck-Condon principle. Vertical transitions, Vibrational spectroscopy, Classification of polyatomic rotors and the non-rigid rotor. ➢ Explain about Batteries and Fuel Cells, Corrosion and its Protection ➢ To make the students understand the Concept of ensembles Partition functions Entropy production, Non-equilibrium stationary states and Onsager's law. ➢ Impart knowledge about Crystal structures, Types of defects, superconductors, Meissner effect and BCS theory
Unit - I	**Advanced Quantum Chemistry: -** Atomic orbitals and their energies: energy levels, ionization energies, shell, subshells, and atomic orbitals. Spectroscopic transitions and selection rule, **Structure of many-electron Atoms:** - Helium atom, hydrogen molecule ion, hydrogen molecule, Pauli principle, electron affinities, Self-consistent field orbitals. Spectra of complex atoms: spin-orbit couplings and term symbols, selection rules, perturbation theory applications.
Unit - II	**Spectroscopy : -** **Microwave spectroscopy:** - The rigid diatomic rotor, Eigen values and Eigen states, selection rules, intensity of rotational transitions, the role of rotational level degeneracy, Classification of polyatomic rotors and the non-rigid rotor. **Vibrational spectroscopy: -**Vibrational spectroscopy, harmonic and anharmonic oscillators, Morse potential, mechanical and electrical anharmonicity, selection rules. The determination of anharmoncity constant, fundamental, overtones, and Normal modes of vibration. **Electronic spectroscopy:** - Electronic transitions, Franck-Condon principle. Vertical transitions. Selection rules, parity, symmetry and spin selection rules. Polarization of transitions. **Raman spectroscopy:** - polarizability and selection rules for rotation and vibrational Raman spectra
Unit - III	**Applied Electrochemistry: -** **Batteries and Fuel Cells: -** Primary and Secondary Systems - Principles and criteria for the selection of anodes, cathodes and separators. Basic electrochemical reactions and performance characteristics of the following **Primary systems: -** Leclanche cell, alkaline batteries (Zn/MnO_2 /KOH, Zinc/air). Classifications of Secondary battery and its applications- Basic electrochemical reactions and performance characteristics of the following Secondary systems: Lead-Acid battery, Ni-Cd battery and Lithium - ion battery–Fuel cells–Introduction – Types of Fuel cells**.** Corrosion and its Protection**:** Importance of corrosion studies–EMF and Galvanic Series, Pourbaix diagram for Fe - H_2O system – Passivity- Electrochemical methods of corrosion rate measurements by DC and AC methods. Cathodic protection and Anodic protection – principle - design aspects and applications.
Unit - IV	**Classical and Statistical Thermodynamics: -** Maxwell relations ,Le Chatelier principle. Concept of ensembles: Canonical ensembles, Grand Canonical ensembles and thermodynamic quantities, Boltzmann distribution, Bose-Einstein and Fermi-Dirac distributions. **Partition functions:** - Molecular, Translational, rotational and vibrational partition functions. Ideal mono atomic and diatomic gases, Classical partition function. , Entropy production.

Unit - V	**Solid state Chemistry: -** **Crystal structures:** - Bragg's law, applications, and band structure of solids. Types of defects, thermodynamics of Schottky and Frenkel defect formation, Kroger-Vink notation for crystal defects. . Electronic structure of solids- band theory, intrinsic and extrinsic semiconductors, p-n junctions. **Superconductors:** - Meissner effect and BCS theory, electrically conducting organic solids, Organic charge-transfer complexes, and organic metals.

Reference and Textbooks:

Ashworth, V., & Googan, C. (1993). *Cathodic protection: Theory and practice*. New York: Ellis Horwood.

Atkins, P. W., Paula, J. D., & Friedman, R. J. (2009). *Quanta, matter, and change: A molecular approach to physical chemistry*. Oxford: Oxford University Press.

Atkins, P. W., Paula, J. D., & Keeler, J. (2018). *Atkins physical chemistry*. New York, NY: Oxford University Press.

Atkins, P., & Paula, J. D. (2017). *Elements of physical chemistry*. Oxford: Oxford University Press.

Banerjee, S. N. (1985). *An introduction to science of corrosion and its inhibition*. New Delhi: Oxonian Press.

Banwell. (2013). *Fundamentals of Molecular Spectroscopy*. New York: McGraw-Hill Education.

Barrow, G. M. (1996). *Physical chemistry*. New York: McGraw-Hill. .

Brown, J. M., & Carrington, A. (2003). *Rotational spectroscopy of diatomic molecules*. Cambridge: Cambridge University Press.

Chandra, A. K. (1994). *Introductory quantum chemistry*. New Dehli: Tata McGraw-Hill

Glasstone, S. (2007). *Thermodynamics for chemists*. New York: Narahari Press.

Gupta, M. C. (2017). *Statistical thermodynamics*. New Delhi: New Age International (P) Limited.

Hollas, J. M. (2010). *Modern spectroscopy*. Chichester: John Wiley & Sons.

Jones, D. A. (2014). *Principles and prevention of corrosion*. Harlow: Pearson.

Levine, I. N. (2014). *Quantum chemistry*. Boston: Pearson.

Linden, D. (1995). *Handbook of batteries and fuel cells*. New York: McGraw-Hill.

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

Prasad, R. K. (2010). *Quantum chemistry*. Tunbridge Wells: New age Science.

Shell, M. S. (2015). *Thermodynamics and statistical mechanics: An integrated approach*. Cambridge: Cambridge University Press.

Silbey, R. J., Alberty, R. A., & Bawendi, M. G. (2005). *Physical chemistry*. New York: J. Wiley.

Smart, L., & Moore, E. (2017). *Solid state chemistry: An introduction*. Boca Raton: CRC Press.

West, A. R. (2014). *Solid state chemistry and its applications*. Chichester: Wiley.

Outcomes	➢ Recognize atomic orbital and their energies ➢ Realize the rules and application of spectroscopy ➢ Understand the concept of fuel cell and batteries and also know about corrosion and its prevention ➢ Realize the Concept of ensembles Partition functions ➢ Understand the Crystal structures, thermodynamics of Schottky and Frenkel defect formation, Superconductors.

Name of the Course Teacher

R. M. Jeyam/ Dr. P. Shakkthivel

Semester – III			
Course code: 538307	**Physical Chemistry Practical**	**Credits: 4**	**Hours : 8**

Objectives	➢ Understand and apply the laws of thermodynamics and kinetics. ➢ Understand the role that thermodynamics and kinetics play in chemical equilibrium ➢ Understand how mathematics, models and approximations are used to explain chemical phenomena and fundamental properties of matter. ➢ Develop skills in making decisions in the lab, in data acquisition, and critical evaluation of data.
1.	Kinetics - Acid hydrolysis of ester
2.	Distribution Law - Study of iodine – Iodide equilibrium
3.	Adsorption - Oxalic Acid /Acetic Acid on charcoal using Freundlich isotherm.
4.	Conductomerty Titration - Acid- Alkali titration.
5.	Conductomerty - Precipitation titration.
6.	Conductomerty - Displacement titration.
7.	Conductomerty - Determination of dissociation constants of weak acids.
8.	Potentiometric Titrations – Acid- alkali titration
9.	Potentiometric Titrations - Precipitation titration
10.	Potentiometric Titrations - Redox titration.
11.	Potentiometric Titrations - Determination of dissociation constant of weak acids.
12.	Determination of Molecular weight by Rast's Method.
13.	Construction of phase diagram for two/three-component systems

Reference Books

Findlay, A., & LEVITT, B. P. (1973). *Findlays practical physical chemistry. 9th ed. Revised and edited by B.P. Levitt*. London: Longman.

Gurtu, J. N., & Kapoor, R. (1987). *Advanced experimental chemistry*. Ram Nagar, New Delhi: S. Chand .

Matthews, G. P. (1985). *Experimental physical chemistry*. Hong Kong: Oxford University Press

Viswanathan, B. R. (2014). *Practical Physical Chemistry*. Place Of Publication Not Identified: Viva Books.

Outcomes	➢ Developed expertise relevant to the professional practice to chemistry. ➢ An understanding of methods employed for problem solving in physical chemistry. ➢ Developed an understanding of the breadth and concepts of physical chemistry. ➢ Developed skills in procedures and instrumental methods applied in analytical and practical tasks of physical chemistry.

Name of the Course Teacher

Prof. K. Gurunathan/ R. M. Jeyam

Elective Course			
Course code: 538501	**Introduction to Nanoscience and Technology**	**Credits: 4**	**Hours : 4**

Objectives	➢ Understand the essential features of nanotechnology. ➢ To make the students understand the principles behind nanoscience and technology and its application. ➢ Employ applications of nanoparticles for analysis and sensing techniques, nanocatalyst, nanomedicine etc. ➢ Impart knowledge about nanoscience and technology. ➢ Apprehend and explain the biomedical applications of nanotechnology.
Unit - I	**Introduction and History: -** Background to nanotechnology - scientific revolutions – atomic structure-atomic size – bottom up/top down nanotechnology-chemical reactivity-Incremental nanotechnology-Evolutionary nanotechnology-Radical nanotechnology-Emergence of nanotechnology-Challenging in nanotechnology-Misnomers and misconception of Nanotechnology..
Unit - II	**Evolution and growth of Nanosystem: -**Basic problems and limitations - opportunities of nano scale -evolution of band structures and Fermi surface. Nanoparticles through homogeneous and heterogeneous nucleation-Growth controlled by surface and diffusion process- Oswald ripening process - influence of reducing agents-solid state phase segregation- grain growth and sintering precipitation in solid solution- hume rothery rule.
Unit - III	**Nanomaterials and classifications: -** Carbon Nanotubes (CNT) - Metals (Au, Ag, Pd, Cu) - Metal oxides (TiO_2, CeO_2, ZnO, MgO) - Semiconductors (Si, Ge, CdS, ZnSe). Classifications of nanomaterials-zero dimensional-one-dimensional-two dimensional-three dimensional nanostructures- Quantum dots-Quantum wire-Quantum well-semiconductors and ceramics.
Unit - IV	**Special nanomaterials: -** Carbon fullerenes-fullerene derived crystals- carbon nanotubes. Micro and Mesoporous material-Ordered mesoporous materials-Random mesoporous materials-crystalline microporous materials.Core/Shell structures-Metal oxide structures-Metal polymer structures-Intercalation compounds-nanograined materials.
Unit - V	**Materials Structure and Properties: -** Space lattice and unit cells, crystal system, Symmetry operation, Structures of common metallic, Semiconductor ceramic and superconductor materials, Miller Indices, Packing fractions, Formation of dangling bonds-atom like behavior of nanomaterials-physicochemical properties. Optical properties of nanomaterials-semiconductor-metal nanoparticles-Electrical and electronic properties-Thermal properties-Ferro electric properties-mechanical and magnetic properties.

Reference and Textbooks:

Cao, G., & Wang, Y. (2011). Nanostructures and Nanomaterials. *World Scientific Series in Nanoscience and Nanotechnology*. doi: 10.1142/7885

Cao, G., & Wang, Y. (2011). Nanostructures and Nanomaterials. *World Scientific Series in Nanoscience and Nanotechnology*. doi: 10.1142/7885

Hornyak, G. L. (2009). *Introduction to nanoscience and nanotechnology*. London: CRC Press.

Ozin, G. A., Arsenault André C., & Cademartiri, L. (2009). *Nanochemistry: a chemical approach to nanomaterials*. Cambridge: Royal Society of Chemistry.

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Raghavan, V. (2013). *Materials science and engineering a first course*. New Delhi: PHI Learning.
Torres, T., & Bottari, G. (2013). *Organic nanomaterials: synthesis, characterization, and device applications*. Hoboken, NJ: Wiley.**(2010). *Morphology Control of Materials and Nanoparticles*. Gardners Books.**
Aceves-Mijares, M., & Caruta, B. M. (2006). *Focus on nanomaterials research*. New York, NY: Nova Science Publ.
Binns, C. (2010). *Introduction to nanoscience and nanotechnology*. Hoboken: John Wiley & Sons.
Capek Ignác. (2010). *Nanocomposite structures and dispersions: science and nanotechnology - fundamental principles and colloidal particles*. Amsterdam: Elsevier.
Edelstein, A. S., & Cammarata, R. C. (2002). *Nanomaterials: synthesis, properties and applications*. Bristol: Institute of Physics.
Hornyak, G. L., Dutta, J., & Tibbals, H. F. (2008). *Introduction to nanoscience*. Boca Raton: CRC Press.
Thomas, S., Rafiei, S., Maghsoodlou, S., & Afzali, A. (2015). *Foundations of nanotechnology*. Oakville, ON, Canada: Apple Academic Press.
</td></tr>
<tr><td>Outcomes</td><td>
➢ Understand how nanotechnology can be tailored and used for biomedical purposes, catalyst, nanorobotics, engineering.
➢ Understand the basic nanotechnology and characterization methods.
➢ Understand how nano-relevant instruments such as focused ion beam scanning electron microscopes, atomic force microscopes and optical microscopes can be used in nanotechnology.
➢ Perform simple micro fabrication procedure
</td></tr>
</table>

Course Teacher
Prof. K. Gurunathan/M.Chinnadurai

Elective Course			
Course code: 538503	**Synthesis and Characterization Techniques of Nanomaterials**	**Credits: 4**	**Hours : 4**
Objectives	➢ Understand the application of spectroscopy techniques for analysis of nanomaterials. ➢ To know the difference between CVD and MOCVD. ➢ Explain the principles and theory of Raman spectroscopy. ➢ To make the students understand the principles Spectroscopy application of group theory to IR spectral activity of vibrational modes of ammonia molecule, selection rules for vibrational IR and RAMAN spectra, Mutual exclusion rule for molecules with center of symmetry, selection rules for rotational spectroscopy. ➢ To understand the uses of magnetobacteria for synthesis of magnetic nanoparticles. ➢ Impart knowledge about sol-gel, co-precipitation methods		
Unit - I	**Synthesis-Physical, Chemical & Biological Approaches** **Physical:** Vapor deposition and different types of epitaxial growth techniques (CVD, MOCVD, MBE, ALD)-pulsed laser deposition, Magnetron sputtering - Etching process: Dry and Wet etching, **Chemical:** Sol- gel processing- Solvothermal, hydrothermal, co-precipitation, colloidal precipitation, Spray pyrolysis, sonochemical method, Electro spraying and spin coating routes, Self-assembly, self-assembled monolayers, gas phase synthesis. Langmuir-Blodgett (LB) films, templated synthesis **Biological :** Use of bacteria, fungi, Actinomycetes for synthesis of nanoparticles - use of viruses for the synthesis of nanostructured materials- use of magnetotactic bacteria for synthesis of magnetic nanoparticles- use of natural plants for synthesis of nanoparticles.		
Unit - II	**Spectroscopic techniques** Principle, theory and instrumentation of UV-Visible spectroscopy-Infra-red spectroscopy- Atomic Spectroscopy-Photoluminescence spectroscopy-Photo Correlation Spectroscopy-Raman Spectroscopy-NMR spectroscopy-Electron Spin Resonance Spectroscopy-Mass Spectroscopy- Fluorescence spectroscopy.		
Unit - III	**Powder X-ray diffraction & Thermo-gravimetric analysis** **Powder X-ray diffraction** Fundamental principal of powder X-ray diffraction-Geometry of crystal-Lattice and crystal system, Lattice planes and direction, inter-planar spacing-X-ray intensities-structure factor polarization factor, multiplicity factor, temperature factor and Lorentz factor. Identification of unknown sample-Determination of crystal structure of cubic system **Thermo-gravimetric analysis** Thermal analysis, theory and principles of DTA and TGA-factors affecting the position of DT and TG traces – application of DTA and TGA -complementary nature of DTA and TGA- influence of reduced pressure, humidity control and heating rate-principle and application of DSC-determination of degree of conversion of high alumina cement-heat flow calibration, temperature calibration		
Unit - IV	**Scanning Electron Microscopy & Transmission Electron Microscopy** **Scanning Electron Microscopy:** Basic design of the high resolution scanning electron microscopy-Modes of operation- Backscattered electrons-secondary electrons-X-rays-		

	typical forms of contrast-Resolution and contrast-enhancement-Specimen Preparation, Replicas Various-application of HR-SEM. **Transmission Electron Microscopy**:Basic principles-Modes of operation-interaction of electron with matter-Specimen preparation-Diffraction in imperfect crystals-Dislocations-precipitates-Structure of grain boundaries and interfaces HR-TEM use in nanostructures-resolution of electron lens-phase contrast images (lattice fringes).
Unit - V	**Atomic Force Microscopy** Basic concepts- modes of operation- Interaction force-AFM and the optical lever-Scale drawing-AFM tip on nanometer scale structures-force curves, measurements and manipulations-different modes of operation -contact, non contact and tapping mode-Imaging and manipulation of samples in air or liquid environments.

Reference and Textbooks:

Ashby, M. F., Schodek, D. L., & Ferreira, P. J. S. G. (2009). *Nanomaterials, nanotechnologies and design an introduction for Engineers and Architects*. S.l.: Butterworth-Heinemann.

Bergese, P., & Hamad-Schifferli, K. (2013). *Nanomaterial Interfaces in Biology Methods and Protocols*. New York: Humana Press.

Denney, R. C., Mendham, J., Bassett, J., & Jeffery, G. H. (2007). *Vogels textbook of quantitative chemical analysis*. Delhi: Pearson education.

Eaton, P., & West, P. (2018). *Atomic force microscopy*. Oxford: Oxford University Press.

Echlin, P. (2013). *Advanced scanning electron microscopy and x-ray microanalysis*. Place of publication not identified: Springer-Verlag New York.

Ozin, G. A., Arsenault André C., & Cademartiri, L. (2015). *Nanochemistry: a chemical approach to nanomaterials*. Cambridge: Royal Society of Chemistry.

Rodriguez José A. (n.d.). *Synthesis, Properties, and Applications of Oxide Nanomaterials*. Wiley.

Waseda, Y., Matsubara, E., & Shinoda, K. (2011). *X-ray diffraction crystallography: introduction, examples and solved problems*. Berlin: Springer Verlag.

Williams, D. B., Carter, C. B., & Spence, J. C. H. (2009). *Transmission electron microscopy. a textbook for materials science*. New York: Springer.

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

Dobrovolskaia, M. A., & McNeil, S. E. (2013). *Handbook of immunological properties of engineered nanomaterials*. Singapore: World Scientific Pub. Co.

Doering, R., & Nishi, Y. (2008). *Handbook of semiconductor manufacturing technology*. Boca Raton: CRC Press.

Fesenko, O., Yatsenko, L., & Brodin, M. (2013). *Nanomaterials Imaging Techniques, Surface Studies, and Applications Selected Proceedings of the FP7 International Summer School Nanotechnology: From Fundamental Research to Innovations, August 26-September 2, 2012, Bukovel, Ukraine*. New York, NY: Springer New York.

Kumar, C. S. S. R. (2010). *Biomimetic and bioinspired nanomaterials*. Weinheim: Wiley-VCH.

MISRA, P. R. A. B. H. A. K. A. R. (2016). *Applied spectroscopy and the science of nanomaterials*. Place of publication not identified: SPRINGER Verlag, SINGAPOR.

Musa, S. M. (2018). *Nanoscale spectroscopy with applications*. Place of publication not identified: CRC Press.

Nagarajan, R. (2008). *Nanoparticles: synthesis, stabilization, passivation, and functionalization*. Washington, DC: American Chemical Society.

Ramesh, K. T. (2009). *Nanomaterials: mechanics and mechanisms*. New York: Springer. Zhong, W.-H. (2012). *Nanoscience and nanomaterials: synthesis, manufacturing and industry impacts*. Lancaster, PA: Destech Publications.	
Outcomes	➢ Recognize atomic orbital and their energies ➢ Realize the rules and application of spectroscopy ➢ Understand the concept of fuel cell and batteries and also know about corrosion and its prevention ➢ Realize the Concept of ensembles Partition functions ➢ Understand the Crystal structures, thermodynamics of Schottky and Frenkel defect formation, Superconductors

Name of the Course Teacher
Prof. K. Gurunathan

Elective Course			
Course code: 538507	**Nanocomposites**	**Credits: 4**	**Hours : 4**
Objectives	➢ Understand the essential features of nanocomposite. ➢ To make the students understand the principles behind materials involved in nanocomposite. ➢ Employ applications of nanocomposite for analysis and sensing techniques, nanocatalyst, nanomedicine etc. ➢ Impart knowledge about nanoscience and technology. ➢ Apprehend and explain the biomedical applications of nanotechnology.		
Unit - I	**Basics of NanoComposites: -** Nomenclature-Electronic and atomic structure of aggregates and nanoparticles-Properties, features and processing of nanocomposites-Sample Preparation and Characterization of Structure and Physical properties-Designing, stability and mechanical properties and applications of Super hard nanocomposites.		
Unit - II	**Metal Based Nanocomposites: -** Metal-metal nanocomposites, sample preparation techniques and their properties-Metal-Oxide or Metal-Ceramic composites, different aspects of their preparation techniques and their final properties and functionality-Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Electrical property of fractal based nanocomposites. Core-Shell structured nanocomposites.		
Unit - III	**Polymer based nanocomposites: -** Definition, Polymer metal nanocomposites, sample preparation and characterization incorporation of nanomaterials in polymer matrix-Copolymer based nanocomposites; Polymer CNT based composites, their mechanical properties, polymer clay nano-composites and industrial possibilities.		
Unit - IV	**Nanocomposite from Bio-materials: -** Definition- sample preparation-Natural nanocomposite systems-spider silk, bones, shells; organic-inorganic nanocomposite formation through self-assembly. Bio-mimetic synthesis of nanocomposite material- use of synthetic nanocomposites for bone, teeth replacement.		
Unit - V	**Application of nanocomposite**: - Electrical, Electronic, Textile, pharmaceutical and energy applications of polymer nanocomposites, polymer metal based nanocomposite.		

Reference and Textbooks:

Bryan, W. W. (2009). *Designing and engineering metal-based nanocomposites for nanotechnological applications*.

Daniel, R., & Musil Jindřich. (2015). *Novel nanocomposite coatings: advances and industrial applications*. Singapore: Pan Stanford Publishing.

Kim, J., Ponnamma, D., Sadasivuni, K. K., & Thomas, S. (2015). *Graphene-based polymer nanocomposites in electronics*. Cham: Springer.

Koo, J. H. (2006). *Polymer nanocomposites: processing, characterization, and applications*. New York: McGraw-Hill.

Makhlouf, A. S. H. (2015). *Handbook of nanoceramic and nanocomposite coatings and materials*.

Mohanty, S. (2015). *Polymer Nanocomposites based on Inorganic and Organic Nanomaterials*. John Wiley & Sons.

Njuguna, J. (2013). *Structural nanocomposites: perspectives for future applications*. Heidelberg: Springer.

Tewari, P. K. (2017). *Nanocomposite membrane technology: fundamentals and applications*. Boca Raton:

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Thomas, S. (2013). Advances in Natural Polymers: Composites and Nanocomposites. Berlin: Springer.
Thomas, S., Shanks, R., & Chandrasekharakurup, S. (2016). Design and applications of nanostructured polymer blends and nanocomposite systems. Amsterdam: Elsevier.

Trindade, T., & L., D. da S. A. (2011). Nanocomposite particles for bio-applications: materials and bio-interfaces. Singapore: Pan Stanford.
Twardowski, T. A. (2007). Introduction to nanocomposite materials: properties, processing, characterization. Lancaster, PA: DEStech.
Yang, J., & Liu, H. (2015). Metal-based composite nanomaterials. Cham: Springer.</td></tr>
<tr><td>Outcomes</td><td>➢ Recognize atomic orbital and their energies
➢ Realize the rules and application of spectroscopy
➢ Understand the concept of fuel cell and batteries and also know about corrosion and its prevention
➢ Realize the Concept of ensembles Partition functions
➢ Understand the Crystal structures, thermodynamics of Schottky and Frenkel defect formation, Superconductors</td></tr>
</table>

Name of the Course Teacher
Prof. K. Gurunathan

Elective Course			
Course code: 538506	**Application of Nanotechnology**	**Credits: 4**	**Hours : 4**
Objectives	➢ Understand the application of wave mechanics and John-teller effect, quantum numbers, zero-point energy, orthogonisation and normality, tunneling, perturbation theory. ➢ To know the difference between Proper and Improper axis of Symmetry, Principal axis and subsidiary axes ➢ Explain the construction of Character Tables for C_{2V} and C_{3V} point group molecules, and Great orthogonality theorem and its proof ➢ To make the students understand the principles Spectroscopy application of group theory to IR spectral activity of vibrational modes of ammonia molecule, selection rules for vibrational IR and RAMAN spectra, Mutual exclusion rule for molecules with center of symmetry, selection rules for rotational spectroscopy. ➢ To understand the Solution and gas phase kinetics, Enzymes, Fast reaction kinetics ➢ Impart knowledge about surface and interfaces, heterogeneous catalysis.		
Unit - I	**Lithography and sensors: -** Silicon MEMS fabrication technology, Advanced lithography: Deep UV/E beam/Ion Beam techniques, Dip pen nanolithography-Polymers in Microsystems, Packaging of MEMS devices by anodic/fusion bonding, Pressure sensors and packaging, MEMS performance and evaluation-Surface confined chemical sensors- Nanoparticles sensors- thermal, radiation magnetic, chemical and mechanical nanosensors.		
Unit - II	**Nanomedicine: -** Principles of nanomedicine – impact of nanotechnology in medicine-nanomedical perspective and the medical applications- nanoparticles delivery for cancer therapy – Bioactive nanomaterials in medicine- Nanodiagnostics - Nanoarrays for diagnostics-nanoparticles for molecular diagnostics- self-assembled protein nanoarrays-protein nanobiochip - Nanobiosensor-CNT biosensor-DNA biosensor.		
Unit - III	**Nanopharmaceutical: -** Nanoparticles for drug discovery – Nanotechnology for Drug Targeting, Targeted, non-targeted delivery, controlled drug release-protein and peptide based compounds for cancer and diabetes - lipid nanoparticles - vaccination - cell therapy -Gene therapy-nanoparticles drug delivery in cardiology and vascular disease-Nanoparticles and protein interactions-inter relationship between nanotech development and nanopharmaceutical development.		
Unit - IV	**Environmental and Bio-compatibility: -** Degradation of hazardous organic-pollution abatement- removal of bacteria and microbes-photocatalytic decontamination-heavy metal removal-detection and extraction of pesticides from water-Fuel cell application-thermoelectric and piezoelectric application-chemical and electrochemical sensor using nanomaterials. Antibacterial, antimalarial, antiviral and anticancer activities using nanomaterials.		
Unit - V	**Nanoelectronics: -** Nanoelectronics-Microelectronics- molecular electronics-photonics–photolithography–carbon nanotubes (CNT) in electronic applications-memories-dye sensitized solar cells-Physical concepts-Quantization of action, charge and flux-electrons in potential well-photons interacting with electrons in solids-diffusion processes-Effects on structure and Morphology of free or Supported Nanoparticles- Size and confinement Effects.		

Reference and Textbooks:

Bawa, R., Audette, G. F., Rubinstein, I., & Reese, B. E. (2016). *Handbook of clinical nanomedicine*. Singapore: Pan Stanford Publishing.

Demetzos, C. (2016). *Pharmaceutical nanotechnology fundamentals and practical applications*. Singapore: Adis.

Fryxell, G. E., & Cao, G. (2007). *Environmental applications of nanomaterials: synthesis, sorbents and sensors*. London: Imperial College Press.

Goser, K., Dienstuhl, J., & Glö sekö tter Peter. (2004). *Nanoelectronics and Nanosystems: from transistors to molecular and quantum devices*. Berlin: Springer.

Jain, K. K. (2008). *The handbook of nanomedicine*. Totowa, NJ: Humana Press.

Jha, A. R. (2008). *Mems and nanotechnology-based sensors and devices for communications, medical and aerospace applications*. Boca Raton: CRC Press.

Kalantar-zadeh, K., & Fry, B. N. (2008). *Nanotechnology-enabled sensors*. New York: Springer.

Liang, X.-J. (2013). *Nanopharmaceutics: the potential application of nanomaterials*. Singapore: World Scientific.

Ninan, N., & Haghi, A. K. (2012). *Nanomedicine and Drug Delivery*. Hoboken: Apple Academic Press.

Prokopovich, P. (2016). *Biological and pharmaceutical applications of nanomaterials*. Boca Raton: CRC Press.

Shoseyov, O., & Levy, I. (2008). *Nanobiotechnology: bioinspired devices and materials of the future*. Totowa, NJ: Humana Press.

Souto, E. B. (2012). *Patenting nanomedicines: legal aspects, intellectual property and grant opportunities*. Heidelberg: Springer.

Sutariya, V. B., & Pathak, Y. (2015). *Bio-interactions of nanomaterials*. Boca Raton, FL: CRC Press.

Outcomes	➢ Understand application of wave mechanics. ➢ Realize the difference between different axis of symmetry and how to represent matrix ➢ Construct Character Tables for C_{2V} and C_{3V} point group molecules ➢ Realize the SALC procedure and application ➢ Recognize the Michaelis-Menten mechanism of enzyme catalysis, catalytic efficiency of enzymes, mechanisms of enzyme inhibition.

Name of the Course Teacher

Prof. K. Gurunathan/M. Chinnadurai

Semester- III			
Course code: 538701	**Physics and Chemistry of nanomaterials**	**Credits: 3**	**Hours: 3**
Objectives	➢ To Unterstand the physical and chemical properties of nanomaterials. ➢ To Understand the quantum mechanical theories of nanomaterials. ➢ To explain the special nanomaterials. ➢ To know the applications of nanomaterials. ➢ To Understand the Nanoelectromechanical system.		
Unit – I	**Properties of materials:-** Size dependent properties – Crystal structure - Energy band – magnetic property – Electron related chemical property – colloids – concepts of nanomaterials		
Unit – II	**Quantum mechanical aspects:-** Simulation of the properties of molecular clusters – Formation of energy gap – Preliminary aspects of lithography – Confinement effects – Discreteness of energy levels – Evaluation of future prospects.		
Unit – III	**Special nanomaterials:-** Carbon fullerenes – Carbon nanotubes – Zeolites – Metal oxide structures – Metal polymer structures – Oxide polymer structure.		
Unit – IV	**Application of nanomaterials (1):-** Molecular electronics and nanoelectronics – Nanobots – Biological applications of nanoparticles – Quantum device: Quantum well, Quantum dots – Photoelectrochemical cell.		
Unit – V	**Application of nanomaterials (2):-** Catalysis - sensors – Fundamentals of Microelectromechanical (MEMSs) – Nanoelectromechanical system (NEMSs)		
Reference and Textbooks (APA format):- Charles P.Poole Jr & Frank J.Owens. (2007). *Introduction to Nanotechnology.* Wiley India Pvt.Ltd. Fahrner, W.R. (2006). *Nanotechnology and Nanoelectronics.* Springer. Guozhong Cao. (2004). *Nanostructures and Nanomaterials*. Imperial College Press. Kittel, C. (1996). *Introduction to solid state physics.* Wiley – Interscience Mannhold, R. (2003). *Microwaves in Organic and Medicinal Chemistry.* Wiley – VCH. Vaseashta, A., Dimova, D., Malinovska & Marshall, J.M. (2005). *Nanostructure and Advanced Materials.* Springer. Wilson, M., Kanagara, K., & Geoff Smith. (2005). *Nanotechnology basic science and emerging technology*. Overseas Press.		
Outcomes	➢ Will be able to study the physical and chemical properties of nanomaterials ➢ Recall the quantum mechanical theory of Nanoscale materials ➢ Will be able to know the applications of special nanomaterials ➢ Recall the informations of nanoelectromechanical systems.		

Name of the course Teacher

Prof. K.Gurunathan

Semester- II			
Course code: 538702	**Applications of Spectroscopy in Materials Chemistry**	**Credits: 2**	**Hours: 3**
Objectives	➢ To Unterstand the principles of raman spectroscopy ➢ To Understand the behavior of organic compound in nmr spectroscopy ➢ To explain the theory and applications of epr technique ➢ To know the knowledge about applications of mass spectroscopy		
Unit – I	**Raman spectroscopy:** Principles and applications of simple organic and inorganic molecules, predicting number of active modes of vibrations, analysis of representative spectra of metal complexes with various functional groups at the coordination sites; application of isotopic substitution.		
Unit – II	**NMR Spectroscopy:** ^{1}H NMR spectroscopy – origin – chemical shift, number of signals, peak area, multiplicity and coupling constants – geminal, vicinal and long range coupling – factors that affect these parameters – ^{13}C NMR spectra – broad band and off resonance decoupling – comparison of ^{1}H and ^{13}C NMR spectra – chemical shifts – gamma gauche effect. Simplification of complex NMR spectra – Shift reagents – high fields – deutration - decoupling.		
Unit – III	**EPR Spectroscopy:** Electron paramagnetic resonance (EPR) spectroscopy of organic and inorganic compounds with unpaired electrons - determination of electronic structure, Zeeman splitting, g-values, hyperfine and super hyperfine coupling constants, practical considerations of measurements, and instrumentation - applications to organic radicals naphthyl, DPPH and inorganic compounds, Cu, Mn and V complexes.		
Unit – IV	**Mass Spectroscopy:** Mass spectrometry, basic principles, ionization techniques, isotope abundance, molecular ion, fragmentation processes of organic molecules, deduction of structure through mass spectral fragmentation, high resolution MS, soft ionization methods, ESI-MS and MALDI-MS, illustrative examples from macromolecules and supramolecules, studies of inorganic/coordination and organometallic representative compounds. **Mossbauer spectroscopy** - Mossbauer effect, recoilless emission and absorption, hyperfine interaction, chemical isomer shift, magnetic hyperfine and quadruple interaction and interpretation of spectra -Fe, Sn.		
Unit – V	Structure elucidation of organic compounds using the UV-VIS, IR, 1H & 13C NMR and Mass spectroscopic techniques. Structure elucidation of inorganic compounds using the UV-VIS, IR, Raman, NMR, EPR and Mass spectroscopic techniques		

Reference and Textbooks (APA format):-

Abragam, A., & Bleaney, B. (2013). *Electron paramagnetic resonance of transition ions*. Oxford: Clarendon Press.

Banwell. (2013). *Fundamentals of Molecular Spectroscopy*. New York: McGraw-Hill Education.

Drago, R. S. (1992). *Physical methods for chemists*. Saunders College Pub.

Günther H. (2013). *Nmr Spectroscopy: Basic Principles, Concepts and Applications in Chemistry*. Somerset: Wiley.

Jayprakasha, G. K., Patil, B. S., & Pellati, F. (2014). *Instrumental methods for the analysis and identification of bioactive molecules*. Washington DC: American Chemical Society.

Jeffery, G. H., & Vogel, A. I. (1989). *Vogels textbook of quantitative chemical analysis*. Harlow: Longman.

Kemp, W. (1995). *Organic spectroscopy*. New York: W.H. Freeman.

Rouessac, F., Rouessac, A., & Brooks, S. (2014). *Chemical analysis: modern instrumentation methods and techniques*. Chichester: John Wiley and Sons, Ltd.

Silverstein, R. M., Webster, F. X., & Kiemle, D. J. (2005). *Spectrometric identification of organic compounds*. Hoboken, NJ: John Wiley & Sons.

Skoog, D. A., Holler, F. J., & Nieman, T. A. (1998). *Principles of instrumental analysis*. Philadelphia ;: Harcourt Brace College Pub.

Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2014). *Fundamentals of analytical chemistry*. Belmont, CA.: Brooks/Cole, Cengage Learning.

Valcarcel, M., Kellner, R., Mermet, J.-M., Otto, M., & Widmer, H. M. (2020). *Analytical Chemistry A Modern Approach to Analytical Science*. Weinheim: Wiley-VCH.

Willard, H. H. (2012). *Instrumental methods of analysis*. New Delhi: CBS.

Outcomes	➢ Will be able to study the physical methods for identification of organic and inorganic compounds ➢ Will be able to know the basic principles involved in spectroscopy ➢ Will be able to know the applications of spectroscopic techniques.

Name of the course Teacher

Prof. K.Gurunathan

M. Sc (Chemistry) with specialization in Nanoscience & Technology & M.Phil (Chemistry)with specialization in Nanoscience & Technology)

List of Board Based Board of studies

Sl. No.	List of Members	
1.	Dr. K. Gurunathan (*Chairman*) Prof & Head Dept. of Nanoscience & Technology Alagappa University Karaikudi	
	Dr. M. Ashokkumar(***Foreign Subject Expert)*** Professor, Department of Chemistry, University of Melbourne, Australia.	
2.	Dr. P. Shakkthivel (*Membe*r) Professor, Dept. of Nanoscience & Technology, Alagappa University, Karaikudi Dept. Faculties	
3.	Prof. S. Muthusamy (*Indian Subject Expert)* Professor, Department of Chemistry, Bharathidasan University, Trichy.	
4.	Dr. S. Murugesan (*Indian Subject Expert)* Professor, Department of Inorganic Chemsitry Madurai Kamarajar University, Madurai	
5.	Dr. S. Ravichandran(*Indus/R&D Expert)* Principal Scientist, Electro Inorganic Division CSIR-CECRI Karaikudi – 630 006.	

Brief- Bio-Data

Dr. K. Gurunathan
Professor & Head, Special Officer (Projects)
Department of Nanoscience & Technology
Science Campus,
Alagappa University
Karaikudi – 630 003
Tamil Nadu, INDIA
Email: kgnathan27@rediffmail.com

Academic Qualifications:

Ph.D (Chemistry-Energy) Highly Commended, 1994, University of Madras, Chennai
M.Sc (Chemistry), 74 %, 1986, Madurai Kamaraj University, Madurai
B.Sc (Chemistry), 79%, 1984, Madurai Kamaraj University, Madurai

Previous Post: Scientist & Program Coordinator, C-MET, Pune

.**Teaching Experience: 14 Years**

Research Experience: 31 Years

Additional Responsibilities

1. Member of Syndicate, Finance Committee (2016-19)
2. Member of Senate, Member of Standing Committee
3. Member of IQAC
4. Member of University & Dept. Admission committee
5. Member of University & Dept. Purchase committee

Research Interest: Photocatalysis, Hydrogen Energy, Nanosensor, Nano- Solar Cells, Conducting polymer Nanocomposites for Renewable energy.

Distinctive Achievements / Awards

1. **BOYSCAST** Fellowship (DST, New Delhi) for the year 1999-2000. The work was carried out in University of Texas at Austin, Austin, TX, USA during March 2000-March 2001 in Lithium battery, Supercapacitor and cathode materials for Solid oxide fuel cell.
2. Brain Pool scientist by **Brain Pool program of KOFTS**, South Korea, during July 2005-June 2006 in " Development of Efficient Visible photocatalysts for Hydrogen Generation" The work was carried out in Korea Research Institute of Chemical technology (KRICT), Daejon, S. Korea.
3. Awardee of "**Rastriya Nirman Rattan**" by Economic Growth Society of India, Delhi awarded during the National seminar on "Individual achievements for Economic & Social Development" on 26th August, 2012 at Delhi.
4. **Fellow, Academy of Sciences, Chennai, 2018**

Cumulative Impact Factor (as per JCR) : 251
h-index 11
i10 index 14
Total Citations: 1281
Ph.D Guidance : Awarded 4; Ongoing -4
No. of Research Publications in Intl. Journals 80
No. conference attended/ presented 225
Guest/Invited lecture delivered 60
Life Fellow in Professional Society : 4 (SAEST,MRSI, ISCA,ASC)

Membership in Professional Society 13

Publication (Listed Few)

1. Interactive Studies on Synthetic Nanopolymer decorated with Edible Biopolymer and its Selective Electrochemical determination of L-Tyrosine" **Scientific Reports-Springer Nature 2019(Accepted)**
2. Biodiesel production from Ulva linza, Ulva tubulosa, Ulva fasciata, Ulva rigida,Ulva reticulate by using Mn_2ZnO_4 heterogenous nanocatalysts, **Fuel** https://doi.org/10.1016/j.fuel.2019.115744
3. CuO–ZnO p–n junction enhanced oxygen sensing propertyof polypyrrole nanocomposite at room temperature, Journal of Materials Science: Materials in Electronics, **J. Materials Science: Materials in Electronics (2019) 30:9989–9998**
4. A.J. Heiner**, K. Gurunathan,** Fabrication of Room Temperature LPG Gas sensor based on Pani – CNT – V2O5 hybrid nanocomposite, **Appl. Nanosci. https://doi.org/10.1007/s13204-019-00967-w**
5. Effective harvesting of UV induced production of excitons from Fe3O4 with proficient rGO-PTh acting as BI-functional redox photocatalyst, Renewable energy, doi.org/10.1016 /j.renene. 2017.09.031

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Prof. Dr. Muthupandian Ashokkumar
Professor & Deputy Head of School
School of Chemistry,
The University of Melbourne,
VIC 3010, Australia
Email: masho@unimelb.edu.au

Publication Citations (As on Sep.2019)	**9536**
h-index	**54**
i10-index	**234**

Professor Muthupandian Ashokkumar (Ashok) is a Physical Chemist who specializes in Sonochemistry, teaches undergraduate and postgraduate Chemistry and is a senior academic staff member of the School of Chemistry, **University of Melbourne**. He is also one of the Associate Deans (International) in the Faculty of Science. Ashok is a renowned sonochemist who has developed a number of novel techniques to characterize acoustic cavitation bubbles and has made major contributions of applied sonochemistry to the Materials, Food and Dairy industry. He has received about **$ 15 million research grants** to support his research work that includes **several industry projects**. He has edited/co-edited several books and special issues for journals; published ~**320 refereed papers in high impact international journals** and books; and delivered over **150 invited/keynote/plenary lectures** at international conferences and academic institutions. Ashok has successfully organised **10national/international scientific conferences/workshops** and managed a number of national and international competitive research grants.

Education and training

- PhD, University of Madras 1989
- MSc, Madurai-Kamaraj University 1984
- BSc, Madurai-Kamaraj University 1982

Awards and honors

- Ian Potter Foundation, 1997
- Grimwade Prize in Industrial Chemistry.
- He is a Fellow of the RACI since 2007.
- Royal Australian Chemical Institute. Member since 2004 .
- European Society for Sonochemistry. Member 2000

Most cited publications (Listed few)

1. The use of ultrasonics for nanoemulsion preparation Published in Innovative Food Science & Emerging Technologies in April, 2008, doi.org/10.1016/ J.IFSET.2007.07.005.

2. Effects of ultrasound on the thermal and structural characteristics of proteins in reconstituted whey protein concentrate, Published in Ultrasonics Sonochemistry in September, 2011, doi.org/10.1016/J.ULTSONCH.2010.12.016.

3. The characterization of acoustic cavitation bubbles – An overview Published in Ultrasonics Sonochemistry in July, 2011, doi.org/10.1016 /J.ULTSONCH. 2010.11.016

4. An overview on semiconductor particulate systems for photoproduction of hydrogen Published in International Journal of Hydrogen Energy in June, 1998, doi.org/10.1016/S0360-3199(97)00103-1.

Brief- Bio-Data

Dr. P.SHAKKTHIVEL Ph.D.,
Professor,*Department of Nanoscience and Technology*
Science Campus, Alagappa University,
Karaikudi -630 002.
E-mail: apsakthivel@yahoo.com

Academic Qualifications:

Years of Experience

Teaching: 12 years, Research: 20 years

Administrative Experience:

i) **Controller of Examination- Alagappa University, Karaikudi, INDIA 21.12.2017 -2/10/2018**

ii) **Chief Warden – Alagappa University Hostels, Karaikudi, Jan. 2016-Dec.2017**

M.Sc., Ph.D., - Earned in Electrochemistry from Alagappa University, India (2001).
(PG- Highest credit holder in the University)

Awards/ Fellowships Received

1. Visiting Professor – Ming Chi University of Technology, Taiwan, 2018
2. Dongguk University Foreign Professor Fellow- 2015
3. Brain Korea 21 fellowship - 2007
4. Taiwan National Science Council Post Doc.fellowship-2006.
5. Marquis Who's Who in the World- name placed in 2009 & 2017 issues.

Area of Research Interest:

Li-ion Batteries, Magnetic Nanoparticles & Targeted drug Delivery
Modified electrodes & Bio-molecule diagnosis

Membership in Professional Bodies: 5 No.s

Guidance Rendered: Ph.D – 5 Awarded, 4-Ongoing

Extension Activities/ Invited Lectures: 25 National and International

Books / Chapter written

Book Title: Biocompatible Nanomaterials Synthesis, Characterization and Applications;

Chapter title: Synthesis, characterization and Application of Biocompatible Magnetic Nanoparticles, Page 171-208, Nova Science Publisher Inc., Newyork.

No. of Research Publications in Intl. Journals	**61**
No. conference attended/ presented	**85**
Guest/Invited lecture delivered	**56**

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Brief- Bio-Data

Profile

Dr.Sengodagounder Muthusamy
Professor
Department of Chemistry
Bharathidasan University
Tiruchirappalli – 620 024 Tamil Nadu,
Email: muthu@bdu.ac.in (or)
smuthus@yahoo.com
Teaching Experience : 14 Years
Research Experience : 27 Years

Publication Citations **(As on Sep.2019)**	**2102**
h-index	**25**
i10-index	**63**

Academic Qualifications :

Certificate in Hindi(Hindi Teaching Scheme, New Delhi), German(Gothe Institute, Germany) 1986: M.Sc. Chemistry, Bharathiar University, Coimbatore - 641 046 1992: Ph.D. Organic Chemistry, University of Madras, Chennai – 600 005

Areas of Research

Development of macrocycles and supramolecular chemistry ✓ Synthesis of new molecules with stereoselectivity✓ Chemistry of carbenoids and carbocations✓ Metathesis reactions ✓ Green Chemistry

Distinctive Achievements / Awards(Listed few)

Royal Society-INSA fellowship, University of Manchester, UK, 2009 • CRSI Bronze Medal lecture award, Indian Institute of Technology, Mumbai, 2006 • Prof. D. K. Banerjee Memorial Lecture Award, IISc, Bangalore, 2003 • Royal Society-INSA exchange fellowship, University of Exeter, UK, 2001 • **CSIR Young Scientist** Award in Chemical Sciences, New Delhi, 1998 • **CSIR Pool Officership**, University of Hyderabad, Hyderabad, 1995 • **Alexander von Humboldt** Postdoctoral Fellowship, Germany, 1993 • CSIR-UGC National Eligibility Test, New Delhi, 1988.

Patents

1. Jasra, R. V.; Muthusamy, S.; Badheka, Y. M. "A process for the preparation of an acylated aromatic ether using clay based catalyst" Patent granted in India, Pat No. 244658, 14 Dec 2010
2. Jasra, R. V.; Muthusamy, S.; Badheka, Y. M. "Clay based eco-friendly catalytic process for the acylation of aromatic ethers to produce acylated aromatic ethers" Patent granted in USA, USA Pat. No. 6,730,814, 4 May 2004
3. Mehta, G.; Maiya, B. G.; Muthusamy, S.; Chanon, M.; Julliard, M. "Novel hybrid molecules of a photosensitizer and a chemotherapeutic agent useful for chemotherapy and photodynamic therapy against cancer and allied diseases and process for their preparation" Patent
4. granted in France, Pat. No. FR 9807228, 9 June 1998.

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Profile

Dr. S. Murugesan
Professor
Department of Inorganic Chemistry
School ofChemistry
Mobile No:+91-9444451460
Email: smsan@mail.com

Publication Citations **(As on Sep.2019)**	**881**
h-index	**17**
i10-index	**23**

Educational Qualifications : M.Sc., B.Ed., Ph.D.
Professional Experience : Research- 20 Years; Teaching-15 years

HONORS/AWARDS/RECOGNITIONS

- ♣ Visiting Researcher award – Royal Inst. of Tech., Stockholm, Sweden, 2005-2007
- ♣ DST Young Scientist award, 2012
- ♣ Active reviewer for 20 Elsevier Science Journals, two ACS Journals and two Taylor & Francis Journals

PUBLICATIONS (Listed Few)

1. M. Karuppuraja, S. Murugesan, Template free solvothermal synthesis of single crystal magnetic Fe3O4 hollow spheres, their interaction with bovine serum albumin and antibacterial activities, J. Saudi Chem. Soc. 2018 (In Press) Imp. Fac. 2.88
2. K. Kumar, S. Murugesan, Synthesis, characterization and anti-bacterial activity of divalent transition meta complexes of hydrazine and trimesic acid, J. Saudi Chem. Soc. 2018, 22, 16-26.IF: 2.88
3. Siva, P. KottalaVijaya, V. Sadhasivam, S. Balakrishnan, C. Chithiraikumar, S. Murugesan, Enantioselective Synthesis of Dihydroquinazolinone derivatives Catalyzed by Chiral Organocatalyst, New J. Chemistry, 2017, 41 7980-7986. Imp. Fac. 3.27
4. P. KottalaVijaya, S. Murugesan, A. Siva, Highly Enantioselective Asymmetric Henry Reaction Catalyzed by Novel Chiral Phase Transfer Catalyst Derived from Cinchona Alkaloids, Organic &Biomolecular Chemistry, 2016 14, 10101-10109. Imp. Fac. 3.56
5. P. KottalaVijaya, K. Duraimurugan, A. JesinBeneto, V. Sadhasivam, S. Murugesan, A. Siva, New quaternary phosphonium salt as multi-site phase-transfer catalyst for various alkylation reactions, Research on Chemical Intermediates, 2016, 42, 8345-8358. Imp. Fac. 1.37

INTELLECTUAL PROPERTY RIGHTS (Patents)

P. Maruthamuthu, B. Muthuraaman, S. Ganesan, S. Anandan, S. Murugesan, J. Madhavan, S.A. Suthanthiraraj, An improved solid-state polymer composition; A process for its preparation and an improved dye-sensitized solar cell, Patent No. 266300 (2728/CHE/2007) dt. 22.11.2007

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Profile

Dr. S Ravichandran
Principal Scientist
CSIR-CECRI
Karaikudi-India
Email:sravi@cecri.res.in

Publication Citations **(As on Sep.2019)**	**1295**
h-index	**16**
i10-index	**29**

Area of Research
Materials Electrochemistry
Energy storage and conversion devices

Electrochemical water treatment

Current Projects

1. Design and development of electrodes and electrolytes for water electrolysis to generate Hydrogen and hydrogen peroxide for sustainable energy and public hygiene - XII five year plan by Solar Energy to Chemical Energy Conversion – TAP SUN – CSIR.

Latest publication

1. Morphology-Dependent Photoelectrochemical and Photocatalytic Performance of γ-Bi2O3 NanostructuresB Jansi Rani, ES Babu, M Praveenkumar, S Ravichandran, G Ravi, ...Journal of nanoscience and nanotechnology 20 (1), 143-154

2. BiVO4 Nanostructures for Photoelectrochemical (PEC) Solar Water SplittingApplicationsBJ Rani, M Praveenkumar, S Ravichandran, G Ravi, RK Guduru, ...Journal of nanoscience and nanotechnology 19 (11), 7427-7435

3. Components of the diffuse ultraviolet radiation at high latitudes, MS Akshaya, J Murthy, S Ravichandran, RC Henry, J Overduin, Monthly Notices of the Royal Astronomical Society 489 (1), 1120-1126

4. Electrochemical surface modification of carbon for enhanced water electrolysisSS Zance, S Ravichandran, Applied Physics A 125 (7), 456

5. WO3 nanocubes for photoelectrochemical water-splitting applications, BJ Rani, MP Kumar, S Ravichandran, G Ravi, V Ganesh, RK Guduru, ...Journal of Physics and Chemistry of Solids

6. Ultrafine M-doped TiO2 (M= Fe, Ce, La) nanospherephotoanodes for photoelectrochemical water-splitting applications, BJ Rani, M Praveenkumar, S Ravichandran, V Ganesh, RK Guduru, ...Materials Characterization 152, 188-203

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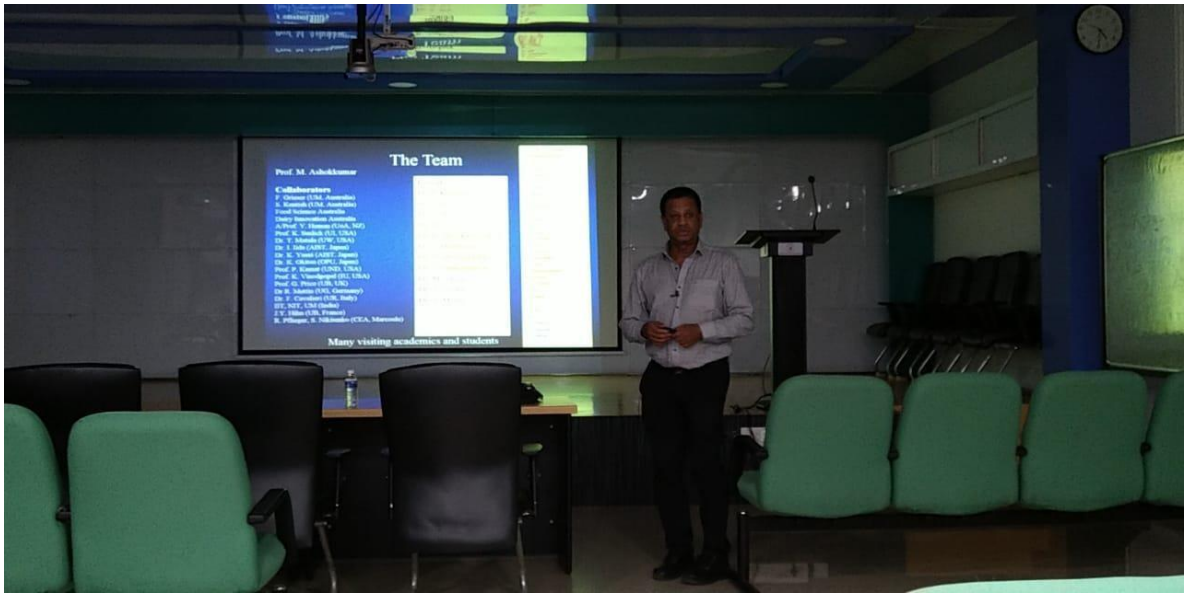
The Team
Prof. M. Ashokkumar
Collaborators
Many visiting academics and students