REVA UNIVERSITY
Bengaluru, India

SCHOOL OF APPLIED SCIENCES

M. Sc. (Chemistry) Program

Hand Book

2019

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Rukmini Educational
Charitable Trust

www.reva.edu.in

Chancellor's Message

"Education is the most powerful weapon which you can use to change the world."
- Nelson Mandela.

There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it. Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look for information and those who look for knowledge.

It is deemed virtuous to serve seekers of knowledge and as educators it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is Power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts in to develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centered and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me and I believe, it takes team-work to build successful institutions. I welcome you to REVA University to join hands in laying the foundation of your future with values, wisdom and knowledge.

Dr. P. Shyama Raju
The Founder and Hon'ble Chancellor, REVA University

Vice-Chancellor's Message

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum "Knowledge is Power", REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this 'temple of learning' has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - a large number of faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of REVA University.

At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The

outcome of the research is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students. REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks the effectiveness of these programs. The entrepreneurship development activities and establishment of "Technology Incubation Centers" in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

With firm faith in the saying, "Intelligence plus character –that is the goal of education" (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavor to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS".

Welcome to the portals of REVA University!

Dr. S. Y. Kulkarni

Vice-Chancellor, REVA University

Director's Message

Higher education across the globe is opening doors of its academic disciplines to the real-world experiences. The disciplinary legitimacy is under critical review. Trans-border mobility and practice learning are being fore-grounded as guiding principles. Interactive learning, bridging disciplines and facilitating learners to gain different competencies through judicious management of time is viewed as one of the greatest and fascinating priorities and challenges today.

The M.Sc. Chemistry is designed keeping in view the current situation and possible future developments, both at national and global levels. This course is designed to give greater emphasis on Research. There are ample number of courses providing knowledge in specialized areas like reaction kinetics, Spectroscopy, Quantum Mechanics, Nanomaterials and analytical techniques, facilitating students to choose specialized areas of their interest. Adequate attention is given to provide students the basic concepts of chemistry and modern computation techniques to be used and knowledge on application of such concepts in practical field. The project, being part of the curriculum will certainly provide students the experience of practical exposure in working environment. The curriculum caters to and has relevance to local, regional, national and global developmental needs. Maximum number of courses are integrated with cross cutting issues with relevant to professional ethics, gender, human values, environmental and sustainability.

The L: T: P structure of teaching and learning under Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) would certainly help our students learn and build competencies needed in this knowledge based society. The curriculum caters to and has relevance to local, regional, national and global developmental needs. Maximum number of courses are integrated with cross cutting issues with relevant to professional ethics, gender, human values, environmental and sustainability.

This handy document containing a brief information about M.Sc. Chemistry, scheme of instruction, course content, CBCS-CAGP regulations and its advantages and calendar of events for the year will serve as a guiding path to students to move forward in a right direction. It would mould them with knowledge, skill and ethical values to face the challenges of this competitive world with greater confidence in becoming proud citizens of mother India.

Dr. Beena G
Director
School of Applied Sciences

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RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of Rukmini Educational Charitable Trust (RECT), in the year 2002. Rukmini Educational Charitable Trust (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfill its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right and the Chairman and Managing Director of the DivyaSree Group of companies. The idea of creating these top notched educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond road park, building and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 15,000+ students study various courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conducive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette dated 7th February, 2013. The University is recognised by UGC under Sec 2 (f) and empowered under Sec.22 of the UGC Act, 1956 to award degrees in any branch of knowledge. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 45 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, custom-built teaching facilities, fully air-conditioned library and central computer center, the well planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

The University is presently offering 27 Post Graduate Degree programs, 29 Degree and PG Degree programs in various branches of studies and has 15000+ students studying in various branches of knowledge at graduate and post graduate level and 494 Scholars pursuing research leading to PhD in 24 disciplines. It has 900+ well qualified, experienced and committed faculty members of whom majority are doctorates in their respective areas and most of them are guiding students pursuing research leading to PhD.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the capabilities to surpass others. These programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners so as to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has also entered into MOUs with many industries, business firms and

other institutions seeking their help in imparting quality education through practice, internship and also assisting students' placements.

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nano Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor and Dean, and supported by well experienced Trainers, Counselors and Placement Officers. The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognized as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Okalahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC^2, VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also

facilitates students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

The University has also given greater importance to quality in education, research, administration and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing and developing different quality tools, implementing them and monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director I.I.Sc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defence Dr. Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

As a part of our effort in motivating and inspiring youth of today, REVA University also has instituted awards and prizes to recognize the services of teachers, researchers, scientists, entrepreneurs, social workers and such others who have contributed richly for the development of the society and progress of the country. One of such award instituted by REVA University is **'Life Time Achievement Award'** to be awarded to successful personalities who have made mark in their field of work. This award is presented on occasion of the **"Founders' Day Celebration"** of REVA University on 6th January of every year in presence of dignitaries, faculty members and students gathering. The first "REVA Life Time Achievement Award" for the year 2015 has been awarded to Shri. Kiran Kumar, Chairman ISRO, followed by Shri. Shekhar Gupta, renowned Journalist for the year 2016, Dr K J Yesudas, renowned play back singer for the year 2017. REVA also introduced "**REVA Award of Excellence"** in the year 2017 and the first Awardee of this prestigious award is Shri Ramesh Aravind, Actor, Producer, Director, Screen Writer and Speaker.

REVA organizes various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVAMP conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another important event is Shubha Vidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing

students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognized by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga class every day to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

Within short span of time, REVA University has been recognised as a fast growing university imparting quality higher education to the youth of the country and received many awards, ranks, and accolades from various agencies, institutions at national and international level. These include: Asia's Greatest Brand and Leaders, by Asia One, National Award of Leadership Excellence, by ASSOCHAM India, Most promising University, by EPSI, Promising Upcoming Private University in the Country, by The Economic Times, Best University of India (South), by Dialogue India, Gold Brand by QS University Ranking, placed under 151-200 band by NIRF, 6TH Rank in the Super Excellence category by GHRDC, 6TH Rank in All India Law School Survey, ranked among Top 30 Best B Schools by Business World, India's Best Law Institution by Careers 360, to mention a few.

ABOUT THE SCHOOL OF APPLIED SCIENCES

The School of Applied Sciences offers graduate and post graduate programs in Biotechnology, Biochemistry, Chemistry, Physics and Mathematics which are incredibly fascinating. It aims to attract talented youth and train them to acquire knowledge and skills useful to industrial sectors, research laboratories, and educational institutions. The School presently offers M.Sc. degree programs in Bio-Chemistry, Bio-Technology, Chemistry, Physics, Mathematics and B Sc with various combinations viz, Physics Chemistry and Mathematics, Mathematics, Physics and Statistics, Mathematics Statistics and Computer Science, and Biology Mathematics & Computer Science and also Post Graduate Diploma in Clinical Research Management. The School also facilitates research leading to PhD in Biotechnology, Biochemistry, Physics, Chemistry, Mathematics and related areas of study.

The School of Applied Sciences is shouldered by well qualified, experienced and highly committed faculty. The state-of-the-art infrastructure digital classrooms, well equipped laboratories, conference rooms and the serene academic atmosphere at REVA University will enhance the transfer as well as creation of knowledge. The school provides an interactive, collaborative peer tutoring environment that encourages students to break down complex problems and develop strategies for finding solutions across a variety of situations and disciplines. The school aims to develop a learning community of critical thinkers who serves as models of innovative problems solving in the university environment to enrich their academic and professional careers.

VISION

To nurture intellect, creativity, character and professionalism among students and impart contemporary knowledge in various branches of Chemical, Biological, Physical and Mathematical Sciences that are socially relevant and transform them to become global citizens.

MISSION

To achieve excellence in studies and research through pedagogy and support interface between industry and academia

VALUES

- Excellence in all our academic and research endeavors
- Dedication and service to our stakeholders
- Leadership through innovation
- Accountability and transparency
- Creating conducive academic environment with service motto
- Integrity and intellectual honesty
- Ethical and moral behavior
- Freedom of thought and expression
- Adaptability to the change
- Team-work

"The constant questioning of our values and achievements is a challenge without which neither science nor society can remain healthy"

— Aage Niels Bohr

M Sc (Chemistry) Program

Program Overview

Chemical sciences are branch of the natural sciences dealing with the composition of substances and their properties and reactions. The chemical sciences provide understanding of the physical and chemical properties of atoms and molecules and practical methods for creating new molecular structures with useful applications. Chemistry is a 'platform science', contributing to fundamental aspects of a range of other sciences and underpinning the dramatic advances seen in recent decades in such fields as biotechnology, energy, the environment, genetics, materials and medicine.

Since the mid-20th century, the importance of S&T for development has increasingly been recognised by international agencies, development assistance partners and the governments of low- and middle-income countries (LMICs). One outstanding example of success is the case of Taiwan, whose per capita Gross National Product rose from US$ 919 in the 1950s to US$ 7358 in 1990, as the agrarian economy was transformed into an export-oriented industrial one. By the early 1990s, the chemical industry was the largest industrial sector, contributing 24.2% of the total production value of US$ 165.3 billion, but only 8.5% directly to export sales of US$ 95.6 billion. This demonstrates the strategic importance of the chemical industry as a supplier of materials and chemicals in underpinning other export industries, including electrical/electronic goods and textiles.

Chemistry is important in storage and use of energy, Creation of new materials, Advances in agriculture, food and nutrition, Better health and Economic growth. Thus, Chemistry is an essential part of the educational system of an advanced society. Indian Society has embraced knowledge economy and its economic growth rate is one of the highest in the world. India has shown highest level of progress in engineering, space, nuclear, aeronautics, biotech, and pharmaceutics. The subject of chemistry has played a major role in the development of country. In this context, Universities across the country offer Chemistry as a subject at undergraduate and Chemistry as a programme at postgraduate level.

M. Sc. (Chemistry) program **at REVA UNIVERSITY** has been designed to meet the human resources needs of existing and futuristic research establishments, industries and academic institutions. The program is designed to produce graduates with higher order critical, analytical, problem solving and research skills; ability to think rigorously and independently to meet higher level expectations of industries, research organization and academic institutions.

The program focuses on theoretical and practical aspects of physical, analytical, organic and Inorganic chemistry aspects with opportunities for project work in the subject area. The courses are tailored to prepare students in teaching and research as well as in community activities and development. The

minor project work that the students must undertake compulsorily is integrated with industry experience. This will not only enhance acquaintance to applications of chemistry to real world problems but improve students' knowledge and self-confidence. The school also has research program leading to doctoral degree. The program focuses on research to offer professional services at National and International levels.

Program Educational Objectives (PEOs)

The aim of the program is to produce postgraduates with - advanced knowledge and understanding of Chemistry; higher order critical, analytical, problem solving and attitudinal skills (transferable) to meet expectations of research establishments, relevant industry and academia. Hence,

The Program Educational objectives are to prepare the students to:

1. Work as a scientist or faculty in educational institutions and research organizations in a team with further training.
2. Develop strong ethics and communication as consultant with lifelong learning attitude.
3. Pursue higher studies to address the problems of the society.

Program Outcomes (POs)

After undergoing this programme, a student will be able to:

1. **Knowledge Sharing:** Apply the knowledge of fundamentals mathematics, physics and advanced chemistry to resolve the problems in everyday life.
2. **Problem analysis:** Analysis of research problems and chemical compounds and provide solutions at national and international level.
3. **Design/development of solutions:** Design and develop the eco-friendly products required for the present and future generation.
4. **Conduct investigations of complex problems:** Formulate and develop methods and utilize advanced scientific tools and techniques to probe complex chemical problems and interpret the data.
5. **Research skills:** Enhance the research skills and carryout the extensive research literature in advanced chemical studies.
6. **Environment and sustainability:** Apply critical thinking ability to achieve sustainable solutions for energy and environment.
7. **Ethics:** Apply ethical principles and commit to ethics, and responsibilities and norms of the professional practice
8. **Individual and team work:** Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.
9. **Communication**: Communicate effectively with the professional community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.
10. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. Lead a team to successfully complete projects, and communicate across teams.

Program Specific Outcomes (PSOs)

After the completion of program, the student will be able to:

1. Apply the various concepts of organic, inorganic, analytical, physical chemistry aspects and their applications in day to day life.
2. Apply various analytical techniques such as XRD, UV, IR, NMR, Mass, Chromatography for chemical analysis.
3. Use modern techniques and tools for research and development and provide solutions in the field of chemical sciences.

M. Sc. (Chemistry) Program

SCHEME OF INSTRUCTIONS

(Effective from the Academic Year 2019-20)

FIRST SEMESTER

SL No	Course Code	Course Title	Course Type	Credit pattern and value				Weekly Contact hours
				L	T	P	C	
1	M19CH1010	Inorganic Chemistry -I	HC	3	1	0	4	5
2	M19CH1020	Organic Chemistry -I	HC	3	1	0	4	5
3	M19CH1030	Physical Chemistry -I	HC	3	1	0	4	5
4	M19CH1040	Analytical Chemistry- I	HC	3	1	0	4	5
Inorganic chemistry								
5	M19CH1051	Introduction to Nano-science and Nanotechnology - I.1	SC*	2	1	0	3	4
Organic Chemistry								
6	M19CH1052	Heterocyclic Chemistry And Chemistry Of Bio-Molecules - I.2	SC*	2	1	0	3	4
Physical Chemistry								
7	M19CH1053	Surface, Interfaces and Catalysis - I.3	SC*	2	1	0	3	4
Analytical Chemistry								
8	M19CH1054	Advanced Instrumental Methods of Analysis- I.4	SC*	2	1	0	3	4
	Practical Courses							
9	M19CH1060	Organic Chemistry-I **(**Practical)	HC	0	1	3	3	5
10	M19CH1070	Physical Chemistry-I**(**Practical)	HC	0	1	3	3	5
Total				**14**	**7**	**6**	**25**	**34**

Note: *Students shall choose any **ONE Soft Core (SC)** out of Four Soft Core Courses

SECOND SEMESTER

Sl. No	Course Code	Course Title	Course Type	Credit pattern and value				Weekly Contact hours
				L	T	P	C	
1	M19CH2010	Inorganic Chemistry -II	HC	3	1	0	4	5
2	M19CH2020	Organic Chemistry -II	HC	3	1	0	4	5
3	M19CH2030	Physical Chemistry -II	HC	3	1	0	4	5
4	M19CH2040	Analytical Chemistry -II (Organic Spectroscopy)	HC	3	1	0	4	5

Inorganic Chemistry								
5	M19CH2051	Chemistry of Life -II.1	SC*	2	1	0	3	4

Organic Chemistry								
6	M19CH2052	Supramolecular and Medicinal Chemistry-II.2	SC*	2	1	0	3	4
Physical chemistry								
7	M19CH2053	Advanced Chemical Kinetics and Thermodynamics-II.3	SC*	2	1	0	3	4
Analytical Chemistry								
8	M19CH2054	Separation Techniques -II.4	SC*	2	1	0	3	4
9	M19CH2060	Sports/Yoga/Music/Dance/ Theatre	RULO	0	0	2	2	4
Practical Courses								
10	M19CH2070	Inorganic Chemistry-II	HC	0	1	3	3	5
11	M19CH2080	Analytical Chemistry-II	HC	0	1	3	3	5
Total				**14**	**7**	**8**	**27**	**38**

Note: *Students shall choose any **ONE Soft Core** (SC) out of four Soft Core Courses

THIRD SEMESTER

Sl. No	**Course Code**	**Course Title**	**Course Type**	**Credit pattern and value**				**Weekly Contact hours**
				L	**T**	**P**	**C**	
	Inorganic Chemistry-III							
1	M19CH3110	Advanced Inorganic Chemistry III.1	HC	2	1	0	3	4
2	M19CH3120	Organometallics-III.2	HC	2	1	0	3	4
3	M19CH3130	Solid state chemistry and Advanced Materials -III.3	HC	2	1	0	3	4
4	M19CH3141	Industrial Inorganic Chemistry-III. 4	SC*	2	1	0	3	4
5	M19CH3142	Structural Methods in Inorganic Chemistry-III. 5						
	Organic Chemistry-III							
6	M19CH3210	Advanced Organic Chemistry -III.1	HC	2	1	0	3	4
7	M19CH3220	Advanced Organic Synthesis -III.2	HC	2	1	0	3	4
8	M19CH3230	Natural Products and Bioorganic Chemistry-III.3	HC	2	1	0	3	4
9	M19CH3241	Organometallic Chemistry in Organic Chemistry -III.4	SC*	2	1	0	3	4
10	M19CH3242	Green Chemistry-III .5						

	Physical Chemistry							
11	M19CH3310	Photo-physical Processes and Applications -III.1	HC	2	1	0	3	4
12	M19CH3320	Fundamentals of Electrochemistry and Applications-III.2	HC	2	1	0	3	4

13	M19CH3330	Advanced Physical Chemistry -III.3	HC	2	1	0	3	4
14	M19CH3341	Polymer Science and Technology -III.4	SC*	2	1	0	3	4
15	M19CH3342	Energy and Energy Conversion Systems -III.5						
	Analytical Chemistry							
16	M19CH3410	Advanced analytical Chemistry -III.1	HC	2	1	0	3	4
17	M19CH3420	Advanced Surface Analysis and Electron Spectroscopy-III.2	HC	2	1	0	3	4
18	M19CH3430	Fundamentals of Electro-analytical Techniques -III.3	HC	2	1	0	3	4
19	M19CH3441	Environmental Chemistry and Applied Analysis -III.4	SC*	2	1	0	3	4
20	M19CH3442	Water Chemistry and Treatment Technology – III.5						
21	M19CH3050	Water Chemistry and Treatment	OE#	3	1	0	4	5
22	M19CH3060	Internship / Skill Development	RULO	0	1	2	2	4
	Practical Courses							
23	M19CH3070	Inorganic Chemistry-III	HC	0	1	3	3	5
24	M19CH3080	Organic Chemistry-III	HC	0	1	3	3	5
Total				**11**	**8**	**8**	**24**	**35**

Note: i) *Students shall choose any **ONE Soft Core** out of **TWO** Soft Core Courses in respective specialization.

ii) # Open Elective (OE) is offered for students other than chemistry discipline. The students of M Sc Chemistry shall choose open elective from other disciplines.

FOURTH SEMESTER

Sl. No	Course Code	Course Title	Course Type	Credit pattern and value				Hrs/Week
				L	T	P	C	
1	M19CH4010	Major Project	HC	--	--	10	10	15
2	M19CH4021	Functional inorganic materials	SC*	2	1	--	3	4
3	M19CH4022	Advanced functional organic materials						
4	M19CH4023	Advanced spectroscopy and applications in structural analysis						
5	M19CH4024	Advanced electroanalytical techniques						
6	M19CH4025	Advances in surface, interface and Catalysis						

7	M19CH4026	Advanced materials in energy storage and conversion devices						
8	M19CH4027	Advances in polymer science and technology						
9	M19CH4030	MOOC/SWAYAM/HARVARD/Edx/ Internship etc	RULO	4	-	-	4	4
Practicals Courses								
10	M19CH4041	Advanced organic chemistry lab-IV.1	SC*	-	0	3	3	5
11	M19CH4042	Advanced Inorganic chemistry lab-IV.2	SC*	-	0	3	3	5
	Total			6	1	13	**20**	**28**

*****Students shall choose **ONE** in each Lab and Theory Courses.

HC=Hard Core; SC=Soft Core; OE=Open Elective; RULO=REVA Unique Learning Offerings

a) Credits Semester wise (2018-20)

Semester	**I**	**II**	**III**	**IV**	**Total**
HC-Theory	4x4 =16	4x4 =16	3x3=9	-----	41
HC-Lab	2x3=6	2x3=6	-----	-----	12
SC-Theory	1x3=3	1x3=3	1x3=3	1x3=3	12
SC-Lab	-----	-----	2x3=6	1x3=3	9
OE	-----	-----	1x4=4	-----	4
Project	-----	-----	-----	10	10
RULO	-----	2	2	4	8
Total	**25**	**27**	**24**	**20**	**96**

Semester-wise Credit Distribution

Semesters	**No. of Credits**	**No. of Hours**
I	25	34
II	27	38
III	24	35
IV	20	28
Total	**96**	**135**

Credit Distribution

Semester	**HC**	**SC**	**OE**	**RULO**	**TOTAL**
I	22	3	-	-	25
II	22	3	-	2	27
III	9	9	4	2	24
IV	10	6	-	4	20
Total	**63**	**21**	**4**	**8**	**96**

Semester-wise Course Types & Credits Based on L: T: P

Semester	**L**	**T**	**P**	**Total**	**Total Hours**
I	14	7	6	25	35
II	14	7	8	27	38
III	11	8	8	24	35
IV	2	3	6	20	28
Total	**41**	**25**	**28**	**96**	**135**

DETAILED SYLLABUS

(Effective from Academic Year 2019-20)

SEMESTER-I: HARD CORE

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH1010	**INORGANIC CHEMISTRY – I**	HC	3	1	0	4	5

Course Objectives:

This course aims to provide the student to

1. The Structure, bonding and properties through Lewis, VSEPR, Valence bond and Molecular orbital theory.
2. The fundamentals of the chemistry of the main group elements include the structure, bonding and properties of Silanes, silicone, boranes, phosphates and inorganic ring system.
3. The HSAB rule, Isopoly, Hetropolyacids and non-aqueous solvents.
4. The structure, bonding and stability of Metal Clusters, Pnictogens, Chalcogens, Halogens and Nobel Gases.

Course Outcomes:

By the completion of course student will be able to

1. Discuss the principles of bonding, predicting the geometries of simple molecules and properties through VSEPR, Valence bond and Molecular orbital theory.
2. Explain the fundamentals of the chemistry of the main group elements include the structure, bonding and properties of Silanes, silicone, boranes, phosphates and inorganic ring system.
3. Classify the substances softness and hardness by using HSAB rule and discuss the properties of non-aqueous solvents.
4. Apply the acquired knowledge to explain the structure, bonding and stability of Metal Clusters, Pnictogens, Chalcogens, Halogens and Nobel Gases.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
M19CH1010	CO1	2	2	0	1	1	0	0	0	0	1	3	2	1
	CO2	3	2	0	1	1	1	0	0	0	1	3	2	1
	CO3	2	1	1	0	1	1	0	0	0	1	3	2	1
	CO4	2	1	1	1	2	2	0	0	0	1	2	2	2

Course Content:

UNIT-I

Periodicity and chemical bonding: Periodic properties, atomic states and term symbols. Bonding and structure; Types of bonds, orbital symmetry and overlaps, concept of MO and VB theory, concept of hybridization, bond energy and covalent radii, concept of resonance, molecular dipole moment; polarizing power and polarizability, Fajan's rules.

VSEPR model, shapes of molecules: ClF_3, ICl_4^-, TeF_5^-, I_3^-, $TeCl_6^{2-}$, XeF_6, $SbCl_6^{3-}$, IF_7, ReF_7, XeF_8^{2-}, TaF_8^{3-}; Bent rules and energetics of hybridization; electronegativity and partial ionic character; Bonds- Multicenter, Synergic and Agostic bonding. Lattice energy: Born-Lande equation, Kapustinskii equation, partial covalent character, radius-ratio rules, structures of simple solids, Zintl- isoelectronic relationship in solids. Molecular orbital theory: LCAO and MO diagrams of heteronuclear diatomic (CO, NO, HF, ICl) and triatomic molecules (CO_2 and NO_2^-). [15 hrs]

UNIT-II

Chemistry of main group elements: Periodic anomalies in main block elements, Inert Pair effect, Relativistic effect, Diborane and its reactions, polyhedral boranes, (Preparation, properties, structure and bonding). Wade's rules, carboranes and borazines. Inorganic chains, rings and cages of boron, carbon and phosphorous.

Silicates: Structure, classification - silicates with discrete anions, silicates containing chain anion, silicates with layer structure, silicones with three-dimensional network and Applications.

Silicone: General methods of preparation, properties. Silicone polymers - silicone fluids, Silicone greases, silicone resins, silicone rubbers and their applications.

Heterocyclic inorganic ring system: Sulphur-nitrogen ring, nitrogen-phosphorous ring. [15 hrs]

UNIT-III

HSAB concept: Basis of HSAB concept, acid-base strength, hardness and softness, symbiosis, applications of HSAB concept; Acid- base concept in non-aqueous media, reactions in BrF_3, N_2O_4, anhydrous H_2SO_4, CH_3COOH. Isopoly and heteropoly acids of W, Mo and V, preparations, properties, structure and applications.

Non-aqueous solvents: Classification of solvents, Properties of solvents (dielectric constant, donor andacceptor properties) protic solvents (anhydrous H_0SO_4, HF and glacial acetic acid) aprotic solvents (liquidSO_2, BrF_3 and N_2O_4). Solutions of metals in liquid ammonia, hydrated electron. Super acids. [15 hrs]

UNIT-IV

Clusters, cages and p block elements: M-M bond and metal atom clusters, halide clusters, bonding in $[ReCl_8]^{2-}$. Metal carbonyl clusters- LNCC's and HNCC's. Electron counting in carbonyl clusters, Wades-Mingos and Lauher rules.

Pnictogens: Nitrogen activation; Oxides of nitrogen and phosphorus; Pnictogen halides; Phosphazenes, rings and clusters.

Chalcogens: Oxo-acids of sulphur, Polyanions of sulfur, selenium, and tellurium; sulphur-nitrogen & phosphorus based compounds.

Halogens: Positive and negative oxidation states, Pseudohalogens; Polyhalides; Structure and bonding in interhalogen compounds; Oxoacids and oxoanions of halogens; Fluorocarbons.

Nobel Gases: Structure and bonding in halides and oxo-halides of xenon compounds.

f-block elements: Lanthanide contraction; Occurrence and recovery; Separation of Lanthanides; electronic spectra and MRI contrast agents. [15 hrs]

Reference Books:

1. Basic Inorganic Chemistry – 3rd edition. F.A. Cotton, G. Wilkinson and P.L. Gaus, John Wiley and Sons (2002).
2. Inorganic Chemistry, 3rd edition. James E. Huheey, Harper and Row Publishers (1983).
3. Inorganic Chemistry, 3rd edition. G.L. Miessler and D.A. Tarr, Pearson Education (2004).
4. Inorganic Chemistry, 2nd edition. D.F. Shriver, P.W. Atkins and C.H. Langford, Oxford University Press (1994).
5. Inorganic Chemistry, 2nd edition. C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd. (2005).
6. Introduction to Modern Inorganic Chemistry, K.M. Mackay and R.A. Mackay, Blackie Publication (1989).

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 1020	**ORGANIC CHEMISTRY -I**	3	1	0	4	5

Course Objectives:

This course aims to provide the student to

1. Analyze the effect of conjugation, hyperconjugation delocalization, resonance and aromaticity in organic molecules
2. Identify the reactive intermediates in the reaction mechanism and also examine the rate of the reaction
3. Discuss the core concepts of stereochemistry in organic molecules
4. Explain the chemistry of carbohydrates, synthesis and biological importance of vitamins

Course Outcome:

By the completion of course student will be able to

1. Explain the effect of conjugation, hyperconjugation delocalization, resonance and aromaticity in organic molecules
2. Analyze the role of reactive intermediates such as carbocations, carbanion's carbenes nitrenes and kinetics during the course of reaction
3. Predict R/S, E/Z configuration, chirality in molecules by applying concepts of stereochemistry
4. Discuss the chemistry of carbohydrates, synthesis and biological importance of vitamins

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
M19CH 1020	**CO1**	1	2	1	2	3	0	2	0	0	0	1	1	1
	CO2	1	3	0	2	3	0	0	0	0	0	1	2	2
	CO3	1	2	0	2	3	0	0	0	0	0	2	2	2
	CO4	1	2	1	0	3	0	0	0	0	1	1	3	2

Course Content:

UNIT-I

Nature of Bonding in Organic Molecules:

Delocalized chemical bonding: Conjugation, cross conjugation, resonance, Concepts of Aromaticity, non-aromaticity and antiaromaticity, NMR in aromatic Character. Aromaticity- Hackles' rule of aromaticity, Aromatic systems with electron numbers other than six (including azulene, tropone, tropolone and annulenes). Antiaromaticity. Aromaticity in benzenoids, Homo-aromaticity. Alternant and nonalternant hydrocarbons, Energy levels in odd and even-alternant hydrocarbons, energy levels for the benzyl cation, benzyl free-radical and benzyl carbanion. Hyper conjugation and Tautomerism. [15 hrs]

UNIT-II

Reaction Mechanisms-I:

Elementary and simple reactions, Transition state structure- Hammond postulate, Curtin-Hammett principle, reaction profile diagram, Thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammett and linear free energy relationship, substituent and reaction constants, Taft equations, kinetic isotope effects, Methods of determining reaction mechanisms, Hard and soft acids and bases, Effect of structure on the strengths of acids and bases.

Reaction Mechanisms-II

Generation, structure, stability and reactivity of carbocations, carbanions, carbon free radicals, carbenes and nitrenes. Effect of structure on reactivity: Resonance and field effects; steric effects, Classification of reactions and mechanisms. Nucleophilic substitution reaction at a saturated carbon: SN1and SN2 mechanism, Effect of substrate structure, attacking nucleophile, leaving group. Ambident nucleophiles and substrates. [15 hrs]

UNIT-III

Stereochemistry-Principles of seterochemistry: Conformational isomerism in acyclic compounds, stereoselectivity, enantioselectivity and diasterioselectivity, stereospecific and Regiospecific reactions. Methods for distinguish enantiomers and diastereomers. Racemic mixtures .Optical and geometrical isomerism. Fischer, Newman, Sawhorse and flying wedge projections and their interconversions. Optical isomerism: Elements of symmetry and chirality, prochairality and topicity D-L conventions. CIP rules, R-S and M-P conventions. Chirality in compounds with a stereogenic axis in allenes, biphenyls and spiranes. Conformational analysis of cycloalkanes: cyclobutane, cyclopentane, cychexanes (monosubstituted e.g., methyl, iso-propyl, tert-butyl and di-substituted cyclohexanes e.g., dialkyl, dihalo, diols). [15Hrs]

UNIT-IV

Carbohydrates – Introduction, Kiliani-Fischer synthesis, Determination of configuration of the monosaccharides, conformational analysis of monosaccharides. Reactions of Carbohydrates, Synthesis of aldonic, uronic, aldaric acids and alditols.Structure elucidation of sucrose and maltose. Structures of lactose, gentiobiose, and meliobiose.

Vitamins - Biological importance and synthesis of Vitamin A Vitamin B1 (thiamine), Vitamin C, Vitamin –E, B6 (pyridoxine), Folic acid, pantothenic acid, riboflavin, Vitamin H (biotin), Vitamins K1 and K2. [15Hrs]

Reference Books:

1. Advanced Organic Chemistry – Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
2. Advanced Organic Chemistry, F A Carey and R J Sundberg Plenum, (1990).
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman, (2000).
4. Structure and mechanism of Organic Chemistry, C K Ingold, Cornell University Press (1999).
5. Organic Chemistry, R T Morrison and R N Boyd, Prentice-Hall, (1998).
6. Modern Organic Reactions, H O House, Benjamin, (1972).
7. Principles of Organic Synthesis, R O C Norman and J M Coxon, Blackie Academic and Professional, (1996).
8. Stereochemistry of Organic Compounds, D Nasipuri, New-Age International, (1999).
9. Stereochemistry of Carbon Compounds, E L Eliel, S H Wilen and L N Mander, John Wiley, (1994). 10. Stereochemistry, Potapov, MIR, Moscow, 1984.
10. Organic Chemistry, Volumes I and II, I L Finar, Longman, (1999)

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 1030	PHYSICAL CHEMISTRY - I	HC	3	1	0	4	5

Course objectives:

This course aims to provide the student to

1. Correlate the basic concepts of Thermodynamics in the in the day to day life and in the industrial perspective.
2. Illustrate the quantum statistical methods that uses molecular properties to predict the behavior of macroscopic quantities of compounds.
3. Conclude the theories of chemical kinetics and study the reactions with advanced flow techniques.
4. Design the electrode and electrolyte systems by the electrode kinetics using the basic knowledge of the electrochemistry.

Course Outcomes:

By the completion of course student will be able to

1. Apply the knowledge of thermodynamic laws to the energy conversion processes in daily life.
2. Explain the behavior of microscopic systems with BE, FD, MB statistics and distribution, ensembles, partition functions and molecular partition functions.
3. Illustrate the kinetics to the complex reactions, Parallel, consecutive, fast reactions and reversible reactions by the modern flow techniques.
4. Judge the Electrochemical reactions by the Debye-Huckel theory, transport numbers, Helmholtz-Perrin, Gouy-Chapman and Stern electrical double layer, reversible and irreversible electrodes to the electrochemical processes.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
M19CH 1030	CO1	1	0	0	0	0	1	0	0	1	2	2	0	0
	CO2	0	0	0	0	0	1	0	0	1	2	1	0	0
	CO3	1	0	0	0	1	1	1	1	2	2	2	0	1
	CO4	1	0	0	0	1	1	1	1	2	2	2	0	2

Course Content:

UNIT – I

Thermodynamics: Brief overview of thermodynamic laws, Concepts of Enthalpy, entropy and free energy. Molar heat capacities, Joul Thomson experiment, carnot cycle, Entropy change during spontaneous process. Helmholtz and Gibbs free energies. Thermodynamic criteria of equilibrium and spontaneity. Variation of free energy with temperature and pressure. Third law of thermodynamics - calculation of absolute entropies.

Partial molar properties: Partial molar volumes and their determination by intercept method and from density measurements. Chemical potential and its significance. Variation of chemical potential with temperature and pressure. Formulation of the Gibbs Duhem equation. [15 hrs]

UNIT – II

Fugacity: Determination of fugacity of gases. Variation of fugacity with temperature and pressure. Activity and activity coefficients. Variation of activity with temperature and pressure. Determination of activity co-efficients by vapour pressure, depression in freezing point, solubility measurements by electrical methods.

Thermodynamics of dilute solutions: Raoult's law, Henry's law. Ideal and non-ideal solutions.

Statistical Thermodynamics: BE, FD, MB statistics and distribution, ensembles, partition functions and molecular partition functions, mean energy, Residual entropy, heat capacity of mono and diatomic gases, Einstein theory of heat capacity of solids. [15 hrs]

UNIT – III

Kinetics: Theory of reaction rates, kinetics of complex reactions, Parallel, consecutive and reversible reactions. Determination of order of reaction. Arrhenius equation, energy of activation and its experimental determination. Simple collision theory - mechanism of bimolecular reaction. Lindemann's theory, Hinshelwood's theory for unimolecular reaction (No derivation). Activated complex theory of reaction rate, classical thermodynamic treatment, partition function, statistical thermodynamic treatment. Kinetics of reactions in solution - Salt effect, effect of dielectric constant (single sphere and double sphere model), effect of pressure, volume and entropy change on reaction rates.

Fast reactions: Study of kinetics by flow techniques, equation for contact time, stopped flow and continuous flow methods. Relaxation method, equation for relaxation time, temperature jump and pressure jump methods, flash photolysis, pulse radiolysis and shock tube method. Potential energy surface, theoretical calculation of energy of activation. [15 hrs]

UNIT – IV

Electrochemistry: Derivation of Nernst equation, Mobility and conductivity of electrolytes, Arrhenius theory of strong and weak electrolytes and its limitations, Concept of activity and activity coefficents in electrolytes, Debye-Huckel theory of strong electrolytes, Debye Huckel-Onsager equation, Debye-Huckel limiting equation for activity co-efficients. A brief survey of Helmholtz-Perrin, Gouy-Chapman and Stern electrical double layer (No Derivation). Liquid junction potential and its determination. Transport Number: Determination of transport number by Hittorf method and e.m.f method. Effect of temperature and concentration on transport number.

Irreversible electrode process: Introduction, reversible and irreversible electrodes, reversible and irreversible cells. Electrode and cell potentials, Polarization, over voltage. Experimental determination of over voltage. decomposition potential Equations for concentration over potential, diffusion current – stationary current, potential curves. Diffusion controlled current – potential curves at a dropping mercury electrode, polarography, half wave potential, application in qualitative and quantitative

analysis. Butler-Volmer equation, Tafel equation (No derivation). [15 hrs]

Reference Books:

1. Thermodynamics for Chemists by S. Glasstone, Affiliated East-West Press, New Delhi, (1965).
2. Chemical Thermodynamics by I.M. Klotz, W.A. Benzamin Inc. New York, Amsterdam (1964).
3. Basic Physical Chemistry by W.J. Moore, Prentice Hall of India Pvt. Ltd., New Delhi (1986).
4. Text Book of Physical Chemistry by Samuel Glasstone, MacMillan Indian Ltd., 2nd edition (1974).
5. Theoretical Chemistry by S. Glasstone.
6. Elementary Statistical Thermodynamics by N.D. Smith Plenum Press, NY (1982).
7. Elements of Physical Chemistry by Lewis and Glasstone.
8. Physical Chemistry by P.W. Atkins, ELBS, 4th edition, Oxford University Press (1990)
9. Chemical Kinetics by K.J. Laidler.
10. Chemical Kinetics by Frost and Pearson.
11. Kinetics and Mechanism of Chemical Transformation by J. Rajaram and J.C. Kuriacose.
12. Chemical Kinetics by L.K. Jain.
13. Chemical Kinetics by Benson.
14. Kinetics in Analytical Chemistry by H.B. Mark and G.A. Rechnitz, Wiley Interscience Publishers, John Wiley and Sons, New York.
15. Introduction to Electrochemistry by S. Glasstone.
16. Statistical Themodynamics by B.C. Meclelland, Chapman and Hall, London (1973).
17. Elementary Statistical Thermodynamics by N.D. Smith, Plenum Press, NY (1982).
18. Elements of Classical and Statistical Thermodynamics by L.K. Nash, Addison- Wesley(1970).
19. Statistical Thermodynamics by I.M. Klotz.

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 1040	ANALYTICAL CHEMISTRY -I	HC	3	1	0	4	5

Course Objectives:

This course aims to provide the student to

1. Application of principles of analytical chemistry in chemistry
2. Knowledge on the basic concepts of Errors and treatments of analytical data.
3. Analysis of chemical data using various statistical tools
4. Describe various fundamentals of analytical techniques

Course Outcome:

By the completion of course student will be able to

1. Apply various statistical tools for data analysis.
2. Formulate experimental data into appropriate statistical model
3. Infer various analytical techniques and their working principles
4. Explain various analytical techniques available for sample analysis in laboratories

Mapping of Course Outcomes with programme Outcomes (sample)

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
M19CH 1040	CO1	1	1	2	2	2	0	0	1	0	0	0	0	1
	CO2	2	1	2	2	2	0	0	1	0	0	1	1	1
	CO3	2	1	1	1	2	0	0	2	0	0	2	1	2

	CO4	2	2	2	2	3	0	0	2	0	0	2	3	2

Course Content:

UNIT – I

Errors and treatment of analytical data: Introduction to analytical techniques. Factors affecting choice of techniques. Basic definitions (Accuracy, precision, mean, median, and significant figures). Way of expressing accuracy; absolute and relative errors (problems). Errors: determinate (systematic) and indeterminate (random) errors and their minimization. Distribution of random errors and explanation using the normal distribution curve (Gaussian distribution). Propagation of determinant and indeterminate errors (problems). Statistical treatment of finite samples; standard deviation and variance (problems). Student's t-test (problems), confidence interval of mean (problems). Testing for significance - comparison of two standard deviations, (problems), Comparison of two means (problems), Comparison of an experimental mean and a true mean, t-test (problems), rejection of a result - Q-test (problems).

How to plot best fitting straight line; the least squares methods, standard deviations of the slope and intercept (related problems). Measure of the correlation between two variables (x and y, problems). Detection limit, statistics of sampling; Sample size, minimum sample size, and minimum number of samples (problems). [15hrs]

Add on program: Application of Excel - spread sheets in analytical chemistry

UNIT – II

Titrimetric analysis: An overview of titrimetry. Principles of titrimetric analysis. Titration curves. Over view of acid-base chemistry, pH calculations, Titrations based on acid-base reactions - titration curves for strong acid and strong base, weak acid and strong base and weak base and strong acid titrations. Selecting and evaluating the end point. Finding the end point by visual indicators, monitoring pH and temperature.

Acid-base titrations in non-aqueous media: Role of non-aqueous solvent in acid-base titrations, solvent systems, differentiating ability of a solvent, levelling effect, selected solvents, titration curves, effect of water, determining the equivalence point, typical applications - determination of carboxylic acids and amines.

Precipitation titrations: Principles of precipitation, common-ion effect, salt effect, Titration curves, feasibility of precipitation titrations, factors affecting shape - titrant and analyte concentration, completeness of the reaction, titrants and standards, indicators for precipitation titrations involving silver nitrate, the Volhard, the Mohr and the Fajan's methods, typical applications. [15hrs]

UNIT-III

Complexometric titrations: Complex formation reactions, stability of complexes, role of metal ions and ligands, stepwise formation constants, chelating agents, EDTA - acidic properties, complexes with metal ions, equilibrium calculations involving EDTA, conditional formation constants, derivation of EDTA titration curves, effect of other complexing agents, factors affecting the shape of titration curves - completeness of reaction, indicators for EDTA titrations - theory of common indicators, titration methods employing EDTA - direct, back and displacement titrations, indirect determinations, titration of mixtures.

Introduction to Electro-analytical techniques:

Introduction to electrochemical cells, Nernst equation, electrode processes, Electrode Potentials, Currents in Electrochemical cells, titrations. Electrogravimetry, Coulometry, and Coulometric titrations.

Amperometry Voltammetry at a dropping mercury electrode (DME): Review of the principles of normal dc polarography – types of currents obtained at a DME – Ilkovic equation and its application – current-potential relation for a cathodic process – half-wave potential – electron transfer-tests for the reversibility of a process – irreversible processes at a DME – factors that set the sensitivity and selectivity limits in normal dc polarography. [15hrs]

UNIT-IV

Analytical Separations Chromatography: Definition, principles and mechanism of separation, classification of chromatographic techniques. General descriptions of column chromatography - frontal analysis, displacement analysis and elution analysis. General theory of column chromatography: characterizing a chromatogram - retention time, retention volume and baseline width. Chromatographic resolution, capacity factor, column selectivity. Column efficiency – band broadening, rate theory and plate theory. Peak capacity, non-ideal behavior. Optimizing chromatographic separations using capacity factor, column selectivity and column efficiency - Van Demeter equation (problems), and its modern versions, Golay and Huber-Knox equations (only equations, terms involved and significance).

Gas chromatography (GC): Principle, instrumentation - mobile phase, chromatographic columns, stationary phases, sample introduction, temperature control, and detectors for gas chromatography and applications.

High performance liquid chromatography (HPLC): Principles, instrumentation – columns (analytical and guard columns), stationary phases, mobile phases, choosing a mobile phase, isocratic vs gradient elution, Detectors for HPLC and applications.

Thermal Methods: Thermo gravimetric analysis– TGA, DTA and DSC; Principle, instrumentation, and Factors affecting the results. Study of thermal stability of $CuSO_4.5H_2O$ and $Ca_2C_2O_4\ 2H_2O$ by TGA. Difference between TG and DTA. [15hrs]

Reference Books:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001, John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
7. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.

SEMESTER-I: SOFT CORE (SC) COURSES

Note: Students shall choose any one SC Course out of Four SC Courses.

SOFT CORE-01

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH1051	**INTRODUCTION TO NANO-SCIENCE AND NANO-TECHNOLOGY**	SC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Introduction to nanotechnology.
2. Classification of nanostructures and the methods of synthesizing
3. The various Nanomaterials characterization techniques nanomaterials and Carbon nanomaterials.
4. The applications of nanomaterials in nanoelectronics and Biochemical sensor

Course Outcomes:

By the completion of course student will be able to:

1. Explain the methods of synthesis of nanomaterials with properties and applications.
2. Categorize the Types of Nanostructures includes carbon nanomaterials and discuss the preparation, properties and applications.
3. Describe the various types of nanomaterials characterization techniques like Imaging techniques and Spectroscopic techniques.
4. Apply the acquired theoretical knowledge to classify as nanocatalysts, chemical sensors, biosensors, drug delivery, Biochemical sensor, Biophysical sensor and nano electronics.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
M19CH 1051	CO1	2	2	1	2	1	1	0	0	0	1	3	1	1
	CO2	2	2	2	2	1	1	0	0	0	1	3	1	1
	CO3	2	1	2	1	1	1	0	0	0	1	3	2	2
	CO4	2	1	2	2	2	1	0	0	0	1	3	2	3

Course Content:

UNIT-I

Background to Nanotechnology: Atom, molecules and nanoscale materials, Electrons in nanostructures, Quantum size effects, Density of states, particle in box model, Gibbs energy at nanoscale, Q dots, Q wires, Q walls, property variations in nanoscale. Size effects on surface energy, surface area, optical, electrical, magnetic, thermal properties. Emergence of Nanotechnology – Challenges in Nanotechnology.

Synthesis issues of nanomaterials: Nucleation-Growth mechanism of nanomaterials, Influence of nucleation rate on the size of the crystals- macroscopic to microscopic crystals and nanocrystals - large surface to volume ratio, top-down and bottom-up approaches-self-assembly process-grain boundary volume in nanocrystals-defects in nanocrystals-surface effects on the properties. Stability of nanomaterials, Synthesis approaches, Physical methods, Chemical methods, Chemical interactions at

nanoparticle surfaces, Functionalization of nanostructures, Self-assembly of nanostructures, Nano Lithographic techniques, Electrodeposition. [15 hrs]

UNIT-II

Types of Nanostructures: Definition of a Nano system – Types of Nanocrystals-One Dimensional (1D)-Two Dimensional (2D) –Three Dimensional (3D) nanostructured materials – Quantum dots – Quantum wire, Quantum wells, Core/Shell structures. Their electronic properties, Physical and chemical methods for preparation of nanomaterials

Carbon nanomaterials: Fullerenes, structure and reactivity of fullerenes, preparation of fullerenes and Functionalization of fullerenes, chemistry of fullerenes, physical properties of fullerenes, Applications – solar cells, medicine, superconductors,

CNT – CNT formation mechanism, Electronic properties of SWNT, DWNT, MWNTs, CNT growth techniques, structure and properties (electrical conduction, magnetic, magnetoresistance, mechanical, thermal), Nanocomposites of CNTs, Applications,

Graphene, Electronic properties of graphene, Diarc fermions in graphene, Anamolous Quantum Hall Effect, Ambipolar conductivity, optical, mechanical properties of graphene, Experimental detection of number of layers, Preparation of graphene: Micromechanical, chemical methods, physical methods, Functionalization, Applications

Nanodiamond and Diamond like carbon: Structure, synthesis, Surface structures, reactivities of nanodiamond, Phase diagram of DLC, Effects on properties with DLC composition, device applications Metals and semiconductors nanomaterials: (Au, Ag) – Metal oxides (TiO_2, CeO_2, ZnO) – Semiconductors (Si, Ge, CdS, ZnSe) – Ceramics and Composites – Dilute magnetic semiconductor-Biological system – DNA and RNA – Lipids. [15 hrs]

UNIT-III

Nanomaterials characterization techniques:

Imaging techniques: Scanning Electron Microscope (SEM) – Field Emission scanning Electron microscope(FESEM)-Atomic force microscopy (AFM), Chemical force microscopy (CFM), optical tweezers for force measurements, scanning tunneling microscopy (STM), scanning near field optical microscopy (SNOM) – Transmission Electron Microscopy (TEM).

Spectroscopic techniques: Infra-red spectroscopy (IR)- UV-visible-Absorption and reflection-Raman Scattering –MicroRaman-tipenhanced Raman-Surface Enhanced Raman scattering (SERS)– Photoluminescence (PL)– Cathodeluminescence (CL). [15 hrs]

UNIT-IV

Applications of Nanomaterials: Molecular electronics and nanoelectronics – Quantum electronic devices - CNT based transistor and Field Emission Display – Nano magnetics, nanophotonics nanospintronics, Biological applications - Inorganic nanoprobes in Quantum dots, Inorganic nanosystems/biomolecules interface toward nanotechnologies, biophysicochemical interaction at the nano/bio interface, Biochemical sensor - Membrane based water purification. Renewable energy (nano solar cells), Photoelectrochemical cells, coloured glasses, (gold and silver ruby glasses), Nanocatalysts, chemical sensors, biosensors, SAM, electrical and electronics,(RAM). Chemical and photocatalytic applications. Drug delivery targeting and medical applications, micro-electrochemical machines (MEMS). [15 hrs]

Reference Books:

1. M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse, Nanotechnology: Basic science and Emerging technologies, Overseas Press India Pvt Ltd, New Delhi, First Edition, 2005.
2. C.N.R. Rao, A.Muller, A.K.Cheetham (Eds), the chemistry of nanomaterials: Synthesis, properties and applications, Wiley VCH Verlag Gmbh&Co, Weinheim, 2004.
3. Kenneth J. Klabunde (Eds), Nanoscale Materials Science, John Wiley & Sons, Inc, 2001.
4. C.S.S.R. Kumar, J.Hormes, C.Leuschner, Nanofabrication towards biomedical applications, Wiley – VCH Verlag GmbH & Co, Weinheim, 2004.
5. W. Rainer, Nano Electronics and information Technology, Wiley, 2003.
6. K.E. Drexler, Nano systems, Wiley, 1992.
7. G. Cao, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperical College Press, 2004.

SOFTCORE – 02

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 1052	HETEROCYCLIC CHEMISTRY AND CHEMISTRY OF BIO-MOLECULES	SC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. To use different heteroatoms in the ring, and uses in drug production.
2. Provides, the synthesis of five, six and seven membered monocycles and the fused heterocycles.
3. It also provides assembly of amino acids, peptide and proteins structures.
4. Discuss the topics include chemical and biochemical strategies used to elucidate natural product pathways.

Course Outcomes:

By the completion of course student will be able to

1. Explain the fundamental concepts of reactivity and aromaticity of various heterocyclic compounds.
2. Illustrate the synthesis of various heterocyclic compounds.
3. Analyze the different types of heterocyclic compounds.
4. Outline the synthesis of prostaglandins-E1, E2 and vitamins.
5. Apply the biological importance of DNA, RNA and classify the different types of proteins.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 1052	**CO1**	**3**	**2**	**2**	**1**	**2**	**0**	**0**	**0**	**1**	**2**	**3**	**4**	**3**
	CO2	**3**	**3**	**3**	**4**	**3**	**1**	**0**	**0**	**1**	**2**	**3**	**4**	**3**
	CO3	**3**	**3**	**3**	**2**	**3**	**0**	**0**	**0**	**1**	**2**	**3**	**4**	**3**
	CO4	**3**	**2**	**3**	**1**	**3**	**3**	**0**	**0**	**1**	**2**	**3**	**3**	**3**

UNIT-I

Nomenclature of heterocyclic compounds, reactivity of pyrrole, furan and thiophene and basicity of pyridine.

Small ring Heterocycles-Three, four and five membered Heterocycles- synthesis and reactions of aziridines, oxiranes, oxitanes, thietane, pyrrole, furan and thiophene.

Benzo fused five membered Heterocycles -Synthesis and reactions of benzo pyrrole, benzo furans and benzo thiophene. [15 hrs]

UNIT-II

Six membered Heterocycles with one heteroatom- Synthesis and reactions of pyrylium salts and their comparison with pyridinium and thio pyrylium salts and pyridones. Synthesis and reactions of coumarin, chromone. Six membered Heterocycles with two and more Heterocycles-Synthesis and reactions of diazine (pyrazine and pyrimidine) & triazine (1,2 and1,3,5)

Seven membered Heterocycles –Structural determination of azepine, oxepine & thiepine. [15 hrs]

UNIT-III

Amino acids, Peptides and Proteins-Classification, general methods of preparation, properties and reactions of amino acids, Peptide bond; Nomenclature and classification of peptides; Proteins: biological importance, classification based on structure and composition. General idea of the peptide linkage and primary structure of proteins and its determination; Sanger and Edman methods; Denaturation and renaturation thermal denaturation- aunfinsen experiment with ribonuclease. Biosynthesis of peptides.

Vitamins-Biological importance and synthesis of Vitamin A, B_6, C and E (tocopherol). [15 hrs]

UNIT-IV

Nucleic Acids-Purine and pyrimidine bases. Structure of nucleosides and nucleotides. Methods of formation of inter nucleotide bonds (DCC, phosphor tri ester approach). Structure of DNA (Watson - Crick Model) and RNAs. Biological importance of DNA and RNAs.

Prostaglandins-General study, nomenclature, classification, structure and biological role of PGE1. PGE2 and PGE3.

[15 hrs]

Reference Books:

1. Joule & Smith: Heterocyclic chemistry (Van Nostrand).
2. R. K. Bansal: Heterocyclic chemistry (Wiley E).
3. L. A. Paquitte: Principals of modern heterocyclic chemistry.
4. M. H. Palamer: The structure and reactions of heterocyclic compounds.
5. A. R. Katritzky: Advances in Heterocyclic chemistry (A.P.). 12. Finar: Organic chemistry (Vol. 1&2)
6. Biochemistry, J. David Rawn, Neil Pattuson publishers, North Carolina, (USA) 1989.
7. Organic Chemistry. Vol I and Vol II, I. L. Finar, 6th edn. ELBS & Longman (London), 1975.
8. Introduction to Lipids, D. Chapman, McGraw-Hill, 1969.
9. Advanced general Organic Chemistry, S. K. Ghosh, DK and Allied publishers (UBS), Calcutta, 1998.
10. Text book of Biochemistry, E. S. West, W. R. Todd, H. S. Mason & J. T. Van Bugen, 4th Edn. Amerind publishing co. (New Delhi), 1974.

SOFTCORE – 03

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 1053	SURFACE, INTERFACE AND CATALYSIS	SC	2	1	0	3	4

Course Objective:

This course aims to provide the student to

1. Correlate the topics like Surface phenomena of solids, solid-liquid interfaces, Homogenous and Heterogeneous Catalysis and Instrumental methods of catalyst characterization.
2. Illustrate Homogenous and Heterogeneous Catalysis and Instrumental methods of catalyst characterization. Describe the *lock-and-key* and *induced-fit* models of enzyme action.
3. Explain the function of a catalyst in terms of reaction mechanisms and potential energy diagrams
4. Gain the Knowledge of Catalyst characteristics, Mechanism of catalytic reactions and design of catalytic Reactor.

Course Outcomes:

By the completion of course student will be able to

1. Use modern methods when planning strategies for synthesis of new substances and characterization of products.
2. Depth knowledge about chemical reactions with a focus on principles for effective synthesis strategies, stereo selectivity, catalysis,
3. Predicting the chemical reaction using efficient computational models can be used to develop high-throughput screening techniques.
4. Research-based in-depth understanding in the field of design and production (synthesis) of complex molecules.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 1053	CO1	3	2	1	1	2	2	2	2	1	2	2	1	1
	CO2	2	2	2	2	3	2	1	2	2	1	2	2	2
	CO3	3	2	2	2	3	2	2	2	3	3	2	2	2
	CO4	3	3	3	2	3	2	1	3	2	2	3	2	1

Course Content:

UNIT – I

Surface phenomena: Surface forces, Structure of clean surfaces; Solid surfaces: External and internal surfaces; Bulk and surface structure of FCC, BCC and HCP metals, Notation of surface structure; Structure of adsorbate layers; Stepped surfaces; Surface relaxation and reconstruction of surfaces; homogeneous and heterogeneous surfaces. Dynamics and energetics of surfaces. Adsorption from solution and gas on surface. [12 hr]

UNIT-II

Types of interfaces. Liquid surfaces: Microscopic picture of interfaces; curved interfaces; Young - Laplace and Kelvin equations; capillary condensation; surface tension; measuring surface tension.
Solid-liquid interfaces: Contact angle and wetting, Gibbs adsorption isotherm. Solid-gas interfaces: Types of adsorption; Adsorption isotherms – Langmuir, Tempkin and BET. Determination of surface area of adsorbents; temperature dependence of adsorption isotherms. [12 hr]

UNIT – III

Fundamentals of Homogenous and Heterogeneous Catalysis, Mechanism, Adsorption isotherms, surface area, pore size and acid strength measurements; Porous solids; Catalysis by metals, semiconductors and solid acids; Supported metal catalysts; Catalyst preparation, deactivation and regeneration. Model catalysts: Ammonia synthesis; Hydrogenation of carbon monoxide; Hydrocarbon conversion. Some important heterogenous catalytic processes. [12 hr]

UNIT – IV

Instrumental methods of catalyst characterization: Diffraction techniques – X-Ray, Neutron, electron, surface area and thermal methods; spectroscopic, ionization techniques, and microscopic techniques. Determination of the extent and rates of adsorption and desorption. [12 hr]

Reference Books:

1. A. Zangwill, Physics at Surfaces, Cambridge Univ. Press, 1988.
2. B. Gates, Catalytic Chemistry, Wiley, 1992.
3. A.W. Adamson, A.P. Gast, Physical Chemistry of Surfaces, Wiley, 1997.
4. J. M. Thomas and W.J. Thomas, Principles and Practice of Heterogeneous Catalysis, Wiley-VCH, 1997.
5. K.W. Kolasinski, Surface Science: Foundations of Catalysis and Nanoscience, Wiley, 2002.
6. D.K. Chakrabarty and B. Viswanathan, Heterogeneous Catalysis, New Age, 2008.
7. G.A. Somorjai, Y. Li , Introduction to Surface Chemistry and Catalysis, Wiley, 2010.
8. Physical chemistry of surfaces by Arthur W. Adamson 1990
9. Chemical kinetics and catalysis by R.I. Masel, Wiley-Interscience, 2001.
10. 10.The chemical physics of surfaces by Roy S. Morrison, S. Roy, 1990.
11. An introduction to chemisorption and catalysis by metals", R.P.H. Gasser, 1985.
12. Modern techniques of surface science by D.P. Woodruff, T.A. Delchar, Cambridge Univ. Press, 1994.
13. Introduction to Scanning Tunneling Microscopy by C. J. Chen, Oxford University Press, New York, 1993.

SOFTCORE – 04

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 1054	ADVANCED INSTRUMENTAL METHODS OF ANALYSIS	SC	2	1	0	3	4

Course Objectives:

This course aims to provide students

1. To get knowledge on concepts of absorption spectroscopy, emission spectroscopy, voltammetry, thermogravimetry, introduction to NMR.
2. Understanding on the principles and applications of advanced instrumental techniques
3. Introduce the spectroscopic techniques importance in analysis of chemical compounds
4. Advances in various analytical techniques

Course Outcomes:

By the completion of course student will be able to

1. Apply the knowledge gained on advanced instrumentation in interpretation of analytical data.
2. Choose the advanced characterization techniques required for complex material analysis.
3. Analyze the surface and interfacial processes using advanced characterization tools.

4. Evaluate the need of instrumental analysis in multidisciplinary research and industrial processes.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
M19CH 1054	**CO1**	**2**	**1**	**1**	**2**	**3**	**1**	**0**	**0**	**1**	**2**	**2**	**2**	**3**
	CO2	**1**	**2**	**1**	**3**	**3**	**1**	**0**	**0**	**1**	**2**	**1**	**1**	**3**
	CO3	**2**	**2**	**2**	**1**	**2**	**1**	**0**	**0**	**2**	**2**	**1**	**3**	**2**
	CO4	**2**	**3**	**2**	**3**	**3**	**2**	**0**	**0**	**2**	**2**	**2**	**2**	**1**

Course Content:

UNIT-I

Absorption Spectroscopy: absorption, emission, fluorescence phenomenon, principles and differences, Flame AAS, Instrumentation, different types of nebulizers, Non flame techniques, GAAS, electrothermal vapourisers, graphite furnace, cold vapor AAS, radiation sources, HCL, EDL, TGL etc. detectors, photo emissive cells, PMT, photodiodes, Interferences, spectral, chemical, matrix, background absorption, correction methods, deuterium arc, zeeman effect, Smith-Hieftje methos, single beam and double beam instruments, evaluation procedures, applications of AAS. [15 Hrs]

UNIT-II

Atomic Emission Spectroscopy: Emission-principle, inductively coupled plasma optical emission spectrometry, theory, ICP characteristics, sample introduction methods, tourch configuration and view modes, analytical performance. merits and limitations of AES over AAS, Detection limit, application to elemental analysis, Microwave induced plasma systems in atomic spectrometry, principal processes, applications. Mass spectrometry in the analysis of inorganic compounds-different techniques, applications. [15 Hrs]

UNIT-III

Electroanalytical Techniques: Electrode Potential, Currents in Electrochemical cells, Potentiometric titrations. Electrogravimetry-faraday's laws of electrolysis, Coulometry, Coulometric titrations. Voltammetry- principle, DME-advantages, limitations, Hydrodynamic Voltammetry, Cyclic voltammetry-principle, conditions for reversible, quasi reversible and irreversible reactions Anodic stripping voltammetry-principle and applications, Polarography, Pulse polarography, Amperometry-titrations, different titration curves, applications, numerical problems on all these techniques. [15Hrs]

UNIT-IV

Thermal Methods of Analysis: Principle, methodology and applications: thermogravimetric and differential thermal analysis, differential scanning calorimetry; Thermo-mechanical and dynamic mechanical analysis; thermometric titrations. Thermal stability of polymers, applications, decomposition patterns, decomposition reactions-examples. Biomolecules-Analysis: Introduction, single biomolecule detection and characterization, Fluorescence, principle, factors influencing fluorescence, fluorescence based biosensors, Fluor immunosensors, Mass spectrometry-principle, sample preparation, probe tip, MALDIMASS, types of ion separation, instrumentation-types, applications in structural biology, Application of NMR spectroscopy in the analysis of biomolecules, Raman spectroscopy- phenomenon, merits and limitations, application to biomolecules. [15 Hrs]

Reference Books:

1. Analytical Chemistry. Gary D Christian, 5th Edition, John – Wiley and Sons Inc.,(1994)
2. Fundamentals of Analytical Chemistry. D. A. Skoog, D. M. West and F. J. Holler, 7th Edition, Saunders College Publishing (1996).
3. Instrumental methods of Analysis. H. H. Willard, L. L. Merrit, J. A. Dean and F. A. Set, CBS Publishers (1996).
4. Instrumental methods of Chemical Analysis, G. W. Ewing, 5th edition, McGraw-Hill, New York, 1988.
5. Electrochemical methods: A.J. Bard & l. R. Faulkner, 2nd edition, Wiley, New York, 2000.
6. Vogel's text book of Quantitative Chemical analysis 5th edition, Ed., Jeffery et. al ELBS/Longman, 1989
7. Encyclopedia of Analytical Chemistry: Ed. By R.A. Meyers Vol. 1 – 15, John Wiley, 2000.
8. Fundamentals of Instrumental Analysis, Skoog, D. M. West and F. J. Holler, 8th Edition, Saunders College Publishing (2004).

SEMESTER-I PRACTICALS

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 1060	ORGANIC CHEMISTRY-I PRACTICALS	0	1	3	3	5

Course Objectives:

I. The practical course on organic chemistry intends to provide the students scientific skills in qualitative and preparative techniques. Appreciate the importance of being systematic in life.
II. It also helps to develop honesty, punctuality, analytical reasoning, questioning, critical evaluation and thinking among students.

Course Outcomes:

On the successful completion of the course students shall be able to

a. Acquire skill to perform common laboratory techniques, including reflux, distillation, steam distillation, re-crystallization, vacuum filtration and aqueous extraction
b. Evaluate data collected to determine the identity, purity, and yield of products
c. Characterize organic molecules by physical methods such as Melting point and boiling point.
d. Predict the outcome and mechanism of some simple organic reactions, using a basic understanding of the relative reactivity of functional groups.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH1060	**CO1**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**
	CO2	**3**	**3**	**1**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**4**	**2**
	CO3	**2**	**3**	**0**	**2**	**2**	**1**	**2**	**1**	**3**	**3**	**1**	**3**	**2**
	CO4	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**1**	**0**	**3**	**2**	**2**	**2**

Course Content:

Preparation (one stage)

1. Cannizarro reaction: Benzaldehyde
2. Fries rearrangement: Phenyl acetate.
3. Friedel-Crafts reaction: Benzene and Acetyl chloride.
4. Sandmeyer reaction: 4-Chlorotoluene from 4-toluidine.
5. Pechmann reaction: Resorcinol and ethylacetoacetate.
6. Oxidation of Cyclohexanol.
7. Preparation of S- Benzylisothiuronium chloride.
8. Synthesis of p-iodonitrobenzene
9. Synthesis of N-Phenyl-2,4-dinitroaniline.
10. Synthesis of 2,4,6-tribromoaniline.
11. Synthesis of 2,4-dichlorophenoxyacetic acid.

Preparation (Two and three stages)

12. 2,4-Dinitrophenylhydrazine from chloronitrobenzene.
13. Anthranilic acid from phthalic acid.
14. Benzanilide from benzophenone.
15. Benzilic acid from benzoin.
16. Synthesis of Acridone.
17. Synthesis of Hydantoin.

Reference Books:

1. Manual of Organic Chemistry - Dey and Seetharaman.
2. Modern Experimental Organic Chemistry by John H. Miller and E.F. Neugil, p 289.
3. An Introduction to Practical Organic Chemistry - Robert, Wingrove etc.
4. A Text Book of Practical Organic Chemistry – A.I. Vogel.

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 1070	PHYSICAL CHEMISTRY – I PRACTICAL	HC	0	1	3	3	5

Course Objectives:

This course aims to provide the student to

1. Knowledge on various analytical techniques for the examination of analyte
2. Apply Skills in qualitative and preparative techniques.
3. Observe and assess the role of electrodes
4. Compare various factors that influence experimental values.

Course outcomes

By the completion of course student will be able to

1. Operate instruments during conduction of experiments.
2. Analyse and interpret the experimental data.
3. Demonstrate experimental skills in laboratories.
4. Identify causes for erratic results and achieve better results.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
	CO1	**1**	**2**	**1**	**2**	**1**	**2**	**0**	**2**	**0**	**0**	**2**	**2**	**2**
	CO2	**2**	**1**	**2**	**2**	**2**	**1**	**0**	**2**	**0**	**0**	**1**	**2**	**1**
	CO3	**2**	**2**	**2**	**1**	**1**	**2**	**0**	**1**	**0**	**0**	**2**	**1**	**2**
	CO4	**2**	**2**	**2**	**2**	**2**	**2**	**0**	**2**	**0**	**0**	**2**	**0**	**0**

Course Content:

Conductometry

1. Conductometric titration of a mixture of HCl, CH_3COOH and $CuSO_4$ against NaOH.
2. To determine the degree of hydrolysis and hydrolysis constant of aniline hydrochloride.
3. Conductometric titration of sodium sulphate against barium chloride
4. Conductometric titration of a mixture of HCl and $ClCH_2COOH$ against NaOH.
5. Conductometric titration of formic acid/oxalic acid against NaOH and NH_4OH.
6. Conductometric titration of orthophosphoric acid against NaOH.

Potentiometry

1. Potentiometric titration of KI *vs* $KMnO_4$ solution.
2. Potentiometric titration of KCl *vs* $KMnO_4$ solution.
3. Potentiometric titration of Fe(II) vs V(V).
4. Potentiometric titration of Fe(II) *vs* Ce(IV).
5. Potentiometric titration of a mixture of halides (KCl+KBr) against $AgNO_3$.
6. Potentiometric titration of $AgNO_3$*vs* KCl.
7. Determination of redox potential of Fe^{2+} ions by potentiometric method.
8. Determine the concentration of KI potentiometrically by calibration method
9. Determination of dissociation constant of a weak acid by potentiometric method.
10. Determination of single electrode potential

pH

1. Preparation of phosphate buffer
2. Calibration of pH meter and pKa measurements

Spectrophotometry

1. To obtain the absorption spectra of coloured complexes, verification of Beer's law and estimation of metal ions in solution using a spectrophotometer.
2. Spectrophotometric titration of $FeSO_4$ against $KMnO_4$.
3. Verification of Beer's law and calculation of molar extinction coefficient for $CuSO_4$system.
4. Spectrophotometric titration of $FeSO_4$ against $K_2Cr_2O_7$.
5. Study of kinetics of reaction between CAT and indigocarmine spectrophotometrically and determination of rate constant

Viscosity

1. Determination of the molecular weight of a polymer material by viscosity measurements (cellulose acetate/methyl acrylate).
2. Determination of the molecular weight of a polymer material by viscosity measurements (polyvinyl alcohol/polystyrene).

3. Binary analysis of two miscible liquids by viscometric method (Ethanol & Water)

Refractive index

1. Analysis of a binary mixture (Gylcerol & Water) by measurement of refractive index.

Distribution

1. Distribution of I_2 between hexane/cyclohexane and aqueous KI solution – calculation of equilibrium constant
2. Distribution of Acetic acid between n-butanol and water

Adsorption

1. Adsorption of acetic acid on charcoal and silica gel

Reference Books:

1. Practical Physical Chemistry – A.J. Findlay.
2. Experimental Physical Chemistry – F. Daniels et al.
3. Selected Experiments in Physical Chemistry – Latham.
4. Experiments in Physical Chemistry – James and Prichard.
5. Experiments in Physical Chemistry – Shoemaker.
6. Advanced Physico-Chemical Experiments – J. Rose.
7. Practical Physical Chemistry – S.R. Palit.
8. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
9. Experiments in Physical Chemistry – Palmer.
10. Experiments in Chemistry – D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994).
11. Experimental Physical Chemistry – R.C. Das and B. Behera, Tata Mc Graw Hill.

SEMESTER-II

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH2010	INORGANIC CHEMISTRY –II	HC	3	1	0	4	5

Course Objectives:

This course aims to provide the student to

1. Correlate topics in coordination chemistry like metal – ligand equilibria, electronic spectra and magnetic properties of metal complexes.
2. Illustrate the MOT of different types of bonding in metal complexes
3. Conclude the varies types of inorganic reaction, mechanism and there application
4. Design the students to have a dynamic interaction to adapt to changes in life

Course Outcomes:

By the completion of course student will be able to

1. Apply the Knowledge of d and f-block elements in explaining, interpreting and examining bonding, structure reactivity of complexes
2. Illustrate the electronic transitions and magnetic behavior and magnetic susceptibility of the complexes determined by new methods.
3. Acquire the detailed knowledge on substation, elimination, oxidation and reduction, photochemical reactions.
4. Students will be able to explore new areas of research in both chemistry and allied fields of science and technology.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19C H2010	**CO1**	**3**	**1**	**0**	**2**	**1**	**1**	**0**	**2**	**0**	**2**	**1**	**2**	**0**
	CO2	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**2**
	CO3	**3**	**2**	**1**	**2**	**0**	**2**	**0**	**2**	**2**	**2**	**1**	**1**	**2**
	CO4	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**1**	**3**

Course Content:

UNIT – I

Metal-Ligand equilibria in solution: Step-wise and overall formation constant and their relationship, trends in step-wise constant, kinetic and thermodynamic stability of metal complexes, factors affecting the stability of metal complexes with reference to the nature of the metal ion and ligand, chelate effect, macrocyclic effect and their thermodynamic origin. Determination of binary formation constant by pH metry, spectrophotometry, polarography and ion exchange methods.

Structure and bonding - Structure and bonding in hydride, dihydrogen, dioxygen, isocyanide, CO, NO, N_2 and tertiary phosphine complexes of transition metals. [15hrs]

UNIT- II

Metal- ligand bonding: Stereoisomerism- coordination numbers 3 to 8. Crystal field theory, salient features, spectrochemical series, splitting of d-orbitals in tetragonal, square planar, trigonal bipyramidal and square-pyramidal geometry, applications of CFT- colours of transition metal complexes, magnetic properties of octahedral complex, distortion of octahedral complex, CFSE and their uses, factors affecting CFSE, limitations of CFT, experimental evidence for metal-ligand covalent bonding in complexes, nephelauxetic effect, Ligand Field Theory, MO theory: tetrahedral and octahedral complexes (including π- bonding), angular overlap model. Redox chemistry and analytical applications. [15 hrs]

UNIT– III

Electronic spectra of coordination compounds: Spectroscopic ground states, selection rules, term symbols for d^n ions, Spin-Orbit coupling, Racah parameters, Orgel, Correlation and Tanaube-Sugano diagrams, spectra of 3d metal-aqua complexes of trivalent V, Cr, divalent Mn, Co and Ni, $CoCl_4^{2-}$, calculation of Dq, B and β parameters, Jahn-Teller distortions and spectra, CT spectra. Spectral properties of Lanthanide and Actinide metal complexes. Photochemical reactions of transition metals complexes: Basic photochemical processes, Kasha's rule, quantum yield, Jabolnskii diagrams, photo substitution reactions, photo-redox reactions, ligand photoreactions, and metal complexes as photosensitizers. [15 hrs]

UNIT– IV

Magnetic properties of coordination compounds: Origin and Types of magnetic behaviour, magnetic susceptibility and its determination- Gouy, Faraday, VSM method. Curie's law and Curie-Weiss law, Diamagnetic correction, orbital contribution, spin-orbital coupling, ferro and antiferromagnetic coupling, spin crossover. Magnetic properties of axially symmetric crystal field, high spin/low spin equilibrium, Magnetic properties of Lanthanide and Actinide metal complexes.

Higher coordination numbers, symbiosis, Introduction to ligand substitution reactions: Inert and labile compounds, mechanism of substitutions – reaction pathways, Linear free energy relationships, selected examples, Introduction to redox chemistry of complexes. [15 hrs]

Reference Books:

1. Basic Inorganic Chemistry- F. A. Cotton, G. Wilkinson and P. L. Gaus; John Wiley and sons. Inc, 6th edition (1999).
2. Chemistry of elements- N. N. Greenwood and A. E. Earnshaw, Butterworth Heinemann (1997).
3. Inorganic Chemistry IV edition; J. E. Huheey, E. A. Keiter and R. L. Keiter, Addison; Wesley (1993).
4. Inorganic Chemistry, II edition, D. F. Shriver, P. W. Atkins and C. H. Langford, ELBS; Oxford University Press, 1994.
5. Inorganic Electronic spectroscopy, A. B. P. Lever, Elsevier. (1968).
6. Magnetochemistry, R.L. Carlin, Springer Verlag.
7. Electronic Absorption Spectroscopy and related Techniques, D. N. Sathyanarayana, University Press (2001).
8. Inorganic Chemistry A Unified Approach by W. W. Porterfield, Elsevier 2005 2nd edition.
9. Textbook of inorganic chemistry by G. S. Sodhi, Viva books Pvt. Ltd (2006)

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 2020	ORGANIC CHEMISTRY – II	HC	3	1	0	4	5

Course Objectives:

This course aims to provide the student to

1. It deals with the relationships between Organic chemical structures and their reactivity.
2. Focuses on studies of reaction mechanisms in addition, elimination, substitution reactions
3. To bring the importance of mechanism in C-C and C-N containing organic compounds and rearrangement reactions
4. To identify the suitable regent for organic reaction and to determine their reaction mechanisms.

Course Outcomes:

By the completion of course student will be able to

1. Analyze functional groups effect on electron density, properties and reactivity in organic compound.
2. Illustrate the reaction mechanical aspects in organic synthesis.
3. Explain the reaction mechanism involved in organic named reactions with respect to C-C and C-N bonding
4. Identify and inspect the mechanisms involved in named reactions, reagents, oxidations and reductions in solving chemistry problems.

Mapping of Course Outcomes with programme Outcomes.

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 2020	**CO1**	**3**	**2**	**0**	**2**	**2**	**2**	**0**	**0**	**1**	**1**	**3**	**2**	**1**
	CO2	**3**	**3**	**1**	**2**	**2**	**2**	**0**	**0**	**1**	**1**	**3**	**2**	**2**
	CO3	**3**	**3**	**1**	**2**	**2**	**1**	**0**	**0**	**1**	**1**	**3**	**2**	**2**
	CO4	**2**	**2**	**1**	**2**	**2**	**2**	**0**	**0**	**1**	**1**	**3**	**2**	**2**

Course Content:

UNIT-I

Aromatic Substitution Reactions: Electrophilic Substitution Reactions: The arenium ion mechanism. Orientation and reactivity. Energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Amination, sulfonation reaction; Diazoniumcoupling.

Nucleophilic substitution reactions: The SNAr, ArSN1, and benzyne mechanisms. Reactivity: effect of substrate structure, leaving group and attacking nucleophile. Goldberg reaction, Bucherer reaction, Schiemann reaction.

Elimination Reactions: The E2, E1 and E1cB mechanisms and Orientation of the double bond. Saytzeff and Hoffmann rules. Mechanism in pyrolytic elimination reactions (including Chugaev elimination reaction).

Addition to carbon-carbon multiple bonds: mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals. Regio, stereo- and chemoselectivities. Orientation and reactivity. Addition to cyclopropane ring.Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Michael reaction. [15hrs]

(Self Study: Vilsmeier-Haackreaction, Gattermanreaction, Gattermann-Koch reaction and Hoesh reaction. von Richter reaction, Sommelet-Hauser and Smiles rearrangements, Addition of alkenes and/or alkynes to alkenes and/or alkynes. Ene synthesis)

UNIT-II

Addition to carbon-heteroatom multiple bonds: Mechanism of metal hydride reduction (NaH, LiH, $LiAlH_4$, $NaBH_4$) of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents and organolithium reagents to carbonyl compounds and unsaturated carbonyl Compounds. Conversion of aldehydes to nitriles. Hydrolysis of nitriles and addition of amines isocyanates. Formation of xanthates. Wittig, Mannich and Stobbe reactions.

Molecular Rearrangements: Molecular rearrangements: Definition and classification. Molecular rearrangements involving i) electron deficient carbon: Wagner- Meerwein, Pinacol-Pinacolone, and Wolf rearrangement. ii) electron deficient Nitrogen: Hofmann, Lossen, Curtius, Schmidt rearrangements iii) electron deficient Oxygen: Baeyer-Villiger oxidation. iv) Base catalysed rearrangements: Aldol condensation, Benzoin, Knoevengel, Sommlett-Hauser and Smiles rearrangement. [15hrs]

UNIT-III

C-C and C-N bond forming reactions: Darzen's reaction, Use of acetylides in C-C bond formation reactions. Acid-catalyzed self-condensation of olefins, Prins reaction, Shapiro reaction, Dieckmann cyclization, Robinson annulations, Hofmann-Loeffler-Freytag reaction. Hofmann-Martius reaction. Acyloin condensation. Houben-Hoesch reaction. Stork-enamine synthesis. Meyer synthesis. Use of nucleophilic nitrogen and electrophilic carbon (NH_3, amines and nitrite as nucleophiles in substitution, NH_3 and amines in addition to ketones and aldehydes) and electrophilic nitrogen and nucleophilic carbon (nitration, nitrosation) for the bond formation reactions. [15hrs]

Self Study: Chichibabin reaction, Skraup synthesis, Mitsunobu reaction, N-Nitroaromatic amine rearrangement, Fisher-Hepp reaction, Japp- Klingemann reaction.

UNIT-IV

Reagents in organic synthesis: Use of the following in organic synthesis and functional group tansformations. Aluminium iso-propoxide, NBS, LDA, DCC, DDQ, 1,3-Dithiane (reactivity and umpolung), PPA, Yamaguchi reagent. Woodward and Prevost hydroxylation
Oxidations-I: Cr (VI) oxidants, Mn (VII) oxidants, OsO_4, SeO_2, Pb $(OAc)_4$.
Oxidations-II: ozone, peroxides (H_2O_2, t-BuOOH, dibenzoylperoxide) and peracids (Preparation, properties and applications of CF_3COOOH, m-CPBA, momoperphthalic acid) as oxidizing agents.
Reductions: Complex metal hydrides, dissolving metal reductions (including Birch, Benkeser, Clemmensen reductions), diimide reduction, catalytic hydrogenation (homogeneous and heterogeneous), organoboranes as reducing agents, McMurry reaction. Pummer, Willgerdo. [15hrs]

Self Study: Corey-Chaykovsky reagent, Raney-Nickel, diazomethane, TMS-chloride, HIO_4, Ag_2O, DMSO, Dess-Martin oxidation. Wolf-Kishner reduction Corey-Bakshi-Shibata and Tishchenko reactions.

Reference Books:

1. Advanced Organic Chemistry – Reactions, Mechanism and Structure, Jerry March, John Wiley (2008).
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum (1990).
3. A Guide Book to Mechanism of Organic Chemistry, Peter Sykes, Longman (2000).
4. Structure and Mechanism of Organic Chemistry, C. K. Ingold, Cornell University Press.
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall (1998).
6. Modern Organic Reactions, H. O. House, Benjamin (1972).
7. Principles of Organic Synthesis, ROC Norman and J. M. Coxon, Blackie Academic and Professional (1996).
8. Photochemistry – J. G. Calverts and J. N. Pitts, John-Wiley & Sons
9. Fundamentals of Photochemistry- K. K. Rohatgi-Mukharjii, Wiley Eastern
10. Introduction to Photochemistry-Wells
11. Photochemistry of solutions-C. A. Parker, Elsevier

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M18CH 2030	PHYSICAL CHEMISTRY- II	HC	3	1	0	4	5

Course Objectives:

This course aims to provide the student to

1. Provides students to enlighten the knowledge on Quantum chemistry,
2. To give insights on molecular symmetry and group theory.
3. Focuses on representation and applications of various spectroscopic techniques like microwave, vibrational, electronic, Raman, EPR and NMR.
4. Understand the importance of physical Principles in spectroscopy and bonding

Course Outcomes:

By the completion of course student will be able to

1. Apply the fundamental knowledge of quantum mechanical processes involved in atoms and molecules, and interpret the symmetry, spectroscopic and electronic properties of matter
2. Devise the character tables to identify the allowed vibrational transitions and analyze the importance of symmetry in chemical bonding

3. Analyze the rotational and vibrational spectra to evaluate the bond strength, bond length and the amount of isotopes mixtures.
4. Interpret various spectroscopic data of materials obtained using advanced analytical tools by utilizing the theoretical basis and predict the structure of chemical compounds.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M18CH 2030	**CO1**	**2**	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**1**	**1**	**2**	**2**	**2**
	CO2	**2**	**3**	**1**	**2**	**2**	**2**	**0**	**0**	**1**	**3**	**2**	**1**	**3**
	CO3	**2**	**3**	**2**	**2**	**3**	**1**	**0**	**0**	**2**	**3**	**2**	**2**	**2**
	CO4	**3**	**3**	**2**	**2**	**3**	**2**	**0**	**0**	**1**	**2**	**3**	**2**	**3**

Course Content:

UNIT – I

Quantum Chemistry: Planck's concept of quantization, Wave-particle duality of material particles, de Broglie equation, Heisenberg Uncertainty principle, Concept of operators (operator–operand), Algebra of operators, commutative and non-commutative operators, linear operator, Laplacian operator, Hamiltonian operator, Eigen value, Eigen function, class Q function, Hermitian operator. Schrodinger wave equation for particles, Eigen values and Eigen functions, postulates of quantum mechanics. Application of Schrodinger equation to a free particle and to a particle trapped in a potential field (one dimension and three dimensions). Degeneracy, Wave equation for H-atom, Physical interperation of wave function, separation and solution of R, ϕ and θ equations. Particle in a box, Application of Schrodinger equation to rigid rotator and harmonic oscillator. Approximate methods – approximate methods, perturbation method, the theory of perturbation method – first order and second order correction, application to He-atom (first order correction only) – calculation of first ionization potential and binding energy. Variation theorem: statement and proof. [15hrs]

UNIT – II

Molecular symmetry: Symmetry elements and symmetry operations, rotation axis, rules for orientation of molecules, plane of symmetry, rotation-reflection axis, centre of symmetry and identity element of symmetry. Products of symmetry operations. General relations among symmetry elements and symmetry operations.

Group **theory:** Concept of a group, definition of a point group, procedure for classification of molecules into point groups. Subgroups. Schoenflies and Hermann-Maugin symbols for point groups. Multiplication tables for the symmetry operations of simple molecules. Matrix notation for the symmetry elements and for geometric transformations. Class of a group and similarity transformation.

Representation of groups: Reducible and irreducible representations. Labeling of irreducible representations. Group theory and hybrid orbitals to form bonds. Character tables (Cs, Ci, C_2, C_2v, C_2h). Applications of group theory: Symmetries of Molecular orbitals, Basic MOT, orbital symmetries, Applications of group theory to crystal field, Symmetry and dipole moments, symmetry and optical activity, crystallography. [15 hrs]

UNIT – III

Microwave spectroscopy: Rotation spectra of diatomic Molecules - rigid and non rigid rotator model. Rotational quantum number and selection rule. Effect of isotopic substitution on rotation spectra.

Classification of polyatomic molecules based on moment of inertia - Linear, symmetric top, asymmetric top and spherical molecules.

Rotation spectra of polyatomic molecules, Moment of inertia expression for linear tri-atomic molecules. Applications - Principles of determination of Bond length and moment of inertia from rotational spectra. determination of dipole moments.

Vibration spectroscopy*:* Vibration of diatomic molecules, vibrational energy curves for simple harmonic oscillator. Effects of anharmonic oscillation. Vibration - rotation spectra of carbon monoxide. Expressions for fundamental and overtone frequencies. Vibration of polyatomic molecules – The number of degrees of freedom of vibration and their symmetry. Parallel and perpendicular vibrations (CO_2 and H_2O). fundamental, overtone, combination and difference bands. Fermi resonance. Force constant and its significance. Theory of infrared absorption and theoretical group frequency. Intensity of absorption band and types of absorptions. Structures of small molecules: XY_2. Factors affecting the group frequency – Physical state, vibrational coupling, electrical effect, hydrogen bonding, steric effect and ring strain. [15 hrs]

UNIT – IV

Raman spectroscopy: Introduction, Raman and Rayleigh scattering, Stokes and anti-Stokes lines, polarization of Raman lines, depolarization factor, polarizability ellipsoid. Theories of Raman spectra - classical and quantum theory. Rotation-Raman and vibration-Raman spectra. Comparison of Raman and IR spectra, rule of mutual exclusion principle.

Electronic Spectroscopy: Franck-Condon principle, Transition moments, assignment of electronic transitions of N_2, H_2O and formaldehyde using group theory, solvent effect,

Introduction to NMR:- Origin of magnetic moments in matter, electronic and nuclear moments, interaction with magnetic field, Larmor equation - conditions for magnetic resonance absorption, relaxation times, line widths and line shapes, chemical shifts, ring currents, diamagnetic anisotropy, spin-spin splitting, high resolution NMR spectra of simple molecules, first and second order treatment of AB systems - FT techniques.

Other Resonance Spectroscopy Methods:- EPR, Electron spin resonance: g value, hyperfine structure, ESR of organic free radicals, ESR of solids, ESR of inorganic ions, ESR of simple free radicals in solutions. [15 hrs]

Reference Books:

1. Elements of Physical Chemistry – Lewis and Glasstone.
2. Physical Chemistry by P.W. Atkins, ELBS, 4th edition, Oxford University Press (1990).
3. Basic Physical Chemistry by W.J. Moore, Prentice Hall, New Delhi, (1986).
4. Physical Chemistry – G.M. Barrow, McGraw Hill International Service (1988).
5. Quantum Chemistry – A.K. Chandra. 2nd edition, Tata McGraw Hill Publishing Co. Ltd., (1983).
6. Quantum Chemistry – Eyring, Walter and Kimball. John Wiley and Sons, Inc., New York.
7. Quantum Chemistry – I.N. Levine. Pearson Education, New Delhi, (2000).
8. Theoretical Chemistry – S. Glasstone. East West Press, New Delhi, (1973).
9. Quantum Chemistry – R.K. Prasad, New Age International Publishers, (1996).
10. Valence Theory – Tedder, Murel and Kettle.
11. Quantum Chemistry – D.A. McQuarrie.
12. Theoretical Inorganic Chemistry – Day and Selbin.
13. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash. 4th edition, Tata McGraw Hill, New Delhi.
14. Introduction to Spectroscopy - Pavia, Lampman and Kriz, 3rd edition, Thomson.
15. Spectroscopy, B.P. Straughan and S. Walker, John Wiley & Sons Inc., New York, Vol. 1 and 2, 1976.

16. Vibration Spectroscopy Theory and Applications, D.N. Satyanarayana, New Age International, New Delhi.

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 2040	ANALYTICAL CHEMISTRY -II (ORGANIC SPECTROSCOPY)	HC	3	1	0	4	5

Course Objectives:

This course aims to provide the student to

1. Device the basic concepts of UV-Visible and IR spectroscopic techniques to analyze the chemical compound and structure,
2. Analyze the organic compound structure by using the knowledge of Chemical shift values and data interpretation.
3. Evaluate the mass of the organic compound by the fragmentation pattern and study the compounds by different modern ionization techniques.
4. Illustrate the of unpaired electron compounds by the principle of ESR technique and Elucidate the structure of organic compound by using the spectral data.

Course Outcomes:

By the completion of course student will be able to

1. Conclude the structure and composition by using the UV-Visible and IR spectroscopic techniques.
2. Apply the knowledge of nuclear spin resonance phenomenon to identify the structure of compounds by the chemical shift values of shielded and De-shielded compounds.
3. Evaluate the mass of the compound by the knowledge of ionization, fragmentation in the process of structure analysis.
4. Decide the structure of unpaired electron system and elucidate the structure of organic compound by using the spectral data.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 2040	**CO1**	**1**	**2**	**0**	**0**	**3**	**1**	**3**	**1**	**2**	**2**	**2**	**3**	**3**
	CO2	**1**	**2**	**0**	**1**	**3**	**2**	**3**	**1**	**2**	**2**	**2**	**3**	**3**
	CO3	**1**	**2**	**0**	**1**	**3**	**2**	**3**	**1**	**2**	**2**	**2**	**3**	**3**
	CO4	**1**	**1**	**0**	**0**	**2**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**2**

Course Content:

UNIT-I

UV AND VISIBLE SPECTROSCOPY: Terminology, classification of electronic transitions. Effect of substituent and conjugation on the spectra of alkenes. Electronic spectra of carbonyl compounds. Effect of solvent on $\pi - \pi^*$ and $n - \pi^*$ transitions. Woodward's rules for calculating absorption maximum in dienes, carbonyl compounds, Electronic spectra of benzene and its derivatives.

INFRARED SPECTROSCOPY

Technique and instrumentation, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides.). Effect of solvent and hydrogen bonding on

the vibrational frequencies in alcohols. IR spectra of metal complexes involving ammine, aqua and carbonyl ligands. [15 Hrs]

UNIT-II

NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY: Introduction, basic principles and instrumentation of NMR spectroscopy. The chemical shift and shielding. Chemical environment and chemical shift. Factors affecting chemical shift. Magnetic anisotropy. Relaxation processes. Spin – spin coupling and splitting of NMR signals. Spin – spin interactions – AX, AX2, AX3, AMX and AB types. The coupling constant. Intensities of multiplets – Pascal's triangle. Equivalence of protons – chemical and magnetic equivalence. Low and high-resolution spectra of ethanol – chemical exchange. Geminal and vicinal coupling. Karplus equation and Karplus curve. Effect of hindered rotation on the NMR spectrum. Applications in structural elucidation. [15 Hrs]

UNIT-III

CARBON–13 NMR SPECTROSCOPY: The carbon – 13 nucleus, carbon – 13 chemical shift. Proton coupled and proton decoupled carbon – 13 spectra. Nuclear overhauser effect. Problems with integration in carbon -13 spectra. Off resonance decoupling. Applications.

MASS SPECTROMETRY: Introduction, principle and instrumentation. Ion production – electron impact, chemical ionization, field desorption and fast atom bombardment techniques. High resolution mass spectrometry – base -, molecular ion -, parent ion -, fragmentation ion -, metastable – and isotopic peaks. Factors affecting fragmentation, ion analysis and ion abundance. Mass spectral fragmentation of organic compounds (hydrocarbons, aromatic compounds, alcohols, carbonyl compounds). McLafferty rearrangement. Determination of molecular weight and molecular formula. [15 Hr]

UNIT-IV

ELECTRON SPIN RESONANCE SPECTROSCOPY: Theoretical principle and Instrumentation, 'g' factor, hyperfine splitting, Illustration of hyperfine splitting using examples, cyclopentadienyl radical, radical anions of benzene, naphthalene, p-benzo semiquinone. Isotropic spectra of some transition metal complexes and compounds, bis(salicylaldimine) Cu(II), $[VO(glycolate)_2]^{-2}$, $[(NH_3)_5Co\text{-}O\text{-}O\text{-}Co(NH_3)_5]^{5+}$, Mn^{2+} as a substitutional impurity in MgO.

MOSSBAUER SPECTROSCOPY: Principle and Instrumentation, Mossbauer effect, quadrupole splitting and magnetic hyperfine interactions, elucidation of electronic structures of Fe(II) and Fe(III) systems.

Structure determination using spectral data. [15Hr]

Reference Books:

1. Physical methods in Inorganic chemistry, R.S. Drago, Affiliated East-West Press Pvt. Ltd., New Delhi (1965).
2. Infrared Spectra of Inorganic and coordination Compounds, K. Nakamoto, Wiley-Interscience, New York, (1970).
3. Vibrational spectroscopy: theory and Applications, D.N. Sathyanarayana, New-Age International Publishers, New Delhi (2000).
4. Electronic Absorption Spectroscopy and related techniques, D.N.Sathyanarayana, Universities Press, Bangalore, (2001).
5. Applications of absorption Spectroscopy to Organic Compounds, J.R. Dyer, Prentice – Hall, New Delhi, (1969).
6. Organic Spectroscopy, W. Kemp, ELBS London, (1975).
7. Spectrometric Identification of Organic Compounds, R.M. Silverstein and W.P. Webster, Wiley & Sons, (1999).

8. Organic Mass Spectroscopy, K.R. Dass and E.P. James, IBH New Delhi, (1976).
9. Mass Spectrometry of Organic Compounds, H. Budzkiewicz, Djerassi C. and D.H Williams, Holden-Day, New York, (1975).
10. Principles of Instrumental Analysis, D.A. Skoog, S.J. Holler, T.A. Nilman, 5th Edition, Saunders College Publishing, London, (1998).
11. Introduction to Spectroscopy, 2nd Edition, Donald L. Pavia, Gary M. Lampman and George S. Keiz, Harcourt Brace College Publishers, (1996).
12. Physical Methods for Chemists, R.S. Drago, 2nd Edition, Saunders College Publishing New York, (1992).
13. Mass Spectrometry Analytical Chemistry By Open Learning R. Davies, M. Frearson and E. Prichard, John Wiley and Sons, New York, (1987).
14. Modern NMR techniques For Chemistry Research, Vol. 6, A.E. Derome, Oxford Pergamon Press, (1987).
15. Spectroscopic Methods in Organic Chemistry, 4th Edition, D.H. Williams and I. FlemingTata-McGraw Hill Publications, New Delhi, (1988).

SEMESTER-II SOFTCORE

SOFTCORE-01

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 2051	CHEMISTRY OF LIFE	SC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Knowledge on green chemistry concepts
2. Applications of various green technology in materials synthesis
3. Class of green chemicals and compounds for sustainability
4. Categorization of reaction mechanisms and schemes for green synthesis

Course Outcomes:

By the completion of course student will be able to

1. Discriminate the role metal ions in biological systems
2. Categorize biomolecules based on their biological functioning
3. Appraise the role of chemistry principles in biological systems
4. Explain the role of analytical techniques in the purification of biomolecules.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 2051	CO1	1	1	0	0	2	2	0	0	0	0	2	2	0
	CO2	2	1	0	1	2	1	0	0	0	0	1	2	2
	CO3	2	2	0	1	2	2	0	0	0	0	2	0	2
	CO4	2	2	0	2	2	2	0	0	0	0	2	2	2

Course Content:

UNIT-I

Bioinorganic chemistry: Introduction to elements and their occurrence, role of some alkali, alkaline and transition elements in Biosystems. Basic principle of selection of metal ions in Biosystems; Irving – Williams's series and its significance. HSAB concept-classification and its importance. Relationship between ionic specificity and field strength. Coordination sites in biomolecules (Proteins, DNA and Vitamins). Respiratory Proteins; Iron storage proteins (Ferritin, apoferritin and Transferrin). Structural aspects of Haemoglobin and myoglobin and their role in oxygen transport. Spin state of iron, Spatial and electronic aspects in dioxygen binding (about d-configuration), oxygenation curve (Bohr Effect). Functional aspects of Cytochromes (c, c oxidase and P-450), Copper-Blue proteins (Type – I, II and III), Fe-S proteins (Rubredoxin and Ferredoxins), peroxidase, catalase, Molybdenum and tungsten enzymes in Biosystems. Bio mineralization (role of Minerals). [15hrs]

UNIT-II

Physical Chemistry in Bio-systems

Bio electrochemistry: Electrochemical cells and membrane potentials, nature of driving forces, origin of membrane potentials, electrochemical potential and Nernst equation for Electroneutrality. Introduction to bilayer lipid membranes and its structure. Membrane transport; purpose of transport process, factors governing permeation and transport, the nature of driving force (Fick's law of diffusion). Types of transport; active, facilitated and passive transports (terms involved), example of K^+/Na^+ pump and Na^+/Ca^{2+} pumps across the membranes (for all the cases diagrammatic representations). Properties of lipids described using chemical potential and phenomenon of lipid and detergent formation into micelles and bilayers. Determination of micelle formation using surface tension. Enzyme catalysis, and its kinetics- Michaelis-Menten equation, and its modified form and Lineweaver–Burk plot; enzyme inhibition types (competitive, non-competitive and un-competitive) and Lineweaver–Burk plots. Osmosis and Donnan membrane potential and its biological significance. Protein solubility and crystallisation; principle (Hoffmeister series) "Salting In" and "Salting Out" for protein purification.

[15hrs]

UNIT-III

Bioenergetics: Oxidation and reduction reactions and bioenergetics (concept of midpoint potential). The central role of ATP in Metabolism and its stability. Mitochondrial flow of electrons from NADH to O_2. Oxidative phosphorylation and respiratory chain. Energetics of electron transfer –I (Introduction to Marcus theory and Frank Condon principle). Thermodynamic principles in coupled reactions (endothermic & exothermic). Mechanism of muscle contraction – role of actin and myosin in presence of ATP. Introduction to enthalpy, free energy, entropy, heat capacity and chemical potential.

Application of some instrumental techniques in the study of biomolecules:

(i) Differential Scanning Calorimetry and ITC: Principle, instrumentation and its application in the study of folding and unfolding biomolecules such as, DNA and proteins.

(ii) Circular Dichroism: Principle, instrumentation and general explanation for its application in the study of based on chirality in proteins and chirality of bases due to double helix model of the DNA.

[15hrs]

UNIT-IV

Bio-organic chemistry: Interactions in Bio systems; hydrogen bonding (in proteins, Nucleic acid, Carbohydrates), Vander walls forces, electrostatic, hydrophobic (Apolar bond), stacking and covalent interactions. Proteins structures (primary, secondary, tertiary and quaternary). Protein folding and unfolding. Detection of intrastrand disulfide bonds in proteins hierarchy of structural organization. Introduction to biopolymers; DNA and its polymerisation, RNA, Chemical methods involved in sequencing of DNA and Proteins. Chemical and biochemical synthesis of DNA- Phosphoramidite

method and replication. Chemical and biochemical synthesis of peptides/proteins- solution phase and solid phase peptide synthesis methods and ribosomal synthesis of proteins. Applications of PNAS.

Non-redox metalloenzymes and their functions: Carboxypeptidase-A, alcohol dehydrogenase, leucine aminopeptidase and carbonic anhydrase (Nitrogen cycle). [15hrs]

Self-study: Protein folding and Prions

Reference Books:

1. W. Kaim. Bioinorganic Chemistry, 2nd Edition, John Wiley. 2013.
2. D. F. Shriver, P. W. Atkins, C. H. Langford, Inorganic Chemistry, ELBS. 1990.
3. C.R. Cantor & P.R. Schimmel, Biophysical Chemistry, W.H. Freeman & Company, 1980
4. David Van Vranken and Gregory A, Introduction to Bioorganic Chemistry and Chemical Biology. Garland Science (Taylor & Francis), 2012.
5. I.L. Finar, Advanced Organic Chemistry, Vol. 2 ELBS, New Delhi, 1975.
6. A. Upadhyay, K. Upadhyay and N. Nath, Biophysical Chemistry, Principle and Technique– Himalaya Publishing House, Bombay, 1998.
7. K. Hussain Reddy, Bioinorganic Chemistry, New Age International Publishers – 2003
8. Alan Cooper, Biophysical Chemistry, Glasgow University, RSC – 2004
9. James P. Allen, Biophysical Chemistry, Wiley – Blackwell Publication, 2008
10. IVANO BERTINI, HARRY B. GRAY, STEPHEN J. LIPPARD and JOAN SELVERSTONE VALENTINE, Bioinorganic Chemistry, University Science Books, 1994

SOFT CORE-02

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 2052	SUPRAMOLECULAR AND MEDICINAL CHEMISTRY	SC	2	1	0	3	4

Course Objectives:

i) This course that will examine the topics of non-covalent bonding, molecular recognition, and self-assembly.

ii) The curriculum shall cover steroids, Antibiotics, drug design, development, pharmacokinetics and pharmacodynamics.

Course Outcomes: By the completion of course student will be able to,

a) Explain the concepts of supramolecular chemistry, apply the knowledge of host - guest relationships in supramolecular complex.
b) Demonstrate the synthesis of different types of steroids, and perceive its roles in human physiology
c) Develop an understanding towards the structure, synthesis and interpretation of the mechanism of action of antibiotics.
d) Describe the theory of drug activity and drug design processes, analyze the concepts of Pharmacokinetics and Structure-activity relationships for Drug Discovery.

Mapping of Course Outcomes with Pos and PSOs

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
M19CH2052	CO1	2	1	2	1	2	1	1	0	0	1	2	1	2
	CO2	3	1	1	2	2	1	2	0	0	1	2	1	3
	CO3	2	2	2	1	3	2	2	0	0	1	2	1	2
	CO4	3	2	1	2	1	2	2	0	0	1	3	1	2

Course Content:

UNIT-I

Supramolecular Chemistry: introduction-definition, Concepts and development, Lock and key principle in supramolecular assemblies and molecular recognition. Nature of binding interactions in supramolecular structures: ion-ion, ion-dipole, dipole-dipole, H-bonding, cation-π, anion-π, π-π and vander Waal interactions. Supramolecular Chemistry in Biological system. Cation binding hosts-Synthesis, structures and applications of crown ethers, Podands, Corand, Spherands, Cryptands, Lariat ethers. Anion binding hosts-polyazamacrocycles, Expanded Porphyrins (sapphyrins), polyazacryptands. Ditopic Ion pair receptor. Receptors in molecular recognition of different types of guests – Guest-Host spatial relationship in Guest-Host interaction, classification of receptors in supramolecular interactions, Calixarene, Cyclodextrins, Cyclophanes, Cryptophanes. Catenanes and Rotaxanes-molecular self-assembly requiring covalent modifications. [15hrs]

UNIT-II

Steroids-Occurrence, Nomenclature, Basic skeleton, Diels hydrocarbon and Stereochemistry. Isolation, structure and structural elucidation of sterols and bile acids (determination of ring size, nature of side chain, position of angular methyl and stereochemistry of ring junctions). Sex hormones and corticosteroids. Synthesis of cholesterol, estrone, progesterone, androsterone, testosterone. Photo products of ergosterol- vitamins D. Barton reaction for the synthesis of aldosterone. Marker degradation. Brief discussion of homosteroids, norsteroids and oral contraceptives. Synthesis of (dl)-norgestrel and ethinyl oestradiol. [15Hrs]

UNIT-III

Antibiotics-General introduction to antibiotics, Classification, Structure elucidation and synthesis of Streptomycin, Penicillins, Cephalosporin-C, Chloromycetin and Tetracyclins (Tetramycin and Aureomycin). [15Hrs]

UNIT-IV

Pharmacological chemistry & Drug design:

Receptor structure and sites, drug discovery development, drug receptor interactions, theories of drug activity, Computer-aided drug design and molecular modeling. Classification of Drugs-anti biotics, anti-analgesic, anti-pyretic, antiviral, anti-histamine etc. QSAR Studies-introduction to quantitative structure activity relationship studies. QSAR parameters-substituent constants -Linear relationships between log p and biological activity. Electronic parameters, effect of electronic and steric parameters on Lipophilicity. Methods in QSAR Studies i) Linear free energy relationship, application of Hammet equation. Hansch analysis-significances of slopes and intercepts in Hansch analysis ii) Craig's plot iii) free Wilson model-advantages and disadvantages v) cluster significant analysis vi) minimal topological difference method. [15Hrs]

Reference Books:

1. Lehn, J. M., Supramolecular Chemistry-Concepts and Perspectives, Wiley –VCH (1995).
2. Beer, P.D., Gale, P. A., and Smith, D. K., Supramolecular Chemistry, Oxford University Press (1999).
3. Steed, J. W., and Atwood, J. L., Supramolecular Chemistry, Wiley (2000).
4. Burger's Medicinal Chemistry and Drug Discovery, Vols. 1-6 Ed. D.J. Abraham, John Wiley, 2003 2.
5. Principles of Medicinal Chemistry, 6th Edition T L Lemke and D A Williams Eds., Lippincott, Williams and Wilkins, 2007.
6. An Introduction to Medicinal Chemistry, P Graham, III Ed., Oxford, 2006 4. Medicinal Chemistry, N Weaver, Oxford, 2006.

7. Goodman and Gilman's Pharmacological Basis of Therapeutics, 11th Edition Tata McGraw-Hill, 2005.
8. The Organic Chemistry of Drug Design and Drug Action, R B Silverman, II Edition Academic Press, Amsterdam, 2004.
9. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical chemistry, J H Block and J M Beale, Jr., Eds., Lippincott, Williams and Wilkins, 2003.
10. Medicinal Chemistry – G R Chatwal, Himalaya, New Delhi, 2002

SOFTCORE-03

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 2053	ADVANCED CHEMICAL KINETICS AND THERMODYNAMICS	SC	2	1	0	3	4

Course Objectives:

1. To provide the student with principles and kinetic tools useful in analyzing the rates of chemical reactions for both homogeneous and heterogenous reactions.
2. To increase the student's ability to do chemical reactor design by providing the knowledge and tools required to obtain, evaluate, and improve rate equations for use in design, operation and optimization of chemical reactors.
3. To present a comprehensive and rigorous treatment of classical thermodynamics while retaining an engineering perspective.
4. To lay the groundwork for subsequent studies in such fields as fluid mechanics, heat transfer and to prepare the students to effectively use thermodynamics in the practice of industry.
5. To develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.
6. To present a wealth of real world industrial examples to give students a feel for how thermodynamics is applied in engineering practice.

Course outcomes:

By the completion of course, the student will be able to,

1. Analyze the theories of reaction rates; assess the kinetics of unimolecular and bimolecular photophysical and photochemical processes.
2. Distinguish the activation and diffusion-controlled process; evaluate the different types of overpotentials and kinetics in the excited State.
3. Explain the concept of chemical kinetics, differentiate between homogeneous and heterogeneous catalysis
4. Explore the advanced solution thermodynamics and familiarize with the modern experimental techniques.

Mapping of Course Outcomes with POs and PSOs

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
M19CH2053	CO1	2	1	2	2	1	2	0	0	0	1	2	2	2
	CO2	2	2	2	2	1	2	0	0	0	1	2	1	2
	CO3	2	3	2	1	2	1	0	0	0	1	2	2	3
	CO4	2	2	2	2	2	2	0	0	0	1	2	1	2

Course Content:

UNIT – I

Chemical kinetics: Overview of theories of Reaction Rates, Potential energy surfaces-adiabatic and non-adiabatic curve crossing Processes- transition state theory- activation/thermodynamic parameters. Various theories of Unimolecular reactions (Lindemann- Christiansen hypothesis; Hinshelwood, RRK and RRKM theories; non RRKM behavior)

Elementary Reactions in Solutions: Influence of solvent properties on rate. Different types of molecular interactions in solution. Diffusion and activation-controlled reactions.

Kinetics in the Excited State: Jablonski diagram. Kinetics of Unimolecular and bimolecular photophysical and photochemical processes. Resonance energy transfer rates-Fluorescence quenching kinetics in solution and gas phase. [15 hrs]

UNIT – II

Electrode Kinetics: Metal/solution interface- Dependence of electrochemical reaction rate on overpotential-current density for single step and multi-step processes-Influence of electrical double layer on rate constants. Activation and diffusion-controlled processes- Marcus kinetics and quadratic dependence of Gibbs free energies-electron transfer processes involving organic and inorganic compounds. Different types of overpotentials- polarization behavior-Mechanism of hydrogen evolution and oxygen reduction in acid and alkaline media- Experimental methods for elucidation of reaction mechanism. [15 hrs]

UNIT – III

Applications of Chemical Kinetics: Homogenous catalysis: Acid-base catalysis, specific acid and base catalysis. General acid and base catalysis. Oxidation of amino acids and carbohydrates in presence of acid and base catalysis. Acidity functions - Bronstead, Hückel, Hammett and Bunnett hypothesis.

Chain reactions: Rice-Herzfeld mechanism for the thermal decomposition of acetaldehyde, Kinetics of explosive reactions, explosion limits (H_2 and O_2 reaction). Kinetics of autocatalytic and oscillatory chemical reactions, oscillatory chemical reaction of oxidation of malic acid by bromate ion catalyzed by Ce(III). Catalyzed and uncatalyzed reaction: Ru(III) catalyzed oxidation reaction of primary amines by chloramine – T in HCl medium.

Heterogenous catalysis, surface and interaction with solids, kinetics of reactions of solids. [15 hrs]

UNIT – IV

Advanced solution thermodynamics: Ideal and non-ideal solutions, activity and activity coefficients, mixing and excess properties of liquid-liquid mixtures. Theories of solutions of electrolyte and non-electrolyte liquids: van Laar theory, van der Waals theory, Scatchard-Hildebrand theory, Lattice theory.

Modern experimental techniques: determination of vapour-liquid equilibrium by static and dynamic methods, heat capacity and heat of mixing by calorimeters, and determination of volumetric, transport, acoustic and optical properties of liquid-liquid mixtures. Partial molar properties, their physical significance and methods of their determination. Study of non-ideal behaviour of various types of solutions: nonpolar + nonpolar, polar + nonpolar, polar + polar, and mixtures with hydrogen-bond formation and charge transfer complexes; interpretation in terms of molecular interactions. [15 hrs]

Reference Books:

1. Text Book of Physical Chemistry by Samuel Glasstone, MacMillan Indian Ltd., 2nd edition, (1974).
2. Elements of Physical Chemistry, S. Glasstone, MacMillan.
3. Solid State Chemistry – N.B. Hannay.
4. A Text Book of Physical Chemistry – G.M. Barrow. Mc Graw Hill – Tokyo, (1973).
5. Elements of Physical Chemistry – Lewis and Glasstone.

6. Theoretical Chemistry by S. Glasstone.
7. Statistical Themodynamics by B.C. Meclelland, Chapman and Hall, London (1973).
8. Elementary Statistical Thermodynamics by N.D. Smith Plenum Press, NY (1982).
9. Elements of Classical and Statistical Thermodynamics by L.K. Nash, Addison-Wesley (1970).
10. Statistical Thermodynamics by I.M. Klotz.
11. Introduction to Statistical Thermodynamics by M. Dole, Prantice-Hall, (1962).
12. Chemical Kinetics and Dynamics; Jeffrey I Steinfeld, Joseph S. Francisco and William L. Hase. Prentice Hall, 2nd edition, 1998.
13. Laidler, K. J.; "Chemical Kinetics", 3rd Edition 1997, Benjamin-Cummings. Indian reprint - Pearson 2009.
14. Laser Spectroscopy- Basic concepts and instrumentation – W. Demtroder (Springer 3rd edition, 2004).
15. K. K. Rohatgi - Mukkerjee, "Fundamentals of Photochemistry", Wiley Eastern Ltd., 1992.
16. W.J. Albery; Electrode kinetics Clarendon Press, Oxford 1975.
17. C.H. Banford and R.G. Compton (ed) Comprehensive chemical kinetics, Vol 26 Electrode kinetics – principles and methodology, Elsevier science publishers 1986.

SOFTCORE-04

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 2054	SEPARATION AND ELECTRO ANALYTICAL TECHNIQUES	SC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Detailed theoretical background of various separation and electroanalytical techniques.
2. Various types of liquid chromatographic techniques.
3. Detailed working of both GC and HPLC techniques.
4. Principle and applications, also electro analytical techniques like electrophoresis and Voltammetry.

Course outcomes:

By the completion of course student will be able to

1. Apprise the use of various separation techniques for sample analysis
2. Categorize specificity of analytical techniques based on nature of the sample
3. Analyse principles that govern compounds separation
4. Outline the role of electroanalytical techniques for materials analysis

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
	CO1	**2**	**2**	**0**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**2**	**2**
	CO2	**2**	**1**	**0**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**2**	**2**	**2**
	CO3	**2**	**2**	**1**	**1**	**2**	**2**	**0**	**1**	**0**	**0**	**1**	**2**	**1**
	CO4	**2**	**1**	**2**	**2**	**2**	**1**	**0**	**2**	**0**	**0**	**2**	**2**	**2**

Course Content:

UNIT-I

Liquid Chromatographic Methods: (i) Reversed phase chromatography for neutral samples. Reverse phase retention process-selectivity- Solvent type selectivity and column selectivity-isomer separations.
(ii) Normal phase Chromatography- Retention mechanism -solvent strength-use of TLC data for predicting NPC retention- Solvent type selectivity and column selectivity-isomer separations.
(iii) Ion Exchange chromatography- ion exchangers, resins-ion exchange selectivity, Zelectivity coefficient, Donnan Equilibrium- Conducting ion exchange chromatography, Gradient elution, Application of ion exchange.
(iv) Ion Chromatography-Suppressed ion –anion and Cation chromatography-Ion chromatography without suppression-detectors-ion pair chromatography
(v) Molecular exclusion chromatography - The elution equation, stationary phase, molecular mass determination.
(vi) Affinity chromatography - Principle-Matrix, ligand, spacer arm-properties required for efficient and effective chromatographic matrix-partial structure of agarose-Types of ligands- need of spacer arm. Immobilized metal affinity chromatography.
(vii) Hydrophilic interaction chromatography (HILIC).
Sample Preparation: Statistics of sampling-choosing a sample size-choosing the number of replicates. Dissolving samples for analysis., dissolving inorganic material, dissolving organic material, decomposition of organic substances, sample preparation techniques and derivatization. [15 Hrs]

UNIT-II

Gas **Chromatography:** Separation process in gas chromatography –schematic diagram open tubular columns, Comparison with packed columns, Effect of column inner diameter and length of the Column, choice of liquid stationary phase, chiral phases for separating optical isomers molecular sieves as stationary pahase-packed columns-Retention index-Temperature and pressure programming-Carrier gas-Guard columns and retention gaps-sample injections, split injection and split less injection, solvent trapping and cold trapping, on column injection-
Detectors: thermal conductivity detector, flame ionisation detector, electron capture detector, Mention about other detectors like nitrogen phosphorous detector, flame photometric detector, photoionisation detector, sulphur chemiluminescence detector -GC- MS-Element specific plasma detectors. Sample preparation-solid phase micro extraction, purge and trap, thermal desorption-Derivatisation in GC-Method development in GC. [15 Hrs]

UNIT-III

High-Performance Liquid Chromatography: The chromatographic process-effect of small particles, scaling relation between columns, relation between number of theoretical plates and particle size, column pressure-The column, stationary phase, monolithic silica columns-Bonded stationary phases-solute column interactions-shape selectivity-The elution process, isocratic and gradient elution, selecting the separation mode, solvents, Maintaining symmetric band shape, dead volume –Injection and detection in HPLC, Detector characteristics, signal to noise ratio, detection limits, Linearity-Spectro photometric detectors, refractive index detector, Evaporative Light scattering detector, Method development in reverse phase separation-Criteria for adequate separation-Optimisation with one solvent, optimization with two or three different solvents-choosing a stationary phase-Gradient separations- Dwell volume and Dwell time- developing a gradient separation. Chiral separation-derivatives for HPLC. [15 Hrs]

UNIT-IV

Electrophoresis and Electrochromatography: General introduction to electrophoresis. Important terms- Basis of electrophoretic separation. Expression for distance traveled on application of electrode potential. Role of buffer in electrophoresis. Classical gel electrophoresis, High performance capillary electrophoresis advantages. Instrumentation set up; sample injection. Comparison of classical and capillary electrophoresis. Electroosmotic flow. Modes of electrophoresis.

Capillary gel electrophoresis, capillary isoelectric focusing; capillary isotachophoresis.

Capillary electrochromatography (basic principle) Micellar electrokinetic capillary electophoresis.

Ion Selective Electrodes: Brief Introduction- Potentiometry- electrodes used: Metallic indicator electrodes: types with one example for each. Metallic redox indicator electrodes.

Ion selective electrodes ISE:

Classification of membranes, Properties of ISE.

Glass membrane electrodes: Composition and structure of glass membrane. Hygroscopicity of glass membrane. Electrical conductance across the glass membrane. Membrane and boundary potential Expression for Eb. Alkaline error. Crystalline membrane electrode. Conductivity of a crystalline membrane.

Voltammetric Techniques: Introduction to voltammetric techniques. Polarization – Ideal polarized and ideal non-polarized electrodes: Sources of polarization. Reaction and concentration polarization. Mechanism of mass transport. The current response to applied potential (in terms of Fermi and molecular orbitals) Faradaic and non- Faradaic currents. Charging and residual currents.

[15 Hrs]

Reference Books:

1. Quantitative Chemical Analysis, Daniel C.Harris, 7th edition., (W. H. Freeman and Company, New York, 2006).
2. Principles of Instrumental Methods of Analysis-Skoog, Holler And Nieman, 5th edition, Saunders College Publishing, International Ltd. (1998).
3. Hand Book of Instrumental Techniques For Analytical Chemistry, Frank Settle, Prentice Hall PTR, (1997).
4. Unified Separation Science-J. Calvin Giddings –John Willy& Sons (1991).
5. Chromatography –Concepts And Contrasts -James M Miller- John Wiley& Sons (1988).
6. Analytical Chemistry: Principles –John H Kennedy, Second Edition, Saunders College Publishing (1990).
7. Experimental Organic Chemistry, Daniel R. Palleros, John Willy& Sons (1999).
8. Fundamentals of Analytical Toxicology, Robert J Flanagan et.al. John Willy& Sons (2007).
9. Fundamentals of Analytical toxicology , Robert J Flanagan, Andrew Taylor et al John Wiley & Sons Ltd (2007).
10. Introduction to modern liquid chromatography –Lloyd R.Synder, Joseph J. Kirkland et al; third edn; John Wiley & Sons Ltd (2010)
11. Principles of Instrumental Analysis, Skoog, Holler and Nieman, 5th edition, Saunders college Publishing, International Limited (1999).
12. Analytical Chemistry Principles – John H Kennnedy, 2nd edition, Saunders College publishing (1990).
13. Modern Analytical Chemistry David Harvey; McGraw Hill Higher education publishers, (2000).
14. Vogel's Text book of quantitative chemical analysis, 6th edition, Pearson Education Limited, (2007).
15. Electrochemical Methods Fundamentals and Applications, Allen J Bard and Larry R Faulkner, John Wiley and Sons, (1980).
16. Instrumental Methods of Analysis Willard, Merrit, Dean and Settle, 7th edition, CBS Publishers

RULO COURSES

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B18BC1080	**Sports/Yoga/Dance/ Music/Theatre**	**RULO**	**0**	**0**	**2**	**2**	**2**

Course Objectives:

1. Yoga is to enable the students to maintain good health
2. To develop a positive attitude towards volleyball /football/ strategies of Basketball as a lifetime sport and to improve physical fitness through participation in volleyball.
3. To teach students the skilled techniques in sprints, relay running, hurdles, long jump, high jump, and shot put and practice them
4. To develop an understanding about the Indian classical dance/acting skills/ Laya, Taala forms and its universal application.

Course Outcome

1. Improve physical fitness and perform better in studies
2. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork
3. Develop basic skills and techniques to improve one's running posture and take-off position for different jumps.
4. Be able to differentiate good acting and understand the importance of good lyrics, stage crafting, music, dance, costume and lighting. Able to learn dance abhinaya and instrument to Sruthi.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
	CO1	**3**	**3**	**1**	**0**	**2**	**1**	**0**	**0**	**0**	**2**	**2**	**4**	**3**
	CO2	**4**	**3**	**3**	**2**	**3**	**3**	**0**	**0**	**1**	**2**	**3**	**4**	**2**
	CO3	**2**	**1**	**3**	**3**	**3**	**2**	**0**	**0**	**1**	**2**	**3**	**4**	**3**
	CO4	**1**	**3**	**3**	**2**	**3**	**3**	**0**	**0**	**1**	**2**	**2**	**4**	**2**

Note: Music, Dance, and Theater courses are offered by the School of Performing Arts, whereas the Sports and Yoga courses are offered by the Department of Physical Education. The students have to choose any **ONE** of these courses.

A. YOGA FOR HEALTH

Course Objectives::

Following are the Course Objectives:.

- To prepare the students for the integration of their physical, mental and spiritual faculties;
- To enable the students to maintain good health;
- To practice mental hygiene and to attain higher level of consciousness;
- To possess emotional stability, self control and concentration; and
- To inculcate among students self discipline, moral and ethical values.

Course Outcomes:

On completion of the course learners will be able to:

- Practice yoga for strength, flexibility, and relaxation.
- Learn techniques for increasing concentration and decreasing anxiety
- Become self disciplined and self-controlled
- Improve physical fitness and perform better in studies
- Gain self confidence to face the challenges in the society with commitment to serve the society

Course Content:

Unit-I:

Yoga: Introduction, **Surya Namaskara:-** 12 counts

Unit-II:

Asanas: Sitting- Vajrasana, Dandasana, Padmasana, Matsyasana, Paschimottasana, Shirasasana.

Asanas: Standing- Tadasana, Trikonasana, Parshwa konasana, Veerabadrasana.

Unit-III:

Asanas: Prone Position- Bhujangasana, Dhanurasana.

Asanas: Supine Position- Sarvangasana, Halasana.

Mudras- Dhyana mudra, Namaste mudra, Nasika mudra

Unit-IV:

Pranayams:- Anuloma – Viloma, Basthrika, Bhramari.

Dhyana & its types: Competition format, Rules and their interpretations

B. VOLLEYBALL

Course Objectives:

To learn the rules, fundamental skills, and strategies of volleyball

1. To develop skills in passing, setting, serving, spiking, and blocking.
2. To learn basic offensive and defensive patterns of play.
3. To develop a positive attitude towards volleyball as a lifetime sport and to improve physical fitness through participation in volleyball.

Course Outcomes:

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with volleyball.
2. Apply these skills while playing volleyball and exhibit improved performance
3. Improve physical fitness and practice positive personal and lifestyle.
4. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Course Content:

Unit-I

- Introduction about Volleyball
- Players Stance, Receiving and passing
- The Volley (Overhead pass), The Dig (Underhand pass), Service Reception

Unit-II

- Service- Under Arm Service, Tennis Service, Side Arm Spin Service, Round Arm Service, High spin service, Asian serve / American serve (floating)
- Setting the ball- Set for attack, Back set, Jump set

Unit-III

- Smash/Spike- Straight smash, Body turn smash, Wrist outward smash, Wrist inward smash
- Block- Single block, Double block, Three-man block
- Rolls- Overhead pass & back rolling, One hand underhand pass with side rolling, Forward dive

Unit-IV

- Attack Combination, Defense Systems, Libero play
- Court marking, Rules and their interpretations and Duties of officials

C. **BASKETBALL**

Course Objectives::

1. To learn the rules, fundamental skills, and strategies of Basketball
2. To develop technical skills in passing, in ball handling, individual offense, individual defense, rebounding, screen, team offense, team defense and fast break.
3. To learn basic offensive and defensive strategies of play.
4. To develop a positive attitude towards Basketball as a lifetime sport and to improve physical fitness through participation in Basketball.
5. To develop positive understanding and appreciation of the basketball game.

Course Outcomes:

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with basketball.
2. Apply these skills while playing basketball and exhibit improved performance
3. Improve physical fitness and practice positive personal and lifestyle.
4. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Course Content:

Unit-I

- Basketball: Introduction
- Grip; Player stance- Triple threat stance and Ball handling exercises
- Passing (Two hand/one hand)- Chest pass, Bounce Pass, Over head pass, Underhand pass, Hook Pass, Behind the back pass, Baseball pass, Side arm pass and passing in running.
- Receiving-Two Hand receiving, One hand receiving, Receiving in stationary position, Receiving while jumping, Receiving while running.

Unit-II

- Dribbling- How to start dribble, How to stop dribble, High / Low dribble with variations
- Shooting- Layup shot and its variations, One hand set shot, One hand jump shot, Free throw, Hook shot, Tip-in shot.
- Stopping- Stride/Scoot, Pivoting and Faking /Feinting footwork.

Unit-III

- Rebounding- Defensive rebound, Offensive rebound, Box out, Rebound Organization.
- Individual Defensive- Guarding the man with the ball and without the ball.

- Offensive drills, Fast break drills, Team Defense/Offense, Team Tactics

Unit-IV

- Court marking, Rules and their interpretations

D. **FOOTBALL**

Course Objectives::

1. To learn the rules, fundamental skills, and strategies of football.
2. To develop skills in passing, receiving, controlling the ball, dribbling, shielding, shooting, tackling, beating a defender and heading in football.
3. To learn basic offensive and defensive patterns of play
4. To use different parts of the body in utilizing the above skills while playing football
5. To develop a positive attitude towards football as a lifetime sport and to improve physical fitness through participation in football.

Course Outcomes:

On completion of the course learners will be able to:

1. Learn basic skills and knowledge associated with football.
2. Apply these skills while playing football and exhibit improved performance
3. Use the knowledge and understanding to perform, refine and adapt the above skills and related skills with precision, accuracy, fluency and clarity in any situation.
4. Improve physical fitness and practice positive personal and lifestyle.
5. Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Course Content:

Unit-I

1. **Football: Introduction**

- Kicks- Inside kick, Instep kick, Outer instep kick, Lofted kick, Chipping, Volley, Half Volley
- Trapping- Trapping rolling the ball, Trapping bouncing ball with sole

Unit-II

- Dribbling- With instep and outer instep of the foot.
- Heading- From standing, running and jumping.
- Feinting- With the lower limb and upper part of the body.

Unit-III

- Tackling- Simple tackling, Slide tackling.
- Throw-in- Standing and Sliding
- Goal Keeping- Collection of balls, Ball clearance, throwing and deflecting.

Unit-IV

- Ground marking, Rules and their interpretations

E. ATHLETICS (TRACK AND FIELD)

Course Objectives:

1. To teach students the skilled techniques in sprints, relay running, hurdles, long jump, high jump, and shot put and practice them.
2. To develop competence among students in demonstrating all the techniques covered in the course.
3. To make students understand some of the scientific and empirical principles and their rationale underlying the development of skilled performance.
4. To inculcate among students the habit of team work and cooperative learning and develop competence in detecting / correcting technique errors.
5. To develop a positive attitude towards sports in general and athletics in particular and to improve physical fitness through participation in various athletic games / sports activities.

Course Outcomes:

On completion of the course learners will be able to:

1. Display competencies in executing basic techniques and skills associated with select track and field events.
2. Develop basic skills and techniques to improve one's running posture and take-off position for different jumps.
3. Learn regular practice of select track and field events and improve physical fitness
4. Appreciate track and field events by applying sports science knowledge to explain the execution of the events.

Course Content:

Unit-I

- Athletics: Introduction
- Track Events - Steeple Chase, Race Walking, Middle and Long distance races
- Race walking - Technique, Faults and Officiating.
- Middle and Long distance races – Technique and Training

Unit-II

- Jumping Events - High Jump and Triple Jump: Basic Skills and techniques
- High Jump - Straddle Roll & Flop Technique, Approach, Take-off, Technique in the air, Clearance over the bar & Landing
- Triple Jump – Hop, Step and Jump Technique, Approach, Take-off & Landing

Unit-III

- Throwing Events - Discus Throw and Hammer Throw: Basic Skills and techniques
- Discus Throw - Standing and Rotatory techniques, Grip, Stance, Rotation Technique, Power stance, Release and Reverse (Follow through)
- Hammer Throw - Grip, Swings, Rotation foot work, Release and Follow through

Unit-IV

- Rules, Officiating and Marking - Ground / Sector Marking, Interpretation of Rules.

Reference Books:

1. Arthur E. Ellison (ed) (1994). Athletic Training and Sports Medicine.
2. Ballisteros, J.M. (1998). Hurdles Basic Coaching Manual, IAAF.
3. Bosen K.O. (1993). Teaching Athletics Skills and Technique.

4. Bosen K.O. (1990). Study Material on Hurdles for the Regular Course Students.
5. Doherty K. (1995). Track and Field Omni book.
6. Martin, David E. Peter N. Coe (1991). Training Distance Runner.
7. Howard S. (1981). Science of Track and Field Athletics.
8. Briggs Graeme (1987). "Track and field coaching Manual", Australian Track and Field Coaches Association. Rothmans Foundation National Sports Division.
9. Carr, Gerry (1999). "Fundamentals of Track and Field. Track Athletics Title G.V. 1060 5.e. 368.
10. I.A.A.F. Level-II (2001). Text Book on Jumping Event.
11. Jarver, Jesse (1987). "The Jumps", Track and Field Coaching Manual Australia.

F. DRAMATICS

Pre-requisites: Students with background in Theatre Arts/ Keen interest in Dramatics.

Course Objectives::

•To imbibe the acting skills.
•To understand the broader applications of theatre studies in allied arts forms.
•To be able to use body language for better communication.
• Students shall also be able to understand voice modulation and Navarasas.

Course Outcomes:

On successful completion of this course, students should be able to:
• Freely express improvisation in non-verbal communication.
•Shall hone good acting skills and be able to emote better.
• Be able to put up a theatre act and play a key role.
• Be able to differentiate good acting and understand the importance of good lyrics, stage crafting, music, dance, costume and lighting.

Course Content:

UNIT – 1

Working on Body:

Body and its analysis. Understanding physical abilities (Anga, Pratyanga and Upanga). Challenges of the body. Using body as metaphor and language. The class's bodies as a collective, an ensemble, a collaborative team.

UNIT – 2

Sound and Movement:

Awareness of creating sound patterns, voice modulations, rhythm in speech and diaologues. Understanding the rhythm and patterns of movements like walking, framing, shaping, primitive and animal movements.

UNIT – 3

Characterization and Improvisation:

Observation of people around. Getting into the role and living it. Developing a character from establishment (pace and rhythm). Improvisation techniques of body and mind.

UNIT – 4

Group work and Production:

Develop a theme, concept or a play and include all the theatre skills, stage craft, costuming and put up an act. Choosing theme and characters.

Reference Books:

1. All about Theatre – Off stage – Chris Hogget.
2. Rangadalli Anataranga – K V Subbanna
3. The Indian Theatre – Hemendranath Das Gupta.
4. A Practical handbook for an Actor – Milisa Bruder, ee Milchel Cohn, Madeleine Oliek et al, Zigler Publisher.

G. **INDIAN CLASSICAL DANCE FORMS (**Bharatanatyam, Kuchipudi ,Mohiniyattam)

Prerequisites: Background of classical dance training or any other dance forms.
Note: Non-classical dancers can also join.

Course Objectives::

- To develop an understanding about the Indian classical dance forms and its universal application.
- To be able to understand the fine nuances of Classical dance.
- To understand the importance of health through Indian classical dance, strengthen the body capacity.
- To understand mythology and its characters in Indian classical dance form through lessons of Abhinaya.

Course Outcomes:

- To be able to identify and appreciate the classical dance forms.
- To be able to execute basics of Adavus with finesse.
- To be able to express through abhinaya.
- To be able to perform to perform the fundamentals in the chosen dance form.

Course Content:

Unit 1

An introduction to Indian classical dance forms
Bharatanatyam, Kuchipudi, Mohiniyattam

Unit 2

Learning of Fundamentals
Exercises and Adavus- I (Bharathanatyam , Kuchipudi, Mohiniyattam)

Unit 3

Adavus –II (Bharathanatyam , Kuchipudi, Mohiniyattam)

Unit 4

Learn a basic composition in the chosen dance form.

Reference Books

1. *Indian classical dance forms –U S Krishna Rao,U K Chandrabhaga Devi*
2. *Classical Dances –Sonal Mansingh, Avinash Parischa*
3. *Kuchipudi – Sunil Kothari*
4. *Bharatanatyam An in depth study- Saroja vydyanathan*
5. *Mohiniyattam – Bharathi Shivaji*

H. PERCUSSION INSTRUMENT (TABLA AND MRIDANGAM)

Pre-requisites: Students with background in Percussion instruments and knowledge of Rhythm/ Keen interest in studying Mridagam / Tabala.

Course Objectives:

•To understand the Rhythmology.
•To understand the importance of Laya, Taala.
•To be able to understand the fine finger techniques of playing the instrument.

Course Outcomes:

On successful completion of this course, students should be able to:
• To be able to set instrument to Sruthi.
• To be able to play the fundamentals on instrument.
• To be able to learn and perform a particular taala.

Course Content:

UNIT- 1

1. Introduction to Musical Instruments
2. Percussion Instruments
3. Mridangam and its History

UNIT - 2

1. Introduction to Tala System
2. Definitions of 5 jaathis and their recitation
3. Adi Talam and its various forms
4. Definitions and recitation of different gathis

UNIT- 3

1. Tisra Jaathi, 2. Khanda Jaathi, 3. Misra jaathi, 4. Sankeerna Jaathi

UNIT - 4

1. Learning of Jathi Formation, 2. Basic jathis, 3. Jathis for Dance forms
4. Some Basic Definitions of Korvai, Teermanam etc.,

Reference Books:

1. Mridangam- An Indian Classical Percussion Drum – Shreejayanthi Gopal
2. Theory and practice of Tabala – Sadanand Naimpally.
3. Theory and practice of Mridangam – Dharmala Rama Murthy
4. The Art of the Indian Tabala – Srdjan Beronja.

SEMESTER-II PRACTICAL COURSES

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 2070	INORGANIC CHEMISTRY PRACTICALS	HC	0	1	3	3	5

Course Objectives:

This course aims to provide the student to

1. Correlate To expose the students to a breadth of experimental techniques using modern instrumentation.
2. To provide a broad foundation in Chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective. Endeavors to contribute to industry and address problems of societal importance.
3. Design To make the Department a growing center of excellence in teaching, cutting-edge research, curriculum development and popularizing Chemistry.
4. To demonstrate the ability to synthesize, separate and characterize compounds using published reactions, protocols, standard laboratory equipment, and modern instrumentation.

Course Outcomes:

By the completion of course student will be able to

1. Have sound knowledge about the fundamentals and applications of chemical and scientific theories
2. Analyze the data obtained from sophisticated instruments (like FTIR, NMR, GCMS, HPLC, GCMS UV-Vis, Fluorescence, and TGA) for the structure determination and chemical analysis.
3. Acquires the ability to synthesize, separate and characterize compounds using laboratory and instrumentation techniques
4. Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and in industries.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
	CO1	3	2	2	2	2	2	2	2	2	2	3	1	0
	CO2	2	3	1	2	2	2	1	1	2	2	3	2	1
	CO3	3	2	2	2	3	2	1	3	3	2	3	2	3
	CO4	2	2	2	3	3	2	1	2	2	2	3	2	3

PART – I

1. Determination of iron in haematite using cerium(IV) solution (0.02M) as the titrant, and gravimetric estimation of insoluble residue.
2. Estimation of calcium and magnesium carbonates in dolomite using EDTA titration, and gravimetric analysis of insoluble residue.
3. Determination of manganese dioxide in pyrolusite using permanganate titration.
4. Quantitative analysis of copper-nickel in alloy/mixture:
   i. Copper volumetrically using KIO_3.
   ii. Nickel gravimetrically using DMG
5. Determination of lead and tin in a mixture: Analysis of solder using EDTA titration.

6. Quantitative analysis of chloride and iodide in a mixture:
    i. Iodide volumetrically using KIO_3
    ii. Total halide gravimetrically
7. Spectrophotometric determinations of:
    a. Titanium using hydrogen peroxide
    b. Chromium using diphenyl carbazide in industrial effluents
    c. Iron using thiocyanate/1,10-phenanthroline method in commercial samples
    d. Nickel using dimethylglyoxime in steel solution

PART – II

Semi micro qualitative analysis of mixtures containing two anions and two cations(excluding sodium, potassium and ammonium cations) and one of the following less common cations: W, Mo, Ce, Th, Ti, Zr, V, U and Li.

Reference Books:

1. Vogel's Text Book of Quantitative Chemical Analysis – 5th edition, J. Basset, R.C.Denney, G.H. Jeffery and J. Mendhom.
2. A Text Book of Quantitative Inorganic Analysis by A.I. Vogel, 3rd edition.
3. Spectrophotometric Determination of Elements by Z. Marczenko.
4. Vogel's Qualitative Inorganic Analysis – Svelha.
5. Macro and Semimicro Inorganic Qualitative Analysis by A.I. Vogel.
6. Semimicro Qualitative Analysis by F.J. Welcher and R.B. Halin.
7. Quantitative Chemical Analysis by Daniel C. Harris, 7th edition, (2006).

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 2080	ANALYTICAL CHEMISTRY PRACTICALS-II	HC	0	1	3	3	5

Course Objectives:

The practical course on Analytical chemistry intends to provide the students to,

1. Acquire the scientific skills in qualitative and preparative techniques.
2. Appreciate the importance of being systematic in life.
3. Understanding of chemical methods employed for elemental and compound analysis.
4. Develop honesty, punctuality, analytical reasoning, questioning, critical evaluation and thinking among students.

Course Out comes:

On successful completion of the practical course students shall be able to:

1. Develop practical skills related to analytical chemistry in analysis of constituents present in different samples.
2. Illustrate the experimental skills on different instrumental analysis of the given compounds.
3. Defend the experimental results with validation.
4. Develop the critical thinking, punctuality, team work and honesty during the conduction of the experiments.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
	CO1	1	2	1	1	3	2	2	1	2	2	2	1	1
	CO2	1	2	1	1	3	2	2	1	2	2	2	1	1
	CO3	1	2	0	1	3	2	2	1	2	2	2	1	1
	CO4	1	2	0	0	2	2	2	2	2	1	1	0	0

PART – I

1. Determination of purity of a commercial boric acid sample, and Na_2CO_3 content of washing soda.
2. Analysis of chromate-dichromate mixture by acid-base titration.
3. Determination of replaceable hydrogen and relative molecular mass of a weak organic acid by titration with NaOH.
4. Analysis of water/waste water for alkalinity by visual, *p*H metric and conductometric titrations.
5. Flame emission spectrometric determination of sodium and potassium in river/lake water.
6. Determination of calcium in limestone by redox, acid-base and complexation titrations.
7. Determination of aluminium and magnesium in antacids by EDTA titration.
8. Determination of saccharin in tablets by precipitation titration.
9. Determination of iodine value and saponification value of edible oils.
10. Analysis of a mixture of iron(II) and iron(III) by EDTA titration using *p*H control.
11. Potentiometric titration of a mixture of chloride and iodide.

PART – II

1. Analysis of waste waters for DO and COD by titrimetry.
2. Photometric and potentiometric titration of iron(III) with EDTA.
3. Photometric and potentiometric titration of copper with EDTA.
4. Conductometric titration of sodium acetate with HCl and NH_4Cl with NaOH.
5. Spectrophotometric determination of iron in natural waters using thiocyanate and 1,10-phenanthroline as reagents.
6. Analysis of a soil sample
7. Determination of total hardness, calcium and magnesium hardness and carbonate and bicarbonate hardness of water by complexation titration using EDTA.
8. Analysis of commercial hypochlorite and peroxide solution by iodometric titration.
9. Determination of ascorbic acid in vitamin C tablets by titrations with $KBrO_3$ and of vitamin C in citrus fruit juice by iodimetric titration.
10. Cation exchange chromatographic separation of cadmium and zinc and their estimation by EDTA titration.
11. Thin layer chromatographic separation of amino acids.

Reference Books:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc. India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Pharmaceutical Drug Analysis by Ashutoshkar, New Age International Publishers, New Delhi, 2005.
7. Practical Pharmaceutical Chemistry, Ed. A. H. Geckett, J. B. Stenlake, 4th edition. Part I and II, CBS Publishers, New Delhi.
8. Quantitative Analysis of Drugs in Pharmaceutical Formulations, P. D. Sethi, 3rd edition, CBS Publishers & Distributors, New Delhi, 1997.
9. Practical Clinical biochemistry methods and interpretations, R. Chawla, J.P. Bothers Medical Publishers (P) Ltd., 1995.
10. Laboratory Manual in Biochemistry, J. Jayaraman, New Age International Publishers, New Delhi, 1981.
11. Practical Clinical Biochemistry, Harold Varley and Arnold. Heinmann, 4th edition.
12. Environmental Science: Laboratory Manual, Maurice A. Strabbe, The C.V. Mosbey Co. Saint Loucs, 1972.
13. Experiments on Water Pollution, D.I. Williams and D. Anglesia, Wayland Publishers Ltd., England, 1978.
14. Experiments on Land Pollution, D.I. Williams and D. Anglesia, Wayland Publishers Ltd., England, 1978.
15. Experiments in Environmental Chemistry, P.D. Vowler and D.W. Counel,PergamonPress, Oxford 1980.
16. Manual Soil Laboratory Testing, vol. I, K.H. Head, Pentech Press, London

SEMESTER-III

INORGANIC CHEMISTRY - HARD CORE COURSES

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3110	ADVANCED INORGANIC CHEMISTRY	HC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Students able to understand the brief of transition metal orbitals, electron counting, formal oxidation state,18-e rule, geometries for transition metal complexes (Crystal Field theory, MO description), σ- and π bonding, metal-metal bonding.
2. To identify survey of types of ligands for TM complexes and their electronic and steric properties. Typical spectroscopic methods and techniques for the characterization of TM complexes.
3. Discuss the Chemical processes on TM: ligand exchange, oxidative addition, reductive elimination, migratory insertion, nucleophilic attach on the ligand. Mechanisms and synthetic outcomes.
4. The concepts of selected representative applications of TM complexes in catalysis, with emphasis on the impact of modern chemistry on urgent global needs such as processes for clean energy: mechanistic and practical aspects.

Course Outcomes:

By the completion of course student will be able to

1. Knowledge of inorganic photochemistry, metal complexes in drugs, medicinal bioinorganic chemistry and advance nuclear chemistry.
2. Evaluating transition metal coordination compounds in terms of their geometry and interpret at a basic level their electronic properties.
3. Explain the Tabulate the coordination complexes undergoing a variety of reactions including electron transfer, ligand exchange and associative process.
4. Identifying the shapes and structure of coordination complexes with coordination numbers ranging from 4- 12.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3110	**CO1**	**2**	**1**	**3**	**3**	**2**	**2**	**0**	**0**	**1**	**2**	**3**	**3**	**2**
	CO2	**4**	**3**	**2**	**2**	**2**	**1**	**0**	**0**	**1**	**2**	**3**	**3**	**2**
	CO3	**2**	**2**	**0**	**3**	**3**	**1**	**0**	**0**	**1**	**2**	**3**	**3**	**3**
	CO4	**4**	**3**	**1**	**2**	**2**	**1**	**0**	**0**	**1**	**2**	**4**	**3**	**3**

Course Content:

UNIT – I

Ligand substitution reactions of complexes: Metal substitution in octahedral complexes, A, D and I mechanisms and associated energetic. Aquation and base hydrolysis, Kinetic chelate effect, Stereochemistry of reactions: Stereo chemical changes, isomerisation and recemisation, Fuoss-Eigen

equation and factors determining A or D mechanisms, lability and inertness of complexes. Kinetic and stereochemistry of substitution in square planar complexes, Nucleophilic substtution, Ligand field effects and reaction rates, Trans effect and its theories, "cis-effect". Designing synthetic routs to Cis-platin and other complexes of Pt group elements. Mechanism of substitution in octahedral and tetrahedral complexes

Redox process and reactions of coordinated ligands: Mechanism of atom transfer processes, halogen, Oxo-and hydride transfer reactions, electron transfer reactions, classification. Outer-sphere electron transfer Mechanisms, their excited state electron transfer, Inner sphere mechanism, Kinetics, effect of metal and ligands, Bridging group effects. Mixed valence complexes.

[15 hrs]

UNIT – II

Applications of redox process in Bioinorganic chemistry: Reactions involving N_2, H_2O_2 and molecular oxygen. Reactions of coordinated Ligands: Acid dissociation, hydrolysis of aminoacid esters, peptides, proteins, nucleotides. Aldol condensation, substitution, amine exchange, trans amination, thermodynamic and kinetic template effects, metal assisted macrocyclization.

Chemistry of variable oxidation states of Transition metals: Low and High oxidation states, negative oxidation states, stability, effect of concentrations on stability, electronic configuration, EMF, properties. Application of XPS in oxidation state analysis.

NQR spectroscopy: NQR isotopes, electric field gradients, Nuclear Quadrupole coupling constants, Experimental techniques and applications,

ELECTRON SPIN RESONANCE SPECTROSCOPY: Theoretical principles, 'g' factor, hyperfine splitting, Illustration of hyperfine splitting using examples, cyclopentadienyl radical. Isotropic spectra of some

transition metal complexes and compounds, bis(salicylaldimine)Cu(II), $[VO(glycolate)2]^{-2}$, $[(NH_3)_5Co\text{-}O\text{-}O\text{-}Co(NH_3)_5]^{5+}$.

MOSSBAUER SPECTROSCOPY: Mossbauer effect and Mossbauer nuclei, isomer shift, quadrupole splitting and magnetic hyperfine interactions, Chemical isomer shift, elucidation of electronic structures of Fe(II) and Fe(III) systems. [15hrs]

UNIT-III

Inorganic Photochemistry: Electronic transitions in metal complexes, metal-centered and charge transfer transitions – Various photophysical and photochemical processes of coordination compounds Unimolecular charge-transfer photochemistry of cobalt (III) complexes. Mechanism of CTTM photoreduction. Ligand-field photochemistry of chromium(III) complexes, Adamson's rules, photoactive excited states, V-C model – photophysics: Excited states of metal complexes, Ligand field chemistry of excited states: rules for photosubstitution, photoaquation and ligand exchange reactions, photoisomerization, Doublet hypothesis, role of quartet exicited states, photosubstitution mechanism, photochroism.

Photo physics and photochemistry of ruthenium polypyridine complexes ($[Ru(bipy)_3]^{2+}$) - photosensitizer, emission and redox properties – quenching process by methyl viologen, chemically modified viologens and non-viologens, Application in water photolysis, Nitrogen and CO_2 reduction. photochemistry of organometallic compounds, metal carbonyl compounds, compounds with metal-metal bonding Reinecke's salt - chemical actinometer. [15hrs]

UNIT-IV

Metal complexes as drugs and therapeutic agents: Introduction, antimicrobial agents, antiviral agents, antiarthritis agents and anticancer agents. Antidote complexes.

Medicinal Bioinorganic Chemistry: Bioinorganic Chemistry of quintessentially toxic metals. Lead, Cadmium, Mercury, Aluminium, Chromium, Iron, Copper, Plutonium. Toxic effects-Mechanism of toxic effects Detoxification by metal chelation - Chelating agents for Hg, Pb, Cd, As toxicity. Drugs that act by binding at the metal sites of Metalloenzymes. Chemotherapy: Chemotherapy with compounds of certain non-essential elements. Platinum complexes in Cancer therapy – Cisplatin and its mode of action and side effects: – Cytotoxic compounds of other metals – Gold containing drugs as anti-rheumatic agents and their mode of action - Lithium in Pschyco-pharmocological drugs. Radiopharmaceuticals – Technetium. metal complexes in diagnosis-gold complexes in magnetic resonance imaging (MRI). [15 hrs]

Reference Books:

1. J. O. Edwards and W. A. Benjamin, Inorganic Reactions Mechanism, INC, New York, 1965.
2. C. H. Langford and H. B. Gray, Ligand Substitution Processes, W. A. Benjamin, New York, 1966.
3. F. Basolo and R. G. Pearson, Mechanism of Inorganic Reactions, 2nd Edn, Wiley, New York, 1967.
4. D. Katakis and G. Gordon, Mechanisms of Inorganic Reactions, John Wiley & Sons, New York, 1987
5. R. G. Wilkinns, Kinetics and Mechanism of Reactions of Transition Metal Complexes, 2nd Edn, VCH, Weinheim, 1991.
6. R. B. Jordan, Reaction Mechanisms of Inorganic and Organometallic Systems, Oxford University Press, Oxford, 1998.
7. J. D. Atwood, Inorganic and Organometallic Reaction Mechanisms, 2nd Edn, Wiley-VCH, Weinheim, 1997.
8. M. B. Wright, Fundamental Chemical Kinetics – An Explanatory Introduction to the Concepts, Harwood Publishing, Chichester, 1999.
9. S. Asperger, Chemical Kinetics and Inorganic Reaction Mechanisms, 2nd Edn, Springer, London, 2012.
10. G. W. Parshall, Homogeneous Catalysis, Wiley, New York, 1980.
11. C. N. Satterfield, Heterogeneous Catalysis in Practice, McGraw-Hill, New York, 1980.

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3120	ORGANOMETALLICS	HC	2	1	0	3	4

Course objectives:

This course aims to provide the student to

1. To provide knowledge on typical organometallic reactions, the use of organometallic reagents in catalysis and organic synthesis,
2. The deep focus on structure and bonding properties and reactivity of main group organometallics (including Grignard reagents, organolithium reagents, organophosphorus compounds, etc.) Organo transition metal chemistry and organometallic catalysis.
3. The constructive components will aim to develop skills in the handling of air-sensitive compounds using the Schlenk technique and the purification of compounds using chromatographic techniques.
4. Also provide orientation about industrial applications for organometallic chemistry.

Course Outcomes:

By the completion of course student will be able to

1. On successful completion of this course, the student will be able to:
2. Analyze the bonding modes, stability and determine reactivity for ligands in organometallic complexes and their applications.

3. Recognize the typical organometallic reactions, explain their mechanisms and interpret them reactivity based on the structure.
4. Correlate the importance of number of homogenous and heterogenous catalysis reactions of organometallic compounds in industries and environment e.g. hydrogenation, hydroformylation and polymerization.
5. Defend, detect and exemplify organometallic applications in novel organic synthesis, pharmaceutical compounds and in conversion processes in petrochemical and energy industries

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3120	**CO1**	**2**	**1**	**1**	**2**	**2**	**1**	**0**	**0**	**1**	**1**	**3**	**1**	**0**
	CO2	**3**	**3**	**1**	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**2**	**1**	**1**
	CO3	**3**	**2**	**1**	**2**	**1**	**1**	**0**	**0**	**2**	**3**	**2**	**1**	**1**
	CO4	**3**	**3**	**1**	**1**	**1**	**1**	**0**	**0**	**2**	**2**	**2**	**1**	**1**

Course Content:

UNIT-I

Organometallic Chemistry 1: Compounds with transition metal to carbon bonds: classification of ligands, nomenclature, Bonding: Ionic vs Covalent model, MOT and eighteen electron rule; Counting electrons in complexes, Hapticity, Limitations of 18-electron rule, Oxidation states transition metal carbonyls: range of compounds and structure, bonding, Outer sphere coordination, Polynuclear carbonyl complexes, vibrational spectra, preparation, reactions; transition metal organometallics: square planar complexes, Ligands similar to CO, Non aromatic metal alkyls, metal alkylidenes and metal alkylidynes; Bridging alkyls, Structure and bonding: metal-olefin bond and arene metal bond. [15 hrs]

UNIT-II

Organometallic Chemistry 2: Compounds with ligands having extended pi systems: cyclic pi systems, bis(cyclopentadienyl) compounds, MO of metallocenes, cyclopentadienyl carbonyl compounds, bis(arene) compounds, arene carbonyl compounds; isolobal analogy, Extensions of analogy, Applications of the analogy metal-metal multiple bonds, Metal-carbonyl-metal bonds, transition metal clusters; clusters and catalysis; hydride and dihydrogen complexes; bridging hydrides, fluxionality. [15 hrs]

UNIT-III

Organometallic Chemistry 3: Organometallic reactions and catalysis: Ligand dissociation and substituition – stereochemical aspect, Ligand cone angles, Redox effects, oxidative addition, reductive elimination, Nucleophilic and electrophilic attack of coordinated ligands, carbonalyte anions, insertion, hydride elimination, abstraction; Catalysis : Homogenous and heterogenous catalysis, alkene hydrogenation, Talman catalytic loop, Synthesis gas, hydroformylation, Wacker process, Ziegler-Natta polymerisation, cyclo oligomerisation, olefin isomerisation, olefin metathesis, Monsanto aceticacid synthesis, Fischer-Tropsch process, hydrosilylation. [15 hrs]

UNIT-IV

Organometallics Chemistry 4: Chemistry of Organolithium, Organomagnesium, Organoboranes, organosilion and selected transistion metal compounds Bonding of Pd and Rh with olefins applications in C-C bond formations, Heck reaction, Carbonylation, hydroformylation, olefin isomerism, arylation,

aryl amination using Pd reagents, olefin metathesis, Stille coupling, Sonogashira reaction, Buchwald reaction and Pauson -Khand reaction. Surface supported organometallic catalysts. [15 hrs]

Reference Books:

1. P. Powell, Principles of Organometallic Chemistry, 2ndEdn. ELBS, 1991.
2. J. E. Huheey, Inorganic Chemistry, 3rdEdn. Harper International, 1983.
3. M. F. Purcell, J.C. Kotz, Inorganic Chemistry, Saunder, 1977.
4. F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 5thEdn. JohnWiley.
5. R. W. Hay, Bio Inorganic Chemistry, Ellis Horwood, 1987.
6. R. M. Roat-Malone, Bio Inorganic Chemistry, John Wiley, 2002.
7. Clayden,J.; Greeves,N.; Warren,S., (2012).Organic Chemistry, Oxford University press, 2nd edition.

SEMESTER III: HARD CORE -3

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3130	SOLID STATE CHEMISTRY AND ADVANCED MATERIALS	HC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Introduction to solid state chemistry is one semester college course on the principles of chemistry.
2. The unique and popular course satisfies the general degree requirement, with an emphasis on solid-state materials and their application to engineering systems.
3. Enroute with an exploration of the fundamental relationship between electronic structure, chemical bonding and atomic order, then proceed to the chemical properties of "aggregates of molecules", including crystals, metals, glasses, semiconductors, solutions and acid-base equilibria, polymers, and biomaterials.
4. Real-world examples are drawn from industrial practice (e.g. semiconductor manufacturing), energy generation and storage (e.g. automobile engines, lithium batteries), emerging technologies (e.g. photonic and biomedical devices) and the environment impact of chemical processing (e.g. recycling glass, metal and plastic).

Course Outcomes:

By the completion of course student will be able to

1. Predict the properties and interactions of chemical substances by understanding their composition at the atomic level, making connections to structure, bonding, and thermodynamics as necessary.
2. Reflecting and reviewing the principles of materials science (specifically microstructure design and selection) to the selection of materials for specific engineering applications.
3. Assess the quality of text and graphics in textbooks and other published sources, and understand the advantages and limitations of different models proposed to explain each concept.
4. Summarize and identify the similarities and differences among important classes of materials including glasses, metals, polymers, biomaterials, and semiconductors.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3130	**CO1**	**2**	**2**	**0**	**0**	**1**	**2**	**2**	**0**	**1**	**2**			
	CO2	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**1**	**2**			
	CO3	**2**	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**2**			
	CO4	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**1**	**3**			

Course Content:

UNIT-I

The solid state: Types of solids, Bonding in solids, isomorphism and polymorphism, laws of crystallography, lattice types, lattice energies, Packing efficiencies, X-ray diffraction, Bragg's equation, Miller indices, Bragg Method, Debye Scherrer method of X-ray structure analysis of crystals, indexing of reflections, identification of unit cells from systematic absence in diffraction pattern, structure of simple lattice and X-Ray intensities, structure factor and its relation to intensity and electron density, phase problem, procedure for an X-ray structure determination. Defects in crystals, Stoichiometric imbalance in crystals. [15 hrs]

UNIT-II

Solid State Reactions: General principle, nucleation and growth process of crystals, types of reactions: Additive, structure sensitive, decomposition and phase transition reactions, tarnish reactions, kinetics of solid state reactions, factors affecting the reactivity of solid state reactions. Methods of Single Crystal Growth: Solution growth; Melt Growth-Bridgeman, Czochralski, Kyropoulus, Chemical Vapour Transport; Fused Salt Electrolysis; Hydrothermal method; Flux Growth. [15 hrs]

UNIT-III

Electronic Properties and Band Theory: Metals, insulators and semi-conductors, free electron theory and its applications, electronic structure of solids, band theory, band structure of metals, insulator, and semiconductors, doping in semiconductors, photoactive semiconductors, p- n junction, super conductors, ionic conductivity in solids, diffusion, drift conductivity, optical properties of solids, photo-conduction and photoelectric effects, laser action, solid state laser and their applications. Thermal conductivity in metals, semiconductors and insulators. [15 hrs]

UNIT-IV

Advanced materials: Advanced semiconductor materials, electronic materials, solar energy conversion materials, Photonics and spintronics materials, solid state structural aspects - electrode materials in electrochemical energy conversion devices, solid state electronic and Ionic conductors, Thermo electric and piezoelectric, Superconducting materials, Photoluminescent materials, Inorganic-organic hybrid materials, Porous materials. [15 hrs]

Reference Books:

1. A guide to laser in chemistry by Gerald R., Van Hecke, Keny K. Karokitis 2. Principals of solid state, H. V. Keer, Wiley Eastern,
3. Solid state chemistry, N. B. Hannay
4. Solid state chemistry, D. K. Chakrabarty, New Age International
5. An Introduction to Crystallography: F. G. Philips
6. Crystal Structure Analysis: M. J. Buerger
7. The Structure and properties of materials: Vol. III Electronic properties by John Walss

8. Electronic processes in materials: L. U. Azroff and J. J. Brophy
9. Chemistry of imperfect crystal: F. A. Krogen
10. Elements of X-ray Diffraction by B. D. Cullity, Addison- Weily.
11. Solid state Chemistry by A.R.West (Plenum)
12. Electronics made simple by Jacobwitz. Paper: PCH: 304 B: Advanced Chemical Kinetics (Elective).

IOC SOFTCORE-01

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3141	INDUSTRIAL INORGANIC CHEMISTRY	SC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Conclude the preparation of some industrial inorganic products and challenges in the production.
2. Defend the following topics: Sulfur industry, Nitrogen based industrial products, inorganic solvents, mineral fertilizers, industrial and domestic water production, industrial gas productions, inorganic solids, cement, glasses and pigments.
3. Appraise the importance of inorganic chemical industry, their economic impact, individual chemical processes and production challenges.
4. Develop practical skills to synthesis of industrial inorganic compounds by the acquired knowledge.

Course Outcomes:

By the completion of course student will be able to

1. Illustrate the basic chemical process involved in the production of major commercial products in industrial Inorganic chemistry.
2. Conclude the operation and solve problems relating to the production process in industrial inorganic chemistry, written and verbal.
3. Evaluate the product in industrial production by the suitable technique.
4. Analyze environmental issues pertaining to the chemical industry.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3141	CO1	2	1	2	0	0	1	0	0	1	1	2	0	1
	CO2	1	1	1	0	0	1	1	0	1	1	2	0	1
	CO3	1	0	1	0	1	2	1	1	1	1	2	0	0
	CO4	1	1	1	0	1	1	1	1	1	1	1	0	0

Course Content

UNIT-I

Materials in Catalysis- Introduction: Basics of catalysis, Fundamental properties of the solid catalysts. Classification of solid catalysts, Metals and metallic alloys. Preparation of metallic catalysts. Structure. Specific features of metallic catalysts. Structure sensitivity of catalytic reactions. Structure of adsorbate layers; Stepped surfaces; Surface relaxation and reconstruction of surfaces; homogeneous and heterogeneous catalytic surfaces Supported metal catalysts. Metal-support interaction. Reaction

mechanisms in catalysis on metals. Fundamentals of kinetics of heterogeneous catalytic reactions. Case study: the ammonia synthesis catalyst and the reaction mechanism involved. Noble metal catalysis
Industrial requirements of catalysts. Homogeneous and heterogenous processes: Catalysis in petroleum refineries, coal–fuel gases and liquid fuels–petroleum–cracking–Octane number–cetane number– coal gas, water gas, producer gas, oil gas and gobar gas production., Hydrogenation, synthetic gas, synthetic gasoline, asymmetric hydrogenation; hydrosilation- Chalk-Harrod mechanism: hydrocyanation-synthesis of buta-1,3-diene; hydroformylation- Cobalt and modified catalysts, Rh catalysts. [15 hrs]

UNIT-II

Heterogeneous Catalysis and porous materials: Classification of solid catalysts, Adsorption of molecules at the solid surfaces, Adsorbed states of molecules on metals, potential-energy curves for adsorption, descriptive chemistry of chemisorption on metals, chemisorption and catalysis by metals quantitative aspects, catalysis by unsupported and supported bimetals, Adsorption and catalysis on semiconducting oxides, selective oxidation of hydrocarbons. Different types of reactors.
Zeolite Compounds and Heterogeneous Catalysis: Introduction to porous materials: Classification into micro-, meso- and macro porous materials, the origin of pores and its significance, distinction from condensed materials.
Natural and synthetic zeolite or aluminosilicates, the primary and secondary building blocks, final framework structures, Lowensteins rule, sodalite and other structures, Nomenclature: Atlas of zeolite; structural distinctions, Novel zeolites, examples of small, medium, large and extralarge pore zeolites;
general properties and application of molecular sieves. Layered double hydroxides, ordered mesoporous materials.
Modifications of carbon: carbon fibers, CNT, Graphene, fullerene, diamond like carbon, properties and application as catalytic - porous support material. [15 hrs]

UNIT-III

Semiconducting materials in electronics and energy devices: Semiconductors, Binary and ternary oxides and non-oxide semiconductors, their structure, properties, doping, band structure modification and working application in solar energy conversion, electronic components, semiconductor.
Materials for Sensors: Thermal, Gas, Biosensors types, sensors and applications.
Chemistry of silicates and Hard materials: Glass, alkali silicates, composition, manufacture, raw materials, properties. Ceramics: classification of ceramic products, manufacture of ceramics, clay, Oxide ceramics, aluminum oxide, zirconium oxide, beryllium oxide, uranium oxide and thorium oxide, other oxide ceramics, electro- and magneto-ceramics and their structure and properties.
Ultra Hard Materials: General manufacturing processes, carbides of the subgroup of the IVth group, carbides of the subgroup of the Vth Group, carbides of the subgroup of the VIth group. Nitrides, Diamond like carbon. [15 hrs]

UNIT-IV

Inorganic polymers, Surfactants, Biosensors, Pesticides. Chemistry of Inorganic polymers: Poly-(sulphur –nitrides), Polyphosphates, polysilicates, polysilicones, organo-metallic polymers, bonding, structure and properties, Inorganic fibers.
Surfactants: Classification with examples, Adsorption and micelle formation, Manufacture of anionic, cationic, zwitterionic and nonionic detergents, Applications as Foaming agent, Wetting agent, Dispersant, Solubilizers, Emulsifiers and Rheology modifiers, Detergent formulations, Detergent biodegradation, Biosurfactants.
Inorganic Pigments: white pigments, titanium dioxide pigments, zinc sulfide pigments, colored pigments.

Pesticides: Introduction, classification, synthesis of few common pesticides of chlorinated (DDT, BHC, Chlordane, Aldrin), organophosphorus and carbamate (parathion, Malathion, carbaryl) compounds family. [15 hrs]

Reference Books:

1. Norris Shreve, R. and J.A. Brink (1977): Jr. Chemical Process Industries. 4th edn. McGrawHill, Tokyo.
2. Chakrabarty, B.N (1981): Industrial Chemistry, Oxford & IBH Publishing Co., New Delhi.
3. Karl Heinz Büchel, Hans-Heinrich Moretto, Dietmar Werner, 2008 Industrial Inorganic Chemistry, 2nd Completely Revised Edition, Wiley – VCH

IOC SOFTCORE-02

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3142	STRUCTURAL METHODS IN INORGANIC CHEMISTRY	SC	2	1	0	3	4

Course objectives:

This course aims to provide the student to

1. Demonstrate the knowledge of the basic concept of spectroscopy laser, optical spectroscopy, mechanism of fluorescence.
2. Explore understanding of photoelectron spectroscopy (PES) and electron energy loss spectroscopy for chemical analysis and other most important applications.
3. Create broad advanced techniques knowledge of SEM, SAM, SPM, STM, LEED, TEM, ASS and ICPMS for structure and chemical analysis applications.
4. Acquire knowledge of non-destructive techniques for various metals, product analysis, effects and other applications.

Course outcomes:

By the completion of course student will be able to

1. Basic spectroscopy, laser, mechanism fluorescence.
2. Applications, electron spectroscopy, chemical analysis.
3. Advanced techniques, applications, analysis.
4. Analysis, applications, effects chemical reactions.

Mapping of Course Outcomes with programme Outcomes (sample)

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3142	**CO1**	**2**	**1**	**0**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**
	CO2	**3**	**0**	**0**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**3**	**3**	**1**
	CO3	**3**	**0**	**0**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**
	CO4	**3**	**0**	**0**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**3**	**1**

Course Content:

UNIT-I

Advanced optical spectroscopy: Overview of basic concepts: Light-matter interaction, Einstein coefficients, introduction to lasers, transition dipole moment, selection rules for electronic transitions, Jablonskii diagram, fluorescence and phosphorescence, kinetics of unimolecular and bimolecular processes.

Advanced concepts: Theory of nonradiative transitions, spin-orbit coupling and singlet-triplet transitions, polarized light absorption and emission: fluorescence anisotropy, solvation dynamics, energetics and dynamics of bimolecular processes like excimer and exciplex formation, resonance energy transfer, mechanisms of fluorescence quenching, introduction to non-linear spectroscopy.

[15 hrs]

UNIT- II

Techniques and instrumentation: Steady-state fluorimetry, lasers as excitation sources, surface plasmon spectroscopy, multiphoton spectroscopy, single-molecule spectroscopy, fluorescence correlation spectroscopy.

Electron spectroscopy: Principle, working, components and applications.

Photoelectron spectroscopy: Electron energy analysis; photon sources UV, X-ray, synchrotron; vacuum - angular dependence - cross section and its determination; photoexcitation, valence and core photoemission, application in chemical analysis

Electron energy loss spectroscopy: Franck and Hertz experiment -- instrumentation -selection rules-theory - studies on molecules - surface states - high resolution spectroscopy - adsorption and catalysis –applications. [15 hrs]

UNIT - III

Imaging and Depth Profiling techniques: Basic concepts in surface imaging; secondary electron microscopy (SEM); secondary Auger microscopy (SAM); scanning probe microscopy (SPM); scanning tunneling microscopy (STM); transmission electron microscopy (TEM); low energy electron diffraction (LEED), surface imaging; depth profiling. Associated techniques of microscopy and spectroscopy.

Destructive techniques: AAS, inductively coupled plasma-atomic emission spectroscopy (ICP-AES).

[15 hrs]

UNIT-IV

Non-destructive techniques: Wavelength and energy dispersive X-ray fluorescence spectroscopy (WDS and EDS); X-ray absorption spectroscopy (XANES and EXAFS); secondary ion mass spectrometry (SIMS); temperature programmed desorption (TPD); thermal desorption spectroscopy (TDS).

Mossbauer spectroscopy: Theoretical basis. Interpretation of Mossbauer spectra-isomer shift-Quadrupole splitting and magnetic hyperfine structure, time and temperature effects. Instrumentation. Applications-structure deducetion-I_2 Br_2 Cl_4, $Fe_3(CO)_{12}$. [15 hrs]

Reference Books:

1. Modern Spectroscopy J M Hollas, John Wiley & Sons, 4th Edn, 2004
2. Modern Optical Spectroscopy, William W Parson, Springer, Student Edn, 2009
3. Fundamentals of Photochemistry, K K Rohatgi-Mukhejee, Wiley Eastern Ltd, 1992
4. Principles of Fluorescence Spectroscopy, J R Lakowicz, Springer, 3rd Edn, 2006
5. Laser Spectroscopy- Basic concepts and instrumentation – W. Demtroder (Springer 3rd edition, 2004)
6. Scanning Probe Microscopy and Spectroscopy, R. Wiesendanger, Cambridge University Press, 1994.

7. Handbook of instrumental techniques for analytical chemistry, Frank A. Settle, Prince Hall, New Jersey, 1997.
8. Foundations of catalysis and nanoscience, K. W. Kolasinski John Wiley and Sons, West Susses, 2002.
9. Physics at Surfaces, A. Zangwill, Cambridge Univ. Press, 1988.
10. Introduction to Surface Chemistry and Catalysis, G.A. Somorjai, Y. Li , Wiley, 2010.
11. Physical chemistry of surfaces by Arthur W. Adamson 1990
12. The chemical physics of surfaces by Roy S. Morrison, S. Roy, 1990.
13. Modern techniques of surface science by D.P. Woodruff, T.A. Delchar, Cambridge Univ. Press, 1994.
14. Introduction to Scanning Tunneling Microscopy by C. J. Chen, Oxford University Press, New York, 1993.

SEMESTER-III

ORGANIC CHEMISTRY

SEMESTER -III: HARD CORE -1

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3210	ADVANCED ORGANIC CHEMISTRY	HC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Explore the structure and reactivity of organic molecules with emphasis on reaction mechanisms.
2. Examine the principles of bonding, stereochemistry, kinetics and thermodynamics in organic synthesis.
3. Evaluate the logical disconnections to identify the synthons and choose the reactants and reagents.
4. Explore the feasibility of a process in terms of cost, conditions and availability of the starting materials.

Course Outcomes:

By the completion of course student will be able to

1. Interpret the mechanisms of organic reactions and identify the synthons.
2. Develop a detailed understanding for appropriate disconnections and possible strategies.
3. Enhance the knowledge on various feasible reactions for synthesizing molecules.
4. Justify the regioselectivity, stereoselectivity and chemoselectivity of reactions.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3210	**CO1**	**3**	**1**	**2**	**1**	**2**	**3**	**1**	**0**	**0**	**1**	**2**	**1**	**2**
	CO2	**2**	**1**	**2**	**2**	**2**	**1**	**2**	**0**	**0**	**1**	**2**	**2**	**3**
	CO3	**2**	**2**	**1**	**1**	**3**	**2**	**3**	**0**	**0**	**1**	**3**	**1**	**2**
	CO4	**3**	**2**	**2**	**1**	**2**	**1**	**2**	**0**	**0**	**1**	**2**	**2**	**3**

Course Content:

UNIT-I

Introduction to Disconnection approach- basic Principle: Synthesis of Aromatic Compounds, strategy I: The order of Events, One-Group C-X Disconnections, Strategy II: Chemoselectivity, Strategy III: Reversal of Polarity, Cyclisation Reactions, Amine Synthesis, Strategy IV: Protecting Groups, One-Group C-C Disconnections I: Alcohols, General Strategy A: Choosing a Disconnection, Strategy V: Stereoselectivity. [15hrs]

UNIT-II

One -Group C-C Disconnections II: Carbonyl Compounds, Strategy VI: Regioselectivity, Alkene Synthesis, Strategy VII: Use of Acatylenes, Two- Group Disconnection I: Diels-Alder Reaction, Strategy VIII: Introduction to Carbonyl Condensations, Two-Group Disconnection II:1,3-Difunctionalised compounds, α,β- unsaturated Carbonyl compounds. Strategy IX: Control in carbonyl compounds. [15hrs]

UNIT-III

Two Group disconnection III: 1,5-difunctionalised Compounds, Micheal Additions and Robinson Annelation, Strategy X: Use of Aliphatic, Nitro Compounds in Synthesis, Two- group Disconnection IV: 1,2-Difuntionalised compounds, strategy XI: Radical Reactions in the Synthesis, FGA and its Reverse, Two-Group Disconnection V: 1,4-Difunctionalised compounds, Strategy XII: Reconnections, Two-Group Disconnection VI: 1,6-Difunctionalised compounds, General Strategy B:Strategy of Carbonyl Disconnections, Strategy XIII: Introduction to Ring Synthesis, Saturated Heterocycles. Three-Membered Rings. [15hrs]

UNIT-IV

Strategy XIV: Rearrangements in Synthesis, Four-Membered Rings: Photochemistry in synthesis, Strategy XV: Use of ketenes in synthesis, Five-Membered Rings, Strategy XVI: Pericyclic Rearrangements in synthesis, Six-Membered Rings, General Strategy C: Strategy of Ring Synthesis, Strategy XVII: Stereoselectivity B, Aromatic Heterocycles, General Strategy D: Advanced Strategy. [15hrs]

Reference Books:

1. Organic synthesis: The synthon approach, S. Warren, John Wiley & Sons, New York, 1st. Edn. 1983.
2. Advanced organic chemistry, J. March, 4th Edn. John Wiley, 2008.
3. Organic Chemistry, R. E. Ireland Prentice-Hall India, New Delhi, 1975.
4. Some modern methods of Organic Synthesis, W. Caruthers, Cambridge Uni. Press London, 2nd Edn., 1998.
5. Designing organic synthesis: A disconnection approach, S. Warren, John Wiley & Sons, New York, 2nd Edn.1987.
6. Carruthers. W., Some Modern Methods of Organic Synthesis, Cambridge University Press (1987)
7. Sanyal, S.N., Reactions, Re-arrangements & Reagents, Bharati Bhavan (2004)
8. Chemistry Education: Research and Practise in Europe, 2002, Vol.3, No.1, pp.33-64
9. Organic synthesis, C. Willis and M. Wills, Oxford University Press, 1995.
10. Organic synthesis: Concepts, methods and starting materials, J. Furhfop and G. Penzillin, Verlag VCH.
11. Principles of organic synthesis, R. Norman and J. M. Coxon, Blackie Academic & Professional
12. Advanced organic chemistry Part B, F. A. Carrey and J. Sundberg, Plenum Press, 1999.
13. Organic chemistry Vol. 2, 6th Edn., I. L. Finar, Longman, 1992.

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3220	ADVANCED ORGANIC SYNTHESIS	HC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. The advanced lineup in organic synthesis provides a deeper understanding of the reactivity and properties of the organic compounds and emphasis on the applications of important reagents and reactions in organic synthesis.
2. Expand a fundamental understanding of carbon-carbon single and double bond formation.
3. Development of highly stereoselective reactions and their applications in complex synthesis. These reactions include stereoselective alkylation of carbonyl compounds, stereoselective aldol condensations, stereoselective oxidations, epoxidations and reductions.
4. Discussion of newer methods for the stereoselective formation of carbon-carbon double bonds, and the modern application of the Diels Alder reaction, particularly its use in the control of stereochemistry in the synthesis of natural products.
5. Determine which strategic bond constructions can be used most effectively to obtain synthetic targets with high selectivity.

Course outcome:

By the completion of course student will be able to

1. Analyze Molecular Orbital (HOMO-LUMO) symmetry concepts and pericyclic reactions.
2. Differentiate the products by photochemical and thermal reactions.
3. Knowledge of name reactions in organic synthesis and their applications.
4. Utilize the principles behind enantioselectivity and Diastereoselective in organic synthesis.

Mapping of Course Outcomes with programme Outcomes (sample)

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH3220	**CO1**	**3**	**3**	**0**	**1**	**3**	**1**	**2**	**0**	**1**	**2**	**3**	**2**	**2**
	CO2	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**0**	**1**	**2**	**4**	**2**	**2**
	CO3	**1**	**2**	**0**	**2**	**3**	**1**	**0**	**0**	**1**	**2**	**1**	**2**	**2**
	CO4	**1**	**3**	**0**	**2**	**3**	**1**	**2**	**0**	**1**	**2**	**1**	**2**	**2**

Course Content:

UNIT-I

Pericyclic Reactions: Introduction, Classification of pericyclic reactions, electrocyclic reactions: con rotation and dis rotation. Electrocyclic ring closure and opening in 4n and 4n+2 systems.

Cycloaddition Reactions: Suprafacial and Antara facial additions in 4n and 4n+2 cycloadditions. Sigmatropic reactions: [i-j] shifts- suprafacial and Antara facial shifts, Cope and Claisen rearrangement reactions. Molecular orbitals: ethylene, 1,3-butadiene, 1-allyl cation.

Frontier Molecular Orbital (HOMO-LUMO) approach-concept: Framing Woodward Hofmann selection rules for all the pericyclic reactions by Frontier Molecular Orbital (FMO) approach. Molecular orbitals: ethylene, 1-3-butadiene, 1-allyl cation. Conservation of orbital symmetry: (Correlation Diagrams) approach- for electrocyclic and cycloadditions. [15hrs]

UNIT-II

Photochemistry: Introduction, Laws of photochemistry, Quantum yield, Photochemical equivalence Photochemistry of (n-π*) Transitions: Excited states of carbonyl compounds, homolytic cleavage of α-bond, Norrish type I reactions in acyclic and cyclic ketones and strained cycloalkane ketones Norrish type II reactions in ketones and esters Addition to carbon-carbon multiple bond-Paterno-Buchi reaction, Photochemistry of nitrites-Barton reaction.

Photochemistry of π-π* Transitions: Excited states of alkenes, cis-trans isomerisation, and photo stationary state. Photochemistry of 1,3-butadiene Electrocyclisation and sigmatropic rearrangements, di-π methane rearrangement. Intermolecular reactions, photocycloadditions, photodimeriastion of simple and conjugated olefins. Addition of olefins to α, β-unsaturated carbonyl compounds. Excited states of aromatic compounds-Photoisimerisation of benzene. [15hrs]

UNIT-III

Common Name reactions: General nature, method, mechanism and synthetic applications of the following reactions: (i) ChiChibabin (ii) Blaise reaction (iii) Knoevanagel reaction (iv) Buchwald Hartwing reaction (cross coupling) (v) Sonogarshira coupling (vi) Gattermann-Koch reaction (vii) Jones oxidation (viii) Swern oxidation reaction (ix) Michael addition (x) Junjappa-Ila (JI) Heteroaromatic Annulation (xi) Doebner reaction (xii) Dickmann reaction (xiii) Hailer-Bauer reaction (xiv) Witting reaction (xv) Still reaction (xvi) Suzuki (xvii) Heck reaction. [15hrs]

UNIT-IV

Asymmetric Synthesis: 'ee' and methods of determination of 'ee'.

Stereoselectivity: classification, terminology and principle. Asymmetric synthesis and asymmetric induction. Double diastereoselection and double asymmetric induction.

Acyclic stereoselection: Addition of nucleophiles to carbonyl compounds (1,2- 1,3- and 1,4asymmetric induction). Asymmetric aldol condensation. Addition of allylmetal and allylboranes to carbonyl group.

Diastereoselection in cyclic systems: Nucleophilic addition to cyclic ketones (formation of axial and equatorial alcohols, catalytic hydrogenation, alkylation, diastereoselective oxidations and stereoselective cyclization of poylenes).

Enantioselective synthesis: Reduction with chiral hydride donors [(S)-PBMgCl, (-)- iBOAlCl$_2$, alpine-borane, (S)-BINAL-H, (R,R)-DIOP, and (S,S)-CHIRAPHOS]. Enantioselective alkylation of ketones via hydrazones. Enantioselective alkylation with chiral PTC. Enantioselective Michael addition. Enantioselective intramolecular aldol condensation.

Use of (+)- and (–)- DET in asymmetric epoxidation. Polymer-bound chiral catalysts in asymmetric induction. Asymmetric amplification. [15hrs]

Reference Books:

1. Principles of Organic synthesis, Richard O.C. Norman and James M Coxon,3rd edition CRC Press, 1993.
2. Advanced organic chemistry, J. March, 4th Edn. John Wiley, 2008.Organic synthesis, R.E.Ireland, Prentice-hall India, New Delhi, 1975.
3. Understanding organic reaction mechanisms, A. Jacob, Cambridge Univ Press, 1997.
4. Introduction to organic chemistry, A. Streitweiser, Jr and C. H. Heathcock, Macmillan, 1985.
5. Physical and mechanistic organic chemistry, R. A.Y. Jones, 1st Edn. Cambridge Univ Press, 1979.
6. Modern synthetic reactions, H. O. House, W. A. Benjamin, California, 2nd Edn. 1972.
7. Some modern methods of organic synthesis, W. Carruthurs, Cambridge Univ. Press, London, 2nd Edn. 1978.
8. Mechanisms of molecular migration, Vols I & II, B.S. Thyagarajan, Pergamon Press, Oxford, 1979.
9. Comprehensive organic chemistry, D. Barton and W. D. Wallis, Pergamon Press, Oxford, 1983.

10. Organic chemistry Vol. II, I. L. Finar 6th Edn. Longman, 1992.
11. Organic reaction Mechanisms, 3rd Edn., V. K. Ahluwalia and R. K. Prashar, Narosa, New Delhi, 2005.

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3230	NATURAL PRODUCTS AND BIOORGANIC CHEMISTRY	HC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. To identify, extract and eventual modification of compounds that are of natural origin- plants, animals and bacteria for pharmaceutical use and other purposes
2. To bring the awareness of the richness and diversity of plants and animals around them.
3. To distinguish the naturally occurring compounds into different classes
4. To formulate different reactions and their mechanism in the natural product synthesis.

Course Outcomes:

By the completion of course student will be able to

1. Acquire the knowledge of Identifying and characterizing various classes of natural products by their structure Appreciate the biogenesis of many natural products of importance.
2. Contribute the knowledge of natural products in drug design and development of new drugs with hemisynthetic routes or with total synthesis.
3. Discuss the use of natural products as starting materials for medicine.
4. Carry out independent investigations of plant materials and natural products

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19C H 3230	**CO1**	**3**	**2**	**0**	**1**	**2**	**0**	**0**	**0**	**1**	**1**	**3**	**2**	**2**
	CO2	**3**	**2**	**3**	**3**	**2**	**0**	**0**	**0**	**1**	**1**	**3**	**2**	**2**
	CO3	**2**	**2**	**3**	**2**	**2**	**0**	**0**	**0**	**1**	**1**	**3**	**2**	**1**
	CO4	**2**	**2**	**2**	**2**	**3**	**2**	**0**	**0**	**1**	**1**	**3**	**2**	**2**

Course Content:

UNIT-I

Terpenoids and Carotenoids: Classification, nomenclature, occurrence and isolation. Isoprene rules. Stereochemistry of citral, farnesol, limonene, 1,8-cineole, menthols and borneols. Correlation of configurations of terpenoids. Structure elucidation of camphene, -pinene, caryophyllene, santonin and gibberrillic acid.

Synthesis and biosynthesis of the following: Linalool, terpineol, fenchone, eudesmol, abietic acid. Commercial synthesis of camphor. Biosynthesis of squalene and cyclisation of squalene into lanosterol and friedelene. Carotenoids: Methods of isolation. Structural relationship of α-, β- and γ-carotenes. Structure elucidation and synthesis of β-carotene. [15hrs]

UNIT-II

Alkaloids: Definition, nomenclature, occurrence, isolation, classification, General methods of structure elucidation. Synthesis and biosynthesis of the following alkaloids:

Ephedrine, hygrine, coniine and cocaine. Cinchona alkaloids: Cinchonine and quinine. Opioid **alkaloids:** Morphine, codeine, thebiene and heroin.
Structure elucidation and synthesis of papaverine, reserpine and ergotamine. Photochemical synthesis of Nuciferine, coradyline and tylophorine. [15hrs]

UNIT-III

Porphyrins and vitamin B12: Structure elucidation and synthesis of haemin, chlorophyll-a and vitamin-B12 (synthesis of Vitamin-B12 from cobyric acid).

Nucleic acids: Introduction, components of nucleic acids, nucleosides, nucleotides and oligonucleotides. Structure elucidation and synthesis of nucleosides and nucleotides. Chemical **synthesis of oligonucleotides:** Protecting groups for hydroxy group in sugar, amino group in the base and phosphate functions. Methods of formation of internucleotide bonds: DCC, phosphodiester approach, phosphotriester approach, phosphite triester and phosphoramidite methods. Solid phase synthesis of oligonucleotides. [15hrs]

UNIT-IV

Prostaglandins: Introduction, nomenclature, classification and biological role of prostaglandins. Structure elucidation and stereochemistry of PGE1, PGE2 and PGE3. Synthesis of PGE1 and PGE2 by Corey's and Stork's approaches. Synthesis of PGE3 by Upjohn's approach. Synthesis of prostacyclin I_2 and thromboxane B2. Biosynthesis of prostaglandins.

Insect pheromones: Introduction, classification. Pheromones in pest control. Syntheses of (one synthesis should be stereoselective synthesis) I) Grandisol (component of boll weevil pheromone) ii) Farenal (trail pheromone of pharaoh's ants) iii) Brevicomin (pheromone from Dendroitis brevicomis) iv) (+)- Disparlure (gypsy moth sex pheromone). v) 3,11-Dimethy1-2-nonacosanone (pheromone of German cockroaches). vi) Bombykol (sex pheromone of silkworm moth). vii) Multistriatin (Elm bark beetle sex pheromone).
[15hrs]

Reference Books:

1. Natural products: Their chemistry and biological significance-J. Mann, R. S. Davidson, J. B. Hobbs, D. V. Banthorpe & J. B. Harborne, Longman, UK, 1994.
2. Terpenes, J. Verghese, Tata McGraw-Hill, New Delhi, 1982.
3. Chemistry of terpenes and terpenoids, A. Newman, Academic Press, London, 1975.
4. Handbook of naturally occurring compounds Vol. II: Terpenes, T. K. Davon, A. I. Scott, Academic Press, NY, 1972.
5. Natural products chemistry Vol. I & II, K. Nakanishi, T. Goso, S. Ito, S. Natori & S. Nozoe, Academic Press, NY, 1974.
6. Total synthesis of natural products Vol. I & VI, Apsimon, John Wiley, NY, 1973-1981.
7. Organic chemistry Vol.II, I. L. Finar, 6th Edn. Longman, 1992.
8. Chemistry of natural products Vol. I & II, O. P. Aggarwal, Goel Publishing House, 6th Edn. 1982.
9. Total synthesis of natural products: The chiral approach Vol.III,S. Hanessian Pergamon Press, 1983.
10. Total synthesis of steroids, Akhaun & Titov, Jerusalem, 1969.
11. Medicinal natural products: A biosynthetic approach, P. M. Dewick. John Wiley, Chichester, 1997.
12. The colours of life: An introduction to the chemistry of porphyrins and related compounds, L. R. Milgrom, Wiley Chichester, 1995.
13. Interpretation of the UV spectra of natural products, A.I. Scott, Pergamon Press, Oxford, 1964.
14. Spectral data of natural products Vol. I- K.Yamaguchi, Elsevier Publishing Co, London, 1970.
15. Chemistry of natural products: A unified approach, N. R. Krishnaswamy, University Press, India, 1999.

SOFTCORE-01

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3241	ORGANOMETALLICS IN ORGANIC SYNTHESIS	SC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Discuss the Complexation and De-Complexation Reactions of S and P- Bonded systems and Use of Organo transition metal complexes as protecting and stabilizing groups
2. Illustrate the synthesis and applications of various organometallic reagents in organic synthesis.
3. Explain the synthetic applications of tri methyl silyl chloride, Organo tin, Organo cerates, and Organo mercurial.
4. Develop and design the catalytic cycle for the Homogeneous and Heterogeneous catalysis.

Course Outcomes:

By the completion of course student will be able to

1. Distinguish between Complexation and De complexation reactions of Organo transition metal complexes.
2. Apply the appropriate mechanistic steps in reactions involving organometallic compounds.
3. Apply organometallic reagents and reactions in organic synthesis.
4. Acquire the knowledge of fundamental organometallic reactions to construct catalytic cycle.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3241	**CO1**	**1**	**0**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**1**	**1**	**1**
	CO2	**2**	**1**	**2**	**0**	**3**	**1**	**2**	**2**	**0**	**0**	**2**	**2**	**2**
	CO3	**2**	**1**	**2**	**0**	**3**	**1**	**2**	**2**	**0**	**0**	**2**	**2**	**2**
	CO4	**2**	**1**	**1**	**0**	**2**	**1**	**1**	**2**	**0**	**0**	**2**	**1**	**1**

Course Content:

UNIT-I

Organometallic Compounds in Organic Synthesis-I

Chemistry of Organo transition metal complexes: General introduction. 16 and 18 Electron rules. General rules Complexation and De-complexation Reactions: s-Bonded systems including h1 ligands. p- Bonded systems involving di hapto to octahapto ligands such as- olefins, acetylenes, allyl moieties, butadiene, cyclobutadiene, arenes, cyclopenta, cyclohexa and cycloheptadienyl moieties; cyclohepta, cyclo octatriene, and cyclo octatetraene moieties.

Use of Organo transition metal complexes as protecting and stabilizing groups: Protection of olefins, acetylenes and dienes. Stabilization of cyclobutadiene and norbornadienones. Organometallics as Electrophiles and nucleophiles: Nucleophilic addition to h2, & h5 complexes. Electrophilic addition to h4, h6 and Carbene complexes.

Organometallics in coupling and cyclization reactions: Coupling and cyclization of organic nucleophiles with olefins (including Heck reaction), and coupling of olefins with acetylenes (including Felkin'sreaction) [15Hrs]

UNIT-II

Organometallic Compounds in Organic Synthesis-II

Chemistry of organometallic compounds: Synthesis and reactions of Organo lithium (n-BuLi, LDA) and Organo magnesium (Grignard reagent).

Organo zincs: Preparation, reaction with compounds containing acidic protons, reaction with C-C multiple bonds, Simmons Smith, and Reformatsky reaction.

Organo Copper Reagents: (Gilman reagents-lithium di alkyl cuprates): Preparation, reactions with alkyl, allyl, vinyl, benzyl and aryl halides, aldehydes, ketones (including a, b-unsaturated carbonyl compounds) and epoxides.

Synthetic applications of Organo boranes: Preparation of Organo boranes viz hydroboration with BH3-THF, dicylohexyl borane, disiamyl borane, thexyl borane, 9-BBN and diisicamphenyl borne, functional group transformations of Organo Boranes-Oxidation. Formation, of carbon-carbon-bonds viz Organo boranes carbonylation, and reaction of alkenyl boranes and tri alkenyl borates.

[15Hrs]

UNIT-III

Organometallic Compounds in Organic Synthesis-III

Organo Silanes: Synthetic applications of tri methyl silyl chloride, tri methyl silyl iodide, silyl carbanion and β-silyl Carboniumions. Peterson olefination.

Organo Sulphur compounds: Introduction. Preparations, reactions and synthetic applications of important Sulphur containing reagents like di thiane, Sulphur ylides etc.

Organo phosphorous compounds: Synthesis and reactions of tri alkyl phosphine, Wittig reaction and **Wittig-Horner reactions:** mechanisms and synthetic uses, Arbasov reaction.

Organo tin: Preparation and reactions of tri-n-butyl tin hydride, Barton decarboxylation and Barton-McCombie reaction.

Organo cerates: Preparation and reactions of Organo cerates.

Organo mercurial: Preparation. Electrophilic substitution reactions. Solvomercuration-demercuration and cyclopropanation of alkenes. [15Hrs]

UNIT-IV

Homogeneous Catalysis: Introduction, properties of catalysis, types of reactions in homogeneous catalysis, hydrogenation of olefins, isomerization of olefins, Oxo-process, Wacker process, Monsanto acetic acid process. Monsanto L-Dopa synthesis, water gas shift reaction, carbonylation, template synthesis, alkene hydrosilylation.

Herterogeneous Catalysis: Introduction, Fischer-Tropsch reaction, Ziegler-Natta catalysis, biological applications and environmental aspects of Organometallic compounds: Introduction, Organometallics in medicine, agriculture, horticulture and environmental aspects. [15Hrs]

Reference Books:

1. Organometallic Chemistry, R. C. Mehrotra and A. Singh, Wiley Eastern, 1991.
2. The Organometallic Chemistry of the transition metals, R. H. Crabtree, 1988.
3. Principles and application of the organotrnsition metal chemistry, J. P. Collman, L. S. Hegedus, University Science books, 1980.
4. An introduction to Organometallic Chemistry, A.W. Parkinsand R.C.Poller, Macmillan, 1986.
5. Modern Synthetic Reactions, H. O. House, W.A. Benjamin, California, 2nd Edn. 1972.
6. Organometallics, Vol. 1 & 2, M. Bochmann, Oxford Chemistry primers, Oxford University Press, 1994.
7. Advanced Organic Chemistry, J. March, 4th Edn. John Wiley, 2008.
8. Organo-transition metal chemistry, S. G. Davies, Pergamon Press, Oxford, 1982

9. Inorganic Chemistry - F.A. Cotton and G. Wilkinson (2nd edn).
10. Inorganic Chemistry Principles and Structure –J. Huheey.
11.Fundamental Transition metal Organometallic Chemistry – Charles M. Lukehart.
12.Inorganic chemistry- Purcell and Kotz. 6. J. March, Advanced Organic Chemistry, Willey Interscience, 1994.
13. Comprehensive Organic Synthesis, – Trost series, Pergamon Press, New York, Vol. 1, 1991. 8. R. Norman and J. M. Coxon, Principles of organic synthesis, 2nd edition, Replika Press Pvt. Ltd., India, 2005.

SEMESTER -III : SOFT CORE -2

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 3242	GREEN CHEMISTRY	2	1	0	3	4

Course objectives:

This course aims to provide the student to

1. This course offers the following concepts for students;
2. Knowledge of green chemistry through various concepts
3. Application of instrumental techniques for the synthesis of green materials or compounds
4. Outline on the synthesis of green materials through various chemical routes
5. Design the concept and discipline of green chemistry and place its growth and expansion in a historical context from.

Course outcome:

By the completion of course student will be able to

1. Employ alternate methods for material synthesis towards better sustainability
2. Design reaction schemes for developing new green products
3. Identify environmental friendly chemicals and techniques for materials synthesis
4. Analyse materials for their applications based on their chemical properties

Mapping of Course Outcomes with programme Outcomes (sample)

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3242	**CO1**	**2**	**2**	**1**	**2**	**1**	**2**	**0**	**1**	**0**	**0**	**2**	**2**	**1**
	CO2	**3**	**1**	**2**	**2**	**2**	**3**	**0**	**2**	**0**	**0**	**2**	**1**	**2**
	CO3	**2**	**3**	**2**	**1**	**2**	**2**	**0**	**2**	**0**	**0**	**1**	**2**	**3**
	CO4	**3**	**2**	**2**	**1**	**2**	**1**	**0**	**2**	**0**	**0**	**2**	**2**	**3**

Course Content:

UNIT-I

Introduction to green chemistry: Green chemistry: Relevance and goals, Anasta's, 12 principles of green chemistry -tools of Green chemistry:- Alternative starting materials, reagents, catalysts, solvents and processes with suitable examples

Use of ultrasound and Microwaves in Organic Synthesis

Use of ultrasound: Introduction, instrumentation, the phenomenon of cavitation. Sonochemical esterification, substitution, addition, alkylation, oxidation, reduction and coupling reactions.

Use of Microwaves: Introduction, concept, reaction vessel/medium, specific effects, atom efficiency (% atom utilization), advantages and limitations. N-alkylation and alkylation of active methylene

compounds, condensation of active methylene compounds with aldehydes and amines. Diels-Alder reaction. Deprotection of esters and silyl ethers. [15hrs]

UNIT-II

Ionic-liquids: Introduction, structure, synthesis and applications of some important ionic liquids in organic synthesis Polymer supported reagents in organic synthesis Introduction- properties of polymer support, advantages of polymer supported reagents and choice of polymers.

Applications: Substrate covalently bound to the support: Synthesis of oligosachcharides, Dieckmann cyclisation. Preparation of polymer bound aldehyde and application in aldol and Wittig reactions. Synthesis of polystyryl boronic acid and use in diol protection reaction. Reagent linked to a polymeric material: Preparation of sulfonazide polymer and application in diazotransfer reaction. Synthesis of polymer bound per acid and its applications. Polymer supported catalytic reactions: Preparation of polymer supported AlCl3 and application in etherification and acetal formation reactions. [15hrs]

UNIT-III

Phase transfer catalysis and Crown ethers

Phase transfer catalysis: Introduction, definition, mechanism of phase transfer catalysis. Types of phase transfer catalysts and reactions and their Advantages.

Preparation of catalysts and their application in substitution, elimination, addition, alkylation, oxidation and reduction reactions.

Crown ethers: Introduction, nomenclature, features, nature of donor site. General synthesis of Crown ethers.

Synthetic applications: Alkylation, generation of carbenes, aromatic substitution and displacement reactions. Generation and application of superoxide anions. Cation deactivation reactions. [15hrs]

UNIT-IV

Supported catalyst and Bio-catalyst for Green chemistry

Introduction-the concept of atom ecomnomy-supported metal catalsts-mesoporous silicas-the use of biocatalyst for green chemistry-modified biocatalyst-Fermentations and Biotransformations-fine chemicals bymicrobial fermentations- vitamins and amino acids -Baker's yeast mediated bio transformation- biocatalyst mediated Bayer-Villiger reactions -Microbial polyester synthesis.

Multi-component Reactions: Studies on the mechanistic aspects and use of the following reactions in organic synthesis: Passerini-Ugi; Hantsch; Biginelli; Doebner-Miller; Ritter; Jacobson; Betti; Robinson-Schopf; Barbier; Baylis-Hilmann; Ivanov and Suzuki coupling reaction. [15hrs]

Reference Books:

1. Green Chemistry -Environmentally benign recations- V.K Ahluwalia. Ane Books India (Publisher) (2006)
2. Green Chemistry-Designing Chemistry for the Environment- Edited by Paul T. Anastas & Tracy C. Willamson. Second Edition, (1998)
3. Green Chemistry-Frontiers in Benign Chemical synthesis and Processes- Edited by Paul T. Anastas & Tracy C. Willamson. Oxford Press (1998)
4. Organic Chemistry, R. E. Ireland Prentice-Hall India, New Delhi, 1975.
5. Some modern methods of Organic Synthesis, W. Caruthers, Cambridge Uni. Press London, 2nd Edn. 1998
6. A textbook of organic chemistry, V. K. Ahluwalia and M. Goyal, Narosa Publishing House, New Delhi, 2000.
7. Organic synthesis: Special techniques, V. K. Ahluwalia and R. Aggarwal, Narosa, New Delhi, 2003.

8. Green Chemistry, environment friendly alternatives, R. Sanghi and M M Srivastava, Narosa, New Delhi, 2003
9. Green Chemistry-an introduction text, Royal Society of Chemistry, UK, 2002.
10. Organic chemistry Vol. 2, 6th Edition, I. L. Finar, Longman, 1992.
11. Crownethers & cryptands,G.W.Gokel,Monograph, The Royal Society of Chemistry, 1991.
12. Macrocyclic Polyether Chemistry, G. W. Gokel, S. M. Korzeniowski, Vol 1 to 3, Wiley, NY, 1978, 1981, 1987.
13. Phase Transfer Catalysis in Organic Synthesis, W. B. Weber, G. W. Gokel, Springer, Berlin, 1977.
14.Phase Transfer Catalysis, E. V. Dehmlov, S. S. Dehmlov, 2nd Edition Verlagchemie, Wienheim, 1983.
15. Polymers as aids in Organic synthesis, N. K. Mathur, C. K. Narang and R. E. Williams, Academic Press, NY, 1980.

SEMESTER-III

PHYSICAL CHEMISTRY HARD CORE

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3310	PHOTO PHYSICAL PROCESSES AND APPLICATIONS	HC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Principles and laws of photochemistry,
2. Measurement of fluorescence and phosphorescence and lifetimes
3. Fluorescence based sensors.

Course Outcomes:

By the completion of course student will be able to

1. Acquire knowledge on laws of photo chemistry, types of electronic transitions and their kinetics.
2. Study of various methods to understand fluorescence and phosphorescence processes.
3. Explain Fluorescence based sensors with relevant examples.
4. Describe principle of photovoltaics, various energy conversion devices and their applications.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
	CO1	2	2	0	0	1	2	2	0	1	2			
	CO2	1	2	2	2	2	2	2	2	1	2			
	CO3	2	1	2	3	2	1	3	2	2	2			
	CO4	2	2	3	2	2	2	2	2	1	3			

Course Content:

UNIT – I

Principles and concepts: overview of: Laws of photochemistry, Beer-Lambert law, electronic energy levels, atomic and molecular term symbols, singlet-triplet state, intensity and strength of electronic transition, selection rules for electronic transition, singlet, triplet states, Jablonski diagram and photophysical processes, Franck-Condon principle, Quantum yield, Quenching. Different types of electronic transitions, Excited state lifetime, steady state and time resolved emission, factors affecting excited state energy: solvent effect, TICT. [12 hrs]

UNIT-II

Excited state kinetics, quantum yield expressions, excimer and exciplex, kinetics of luminescence quenching: static and dynamic, Stern-Volmer analysis, deviation from Stern-Volmer kinetics. Photoinduced electron transfer rates, free energy dependence of electron transfer on rate, Photoinduced energy transfer, FRET, rate and efficiency calculation of FRET. [12 hrs]

UNIT – III

Methods: Measurement of fluorescence and phosphorescence and lifetimes. Quantum yield, Introduction to time-resolved techniques for absorption and emission measurements, detection and kinetics of reactive intermediates. Examples of low temperature matrix isolation of reactive intermediates. [12 hrs]

UNIT – IV

Applications: Fluorescence based sensors – examples of molecular and supramolecular systems. Conversion of solar energy to chemical and other forms of energies, Principles of photovoltaics, Semiconductors, crystalline solid in Photoactive materials, solar photovoltaic cell, basic principle and design of the cell. Organic photovoltaics, Dye sensitized solar cells, Emission devices, Light emitting devices, LED, organic LED. [12 hrs]

Reference Books:

1. Physical Chemistry by P.W. Atkins, ELBS, 4th edition, Oxford University Press (1990)
2. Elements of Physical Chemistry, S. Glasstone, MacMillan.
3. Modern Spectroscopy, J M Hollas, John Wiley & Sons, 4th Edn, 2004
4. Modern Optical Spectroscopy, William W Parson, Springer, Student Edn, 2009
5. Fundamentals of Photochemistry, K K Rohatgi-Mukhejee, Wiley Eastern Ltd, 1992
6. Principles of Fluorescence Spectroscopy, J R Lakowicz, Springer, 3rd Edn, 2006 7.Laser Spectroscopy- Basic concepts and instrumentation – W. Demtroder (Springer 3rd edition, 2004)
8. Fundamentals of Photoinduced Electron Transfer, G. J. Kavarnos, VCH publishers Inc., New York, 1993.
9. Molecular Fluorescence: Principles and Applications, B. Valeur, Wiley-VCH Verlag GmbH, Weinheim, 2002.
10. Modern Molecular Photochemistry of Organic Molecules, N. J. Turro, V. Ramamurthy, J. C. Scaiano, University Science, Books, CA, 2010.
11. Photochemical Synthesis, I. Ninomiya, T. Naito, Academic Press, New York, 1989.

Course Code	Course Title	Type	L	T	P	C	Hrs/Wk
M19CH 3320	FUNDAMENTALS OF ELECTROCHEMISTRY AND APPLICATIONS	HC	2	1	0	3	4

Course of Objective

This course aims to provide the student to

1. Explain the fundamental concept, principles and laws of electrochemistry,
2. Discuss related to the types of electrodes and study of electrode reactions pathway.
3. Explain the concept of spectro-electrochemical and spectroscopic techniques.
4. Construction of electrode materials for various application.

Course of Outcome

By the completion of course student will be able to:

1. Build the knowledge about the electrochemical reaction and mechanism.
2. Development of electrode materials in various applications.
3. Apply the spectro-electrochemical and spectroscopic in better understanding structural feature and prospective of electrode materials.
4. Design the new electrode materials for various application in the field of electrochemical sensors and electrochemical energy devices.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3320	**CO1**	**2**	**2**	**3**	**3**	**3**	**3**	**0**	**0**	**1**	**2**	**3**	**3**	**3**
	CO2	**2**	**3**	**1**	**3**	**2**	**2**	**0**	**0**	**1**	**2**	**3**	**4**	**3**
	CO3	**3**	**3**	**1**	**4**	**3**	**0**	**0**	**0**	**1**	**2**	**3**	**5**	**3**
	CO4	**2**	**2**	**3**	**3**	**3**	**3**	**0**	**0**	**1**	**2**	**3**	**3**	**3**

Course Content:

UNIT – I

Electrochemical cells, Electrical double layer theories, Electrolyte conduction process, different types of electrochemical cells, Mass transport, Linear diffusion, Fick's laws and diffusion coefficient, The charged interface, Potential step and potential sweep experiments, Reactions controlled by rate of electron transfer and activated complex theory, Role of electron tunneling. [15hrs]

UNIT – II

Electrode Types and Study of Electrode Reactions: Carbon electrodes, Semiconductor film electrodes, Microelectrodes, Ultra-micro electrodes, Ion-selective electrodes, Porous electrodes and non uniform reaction rates, Hydrodynamic/Rotating disk electrodes, Semiconductor electrodes and electrical capacitance.

Cyclic voltammetry in reversible, quasi-reversible and irreversible systems, Study of reaction mechanisms, Surface modification in charge transfer and interfacial activity Electron transfer in DNA and biosystems, Potentiometry, coulometry, pulse techniques. [15 hrs]

UNIT-III

Spectro-Electrochemical and Spectroscopic Techniques: Impedance Spectroscopy, Scanning Electrochemical Microscopy, Electrochemical AFM and STM, Electrochemical Quartz Crystal Microbalance, Photoelectochemistry.

Electrode Materials and Sensors: Electroactive Fullerenes, Carbon Nanotubes, Biomolecules, Controlled Potential Techniques, Electrochemical synthesis of nanomaterials, nanowires and conducting polymers, Functional nanoparticles as catalysts and sensors, MOSFETS and ISFETS, Solid state molecular devices. [15 hrs]

UNIT-IV

Electrochemical Energy Systems: Photo-electrochemistry, Monitoring photolytic intermediates, Electroluminescence and devices and sensors, Electro - chemiluminescence, Digital simulation of electrochemical problems, Sample BASIC programs.

Fuel cells: Electrode materials, Diagnostic tools in fuel cell research, Determination of injection efficiency and electron diffusion length under steady state condition, Small-amplitude time-resolved methods, Organic solar cells, DSSC, battery electrochemistry. [15 hrs]

Reference Books:

1. Electrochemical Methods: Fundamentals and Applications, Allen J. Bard and Larry R. Faulkner, 2nd edition 2001, John Wiley & Sons
2. Electroanalytical Chemistry, Allen J. Bard (Ed, Vol.13, Plenum Press 1983
3. Analytical Electrochemistry, Joseph Wang, 3rd edition 2006, John Wiley & Sons
4. Electrochemistry of Functional Supramolecular Systems, Paola Ceroni, Alberto Credi and Margherita Venturi (Ed), 2010, John Wiley & Sons
5. Electrochemistry in Non-aqueous Solutions, Kosuke Isutzu, Wiley – VCH Verlag GmbH & Co. 2002
6. Dye-Sensitized Solar Cells, K. Kalyanasundaram (Ed), EPFL Press, 1st Edition 2010.
7. Electrochemical Systems, J. Newman, Wiley-Interscience, 3rd edition 2004

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3330	ADVANCED PHYSICAL CHEMISTRY-III	HC	2	1	0	3	4

Course objectives:

1. This course intends to make the students to understand topics like quantum chemistry and its application is in molecular architecture.
2. Bring awareness about the differences in Statistical Thermodynamics and non equilibrium thermodynamics and molecular motions.
3. To develop the ideas pertaining to molecular interactions in quantum level.
4. To build and utilize knowledge of macro molecules in the construction of new drug entities.

Course outcomes: After completion of the course student will,

1. Analyze the quantum mechanical aspects in the molecular dynamics.
2. Acquire knowledge on Schrodinger equation, particle in box, Characteristics of many electron systems.
3. Understand the statistical thermodynamics, non-equilibrium thermodynamics, Molecular forces, Electrical properties of molecules.
4. Construct ideas pertaining to the statistical thermodynamics and macro molecular interactions.

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
M19CH3330	**CO1**	**3**	**2**	**1**	**3**	**2**	**3**	**0**	**0**	**1**	**1**	**3**	**2**	**2**
	CO2	**3**	**2**	**1**	**1**	**2**	**2**	**0**	**0**	**1**	**1**	**3**	**2**	**2**
	CO3	**3**	**2**	**0**	**2**	**2**	**1**	**0**	**0**	**1**	**1**	**3**	**2**	**2**
	CO4	**3**	**2**	**3**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**3**	**2**	**2**

Course Content:

UNIT – I

Quantum Chemistry II: Solutions of Schrondinger equation for: free particle in 1D, finite and infinite potential wells, Particle in 3D box, Zero point energy significance, 1D Harmonic oscillator, selection rules in vibrational transitions

Many body problem, approximations, independent particle model, Perturbation method. Application to particle in 1D box of increasing potential, Helium atom, Self consistent field method, Hartee Equation and Hartee-Fock Equations. Pauli's exclusion principle, Symmetry and antisymmetry wave functions. Spin orbit coupling, Term symbols and spectral lines.

Characteristics of many electron systems, Born-Oppenheimer approximation, Valence bond and Molecular orbital theory, Electron density distribution and stability of H_2^+ ion. [15 hrs]

UNIT – II

Statistical Thermodynamics and non equilibirium thermodynamics:

Transitional, rotational, vibrational and electronic partition functions of diatomic molecules, Calculation of thermodynamic functions including chemical potential, equlibrium constant, salient features of Fermi-Dirac and Bose-Einstein statics.

Non equilibrium thermodynamics: Thermodynamic fluctuation around equilibrium, Entropy production, energy flux, thermodynamic flux, thermodynamic force, phenomenological laws and Onsagar reciprocity relations, Applications. [15 hrs]

UNIT – III

Molecular Interactions: Molecular forces, Electrical properties of molecules, electric dipole moments, Molar Polarization, Mosotti-Clausius and Debye-Langevin equation – their derivation, uses and limitations, Onsager equation, Ferro-electricity, Intermolecular forces, London dispersion force, Lennard-Jones potential, Nature of binding interactions in supramolecular structures: ion-ion, ion-dipole, dipole-dipole, H-bonding, cation-p, anion-p, p-p, and van der Waals interactions., Crystal engineering: role of H-bonding and other weak interactions. Dielectric effects in absorption and emission spectra in solution, Lippert equation. Molecular interaction in liquids. [15 hrs]

UNIT – IV

Macromolecules: Introduction, Classification, Nomenclature, Different structures, Viscosity, Molecular weight determination, Flory-Huggins theory, Amorphous and semicrystalline states, glass transition and related theories, melt transition, viscoelasticity, Maxwell-Voight models, Rubber elasticity – thermodynamic theories. Macromolecule motion. Kinetics and mechanism of addition and condensation polymerisation, Biological macromolecules, Properties of macromolecules. [15 hrs]

Reference Books:

1. Quantum Chemistry – A.K. Chandra. 2nd edition, Tata McGraw Hill Publishing Co. Ltd., (1983).
2. Quantum Chemistry – Eyring, Walter and Kimball. John Wiley and Sons, Inc., New York.
3. Quantum Chemistry – I.N. Levine. Pearson Education, New Delhi, (2000).
4. Theoretical Chemistry – S. Glasstone. East West Press, New Delhi, (1973).

5. Quantum Chemistry – R.K. Prasad, New Age International Publishers, (1996).
6. Statistical Thermodynamics by I.M. Klotz.
7. Introduction to Statistical Thermodynamics by M. Dole, Prantice Hall, (1962).
8. Statistical Themodynamics by B.C. Meclelland, Chapman and Hall, London (1973).
9. Physical Chemistry by P.W. Atkins, ELBS, 4th edition, Oxford University Press (1990)
10. Elements of Physical Chemistry, S. Glasstone, MacMillan.11. Thermodynamic Properties of Nonelectrolyte Solutions, Acree W.E., (Academic Press, 1984)
12. Chemical Thermodynamics: Advanced Applications, J. Bevan Ott, Juliana Boerio-Goates, (Academic Press, 1st edition, 2000).
13. The Molecular Theory of Solutions, Prigogine, (North Holland Publishing Co. Amsterdam 1957).
14. Molecular Theory of Solutions, Arieh Ben-Naim, (Oxford University Press, USA, 2006).

SOFTCORE-01

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3341	POLYMER SCIENCE AND TECHNOLOGY	SC	2	1	0	3	4

Course objectives:

This course aims to provide the student to

1. Demonstrate the knowledge of the basic concept of polymer, analysis of molecular weight of polymer.
2. Explore physical factors of polymers, analysis of glass transition temperature of polymer, Thermodynamic equation of polymer.
3. Create broad knowledge on polymer classification, mechanism of polymerization, instrumentation method of polymer characterization.
4. Acquire broad knowledge of polymers for medical, environmental, catalysis and device applications.

Course Outcomes:

By the completion of course student will be able to

1. Basic of polymer, analysis.
2. Physical factors, analysis, equations.
3. Classification, mechanism, techniques.
4. Applications, environmental.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3341	**CO1**	**2**	**1**	**0**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**1**
	CO2	**2**	**0**	**0**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**1**
	CO3	**2**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**1**
	CO4	**2**	**0**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**2**	**1**

Course Content:

UNIT – I

Basic concepts - classification, nomenclature, molecular weights, molecular weight distribution, glass transition, degree of crystallinity, morphology, and viscosity-molecular weight, mechanical property - molecular weight relationships.

Molecular weights and Methods of determination, molecular weight distribution, size and shape of macromolecules. Intrinsic viscosity, Mark-Houwink relationship.

Chain structure and configuration, conformation, size of an ideal chain (freely jointed chain and other models), Real chains, Flory theory. [15 hrs]

UNIT – II

Thermodynamics of polymer solutions; Molecular motion (self-diffusion, hydrodynamic radius, Rouse Model, Zimm Model, entangled polymer dynamics and de Gennes reptation model).

Glass transition temperature – elementary theories and methods of determination. Variation of glass transition with structure.

Rubber elasticity - concepts, thermodynamic equation of state. Elementary theories of viscoelasticity (Maxwell, Voight). [15 hrs]

UNIT – III

Classification of polymers, Structure- property relationship, Mechanisms and Methods of Polymerization - Step (condensation) polymerization - Description - Reactivity Functional Groups - Kinetic and thermodynamic considerations - Molecular weight distribution. Chain polymerization, controlled radical polymerizations (INIFERTER, ATRP, RAFT, SET). Living Polymerizations. Ziegler-Natta and metathesis polymerizations. Kinetics and mechanism of addition and condensation polymerisation, Moulding and fabrication of polymer.Introduction to Instumental methods for characterisation of polymers. [15 hrs]

UNIT – IV

Applications of Polymers: Electrically conductive polymers, Charge transport mechanism, Photoactive polymers, OLED, polymers energy conversion devices, corrsion prevetion, Thermal resistant polymers, catalysis, medical prothesis, Metallopolymers, metalloorganic frameworks, applications, biodegradable polymers, degradation pathways, environmental effects. [15 hrs]

Reference Books:

1. Polymer Structure, Properties and application, R.D. Deanin, American Chemical Society, 1974.
2. Relating Materials, Properties to Structure; Handbook and Software for Polymer calcilations and Materials Properties, D. J. david and Ashok Mishra, Technical Publishing Componey, Inc, 1999.
3. Properties of Polymer; Correlations with Chemical Structurees and their numerical Estimation and Predication from Additive Group Contribution van Krevelen, Elsevier Publication Company, 1990.
4. Relating Materials Properties to structure, D. J. David, Technical Publishing Company Inc, 1999.
5. Polymer Chemistry, C. E. Carrshar, Marcel Dakker Inc, 2003.
6. Physical chemistry of Polymers, A. Tager, Mir Publishers, 1978.
7. Polymer Association Structures M. A. EL-Nokally, American Chemical Society, 1989.
8. Polymer Solutions; Introduction to Physical Properties, Teraoka, Iwao, John Wiley and Sons. Inc, 2002.
9. Polymer Chemistry; An Introduction, M. P. Stevens, Oxford University Press, 1990.

10. Text book of Polymer Science by Billmeyer, John Wiley ans Sons 1984.
11. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
12. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
13. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
14. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Inter Science Publication, 1977.

SOFTCORE-02

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3342	ENERGY AND ENERGY CONVERSION SYSTEMS	SC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Fundamental importance of energy and energy conservation required to have sustainable life.
2. The present situation of the availability non-renewable energy resources and reason to shift over to renewable energy sources.
3. The different renewable energy sources and how to make use of them for our day to day life.
4. Methods involved in converting and storing of the renewable energy sources for the continuity supply of energy.

Course outcomes:

By the completion of course student will be able to

1. Explore the Renewable and non-renewable energies, their advantages and disadvantages, Environmental effects.
2. Analyse the status of the renewable and non-renewable sources in the world and discuss the importance of renewable sources
3. Acquire the knowledge of renewable sources and list out the different renewable sources to convert, store, and usage in daily life.
4. Evaluate the efficiencies of solar cells, electrochemical energy conversion (HER and OER), storage (batteries, and supercapacitors) and fuel cells with their examples.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3342	**CO1**	**2**	**1**	**2**	**0**	**1**	**2**	**0**	**1**	**0**	**1**	**0**	**0**	**0**
	CO2	**1**	**0**	**1**	**0**	**1**	**2**	**1**	**1**	**0**	**0**	**1**	**1**	**1**
	CO3	**3**	**1**	**2**	**0**	**2**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**1**
	CO4	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**	**0**	**1**	**2**	**3**	**2**

Course Content:

UNIT – I

Energy systems - Available energy options, Renewable and non renewable, their advantages and disadvantages. Environmental effects, comparative evaluation of energy options and energy needs.

Fossil fuels: petroleum, natural gas and coal - Origin, processing and production of value added products - available current conversion technologies.

Nuclear Energy: Principles of Fission - Fission reactors, U enrichment and processing of spent fuels. Nuclear reactor kinetics and control - nuclear fusion - magnetic and other confinement - evaluation of the option of nuclear energy. [15 hrs]

UNIT – II

Electrochemical power sources - theoretical background on the basis of thermodynamic and kinetic considerations.

Primary cells - various types, especially magnesium and aluminum based cells - magnesium reserve batteries.

Secondary cells: classification based on electrolyte type, temperature of operation on the basis of electrodes - chemistry of the main secondary batteries - Batteries for electric vehicles - present status. [15 hrs]

UNIT – III

Fuel cells - classification - chemistry of fuel cells - detailed description of hydrogen/oxygen fuel cells - methanol - molten carbonate, solid oxide fuel cells solid polymer electrolyte and biochemical fuel cells.

Hydrogen as a fuel - production (thermal, electrolysis, photolysis and photoelectrochemical) storage and applications of hydrogen storage.

Other methods of energy conversion: processes especially in the form of storage as chemical energy. [15 hrs]

UNIT – IV

Semiconducting materials, Solar energy conversion devices, principle, Photoconversion processes - photovoltaic cells - photoelectrochemical cells - semiconductor electrolyte junctions photocatalytic modes for fuel conversion process - photobiochemical options. [15 hrs]

Reference Books:

1. C. A. Vincent Modern Batteries, Edward Arnold, 1984.
2. R. Narayanan and B. Viswanathan, Chemical and Electrochemical energy systems, Orient Longmans, 1997.
3. K. Sriram, Basic Nuclear Engineering, Wiley Eastern, 1990.
4. A. S. J.. Appleby and F. K. Foulkes, Fuel cell Hand Book, Von Nostrand Reinhold, 1989.
5. D. Linden, Hand book of batteries and Fuel cells, McGraw Hill Book Company, 1984.
6. T. Ohta, Solar Hydrogen energy systems, Peragamon Press, 1979.
7. M. Gratzel, Energy Resources through photochemistry and catalysis, Academic Press, 1983.
8. T. Ohta, Energy Technology, Sources, Systems and Frontiers conversions, Pergamon, 1994.
9. J. G. Speight, The chemistry and technology of petroleum, Marcel Dekker Inc. 1980

SEMESTER-III

ANALYTICAL CHEMISTRY **HARD CORE COURSES**

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3410	ADVANCED ANALYTICAL CHEMISTRY	HC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. To understand the separation and extraction of compounds by different methods
2. Exposure to the various analytical techniques for the detection of elements in the solution
3. Highlights and study of instrumental techniques such as Atomic and atomic Spectroscopy.
4. Development of sensors, optical, biosensors and their types correlation with basic instrument

Course outcomes:

By the completion of course student will be able to

1. Identification of the elements and their properties by using instrumental methods.
2. Explain the various extraction methods involved during the separation of the compounds.
3. Elaborate the principle, instrumentation and applications of various analytical and spectroscopic techniques.
4. Design the detectable concentration of a given specific analytes.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3410	**CO1**	**3**	**2**	**0**	**2**	**3**	**0**	**0**	**0**	**1**	**2**	**3**	**3**	**3**
	CO2	**2**	**2**	**1**	**3**	**3**	**2**	**0**	**0**	**1**	**2**	**3**	**2**	**3**
	CO3	**3**	**3**	**0**	**3**	**3**	**1**	**0**	**0**	**1**	**2**	**4**	**3**	**2**
	CO4	**4**	**3**	**1**	**3**	**3**	**1**	**0**	**0**	**1**	**2**	**4**	**4**	**3**

Course Content:

UNIT-I

Classical approach for aqueous extraction: Introduction, Liquid-Liquid extraction (LLE) (Theory of LLE, selection of solvents, solvent extraction, problems with LLE process), purge and trap for volatile organics in aqueous samples.

Solid Phase extraction (SPE): Introduction, Types of SPE media, SPE formats and apparatus, method for SPE operation, solvent selection, factors affecting SPE, selected methods of analysis for SPE, Automation and On-Line SPE. Microwave assisted extraction: Introduction, instrumentation, Applications. [15Hrs]

UNIT-II

Atomic Spectroscopy: Theory, sources, burners, atomic emission spectra, atomic absorption spectra, effect of temperature on emission, absorption and fluorescence, electro thermal atomizers, Instrumentation for FES, radiation sources atomic absorption methods, instrumentation for AAS, spectral interferences, standard addition and internal standard method of analysis, comparison of atomic absorption and emission methods, inductively coupled plasma and direct current plasma emission

spectroscopy, Cold vapor technique, Applications of AAS, AES and ICPAES, analysis of micronutrients like Mo, B, Cu, Zn essential towards the healthy growth of crops, fruits, determination of these micronutrients from soils, plants and fruits. [15Hrs]

UNIT-III

Atomic Mass Spectroscopy: Features of atomic mass spectroscopy, Atomic weight in mass spectroscopy, mass to charge ratio, Types of atomic mass spectroscopy, mass spectrometers, transducer for mass spectroscopy, qudrapole mass analyzer, time of flight mass analyzer, inductively coupled mass spectroscopy (ICPMS), Instrumentation for ICPMS, Atomic mass spectra and interferences, Applications of ICPMS.

Atomic Fluorescence, Resonant Ionization and laser based-Enhanced Ionization:

Atomic Fluorescence Spectroscopy (AFS): Atomic fluorescence, apparatus for AFS, EMR source for AFS, LASERS, Cells for AFS, Plasmas, Wavelength selection for AFS, Detectors for AFS, Theory of AFS, Analysis with AFS, Interference With AFS. Resonanant Ionization Spectroscopy, Laser-enhanced ionization spectroscopy. [15Hrs]

UNIT-IV

Chemical Sensors: Introduction, definitions, Classification of chemical sensors, descriptions of chemical sensors (electrochemical sensors, potentiometric sensors, voltametric chemical sensors, sensors based on conducting properties), Optical sensors (light guides, the evanescent wave, design of fiber optic sensor, indicator mediated sensor), Calorimetric sensors (catalytic gas sensor, thermal conductivity sensor), mass sensor (piezoelectric quartz crystal resonator, surface acostic wave sensor).

Biosensors in analysis: Introduction, producing biological surface, Achievement of biotransduction (amperometric, potentiometric, optical). [15Hrs]

Reference Books:

1) Introduction to Instrumental Analysis by R. D. Broun, Mc Graw Hill (1987)
2) Instrumental methods of chemical analysis by H. willard, L.Merrit, J.A. Dean and F.A. settle. Sixth edition CBS (1986)
3) Fundamentals of Analytical Chemistry, 6 edition, D.A. Skoog, D.M. West and F.J. Holler, Saunders college publishing.
4. Principles of Instrumental Analysis, Skkog, Holler, Nieman, (Sixth Ed.)
5) Vogel's Textbook of Quantitative analysis 6th Ed.
6) Modern analytical techniques in the pharmaceutical and bio analysis By Dr. Istvan Bak (Book Available Online).
7) Preparative chromatography Chrome Ed. book series, Raymond P. W. Scott (free e book available on internet)
8) Extraction technique in analytical science, John R. Dean, Wiley (2009)
9) Practical HPLC method Development, Snyder, Kirkiand, Glajch, Wiley India Pvt.Ltd.
10) Standard methods of chemical analysis, Sixth Edition, F.J. Welcher.
11) Quantitative Inorganic Analysis including Elementary Instrumental analysis, By A. I. Ed Vogel, 3, ELBS, 1964.
12) Instrumental methods of analysis, R. D. Braun
13) Analytical Chemistry, Ed. by Kellner, Mermet, otto, Valcarcel, Widmer, Second Ed. Wiley –VCH

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3420	ADVANCED SURFACE ANALYSIS AND ELECTRON SPECTROSCOPY	HC	2	1	0	3	4

Course Objective:

This course aims to provide the student to

1. Explain emerging trends in nanotechnology and scope of other materials like zeolites
2. Discuss the various techniques involved in synthesis of ceramics and nanomaterials
3. Make use of different spectroscopic techniques for chemical analysis
4. Analyse the applications of nanomaterials in various fields like agriculture, health, electronics, medical, food safety etc.

Course Outcome:

By the completion of course student will be able to

1. Discuss emerging trends in nanotechnology and scope of other materials like zeolites
2. Explain the various techniques involved in synthesis of ceramics and nanomaterials
3. Demonstrate the knowledge spectroscopic techniques for chemical analysis
4. List the application of nanomaterials in various fields like agriculture, health, electronics, medical, food safety etc.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3420	**CO1**	**3**	**3**	**1**	**0**	**2**	**1**	**0**	**0**	**0**	**2**	**2**	**4**	**3**
	CO2	**4**	**3**	**3**	**2**	**3**	**3**	**0**	**0**	**1**	**2**	**3**	**4**	**2**
	CO3	**2**	**1**	**3**	**3**	**3**	**2**	**0**	**0**	**1**	**2**	**3**	**4**	**3**
	CO4	**1**	**3**	**3**	**2**	**3**	**3**	**0**	**0**	**1**	**2**	**2**	**4**	**2**

Course Content:

UNIT-I

Scope of materials science: Types of materials based on structure (i) layered materials (clays, MoS2, LDH) (ii) Porous materials: Microporous (zeolites), Mesoporous materials (MCM-41) (iii) Metal Organic Frameworks and dendrimers. (structure and applications in each case need to be discussed)

Introduction and definition of nanoparticles and nanomaterials, emergence of nanotechnology, Challenges of nanotechnology. Nanotechnology in relation to other branches of science.

Structure of solids: crystalline and non-crystalline. Types of common materials and advanced materials inorganic, organic, biological. Types of nanomaterials depending upon their properties: electronic, semiconductors, superconductors, superionic, magnetic, optic, opto-electronic, spintronics, ceramics.

[15 Hrs]

UNIT-II

Preparation techniques

Principles of solid state synthesis-ceramic methods, solid solution and compound precursors, sol- gel, spray, pyrolysis, and combustion, hydrothermal, electrosynthesis.

Preparation of nanoscale materials: Precipitation, mechanical milling, colloidal routes, self assembly, chemical vapour deposition, sputtering, evaporation.

Overview of inorganic functional materials, their properties and applications. Crystal structure and amorphous materials. Defects and non-stoichiometric solid solutions. Band theory and electronic

conductivity. Synthesis and processing of inorganic materials. Properties of inorganic materials: superconductivity, magnetic, dielectric and optical properties. [15Hrs]

UNIT-III

Electron spectroscopy: Introduction, principle of electron spectroscopy for chemical analysis(ESCA), ESCA satellite peaks, spectral splitting, ESCA chemical shifts, Apparatus used for ESCA, X-ray source, samples, Analyzers, Detectors, Chemical analysis using ESCA, Applications, Auger electron microscopy, Ultraviolet photoelectron spectroscopy.

X- ray Methods of Analysis: Principle, Theory- X-ray spectral lines, X-ray tube, X-ray emission, Absorptive apparatus: Sources, Collimation, sample handling, wavelength dispersive devices, Energy dispersive devices, detectors, readout device, Chemical analysis using X-ray absorption, X-ray Fluorescence- instrumentation and chemical analysis, X-ray Diffraction, Chemical analysis with X-ray diffraction, numerical problems. [15 Hrs]

UNIT-IV

Characterization techniques: Principle, technique and specific applications of Electron microscopy (TEM and SEM), Atomic Force Microscopy, Photoelectron spectroscopy (XPS and Auger spectroscopic techniques), BET surface area, porosity, solid state NMR (introduction) and applications.

Nanotechnology in modern technology in relation to electronic, biological, consumer and domestic applications. Energy related application: photo-volatile cells. Energy storage nanomaterials. Sensors: Agriculture, health and medical, food, security. Applied nanobiotechnology and nanobiomedical science drug delivery, drug targeting, biosensors, bioimaging, neutron capture therapy. [15Hrs]

Reference Books:

1. Encylopedia of nanomaterials and nanotechnologies, H. S. Nalva.
2. Nanostructures materials: Processing, Properties and applications, C. C. Kouch, William Andrew publications, Newyork, 2002.
3. Introduction to nanotechnology, C. P. Poole Jr, F. J. Owens, 2nd edition, Wiley-India, Delhi, 2008.
4. Nanostructures and nanomaterials, G. Cao, Imperial College Press, University of Washington, USA, 2004.
5. Biomaterials, S. V. Bhat, 2nd edition, Narasa Publishing house, New Delhi, 2005.
6. Nanotechnology Fundamentals and applications, M. Karkare, I. K. international publishing house pvt. Ltd., Bangalore, 2008.
7. Nanomaterials: Synthesis, properties and applications, A. S. Edelstein, T. C. Cammarata, Inst. Of. Physics, UK, 1966.
8. Springer Handbook of Nanotechnology, B. Bhusan, 3rd edition, Springer-Verlag, 2009.
9. Chemistry of Nanomaterials: Synthesis, Properties and Applications, CNR Rao and T. Cheetham, Wiley & Sons, 2005.
10. Encyclopedia of Nanotechnology, Hari Singh Nalwa, American Scientific Publishers, 2004.

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3430	FUNDAMENTALS OF ELECTROANALYTICAL TECHNIQUES	HC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Conclude the different types of conductivities dealt in electrode system which are involved in the determination of properties of electrolytes.
2. Defend the following topics: pulse polarography, coulometry, polarography Types of electrodes and systems, redox systems, membrane electrodes, double layer, theories related to electrochemistry, electrochemical interfaces.
3. Analysis the importance of electrochemistry, their economic importance, chemical principles and challenges in energy storage devices.
4. Develop practical skills to design the industrially important energy materials by the acquired the knowledge from principles of electrochemistry.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

1. Illustrate the chemical reactions involved in the determination of conductivities related to different systems.
2. Conclude the reactions and solve problems relating to the energy production process in electrochemistry written and verbal.
3. Analyze the energy storage device designed by industry with suitable technique.
4. Understand the emissions of materials related to environmental issues pertaining to the manufacturing industry.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3430	**CO1**	**2**	**1**	**0**	**1**	**1**	**1**	**0**	**1**	**0**	**1**	**1**	**1**	**2**
	CO2	**1**	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**0**	**1**	**2**	**2**	**1**
	CO3	**1**	**2**	**1**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**1**
	CO4	**2**	**1**	**1**	**3**	**1**	**3**	**3**	**1**	**1**	**0**	**1**	**1**	**1**

Course Content:

UNIT-I

Electrolytic conductance, specific, equivalent and molar conductance, cell constant, conductometric titrations. Theory of potentiometry, calculation electrode potential at the equivalence. Finding of equivalence volume, derivative and linear titration plots. Ion-sensitive electrodes –types of ion sensitive electrodes–metal based cation and anion sensitive electrodes, solid membrane electrodes, glass electrodes. Liquid ion-exchange electrodes, gas sensing membrane lectrodes, Electrochemical cell, electrodes: reference and indicator electrodes, membrane electrodes, electrode-solution interface layer, gas-sensing probe, electrolytic process. [15Hrs]

UNIT-II

Coulometry: Current voltage relationship during an electrolysis, Operating cell an at fixed applied potential, Electrolysis at constant working electrode potential, Coulometric methods of analysis,

Faradays laws of electrolysis, Instrumentations-Constant current and constant voltage instruments, potentiostatic coulometry-Instrumentation and applications, coulometric titrations (Amperostatic coulometry)-Apparatus and applications, advantages and limitations, problems.
Electrochemical interfaces – electrical double layer – Lippmann equation, Helmholtz and Gouy – Chapman – Stern models of the double layer, Modern theories of electrical double layer, Adsorption of ions and dipoles. [15Hrs]

UNIT-III

Polarography: Polarographic principles, Instrumentation (different types of microelectrode such as dropping mercury electrode, the static drop Mercury electrode, rotating disc and ring disc electrode, cell for polarography, reference and counter electrode and circuit diagram), polarogram and polarographic currents, charging or capacitive current, role of supporting electrolyte, factors affecting on polarographic wave, Ilkovic Equation, advantages and disadvantages of DME, polarographic maxima and maxima suppresors, interference due to dissolved oxygen, Applications (qualitative analysis, quantitative analysis by calibration curve and standard addition methods), specific examples of analysis – analysis of Cu, Cd, Zn, Pb, etc. from tap water and alloys. Hydrodynamic voltametry and applications of hydrodynamic voltammetry: volatametric detectors in chromatography and flow injection analysis, Voltametric oxygen sensor. [15Hrs]

UNIT-IV

Pulse Polarography: different types of excitation signals in pulse polarography, Differential pulse polarography, square wave polarography, Stripping method. Voltametry with ultra microelectrode, Applications of these technique Cu and Zn from tap water by differential pulse polarography and by square wave polarography, Vitamin-C by differential pulse polarography, Determination of Pb in tap water by stripping method) D) Cyclic Voltametry: Principle of cyclic Voltammetry, cyclic voltamogram of K3[Fe(CN)6], and parathion, criteria of reversibility of electrochemical reactions, quasi- reversible and irreversible processes.
Amperometry: Principle, Instrumentation, typical applications, amperometric titrations, chrono-amperometry and chrono-potentiometry. [15Hrs]

Reference Books:

1) Introduction to instrumental analysis by R. D. Broun, Mc Graw Hill (1987)
2) Instrumental methods of chemical analysis by H. willard, L.Merrit, J.A. Dean and F.A. settle. Sixth edition CBS (1986)
3) Fundamentals of analytical chemistry by D. A. Skoog, D. M. West and H. J. Holler sixth edition (1992) and Principles of Instrumental Analysis Skoog, West, Niemann.
4) Vogel Text Book of quantitative analysis 6 Ed.
5) J. chemical education, 60,302 to 308 (1983)
6) Thermal analysis by W.W. Wendlandt, John Wiley, (1986)
7) Cyclic Voltammetry and frontiers of electrochemistry by N.Noel and K.I. Vasu IBH, New Delhi (1990)
8) Source book of Atomic energy by Glasstone.
9) Principle of Activation Analysis- P. Kruger, John Wiley and sons, (1971).
10) Nuclear Analytical Chemistry – J. Tolgyessy and S. Verga vol. 2, University Park press (1972)

SEMESTER III –SOFT CORE -1

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 3441	ENVIRONMENTAL CHEMISTRY AND APPLIED ANALYSIS	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Demonstrate a knowledge and understanding of the basic facts and experimental basis of environmental chemistry.
2. Develop an understanding of how chemists approach and attempt to solve environmental problems.
3. Review the basic principles of analytical procedures to analyze food constituents and Evaluate quality control results and estimation of vitamins, lipids and other minerals.
4. Describe the mechanism of drug molecules, principles and procedures of various tests performed in Clinical Chemistry laboratory.

Course Outcomes:

By the completion of course student will be able to

1. To create environmental awareness to understand the vulnerability and sensitivity of environment. To promote a sense of responsibility and proactive citizenship.
2. Recognize different types of toxic substances, their responses and analyze toxicological information and implement pollution monitoring techniques.
3. Illustrate the major chemical reactions occurring during processing and storage of food and method of analysis of various minerals in vitamins and also the estimation of lipids.
4. Construct the mechanism of drug interaction and interpretation of clinical data.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19C H 3441	**CO1**	3	3	1	0	1	3	3	1	1	3	0	1	0
	CO2	1	3	2	2	1	1	1	1	0	1	0	1	1
	CO3	1	3	1	1	1	2	2	0	0	1	1	3	1
	CO4	1	2	3	3	3	1	1	1	0	1	2	3	2

Course Content:

UNIT – I

Environmental Chemistry: Introduction: Environmental chemistry, environmental segments classification of environmental pollution.

Air Pollution: Introduction, Air pollutants, Primary pollutants,Sources (CO, NOx, HC, SO_2,and particulates). Particulates–Sources (Inorganic and organic particulate matters).

Effects on: Humans, materials, vegetation and animals. Air quality standards, Sampling, monitoring and analysis: CO by gas chromatography, NOx by Spectrophotometric method using sulphanilamide and NEDA, SO_2 by pararosaniline (PRA), H_2S by colorimetric using ethylene blue, hydrocarbons by chemiluminescence, control of air pollution: Control of particulate matter and gaseous pollutants.

Radioactive Pollution: Introduction, Sources, Radiation from natural and manmade activities, radioactive effects on human and plants, Storage and disposal of radioactive waste, Detection and monitoring of radioactive pollutants. [15 Hrs]

UNIT-II

Water Pollution: Introduction, Sources, Water pollutants classification: Organic pollutants –Pesticides, insecticides, detergents. Inorganic pollutants, Sediments, Radioactive materials and Thermal pollutants. Drinking water supplies, Trace elements in water. COD, BOD, TOC-definitions. Monitoring techniques and methods: Determination of pH, conductance, dissolved oxygen by Winkler's method, nitrate/nitrite by diazo coupling, chloride by Mohrs and Volhard's method, and fluoride by Alizarin Visual method, Water contamination with cyanide, sulfide, sulphate, phosphate and total hardness. Analysis of Arsenic by Atomic absorption spectroscopy (AAS), cadmium and mercury by dithizone method, chromium by diphenyl carbazide method, lead by polarographic method. Water pollution control and management.

Soil Analysis: Introduction, Origin and nature of soil, Sources of soil pollution and explanation in brief, Purpose of soil analysis, Techniques for the analysis of soil Lime Potentials: Moisture measurement by gravimetric method, pH using calomel glass electrode method, total nitrogen by kjeldhal method, determination of nitrate nitrogen by Bratton and Marshal method, determination of potassium and sodium by Flame photometry, calcium by EDTA titration ,organic matter by combustion, total sulphur by oxidation as sulphate. [15 Hrs]

UNIT - III

Food Analysis: Sampling, Preparation and storage of samples, Estimation of moisture, ash, crude protein, crude fat, sugars, nitrogen, crude fibre, starch in food. Polyphenols: Extraction, detection and analysis, characterization and spectral identifications of anthocyanins and anthocyanidins. Estimation of Tannins.

Vitamins: Estimation of Vitamin-C (Ascorbic acid), Thiamine, Riboflavin, Folic acid Minerals: Preparation of sample, Estimation of calcium, Magnesium, phosphorus, iron, potassium, sodium, copper, tin, zinc, lead, arsenic, mercury.

Lipids: General composition of edible oils, Physical and chemical characteristics. Composition and structure of free fatty acids. Test for the presence of specific oils: Ground nut oil, Sesame oil, cottonseed oil, linseed oil, argemone oil, presence of mineral oil, Fatty acid analysis. Estimation of fatty acid composition, tests for stability of fats. [15 Hrs]

UNIT-IV

Analysis of Drugs: Drug design: Characteristics of an ideal drug molecule, mechanism of drug interaction, Antibiotics, classification and structure, mode of action, Theory and assay of Aspirin(titrimetry), methyldopa (nonaqueous titrimetry), Analgin(iodimetry), chloral hydrate (argentiometry), cholesterol (gravimetry), hydrocortisone acetate (tetrazolium assay). Clinical Chemistry: Composition of blood, collection, and preservation of samples- anticoagulants, proteinprecipitants. Interpretation and Clinical analysis of Blood glucose(glucose oxidase methods), proteins, blood urea (Nesslerisation method). Lipids, Calcium, phosphorus, phosphatases, iodine, iron, copper, Sulfur, Magnesium, Chloride, sodium and potassium. [15 Hrs]

Reference Books:

1. Dr. H. Kaur, Environmental Chemistry (2010)
2. Khopkar. S. M, Environmental pollution, monitoring and control, IIT Mumbai (2004)
3. Asim K. Das, Environmental Chemistry with Green Chemistry (2010)
4. P. R. Hesse, A text book of Soil Chemical Analysis (2002)
5. A. K. De, Environmental Chemistry (7th edition), Uttarpara West Bengal (2010)

6. N. Manivasakam, Physico chemical examination of water, sewage and industrial effluents (6th edition 2010)
7.Hand book of Analysis and Quality control for fruit and vegetable products. S Ranganna, Tata McGraw-Hill Publishing Co. Ltd, Second Edition
8. Pharmaceutical Drug Analysis. AshutoshKar, New Age International Publishers
9. Practical Clinical Biochemistry, Harold Varley, Fourth Edition
10. Food Analysis, A G Woodman, McGraw-Hill
11. Principles of Medicinal Chemistry Vol 1, Dr. S S, Kadam, Dr. K R Mahadic, Dr. K G Bothara, Niraliprakashan.

SOFTCORE-02

Course Code	**Course Title**	**Type**	L	T	P	C	Hrs/Week
M19CH 3442	WATER CHEMISTRY AND TREATMENT TECHNOLOGY	SC	2	1	0	3	4

Course Objectives:

This course aims to provide the student to:

1. Determine the basic concepts of water pollution, various water analysis methods like COD, BOD, TOC, hardness and properties of water.
2. Analyze the estimation of dissolved oxygen, alkalinity, acidity and chlorides in water, Water treatment for domestic purpose.
3. Define the Ion-Exchange and Permutit processes, Lime soda process.
4. Conclude the Biological relevance of pH and pKa of functional groups in biopolymers, proteins and nucleic acids.

Course Outcomes:

By the completion of course student will be able to

1. Differentiate between the Organic pollutants and Inorganic pollutants
2. Acquired the knowledge about Acid-base reactions and alkalinity/acidity to solve problems associated with water/wastewater treatment and natural water quality.
3. Explain the hardness of water and their internal and external treatment
4. Analyze Properties of water and Buffers, pH value of various bio-entities

Mapping of Course Outcomes with programme Outcomes

Course Code	**POS/ COs**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PS O1**	**PS O2**	**PS O3**
M19CH 3442	**CO1**	**1**	**2**	**1**	**0**	**0**	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**0**
	CO2	**1**	**2**	**1**	**2**	**0**	**2**	**1**	**0**	**1**	**1**	**1**	**0**	**1**
	CO3	**2**	**2**	**1**	**1**	**0**	**2**	**1**	**1**	**0**	**0**	**1**	**0**	**1**
	CO4	**3**	**1**	**1**	**0**	**1**	**2**	**1**	**1**	**0**	**0**	**1**	**0**	**1**

Course Content:

UNIT-I

Introduction, Sources, Water pollutants classification: Organic pollutants –Pesticides, insecticides, detergents. Inorganic pollutants, Sediments, Radioactive materials and Thermal pollutants. Drinking water supplies, Trace elements in water. COD, BOD, TOC-definitions. Monitoring techniques and

methods: Determination of pH, conductance, dissolved oxygen by Winkler's method, nitrate/nitrite by diazo coupling, chloride by Mohrs and Volhard's method, and fluoride by Alizarin Visual method, Water contamination with cyanide, sulfide, sulphate, phosphate and total hardness.Analysis of Arsenic by Atomic absorption spectroscopy (AAS), cadmium and mercury by dithizone method, chromium by diphenyl carbazide method, lead by polarographic method. Water pollution control and management. [12Hrs]

UNIT-II

Determination of Hardness of water and its Units, Disadvantages of hard water, Estimation of hardness by EDTA method, Numerical problems on hardness, Estimation of dissolved oxygen, Alkalinity, acidity and chlorides in water, Water treatment for domestic purpose (Chlorination, Bleaching powder, ionization)

Industrial Use of water: For steam generation, troubles of Boilers: Scale & Sludge, Priming and Foaming, Caustic Embrittlement and Boiler Corrosion. [12Hrs]

UNIT-III

Treatment of Boiler Feed water:

Internal Treatment: Colloidal, Phosphate, Carbonate, Calgon and sodium aluminate treatment.

External Treatment: Ion-Exchange and Permutit processes, Lime soda process.

Demineralization of brackish water: Reverse Osmosis and Electro dialysis Determination of turbidity of wastewater, Total solids, volatile solids and fixed solids of wastewater, nitrogen, Phosphorous from waste water. [12Hrs]

UNIT-IV

Properties of water: Ionic product of water and its measurements. Importance of water in biological system with special reference to the maintenance of the native structure of biological molecules. Types of bonding in biological molecules. Biological relevance of pH and pKa of functional groups in biopolymers, proteins and nucleic acids. Buffers, pH value of various bio-entities, buffer action, buffer capacity and their importance in biological systems. Isoelectric points for amino acids. Titration of proteins and preparation of buffer.

Karl-Fischer titrations: Stoichiometry of the reaction, preparation of the reagent, titration method, standardization of the reagent using water-in-methanol, determination of water in samples, interference and their elimination, application to quantitative analysis of some organic compounds- alcohols, carboxylic acids, acid anhydrides and carbonyl compounds. [12Hrs]

Reference Books:

1. A Text Book of Enigneering Chemistry, Jain and Jain, Dhanapathi Rai Publications, New Delhi
2. Engineering Chemistry by K.B.Chandra Sekhar, UN.Das and Sujatha Mishra, SCITECH, Publications India Pvt Limited.
3. Concepts of Engineering Chemistry- Ashima Srivastavaf and N.N. Janhavi
4. Text Book of Engineering Chemistry – C. Parameswara Murthy, C.V.Agarwal and Andra Naidu
5. Chemistry of Engineering Materials, C.V.Agarwal, C.Parameswaramurthy and Andranaidu
6. Text Book of Engineering Chemistry, Shashichawla, Dhanapathirai Publications.

OPEN ELECTIVE FOR PG STUDENTS OF DISCIPLINES OTHER THAN CHEMISTRY

(Offered by School of Applied Sciences - Chemistry)

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 3050	WATER CHEMISTRY AND TREATMENT	3	1	0	4	5

Course Objectives:

This course aims to provide the student to:

1. Determine the basic concepts of water pollution, various water analysis methods like COD, BOD, TOC, hardness and properties of water.
2. Analyze the estimation of dissolved oxygen, alkalinity, acidity and chlorides in water, Water treatment for domestic purpose.
3. Define the Ion-Exchange and Permutit processes, Lime soda process.
4. Conclude the Biological relevance of pH and pKa of functional groups in biopolymers, proteins and nucleic acids.

Course Outcomes:

By the completion of course student will be able to

1. Differentiate between the Organic pollutants and Inorganic pollutants
2. Acquired the knowledge about Acid-base reactions and alkalinity/acidity to solve problems associated with water/wastewater treatment and natural water quality.
3. Explain the hardness of water and their internal and external treatment
4. Analyze Properties of water and Buffers, pH value of various bio-entities

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 3050	CO1	1	2	1	0	0	1	1	1	0	0	1	0	0
	CO2	1	2	1	2	0	2	1	0	1	1	1	0	1
	CO3	2	2	1	1	0	2	1	1	0	0	1	0	1
	CO4	3	1	1	0	1	2	1	1	0	0	1	0	1

Course Content:

UNIT-I

Introduction, Sources, Water pollutants classification: Organic pollutants –Pesticides, insecticides, detergents. Inorganic pollutants, Sediments, Radioactive materials and Thermal pollutants. Drinking water supplies, Trace elements in water. COD, BOD, TOC-definitions. Monitoring techniques and methods: Determination of pH, conductance, dissolved oxygen by Winkler's method, nitrate/nitrite by diazo coupling, chloride by Mohrs and Volhard's method, and fluoride by Alizarin Visual method, Water contamination with cyanide, sulfide, sulphate, phosphate and total hardness. Analysis of Arsenic by Atomic absorption spectroscopy (AAS), cadmium and mercury by dithizone method, chromium by diphenyl carbazide method, lead by polarographic method. Water pollution control and management. [12Hrs]

UNIT-II

Determination of Hardness of water and its Units, Disadvantages of hard water, Estimation of hardness by EDTA method, Numerical problems on hardness, Estimation of dissolved oxygen, Alkalinity, acidity and chlorides in water, Water treatment for domestic purpose (Chlorination, Bleaching powder, ionization)

Industrial Use of water: For steam generation, troubles of Boilers: Scale & Sludge, Priming and Foaming, Caustic Embrittlement and Boiler Corrosion. [12Hrs]

UNIT-III

Treatment of Boiler Feed water:

Internal Treatment: Colloidal, Phosphate, Carbonate, Calgon and sodium aluminate treatment.

External Treatment: Ion-Exchange and Permutit processes, Lime soda process.

Demineralization of brackish water: Reverse Osmosis and Electro dialysis

Determination of turbidity of wastewater, Total solids, volatile solids and fixed solids of wastewater, nitrogen, Phosporous from waste water. [12Hrs]

UNIT-IV

Properties of water: Ionic product of water and its measurements. Importance of water in biological system with special reference to the maintenance of the native structure of biological molecules. Types of bonding in biological molecules. Biological relevance of pH and pKa of functional groups in biopolymers, proteins and nucleic acids. Buffers, pH value of various bio-entities, buffer action, buffer capacity and their importance in biological systems. Isoelectric points for amino acids. Titration of proteins and preparation of buffer.

Karl-Fischer titrations: Stoichiometry of the reaction, preparation of the reagent, titration method, standardization of the reagent using water-in-methanol, determination of water in samples, interference and their elimination, application to quantitative analysis of some organic compounds- alcohols, carboxylic acids, acid anhydrides and carbonyl compounds. [12Hrs]

Reference Books:

1. A Text Book of Engineering Chemistry, Jain and Jain, Dhanapathi Rai Publications, New Delhi
2. Engineering Chemistry by K.B. Chandra Sekhar, UN.Das and Sujatha Mishra, SCITECH Publications India Pvt Limited.
3. Concepts of Engineering Chemistry- Ashima Srivastava and N.N. Janhavi
4. Text Book of Engineering Chemistry – C. Parameswara Murthy, C.V.Agarwal and Andra Naidu
5. Chemistry of Engineering Materials, C.V. Agarwal, C. Parameswaramurthy and Andranaidu
6. Text Book of Engineering Chemistry, Shashichawla, Dhanapathirai Publications.

SEMESTER-III RULO- INTERNSHIP / SKILL DEVELOPMENT

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M19CH 3060	INTERNSHIP / SKILL DEVELOPMENT	RULO	0	0	2	2	4

Note: The students will have to undergo Skill Development course being conducted by Training and Placement cell of the University.

SEMESTER-III PRACTICALS-III

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3070	INORGANIC CHEMISTRY PRACTICALS-III	HC	3	1	0	4	5

Course Objectives:

This course aims to provide the student to

1. The practical course on Inorganic chemistry intends to provide the students scientific skills in qualitative and preparative techniques.
2. Appreciate the importance of being systematic in life.
3. It also helps to develop honesty, punctuality, analytical reasoning, questioning, critical evaluation and thinking among students.

Course Outcomes:

By the completion of course student will be able to

1. Apply the practical knowledge in determination of strength of analyte.
2. Identify individual functional groups present in mixture of salt.
3. Detect the ions present in the sample by different techniques.
4. Estimate the amount of ions by volumetric and gravimetric methods.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19C H 3070	**CO1**	**3**	**2**	**2**	**2**	**3**	**2**	**2**	**0**	**1**	**2**	**3**	**2**	**2**
	CO2	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**3**	**2**	**2**
	CO3	**2**	**2**	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
	CO4	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**

Course Content:

PART – I

1. Simultaneous spectrophotometric determination of chromium and manganese in a steel solution.
2. Quantitative analysis of copper(II) and iron(II) in a mixture:
   i. Copper gravimetrically as CuSCN and
   ii. Iron volumetrically using cerium(IV) solution
3. Flame photometric determination of the following metal ions from different samples:
   a) sodium
   b) potassium
   c) calcium
   d) lithium and
   d) sodium and potassium in a mixture.
4. Quantitative determination of nickel using dithizone and 1,10-phenanthroline by synergistic extraction.
5. Spectrophotometric determination of the pKa value of methyl red.
6. Micro-titrimetric estimation of : a) Iron using cerium(IV), b) Calcium and magnesium using EDTA
7. Quantitative estimation of copper(II), calcium(II) and chloride in a mixture.

PART – II

1. Preparation and characterization of:
    a) Chloropentammine cobalt(III) chloride
    b) Estimation of chloride in a complex by potentiometric or ion-exchange method
    c) Record the electronic absorption spectrum of a complex and verify Tanabe Sugano diagram
2. Preparation of hexamine cobalt(III) chloride and estimate cobalt ion.
3. Determination of the composition of iron-phenanthroline complex by:
    (a) Job's method
    (b) mole-ratio method and
    (c) slope-ratio method.
4. Preparation of tris(oxalate)ferrate(III) and estimate the metal ion.
5. Using chloropentamine cobalt(III) chloride, prepare nitro and nitritopentamine cobalt(III) chloride. Record the IR spectra of the isomers and interpret.
6. Estimate the chloride ion in a given complex by silver nitrate titration after ion- exchange separation.

7. Demonstration Experiments:
    a) Interpretation of IR and NMR spectra of complexes.
    (b) DNA interaction with metal complexes by UV-visible absorption and viscosity methods.
    (c)Preparation of Metal oxide-conducting polymer composite

Reference Books:

1. Advanced Physico-Chemical Experiments – J. Rose.
2. Instrumental Analysis Manual - Modern Experiments for Laboratory – G.G. Guilbault and L.G. Hargis.
3. A Text Book of Quantitative Inorganic Analysis – A.I. Vogel, 5th edition.
4. Experimental Inorganic Chemistry – G. Palmer.
5. Inorganic Synthesis – O. Glemser.
6. Experimental Inorganic/Physical Chemistry- Mounir A. Malati.

7. Quantitative Chemical Analysis – Daniel C. Harris, (2006) 7th edition.
8. Spectrophotometric Determination of Elements – Z. Marczenko

Course Code	Course Title	Type	L	T	P	C	Hrs/Week
M19CH 3080	ORGANIC AND PHYSICAL CHEMISTRY-III PRACTICAL	HC	0	1	3	3	5

Course Objectives:

This course aims to provide the student to

1. The practical course on organic and physical chemistry intends to provide the students scientific skills in qualitative and preparative techniques.
2. Bring the knowledge of handling the chemicals and their identification through chemical analysis.
3. Appreciate the importance of being systematic in life.
4. Also helps to develop honesty, punctuality, analytical reasoning, questioning, critical evaluation and thinking among students.

Course Outcomes:

By the completion of course student will be able to

1. Acquire skill to perform chemical reaction, common laboratory techniques, including reflux, distillation, steam distillation, re-crystallization, vacuum filtration and aqueous extraction.

2. Calculate a limiting reagent and percent yield.
3. Evaluate data collected to determine the identity, purity, and yield of products, and also able to characterize organic molecules by physical methods such as melting point and boiling point.
4. Predict the outcome and mechanism of some simple organic reactions, using a basic understanding of the relative reactivity of functional groups.

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19C H 3080	**CO1**	**3**	**2**	**1**	**3**	**2**	**0**	**3**	**0**	**0**	**1**	**3**	**3**	**2**
	CO2	**2**	**2**	**1**	**3**	**1**	**1**	**1**	**0**	**3**	**1**	**3**	**2**	**2**
	CO3	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**0**	**2**	**1**	**3**	**2**	**2**
	CO4	**2**	**2**	**1**	**1**	**2**	**1**	**0**	**0**	**0**	**1**	**3**	**2**	**1**

Course Content:

Organic Chemistry Practicals - II

Qualitative analysis Systematic analysis and identification of organic compounds

Physical Chemistry Practicals - II

1. To study the kinetics of reaction between acetone and iodine - determination of order of reaction w.r.t. iodine and acetone.
2. Determination of mean ionic activity coefficient of a weak electrolyte (acetic acid) by conductometric measurements.
3. Potentiometric titration of $Pb(NO_3)_2$ *vs* EDTA.
4. Preparation of Ag/AgCl electrode and to determine the activity of 0.2M HCl.
5. To determine the eutectic point of a two component system (Naphthalene-biphenyl system).
6. Conductometric method of determination of solubility of sparingly soluble salt.
7. Study of *p*H effect (by inhibitors) on electrochemical dissolution of a metal.
8. Determination of *p*K value of an indicator (methyl orange).
9. Spectrophotometric analysis of a mixture of (a) $KMnO_4$ and $K_2Cr_2O_7$.
10. To study the kinetics of saponification of ethyl acetate by conductivity method, determination of order of reaction w.r.t. $[OH^-]$.
11. To study the kinetics of reaction between acetone and iodine-determination of order of reaction w.r.t. iodine and H_2SO_4.
12. Kinetics of decomposition of benzene diazonium chloride, determination of energy of activation and thermodynamic parameters.
13. Determination of ionic product of water and study the effect of temperature by conductivity method.
14. Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal
15. Verification of Beer-Lambert law using gold/silver nanoparticles
16. Determination of pKa of a weak organic acid or a base using UV-Vis spectrophotometry
17. Determination of stability constant of metal-ligand complexes by spectrophotometric method – Fe^{II}-(1, 10-phenantroline) complex
18. Determination of stability constant of metal-ligand complexes by ny pH-metric methods – Cu^{II}-glycinate, Cu^{II}- sulfosalicylate complexes.

SEMESTER -IV **HARDCORE**

Course Code	Course Title	Type	L	T	P	C	Hrs./
M19CH 4010	MAJOR PROJECT	HC	--	--	--	10	15

Course Objective:

To carry out the research under the guidance of R&D supervisor/Industry/R&D Institution and in the process learn the techniques of research.

Course Outcomes: :

On successful completion of the project, the student shall be able to:

1. Familiarize with literature search
2. Conduct the experiments related to research and formulate computational techniques
3. Interpret the scientific data
4. Write report and defend the research findings.

Course Content:

Project:

This project will be based on preliminary research-oriented topics both in theory and experiment. The teachers who will act as supervisors for the projects will float projects and any one of them will be allocated to the student. The research projects floated should be completed in 18 weeks. After the completion of the project the student shall submit project report in the form of dissertation on a specified date by the School. The details of assessment of project are explained under the heading "Evaluation of Minor Project / Major Project / Dissertation" in this handbook.

SEMESTER -IV **SOFTCORE**

SOFTCORE-01

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 4021	FUNCTIONAL INORGANIC MATERIALS	2	1	0	3	4

Course of Objective:

This course aims to provide the student to

1. Explain the basic concept the inorganic based metal complexes.
2. Elaborate the synthesis, reaction, properties and applications of magnetic materials.
3. Discuss the crystalline inorganic metal oxide for the structural correlation with properties.
4. Explain the various superconductors for the device application.

Course of Outcome:

By the completion of course student will be able to

1. Build the knowledge on inorganic based metal complexes.
2. Importance of magnetic materials and their application in various sector.
3. Interpretation of metal oxide with the help of structure-property correlations and potential applications.
4. Design the superconducting materials based on the device application.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PS O2	PS O3
M19C H 4021	**CO1**	**2**	**3**	**1**	**2**	**3**	**0**	**0**	**0**	**1**	**2**	**3**	**2**	**3**
	CO2	**3**	**3**	**1**	**2**	**3**	**2**	**0**	**0**	**1**	**2**	**3**	**3**	**3**
	CO3	**3**	**3**	**0**	**2**	**2**	**0**	**0**	**0**	**1**	**2**	**3**	**3**	**3**
	CO4	**3**	**2**	**1**	**2**	**3**	**1**	**0**	**0**	**1**	**2**	**3**	**4**	**3**

Course Content:

UNIT -I

Macrocyclic inorganic complexes, Supramolecular organometallic compounds, Metalloorganic frameworks and metallopolymers. [10hr]

UNIT -II

Metallomesogens – synthesis, properties, applications, Molecular Magnetic materials, GMR materials, Compounds intercalation and redox reactions. [10hr]

UNIT -III

Synthesis, structure, properties, structure-property correlations and potential applications of crystalline inorganic solid state materials. Functional oxides, mixed metal oxides. [10hr]

UNIT -IV

Superconductors –(Ba,K)BiO3, Cuprates, MgB2, , Ferroelectric materials, Piezoelectric materials, ionic conductors, Spintronics Materials – Principle, Synthesis – Gas storage materials, Photoluminescent materials. [10hr]

Reference Books:

1. Lalena, J.N.; Cleary, D.A. Principles of Inorganic Materials Design ; Wiley: New York, 2010
2. Maier, J. Physical Chemistry of Ionic Materials: Ions and Electrons in Solids; Wiley: New York, 2004
3. Solid-state Chemistry of Inorganic Materials VI (SYMPOSIUM QQ AT THE 2006 MRS FALL MEETING); Curran Associates, Inc., 2007
4. P. D. Beer, P. A. Gale, D. K. Smith; Supramolecular Chemistry (Oxford University Press, 1999)
5. J. W. Steed and J. L. Atwood; Supramolecular Chemistry (Wiley, 2000).

SOFTCORE-02

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 4022	ADVANCED FUNCTIONAL ORGANIC MATERIALS	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. To develop the knowledge of functional organic materials, organic optical devices.
2. Apply the synthetic organic chemistry knowledge in making MOF's and organic electronic devices, solar devices.
3. To understand the application of organic materials in the area of organic electronics, metal organic frameworks, optical materials and in solar cells.
4. To construct the materials based on their requirement like solar cells, OLEDs, energy storage devices etc.

Course Outcomes:

By the completion of course student will be able to

1. Acquire knowledge on functional organic materials as molecular spintronic.
2. Understand the applications of MOFs as energy materials etc.
3. Categorize the optical materials for OLED´s.
4. Application of organic materials for solar cells.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 4022	**CO1**	**3**	**0**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**2**	**2**
	CO2	**1**	**1**	**2**	**0**	**0**	**3**	**0**	**0**	**0**	**0**	**3**	**2**	**1**
	CO3	**2**	**0**	**2**	**2**	**0**	**2**	**0**	**0**	**2**	**0**	**2**	**2**	**2**
	CO4	**3**	**1**	**3**	**3**	**2**	**2**	**0**	**0**	**2**		**2**	**3**	**2**

Course Content:

UNIT-I

Functional organic materials: Introduction to material science. Classification and examples of application of functional (in) organic molecules.

Organic electronics: Electron transport in organic materials. (A) chiral organic (supra)conductors. Molecular spintronics–classification, concepts, materials and applications.

[10hr]

UNIT-II

Metal-organic frameworks: Definition, nomenclature and classification of metal-organic frameworks (MOF´s). Synthesis, physico-chemical properties and catalytic applications. Molecules encapsulation in MOF´s and its applications – molecular gas cylinders (hydrogen, methane, acetylene), drug carriers (ibuprofen). Nanotechnologies based on MOF´s. [10hr]

UNIT-III

Non-linear optical materials: Principles of fluorescence and phosphorescence. Organoluminescence – classification, chemistry and applications. Organic light-emitting diodes (OLED´s). Polymeric opto-

elektronic materials. Electroluminescence, mechanochromic fluorescence and piezofluorochromism – concepts, materials and future applications. [10hr]

UNIT-IV

Solar cells: Photoelectric effect. Basic principles of organic solar cells. Dye-sensitised solar cells (DSSC) – classification, concepts, chemistry and applications. Organic photovoltaics. Chemistry of personalised solar energy. [10hr]

SOFTCORE-03

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 4023	ADVANCED SPECTROSCOPY AND APPLICATIONS IN STRUCTURAL ANALYSIS	2	1	0	3	4

Course Objectives:

This course on Advanced spectroscopy and applications in structural analysis,
i) Intends to enlighten the students on topics in Principle, technique and specific applications of ESCA, XPS, XRD.
ii) This course provides students to analyse the compounds using spectroscopic data of UV-Vis spectra, IR, NMR, CMR, MASS.

Course objectives

CO-1: Demonstrate the knowledge of the basic concept and technique of ESCA, XPS, XRD for analysis and their applications.

C0-2: Explore understanding of X-ray methods, instrumentation, chemical analysis and determinations.

C0-3: Acquire basic and analysis knowledge of XPS, AES, EELS, ND, XD for various application.

C0-4: Apply knowledge for interpret the organic compounds by using the spectral data of UV-Vis Spectra, IR, NMR, CMR, MASS.

C0-4: Chemical compounds, Applications, interpret.

Course code	Course outcome (COs)	Program outcomes (POs)										(PSO)		
		PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PS0-2	PSO-3
M18CH4023	CO-1	2	0	0	3	1	0	0	0	0	0	2	2	1
	CO-2	2	0	0	3	1	0	0	0	0	0	2	2	1
	CO-3	2	0	0	3	1	0	0	0	0	0	2	2	1
	CO-4	2	1	0	2	1	0	0	0	0	0	2	2	1

Course Content:

UNIT-I

Electron spectroscopy:

Principle, technique and specific applications of ESCA, electron spectroscopy for the chemical analysis, ESCA satellite peaks, spectral splitting, ESCA chemical shifts, Instrumentation of ESCA, X- ray source, samples, analysers, detectors, applications, Photoelectric effect, Koopman's theorem, XPS and UPS, spin-orbit coupling in core level spectra, applications of core level spectra-ESCA. [10hr]

UNIT-II

X-Ray methods of Analysis:

Principle, theory, X-ray spectral lines, X-ray tube, X-ray emissions, absorptive apparatus: source, collimation, sample handling, wavelength dispersive devices, Energy dispersive devices, detectors, chemical analysis using X-ray absorption, X-ray fluorescence- instrumentation and chemical analysis, determination of crystal structure (Powder as well as single crystal). [10hr]

UNIT – III

Fundamental and oxidation state analysis using XPS spectra, Auger electron spectroscopy and applications, Electron energy loss spectroscopy- basic principles and applications, Neutron diffraction, electron diffraction. [10hr]

UNIT-IV

Spectral analysis:

Problem solutions using spectroscopic data of UV-Vis spectra, IR, NMR, CMR, MASS Spectra Selected examples Isobutyl alcohol, 3-chloroproponoic acid, chloroacetic acid, ethyl cyanoacetate, para toluidine, Trans-1- bromo-2 phenyl ethylene, 1,3 dibromo propane, benzaldehyde etc. [10hr]

SOFTCORE-04

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 4024	ADVANCED ELECTROANALYTICAL TECHNIQUES	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Knowledge on Electrode types, Electrochemical characterization techniques, Electrochemical STM, Electrochemical AFM, Sensors.
2. Skilled in problem solving, critical thinking and Analytical reasoning as applied to scientific Problems
3. Conclude Fundamental Concepts in Analytical Electrochemistry- Mass transport, Linear diffusion, Fick's laws and diffusion coefficient.
4. Design and carryout scientific experiments as well as accurately record and analyze the results of such experiments

Course Outcomes:

By the completion of course student will be able to

1. Acquire the knowledge Mass transport, Linear diffusion, Fick's laws and diffusion coefficient, the charged interface, Potential step and potential sweep experiments.
2. Analyze the compounds by using the analytical techniques.

3. Explain the Advanced analytical techniques (Sensors) which are useful to analyse the compounds.
4. Students will be able to function as a member of an interdisciplinary problem solving.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 4024	**CO1**	**3**	**1**	**0**	**3**	**2**	**0**	**2**	**2**	**0**	**2**	**2**	**2**	**1**
	CO2	**2**	**2**	**2**	**3**	**3**	**0**	**1**	**2**	**2**	**3**	**0**	**2**	**2**
	CO3	**3**	**2**	**2**	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**1**	**1**	**2**
	CO4	**2**	**3**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**1**	**2**

Course Content:

UNIT- I

Fundamental Concepts in Analytical Electrochemistry: Mass transport, Linear diffusion, Fick's laws and diffusion coefficient, The charged interface, Potential step and potential sweep experiments, Reactions controlled by rate of electron transfer and activated complex theory and Electrode reactions.

[10hr]

UNIT -II

Electrode types, Electrochemical characterization techniques – Cyclic voltammetry, Potentiostatic and galvanostatic methods, Pulse methods, RRDE, impedance analysis.

UNIT -III

Photoelectrochemical measurements, Spectroelectrochemistry, Electrochemical STM, Electrochemical AFM.

UNIT -IV

Electrochemical sensing, Electrochemical biosensors, Electron transfer in DNA and biosystems, Photoelectrochemical sensing.

Reference Books:

1. Allen J. Bard and Larry R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2nd edition 2001, John Wiley & Sons
2. Allen J. Bard (Ed), Electroanalytical Chemistry, Vol.13, Plenum Press 1983
3. Joseph Wang, Analytical Electrochemistry, 3rd edition 2006, John Wiley & Sons
4. J. Newman, Electrochemical Systems, Wiley-Inter science, 3rd edition 2004

SOFTCORE-05

Course Code	Course Title	L	T	P	C	Hrs/Week
M18CH 4025	ADVANCES IN SURFACE, INTERFACE AND CATALYSIS	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Intends to enlighten the students in Suface forces, surface energy, Electrostatic forces, Electrical double layer, Solid surfaces, structures, Thermodynamics of Adsorption processes.

2. This course provides students to get knowledge on Fundamental processes in catalysis, Structures, Kinetic aspects Heterogenous catalysts, Synthesis of metal oxide catalysts, catalysis by porous materials.
3. Students are able to understand the fundamental of metal oxide and catalysis.
4. Build research knowledge on photocatalysis, electrocatalysis, devices and their application.

Course Outcomes:

By the completion of course student will be able to

1. Acquire the knowledge of suface forces, surface energy, Electrostatic forces, Electrical double layer, Solid surfaces and structures.
2. Explain the Fundamental processes in catalysis, Structures, Kinetic aspects Heterogenous catalysts, Bio enzyme catalysis.
3. Synthesize the metal oxide catalysts, catalysis by porous materials.
4. Identify the Photocatalysts, Electro catalysts.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M18C H 4025	**CO1**	**3**	**3**	**1**	**0**	**2**	**1**	**0**	**0**	**0**	**2**	**2**	**4**	**3**
	CO2	**4**	**3**	**3**	**2**	**3**	**3**	**0**	**0**	**1**	**2**	**3**	**4**	**2**
	CO3	**2**	**1**	**3**	**3**	**3**	**2**	**0**	**0**	**1**	**2**	**3**	**4**	**3**
	CO4	**1**	**3**	**3**	**2**	**3**	**3**	**0**	**0**	**1**	**2**	**2**	**4**	**2**

Course Content:

UNIT - I

Sufaces: Suface forces, surface energy, Electrostatic forces, Electrical double layer, Solid surfaces, structures, Thermodynamics of Adsorption processes, Colloidal systems, stability, -coagulation, charged colloids, thin liquid films, emulsions Application of colloids. [10hr]

UNIT- II

Interface: Solid-liquid interface, Liquid-liquid interface, Surface analysis – scanning probe microscopy, EELS, BET- Surface area analysis, Microscopic analysis, Thermal analysis
[10hr]

UNIT -III

Catalysis: Fundamental processes in catalysis, Structures, Kinetic aspects Heterogenous catalysts, Synthesis of metal oxide catalysts, catalysis by porous materials. [10hr]

UNIT IV

Catalysis for sustainable energy: Photocatalysts, Electrocatalysts, device application, Catalysis in industrial processes, Bio enzyme catalysis. [10hr]

Reference Books:

1. Physical chemistry of surfaces by Arthur W. Adamson 1990
2. K.W. Kolasinski, Surface Science: Foundations of Catalysis and Nanoscience, Wiley,

2002.
3. Modern techniques of surface science by D.P. Woodruff, T.A. Delchar, Cambridge Univ. Press, 1994.
4. M. Thomas and W.J. Thomas, Principles and Practice of Heterogeneous Catalysis, Wiley-VCH, 1997.

SOFTCORE-06

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 4026	ADVANCED MATERIALS IN ENERGY STORAGE AND CONVERSION DEVICES	2	1	0	3	4

Course Objectives:

This course aims to provide the student to

1. Intends to enlighten the students in charge transfer process, electrochemical energy conversion device processes.
2. This course provides students to get knowledge Electro catalysis in fuel cells, semiconducting materials.

Course Outcomes:

By the completion of course student will be able to

1. Acquire the knowledge of charge transfer processes, electrochemical energy conversion device processes in the cells.
2. Construct the different types of Batteries.
3. Identify the Electrode and Electrolyte materials used in the different batteries.
4. Explain the solar cells, water splitting and photo electrochemical cells.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 4026	**CO1**	**3**	**2**	**2**	**2**	**1**	**3**	**2**	**1**	**2**	**1**			
	CO2	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**			
	CO3	**2**	**3**	**2**	**3**	**3**	**1**	**2**	**2**	**2**	**2**			
	CO4	**3**	**1**	**1**	**2**	**2**	**2**	**2**	**2**	**3**	**3**			

Course Content:

UNIT- I

Electrochemistry: fundamental processes, charge transfer process, Electrochemical energy conversion device processes, Fundamental thermodynamic and kinetic consideration, Available energy resources, Ragone plot. [10hr]

UNIT -II

Different battery systems Electrode materials for Lithium-ion batteries, Sodium ion batteries, Cathode materials, anode materials, high power supercapacitors. [10hr]

UNIT -III

Electrocatalysis in fuel cells, HOR, ORR Noble metals, non noble metal and other electrocatalysic systems, Different types of fuel cells, acid, alkaline, molten carbonate, solid oxide fuel cells solid polymer electrolyte, methanol, biochemical fuel cells and Photoelectrocatalysis.

[10hr]

UNIT -IV

Fundamentals of semiconducting materials – solar energy conversion, Photoelectrochemical cells, Organoelectronics, Hydrogen a clean fuel – water splitting and photoelectrochemical cells hydrogen storage materials. [10hr]

Reference Books:

1. R. Narayanan and B. Viswanathan, Chemical and Electrochemical energy systems, Orient Longmans, 1997.
2. K. Sriram, Basic Nuclear Engineering, Wiley Eastern, 1990.
3. A. S. J.. Appleby and F. K. Foulkes, Fuel cell Hand Book, Von Nostrand Reinhold, 1989.
4. D. Linden, Hand book of batteries and Fuel cells, McGraw Hill Book Company, 1984.
5. T. Ohta, Solar Hydrogen energy systems, Peragamon Press, 1979.
6. M. Gratzel, Energy Resources through photochemistry and catalysis, Academic Press, 1983.
7. T. Ohta, Energy Technology, Sources, Systems and Frontiers conversions, Pergamon, 1994.
8. Electrochemistry by Bockris and Reddy

SOFTCORE-07

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 4027	ADVANCES IN POLYMER SCIENCE AND TECHNOLOGY	2	1	0	3	4

Course objectives:

This course aims to provide the student to

1. Demonstrate the knowledge of the basic concept of polymer, analysis of molecular weight of polymer.
2. Explore physical factors of polymers, analysis of glass transition temperature of polymer, Thermodynamic equation of polymer.
3. Create broad knowledge on polymer classification, mechanism of polymerization, instrumentation method of polymer characterization.
4. Acquire broad knowledge of polymers for medical, environmental, catalysis and device applications.

Course Outcomes:

By the completion of course student will be able to

1. Basic of polymer, analysis.
2. Physical factors, analysis, equations.
3. Classification, mechanism, techniques.
4. Applications, environmental.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19CH 4027	**CO1**	**2**	**1**	**0**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**1**
	CO2	**2**	**0**	**0**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**1**
	CO3	**2**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**2**	**1**
	CO4	**2**	**0**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**	**2**	**1**

Course Content:

UNIT- I

Introduction to polymer science, Molecular weights and Methods of determination, molecular weight distribution, size and shape of macromolecules, Mark-Houwink relationship. chain structure and configuration, conformation, size of an ideal chain (freely jointed chain and other models), Real chains, Thermodynamics of polymer solutions; Molecular motion (self-diffusion, hydrodynamic radius, Rouse Model).Glass transition temperature – elementary theories and methods of determination. Variation of glass transition with structure. [10Hrs]

UNIT -II

Membrane technology for separation: Basic principle, Types of membranes/classification, synthesis of membrane; polymer membranes, structural analysis, factors affecting membrane separation, comprehensive applications. Ionically conducting membranes and Applications. [10Hrs]

UNIT -III

Polymer characterisation: Transport mechanism in membranes, characterisation of ionic membranes, porous and nonporous systems, Microscopic techniques, Gas adsorption-desorption, Thermoporemetry
Inorganic membranes: Introduction, types, membrane synthesis, glass membranes and Applications.
[10Hrs]

UNIT- IV

Applications of Polymers: Conducting polymers, Organic Photovoltaics, polymer electronics energy conversion devices, Corrosion protection, Thermal resistant polymers, catalysis, Metallopolymers, Biocompatible polymers, Biodegradable polymers. [10Hrs]

Reference Books:

1. F. W. Billmeyer, Textbook of Polymer Science, 3rd Edition, John Wiley, 1994.
2. V. R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar, New Age International (P) Ltd, 2005.
3. G. Odian, Principles of Polymerization, Fourth edition, Wiley-Interscience, 2004.
4. Marcel Mulder, Basic principles of Membrane technology, Springer, 1996

SEMESTER-IV RULO - MOOC / SWAYAM / HARVARD /Edx / INTERNSHIP

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M19CH 4030	MOOC/SWAYAM/HARVARD/Edx/ INTERNSHIP	RULO	0	0	4	4	4

Course Objectives:

To carry out the research or internship at Industry/R&D Institution and in the process learn the techniques of research or Self learning related courses from MOOC/SWAYAM/HARVARD/Edx.

Course Outcomes:

By the completion of course student will be able to

1. Familiarize with R&D culture.
2. Conduct the experiments related to research and formulate computational techniques
3. Interpret the scientific data and Write report and defend the research findings.
4. Apply the self-learning capabilities

Internship: Minimum of four weeks duration internship should be carried out by the student either in industry or in an R&D organization, including educational institutes with excellent research culture. In case, if a student is unable to secure internship either in industry or in an R&D organization, a project may be carried out within the university. The student is expected to submit a formal report at the end of the internship programme. The student shall be awarded the marks for internship based on the (a) presentation and (b) comprehensive viva by the panel of examiners constituted by the school.

MOOC/ SWAYAM: Globally, MOOC (Massive Open Online Course) platforms are gaining much popularity. Considering the popularity and relevance of MOOCs, Government of India has also launched an indigenous platform, SWAYAM. SWAYAM (Study Webs of Active Learning for Young Aspiring Minds) is basically an integrated MOOCs platform for distance education that is aimed at offering all the courses from school level (Class IX) to post-graduation level. The platform has been developed collaboratively by MHRD (Ministry of Human Resource Development) and AICTE (All India Council for Technical Education) with the help of Microsoft and is capable of hosting 2,000 courses.

A student shall register and successfully complete any of the courses available on SWAYAM.

Student shall inform the MOOC/SWAYAM coordinator of the school about the course to which he/she has enrolled. The minimum duration of the course shall be not less than 40 hours and of 4 credits. The student should submit the certificate issued by the SWAYAM to the MOOC/SWAYAM coordinator of the school, the grades obtained in the course shall be forwarded to concerned authority of the University.

SEMESTER IV – PRACTICALS COURSES (SC)

1. **Advanced Organic Chemistry Lab**

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 4041	ADVANCED ORGANIC CHEMISTRY LAB-IV.1	0	1	3	4	5

Course Objectives:

This course on ADVANCED ORGANIC CHEMISTRY LAB provides students to enlighten the knowledge on topics like

i. Synthesis, separation, purification, characterization and property measurements of Organic compounds with an emphasis on different techniques of reaction set-up.
ii. Exposure to various spectroscopic characterization techniques

Course Outcomes: By the completion of course student will be able to,

a) Apply the knowledge of Synthesis
b) Develop skills on separationand purification
c) Interpret the structure of compounds by characterization
d) Demonstrate proficiency in spectroscopic techniques.

Mapping of Course Outcomes with Pos and PSOs

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
M18CH4041	CO1	3	2	3	1	2	3	2	0	0	1	2	3	2
	CO2	2	2	2	3	2	2	2	0	0	1	3	2	3
	CO3	2	2	3	1	3	2	3	0	0	1	3	3	2
	CO4	3	2	3	1	2	1	2	0	0	1	2	2	3

2. **Advanced Inorganic Chemistry Lab**

Course Code	Course Title	L	T	P	C	Hrs/Week
M19CH 4042	ADVANCED INORGANIC CHEMISTRY LAB-IV.2	0	1	3	4	5

Course Objectives:

This course aims to provide the student to

1. Synthesis, characterization and property measurements of inorganic compounds with an emphasis on different techniques of reaction set-up, conducting polymers.
2. Exposure to various spectroscopic characterization techniques.
3. To use electroanalytical techniques in synthesis and characterization.
4. To analyse coordination complexes and conducting polymers and metal oxides.

Course Outcomes:

By the completion of course student will be able to

1. Apply the experimental knowledge to synthesis new compounds by environmental benign routes and interpret their properties
2. Devise the methodology in synthesis and optimize the condition for preparation new experiments
3. Analyze the spectral data and evaluate the electronic properties and bond vibrations and bond strengths
4. Interpret the data obtained through various electrochemical and solution synthesis techniques of chemical compounds and their characterization

Mapping of Course Outcomes with programme Outcomes (sample)

Course Code	POS/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3
M19C H 4042	**CO1**	**2**	**1**	**2**	**2**	**2**	**1**	**0**	**0**	**1**	**1**	**2**	**2**	**2**
	CO2	**2**	**1**	**1**	**2**	**2**	**1**	**0**	**0**	**1**	**2**	**2**	**1**	**3**
	CO3	**2**	**1**	**2**	**2**	**2**	**1**	**0**	**0**	**2**	**2**	**2**	**2**	**2**
	CO4	**3**	**1**	**2**	**2**	**2**	**2**	**0**	**0**	**1**	**2**	**3**	**2**	**3**

INORGANIC CHEMISTRY

Course Outcomes:

- During the study of this course the students will acquire a deeper knowledge about basics in inorganic chemistry periodic properties, solvents, nuclear chemistry etc.
- After studying this subject student is able to understand how nanomaterials are completely different from that of bulk materials, its approaches for synthesis and its applications.
- During the study of this course the students will acquire a deeper knowledge complexes, metal ligand interactions about chemistry.
- Student is able to understand various principles of bioinorganic chemistry, Bioenergetics, biophysical chemistry, bioorganic chemistry etc.
- The students are expected to acquire knowledge about inorganic reaction mechanisms and organometallic chemistry.
- After the completion student is able to understand about energy for chemical industry, surfactants, explosives, pesticides their effect to the environment. Importance of industrial materials like cement, polymers, glass, paint, fertilizes etc can be understood here.
- Student is able to understand different types of solids, its reactions, electronic properties and band theory and gets an information regarding advanced electronic materials.
- Student will be familiar with various spectroscopies like electron spectroscopy, Mossbauer spectroscopy, destructive techniques and non-destructive techniques, SAM, SPM, TEM, LEED etc.
- Students will understand the principles in inorganic photochemistry, metal complexes in drugs, medicinal bioinorganic chemistry and advance nuclear chemistry.

ORGANIC CHEMISTRY

Course Outcomes:

The students will acquire knowledge of:

- The structure, nature of bonding in the molecules and reaction mechanism.
- Conformational analysis of cycloalkanes, reactivity, chirality, interconversion, resolution and asymmetric synthesis.
- Organization and working of various components present in living cell.
- Nomenclature of different heterocyclic compounds.
- Synthesis and reactivity five, six and seven membered monocycles and the fused heterocyclic compounds.
- Molecular structure of proteins, DNA, RNA and vitamins, organization and working of various components present in living cell.
- Mechanistic aspects of nucleophilic, electrophilic substitution and elimination reactions.
- Molecular orbital symmetry and possibility of thermally and photochemically pericyclic reactions.
- Conversion of different functional groups via rearrangement reactions.
- Molecular recognition and nature of binding involved in biological systems.
- Structure of supramolecules of various types in solution, solids and their applications in miniaturization of molecular devices.
- Drug designing, development, mode of action of different drugs and role of drugs to inhibit particular enzymes and treatment of disease.
- Mechanistic pathway of organic reactions.
- Retrosynthetic approach of planning organic synthesis
- Conversion of different functional groups via reactions.
- Mechanism of major chemical reactions.
- Utilizing reagents in organic transformations.
- The principles behind Enantio-selectivity and Diastero-selectivity, analyze how stereochemical outcome of the reaction can be predicted.
- Identifying and characterizing various classes of natural products by their structure.
- Appreciate the biogenesis of many natural products of importance.
- The contribution of natural products in drug design and development of new drugs with hemisynthetic routes or with total synthesis.

PHYSICAL CHEMISTRY

Course Outcomes:

After completion, of course students will:

1. Acquire knowledge about basics of thermodynamics, chemical kinetics and electrochemistry.
2. Understand the Thermodynamic laws, concepts of entropy and free energy, partial molar properties, fugacity of gases, thermodynamics of dilute solutions, statistical thermodynamics.
3. Get knowledge on kinetics of complex reactions, Parallel, consecutive and reversible reactions.
4. Acquire knowledge on theories of electrolytes and irreversible electrode processes, cyclic voltammetry, Impedance Spectroscopy, Scanning Electrochemical Microscopy, Electrochemical AFM and STM, electrochemical sensors and energy systems.

5. Able to analyze the kinetics of the different types of reactions
6. Understand Surface phenomena of solids, solid-liquid interfaces, Homogenous and Heterogeneous Catalysis.
7. Analyze the instrumental methods of catalyst characterization.
8. Enlighten the knowledge on Quantum chemistry, molecular symmetry, group theory: representation and applications, various spectroscopic techniques like microwave, vibrational, electronic, Raman, EPR and NMR.
9. Understand the principles and laws of photochemistry, measurement of fluorescence and phosphorescence and lifetimes and Fluorescence based sensors.
10. Get knowledge on topics like energy systems: renewable and non-renewable, nuclear energy, electro chemical power sources, chemistry of fuel cells and semi conducting materials.
11. Understand topics like quantum chemistry, Statistical Thermodynamics and non-equilibrium thermodynamics, molecular interactions and macro molecules.
12. Understand topics like quantum chemistry, Statistical Thermodynamics and non-equilibrium thermodynamics, molecular interactions and macro molecules.
13. Understand basic concepts of polymers, thermodynamics of polymer solutions, classification, structure-property relation of polymers and different applications of polymers.

ANALYTICAL CHEMISTRY

Course Outcomes:

After completion, of course students will:

1. Acquire knowledge of Data handling/ statistical treatment of data.
2. Acquire knowledge of Potentiometric, Coulometric, and Voltametric methods of analysis, Chromatographic Techniques and applications.
3. Identify and describe the steps that are included in a complete analytical procedure
4. learn the basic analytical and technical skills to work effectively in the various fields of chemistry.
5. To know and understand the issues of safety regulations in the use of chemicals in their laboratory work.
6. Students can define and calculate the retention factor, R f, and describe how TLC and column chromatography can be used for separation and qualitative analysis.
7. This study is useful to furnish students with the advanced technical skills and knowledge base
8. That is required in the field of instrumental analysis and which will enable them to pursue careers as analysts in the chemical and/or pharmaceutical industry.
9. The fundamental analytical techniques, Mass spectrometry, NMR spectroscopy and eclectron spectroscopy.
10. Other general characterisation techniques (IR & UV spectroscopy, mass and NMR spectroscopy).
11. About spectroscopy and its application in studying the structure of organic molecules.
12. Gain knowledge and understand the principle of Separation techniques, analysis by using spectroscopic techniques.
13. Demonstrate the Chromatographic Techniques and applications.
14. In this practical course the students acquire practical skills related to analytical chemis-try in analysis of constituents present in different samples.

15. The students will acquire knowledge of development of experimental skills on conductivity meter, potentiometer, pH meter and voltammeter for different applications
16. Different concepts of atmosphere, stratospheric and tropospheric chemistry, photochemical smog, acid rain, atmospheric aerosols, global climate.
17. Chemistry of colloids with reference to environment.
18. Air pollution, water pollution, soil pollution and its control.
19. Analysis of various components in food and drug analysis.
20. Concepts and applications of Green Chemistry.
21. Concepts of types of materials, properties of nanomaterials and various preparation methods and characterization techniques like XRD, SEM, TEM, NMR, XPS and applications
22. Concepts of water pollution and water analysis methods.

CAREER DEVELOPMENT AND PLACEMENT

Having a degree will open doors to the world of opportunities for you. But Employers are looking for much more than just a degree. They want graduates who stand out from the crowd and exhibit real life skills that can be applied to their organizations. Examples of such popular skills employers look for include:

1. Willingness to learn
2. Self motivation
3. Team work
4. Communication skills and application of these skills to real scenarios
5. Requirement of gathering, design and analysis, development and testing skills
6. Analytical and Technical skills
7. Computer skills
8. Internet searching skills
9. Information consolidation and presentation skills
10. Role play
11. Group discussion, and so on

REVA University therefore, has given utmost importance to develop these skills through variety of training programs and such other activities that induce the said skills among all students. A full-fledged Career Counseling and Placement division, namely Career Development Center (CDC) headed by well experienced senior Professor and Dean and supported by dynamic trainers, counselors and placement officers and other efficient supportive team does handle all aspects of Internships and placements for the students of REVA University. The prime objective of the CDC is to liaison between REVA graduating students and industries by providing a common platform where the prospective employer companies can identify suitable candidates for placement in their respective organization. The CDC organizes pre-placement training by professionals and also arranges expert talks to our students. It facilitates students to career guidance and improve their employability. In addition, CDC forms teams to perform mock interviews. It makes you to enjoy working with such teams and learn many things apart from working together in a team. It also makes you to participate in various student clubs which helps in developing team culture, variety of job skills and overall personality.

The need of the hour in the field of Chemistry is not only knowledge in the subject, but also the skills to do the job proficiently, team spirit and a flavour of innovation. This kept in focus, the CDC has designed the training process, which will commence from second semester along with the curriculum. Special coaching in personality development, career building, English proficiency, reasoning, puzzles, and communication skills to every student of REVA University is given with utmost care. The process involves continuous training and monitoring the students to develop their soft skills including interpersonal skills that will fetch them a job of repute in the area of his / her interest and march forward

to make better career. The School of Applied Sciences also has emphasised subject based skill training through lab practice, internship, project work, industry interaction and many such skilling techniques. The students during their day to day studies are made to practice these skill techniques as these are inbuilt in the course curriculum. Concerned teachers also continuously guide and monitor the progress of students.

The University has also established University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director to facilitate skill related training to REVA students and other unemployed students around REVA campus. The center conducts variety of skill development programs to students to suite to their career opportunities. Through this skill development centre the students shall compulsorily complete at least two skill / certification based programs before the completion of their degree. The University has collaborations with Industries, Corporate training organizations, research institutions and Government agencies like NSDC (National Skill Development Corporation) to conduct certification programs. REVA University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana.

The University has also signed MOU's with Multi-National Companies, research institutions, and universities abroad to facilitate greater opportunities of employability, students' exchange programs for higher learning and for conducting certification programs.

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1	Dr. Madhusudana Reddy M B	Professor & Co ordinator	madhusudana@reva.edu.in	9480224757
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