



**KANNUR UNIVERSITY**

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**FIVE YEAR INTEGRATED MASTERS  
PROGRAMME (FYIMP)**

**PHYSICAL SCIENCE**

(PHYSICS/CHEMISTRY)

**Syllabus**

**DEPARTMENT OF PHYSICS**

**DEPARTMENT OF CHEMISTRY**

Swami Anandatheertha Campus

Payyanur, Edat (PO)

Kannur - 670327

Kerala

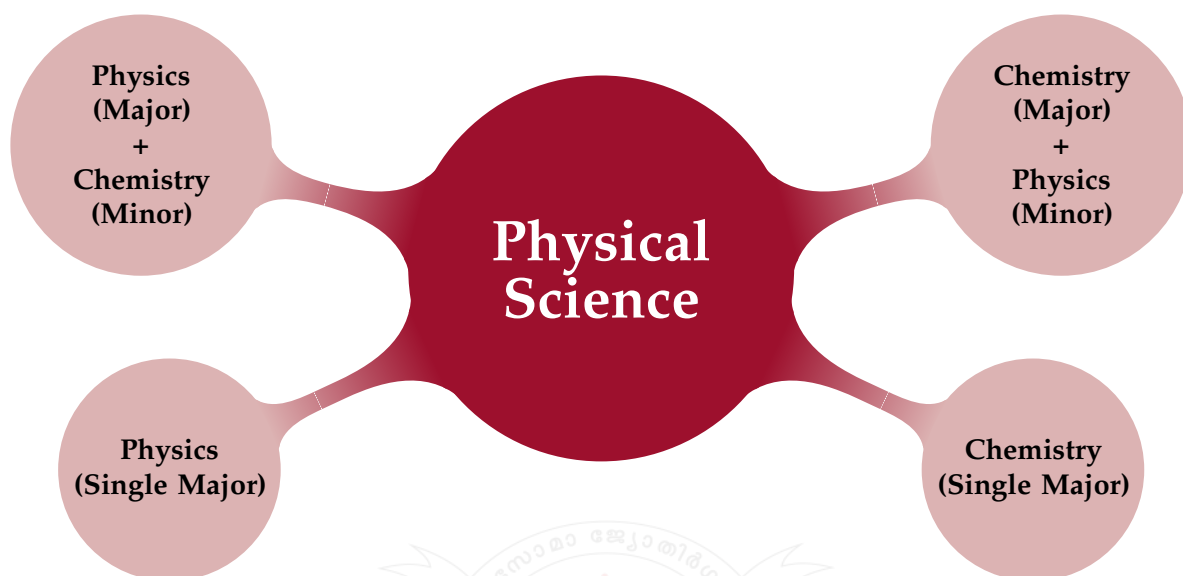
2024

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## Programme Pathways



The Five Year Year Integrated Masters Programme (FYIMP) in Physical Science of Kannur University spans ten semesters of student-centric teaching-learning process with a meticulously designed curriculum including both theory and practicum courses. The Programme structure ensures a strong foundation and in-depth knowledge in the subject for aspiring students while maintaining the essential flexibility in choosing the learning Pathway. The Two main Pathways are: Pathway - 1 offers a Major degree in Physics with optional Minor in Chemistry; For Pathway - 2, the Major degree will be in Chemistry with optional Minor in Physics.

### Types of Courses

- **Discipline Specific Course (DSC):** Discipline Specific Core should be pursued by a student as a mandatory requirement of his/ her programme of study.
- **Discipline Specific Elective (DSE):** The Discipline Specific Electives are a pool of credit courses offered in the Major/Minor discipline from which a student will choose to study based on his/ her interest.
- **Ability Enhancement Course (AEC):** AECs are part of the Foundation courses which offer knowledge enhancement through various areas of study. They are based on Language and Literature which are mandatory for all disciplines.
- **Skill Enhancement Course (SEC):** SECs provide skill training and proficiency to students in various areas and courses may be chosen from a pool of courses offered by various departments.
- **Value Added Course (VAC):** VACs are offered by different disciplines and aimed towards personality building, embedding ethical, cultural and constitutional values and will help in all round development of students.
- **Multi Disciplinary Course (MDC):** These are introductory-level courses in broad disciplines other than Physics/Chemistry. These courses are intended to broaden the intellectual experience and will be useful to understand society.

- **Internship:** internships in a firm, industry, or organization or Training in labs with faculty and researchers in the University or other higher education institutes.
- **Project/Dissertation:** Students can choose to take up research projects under the guidance of a faculty member. The research outcomes of their project work may be published in peer-reviewed journals or may be presented in conferences /seminars or may be patented.

### Teaching/Assessment modes

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.



## Programme Outcomes (POs)

Program Outcomes (POs) serve as a foundational framework defining the skills, knowledge, and attributes that students of Kannur University are expected to acquire upon completion of a specific academic program. Tailored to the unique goals of each program, POs articulate the overarching learning objectives that guide curriculum design and assessment. These outcomes encompass a diverse range of competencies, including critical thinking, problem-solving, effective communication, and discipline-specific expertise. POs play a crucial role in shaping educational experiences, ensuring alignment with academic standards and industry expectations. By articulating clear and measurable expectations, POs contribute to the continuous improvement of academic programs and provide a roadmap for students to develop into well-rounded, competent professionals within their chosen fields.

PO1	<b>Critical Thinking and Problem-Solving</b> -Apply critical thinking skills to analyze information and develop effective problem-solving strategies for tackling complex challenges.
PO2	<b>Effective Communication and Social Interaction</b> -Proficiently express ideas and engage in collaborative practices, fostering effective interpersonal connections.
PO3	<b>Holistic Understanding</b> -Demonstrate a multidisciplinary approach by integrating knowledge across various domains for a comprehensive understanding of complex issues.
PO4	<b>Citizenship and Leadership</b> -Exhibit a sense of responsibility, actively contribute to the community, and showcase leadership qualities to shape a just and inclusive society.
PO5	<b>Global Perspective</b> -Develop a broad awareness of global issues and an understanding of diverse perspectives, preparing for active participation in a globalized world.
PO6	<b>Ethics, Integrity and Environmental Sustainability</b> -Uphold high ethical standards in academic and professional endeavors, demonstrating integrity and ethical decision-making. Also acquire an understanding of environmental issues and sustainable practices, promoting responsibility towards ecological well-being.
PO7	<b>Lifelong Learning and Adaptability</b> -Cultivate a commitment to continuous self-directed learning, adapting to evolving challenges, and acquiring knowledge throughout life.

## Programme Specific Outcomes (PSOs)

PSO1	Use concepts and principles in physical/chemical sciences with specific emphasis on fundamental laws and basic concepts to cater to the real-world problems.
PSO2	Apply mathematical/experimental techniques to solve and interpret the results of various physical/chemical systems.
PSO3	Illustrate the methodology required for the execution of physical/chemical experiments and analyze the experimental results with the corresponding interpretations.
PSO4	Develop communication skills to explain the basic concepts to both specialized and non-specialized audiences.

## Course Structure: Physics

Type	Course	Code	Credit	Level
<b>SEMESTER - I</b>				
DSC	Core Concepts in Physics (A-1)	KU01DSCPHY101	4	100
	B-1		4	
	C-1		4	
AEC	Language (AEC-1)		3	
	Language (AEC-2)		3	
MDC	MDC -1		3	
Minimum Credit Requirement for SEMESTER I			<b>21</b>	
<b>SEMESTER - II</b>				
DSC	Electricity & Magnetism (A-2)	KU02DSCPHY101	4	100
	Mechanics (A-3)	KU02DSCPHY102	4	
	B/C-2		4	
	B/C-3		4	
AEC	Language (AEC-3)		3	
MDC	MDC-2		3	
Minimum Credit Requirement for SEMESTER II			<b>22</b>	
<b>SEMESTER - III</b>				
DSC	Fundamentals of Optics (A-4)	KU03DSCPHY201	4	200
	Basic Electronics (A-5)	KU03DSCPHY202	4	
	Quantum Physics: Basics (A-6)	KU03DSCPHY203	4	
	Introduction to Solid State Physics (A-7)	KU03DSCPHY204	4	
MDC	Kerala Studies (MDC-3)		3	
VAC	VAC-1		3	
Minimum Credit Requirement for SEMESTER III			<b>22</b>	
<b>SEMESTER - IV</b>				
DSC	Electromagnetic Theory-I (A-8)	KU04DSCPHY201	4	200
	Thermodynamics (A-9)	KU04DSCPHY202	4	
	Introduction to Astrophysics (A-10)	KU04DSCPHY203	4	
	Introduction to Nuclear & Particle Physics (A-11)	KU04DSCPHY204	4	
SEC	SEC-1		3	
VAC	VAC-2		3	
Internship	Internship (Vacation)	KU04INTPHY201	2	
Minimum Credit Requirement for SEMESTER IV			<b>24</b>	
<b>SEMESTER - V</b>				
DSC	Mathematical Physics I (A-12)	KU05DSCPHY301	4	300
	Electromagnetic Theory-II (A-13)	KU05DSCPHY302	4	
	Quantum Physics: Applications (A-14)	KU05DSCPHY303	4	
	Numerical Methods in Physics (A-15)	KU05DSCPHY304	4	
DSE (Minimum 1)	Biophysics	KU05DSEPHY301	4	
	Python Programming	KU05DSEPHY302		
SEC	SEC-2		3	
Minimum Credit Requirement for SEMESTER V			<b>23</b>	

## Course Structure: Physics

Type	Course	Code	Credit	Level
<b>SEMESTER - VI</b>				
DSC	Classical Mechanics (A-16)	KU06DSCPHY301	4	300
	Advanced Electronics (A-17)	KU06DSCPHY302	4	
	Modern Optics (A-18)	KU06DSCPHY303	4	
DSE (Minimum 1)	Introduction to Nanomaterials	KU06DSEPHY301	4	
	Energy Physics	KU06DSEPHY302		
SEC	SEC-3		3	
Internship	Internship (Vacation)	KU06INTPHY301	2	
Minimum Credit Requirement for SEMESTER VI			<b>21</b>	
<b>Students exiting after 3rd Year: awarded UG Degree with Major in Physics</b>				
Total Credit Requirement for UG Degree			<b>133</b>	
<b>SEMESTER - VII</b>				
DSC	Quantum Mechanics (A-19)	KU07DSCPHY401	4	400
	Mathematical Physics II (A-20)	KU07DSCPHY402	4	
	Statistical Mechanics (A-21)	KU07DSCPHY403	4	
DSE (Minimum 2)	Photovoltaic Energy Conversion	KU07DSEPHY401	4+4	
	Fiber Optics	KU07DSEPHY402		
	Thin Film Technology	KU07DSEPHY403		
	Semiconducting Materials & Devices	KU07DSEPHY404		
MOOC	MOOC/Online Course		4	
Minimum Credit Requirement for SEMESTER VII			<b>24</b>	
<b>SEMESTER - VIII</b>				
DSC	Research Methodology (A22)	KU08DSCPHY401	4	400
MOOC	MOOC/Online Course		4	
Project	<b>For Honours with Research</b>		12	
	Research Project	KU08RPHPHY401		
DSC* (in lieu of Project*)	<b>For Honours – three 4C Courses in lieu of Project*</b>			
	Advanced Quantum Mechanics (A-23)	KU08DSCPHY402		
	Condensed Matter Physics (A=24)	KU08DSCPHY403		
	Nuclear Physics (A-25)	KU08DSCPHY404		
Minimum Credit Requirement for SEMESTER VIII			<b>20</b>	
<b>Student Exit After Four Year: Hons/Hons with Research Degree with Major in Physics</b>				
Total Credit Requirement for Hons/Hons with Research			<b>177</b>	
<b>SEMESTER - IX</b>				
DSC	Atomic & Molecular Physics (A-26)	KU09DSCPHY501	4	500
	Nanophotonics (A-27)	KU09DSCPHY502	4	
	Quantum Field Theory (A-28)	KU09DSCPHY503	4	
	Particle Physics & Astrophysics (A-29)	KU09DSCPHY504	4	
	General Theory of Relativity (A-30*)	KU09DSCPHY505	4	
Optional*: One MOOC/Online/blended course in lieu of one DSC				
Minimum Credit Requirement for SEMESTER IX			<b>20</b>	
<b>SEMESTER - X</b>				
Research	Dissertation 20 Credits	KU10RPHPHY501	20	500
Minimum Credit Requirement for SEMESTER X			<b>20</b>	
<b>After Five Year: Integrated Post Graduate Degree in Physics</b>				
Total Credit Requirement for Post Graduate Degree			<b>217</b>	

The logo of Kannur University is centered in the background. It features a stylized sun with rays rising from a base, with a banner above it containing Malayalam text and a banner below it with the English text 'KANNUR UNIVERSITY'.

**DEPARTMENT OF PHYSICS**

**CORE COURSES**



## Semester - I

### Core Concepts in Physics

<b>Course Title</b>	: Core Concepts in Physics
<b>Semester</b>	: 01
<b>Course Code</b>	: KU01DSCPHY101
<b>Course Type</b>	: DSC
<b>Course Credits</b>	: 4
<b>Pre-requisites</b>	: Higher secondary level Physics

#### Course Description:

- Introduce the basic concepts in Physics.
- Introduce dimensional analysis and equations of motion.
- Explain the concepts of Work & Energy
- Illustrate the basic idea of conservation of a physical quantity.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

#### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Recall Newton's laws of motion and describe the basic concepts related to objects in motion	R, U
2	Understand the basic concepts of Work, Energy, & Power	U, A
3	Understand linear momentum and apply its conservation law in problems related to objects in motion	U, A
4	Understand & apply conservation of angular momentum and the concept of moment of inertia	U, A

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

#### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO1</b>	3	2	-	-	1	-	2	-	-	-	1
<b>CO2</b>	3	2	-	-	1	-	2	-	-	-	1
<b>CO3</b>	3	2	-	-	1	-	2	-	-	-	1
<b>CO4</b>	3	2	-	-	1	-	2	-	-	-	1

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (12 Hours): Newton's Laws of motion

What is physics; Concepts, models and theories; Dimensional analysis; Vectors, displacement and velocity; Instantaneous velocity, acceleration; Physiological effects of acceleration, Equations of motion, vertical free fall, terminal speed; Newton's Laws, applications of Newton's law, illustration of initial conditions; projectile motion; Historical notes: the geocentric theory verses the heliocentric theory.

### Module II (9 Hours): Work & Energy

Force and mass, Work done by a constant and variable force; Integrating equation of motion; Work energy theorem in one and three dimensions; Power; Potential energy, Conservative forces, Potential energy functions; Conservation of mechanical energy, Non-conservative forces.

### Module III (12 Hours): Linear Momentum

Conservation of linear momentum, elastic collision in one dimension; Elastic collision in three dimension, Impulse, comparison of linear momentum with kinetic energy, rocket propulsion, Historical note: Robert Goddard and early rocketry.

### Module IV (12 Hours): Rigid body motion & Conservation of Angular momentum

Centre of mass; Moment of inertia, Torque; The parallel axis theorem; rotational dynamics of rigid body along a fixed axis, angular momentum; Conservation of angular momentum, Spin and orbital angular momentum; Gyroscopic motion; Special topics: twist and somersaults.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Practicals (30 Hours): At least 6 Experiments to be performed

1. Find the moment of inertia of a rod, disc, ring familiarization of Vernier calipers, screw gauge.
2. Helical spring- Spring constant.
3. Show that the period of oscillation of a simple pendulum is independent of the mass of the bob used.
4. Determination of moment of inertia of fly wheel.
5. Inclined plane - determine the downward force along an inclined plane.
6. Concurrent forces - parallelogram law verification.
7. Concurrent forces - determination of unknown mass.
8. Simulation experiments using ExpEYES-SEELAB/ Virtual lab/PhET simulations

### Core Compulsory Readings

1. Benson Harris, University Physics (R/e), Wiley India (1996).
2. Sears & Zemansky's University Physics with Modern Physics (13/e), Hugh Young and

- Roger Freedman, , Pearson (2012).
- R. Resnick, D. Halliday and K. S. Krane, Physics Vol 1 (5/e), John Wiley (1991).
  - D. Kleppner and R. Kolenkow, An Introduction to Mechanics (1/e), McGraw Hill Inc USA (1973).
  - C. Kittel et.al., Mechanics Vol 1 (2/e), Berkeley Physics Course, Tata-McGraw Hill Ltd (2008).
  - Halliday & Resnick, Fundamentals of Physics (10/e), Jearl Walker, Wiley (2013).

### Core Suggested Readings

- A. P. French, Newtonian Mechanics (M.I.T. Introductory Physics Series), CBS (1987).

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Discuss the projectile motion
2. Discuss the conservative and non-conservative forces.
3. Explain the conservation of linear momentum.
4. Explain the concept of moment of inertia.

## Semester - II

### Electricity & Magnetism

Course Title	:	Electricity & Magnetism
Semester	:	02
Course Code	:	KU02DSCPHY101
Course Type	:	DSC
Course Credits	:	4
Pre-requisites	:	Higher secondary level Physics

#### Course Description:

- This course aims to explain the concept of electric field, electric potential, magnetic field and magnetic potentials.
- With the Principle of superposition and law of Gauss, electric field intensity calculations are performed.
- Determine Electric potential of charge distributions and hence specify electric field intensity.
- Basic properties of conductors and capacitors are explained.
- Calculate the magnetic fields due to currents using Biot-Savart and Ampere's laws.
- Compare Magnetostatics and Electrostatics and understand Diamagnets, Paramagnets and Ferro magnets.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

#### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Understand the fundamental concepts of electric field associated with static charge distributions	R, U
2	Understand the concepts of electric field, electric potential, and capacitors.	U, A
3	Learn the basics of current electricity and solve circuit element problems	U, An
4	Describe the idea of magnetic field associated with a current carrying conductor.	U, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	-	-	1	-	2	-	-	-	1
CO2	3	2	-	-	1	-	2	-	-	-	1
CO3	3	2	-	-	1	-	2	-	-	-	1
CO4	3	2	-	-	1	-	2	-	-	-	1

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

### Course Contents:

#### Module I (9 Hours): Electrostatics

Electric field - Coulomb's law, Gauss's law and applications, Potential difference - potential of a localised charge distributions - Electrostatic boundary conditions.

#### Module II (9 Hours): Work & Energy

Work and energy in electrostatics - Work done to move a charge - Energy of a point charge distribution - Energy of a continuous charge distribution - Electrostatic energy, Conductors - Induced charges - Surface charge and Force on a conductor - Capacitors.

#### Module III (15 Hours): Electric Currents

Electric current and current density, Electrical conductivity and Ohm's law, The physics of electrical conduction, Conduction in metals, Semiconductors, Circuits and circuit elements, Energy dissipation in current flow, Electromotive force and the voltaic cell, Networks with voltage sources, Variable currents in capacitors and resistors.

#### Module IV (12 Hours): Magnetostatics

Magnetic fields, Magnetic force, Lorentz law, Biot-Savart Law, Ampere's Law, Magnetization, Inductance, Inductance Circuit, Faraday's law of electromagnetic induction, Lenz's law, self-inductance, mutual inductance, Energy stored in the magnetic field.

#### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

#### Practicals (30 Hours): At least 6 Experiments to be performed

1. Potentiometer-Resistivity
2. Potentiometer - Calibration of low range voltmeter, high range voltmeter, & ammeter.
3. Potentiometer – EMF of a thermocouple
4. Circular coil- magnetization of a magnet
5. Circular coil-dipole moment
6. Circular coil - Variation of field with distance.
7. Searle's vibration magnetometer- ratio of magnetic dipole moments.
8. Box type vibration magnetometers.

9. Deflection magnetometer - Tan A, Tan B, positions - magnetic dipole moment.
10. To study the frequency response of a series RC circuit

### Core Compulsory Readings

1. D. J. Griffith, Introduction to electromagnetic Theory (3/e)
2. Edward M. Purcell, Electricity and Magnetism (2/e), Berkeley Physics Course Vol. 2.
3. Resnick and Halliday, Physics Vol. II
4. Arthur F Kip, Electricity and magnetism

### Core Suggested Readings

1. Hugh D Young and Roger A Freedman, Electricity and Magnetism

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. State and prove Gauss's law.
2. Calculate the energy of a point charge distribution.
3. Describe the process of electrical conduction in metals

## Mechanics

Course Title	:	Mechanics
Semester	:	02
Course Code	:	KU02DSCPHY102
Course Type	:	DSC
Course Credits	:	4
Pre-requisites	:	Basics Physics

### Course Description:

- This course will introduce the basic concepts of fluid mechanics and oscillations.
- Waves and Fourier analysis will be discussed.
- The concepts of central force problem will be discussed.
- This course will illustrate planetary motion using Kepler's laws.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Recall concepts like surface tension, viscosity and Pascal's law and understand the basics of fluid dynamics in detail	R, U
2	Understand the basic concepts of simple harmonic motion in oscillations	U, A
3	Learn wave motion from basics concepts and explore Fourier analysis in wave mechanics	U, An
4	Recall Newton's law of gravitation and understand planetary motion basics	R, U, A

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	-	-	1	-	2	-	-	-	1
CO2	3	2	-	-	1	-	2	-	-	-	1
CO3	3	2	-	-	1	-	2	-	-	-	1
CO4	3	2	-	-	1	-	2	-	-	-	1

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -



## Course Contents:

### Module I: Fluid Mechanics (9 Hours)

Fluid statics, Pressure & density, Depth, and Pascal's Law; Hydraulic Lever; Buoyancy; Archimedes's principle; Surface Tension; Equation of continuity; Bernoulli's Equation and its applications; Viscosity, turbulence and chaotic flow.

### Module II: Oscillations (12 Hours)

Simple harmonic motion (SHM), block spring system, energy in SHM pendulum, small oscillations, damped oscillations, energy, Q value, forced oscillations, Resonance, undamped and forced harmonic oscillator.

### Module III: Waves (12 Hours)

Wave characteristics, superposition of waves, reflection and transmission, traveling waves, standing waves, Transverse waves in stretched strings; longitudinal waves, Resonant standing waves on a string, the wave equation, Fourier analysis, interference, nature of sound waves, Resonant standing sound waves, interference of sound waves, Doppler effect.

### Module IV: Central force problem (12 Hours )

Newtons law of gravitation, gravitational potential, escape velocity, Kepler's laws of planetary motion, satellite orbits, Central force motion as a one-body problem, The energy equation and energy diagrams; Tides.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Atwood Apparatus - to determine  $g$ .
2. Torsion pendulum- Moment of inertia of a disc and rigidity modulus (using two identical masses)
3. Compound pendulum- To find  $g$  and radius of gyration
4. Young's modulus using cantilever bending
5. Young's modulus of the material of bar - uniform bending using optic lever
6. Young's modulus of the material of bar -non uniform bending
7. Surface tension by capillary rise method
8. Coefficient of viscosity –Poiseuille's formula (by measuring radius of capillary tube using mercury)
9. Young's Modulus by Koenig's Method
10. Melde's Apparatus
11. Helmholtz resonator - determination of unknown frequency of a tuning fork.
12. Kundt's tube - to determine the velocity of sound.
13. Simulation experiments using ExpEYES-SEELAB/ Virtual lab/PhET simulations



### Core Compulsory Readings

1. Sears & Zemansky's University Physics with Modern Physics (13/e), Hugh Young and Roger Freedman, Pearson.
2. R. Resnick, D. Halliday and K. S. Krane, Physics Vol 1 (5/e), John Wiley (1991).
3. Benson Harris, University Physics (R/e) , Wiley India.

### Core Suggested Readings

1. D. Kleppner and R. Kolenkow, An Introduction to Mechanics, McGraw Hill Inc USA (1973).

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Explain Pascal's law
2. How to determine the viscosity of a given liquid?
3. Explain forced and damped oscillations.
4. Explain central force motion as a one-body problem.

## Semester - III

### Fundamentals of Optics

<b>Course Title</b>	: Fundamentals of Optics
<b>Semester</b>	: 03
<b>Course Code</b>	: KU03DSCPHY201
<b>Course Type</b>	: DSC
<b>Course Credits</b>	: 4
<b>Pre-requisites</b>	: Basics of Electricity & Magnetism

#### Course Description:

- This course will introduce the basics of geometrical optics.
- Explain the wave nature of light via waveoptics.
- Illustrate interference and diffraction.
- Introduce plane of polarization of light and associated effects.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

#### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain the fundamental laws of Optics and describe the applications of geometric optics	U
2	Learn and illustrate the wave nature of light through wave optics	U, A
3	Learn and illustrate the diffraction of light	U, A
4	Understand the importance of polarization of an electromagnetic wave and extend the understanding to nontrivial cases.	U, A , An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

#### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO1</b>	3	2	2	1	1	1	-	-	-	-	1
<b>CO2</b>	3	2	2	1	1	1	-	-	-	-	1
<b>CO3</b>	3	2	2	1	1	1	-	-	-	-	1
<b>CO4</b>	3	2	1	1	1	-	-	-	-	-	1

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (9 Hours)

Geometrical Optics: Rectilinear propagation of light; The refractive index; Optical path; Laws of reflection and refraction; Fermat's principle; Color dispersion.

### Module II (12 Hours)

Wave Optics: Interference of light, principle of superposition, Huygens' Principle; Young's experiment; Conditions for maximum and minimum intensities, Coherent sources, Theory of interference fringes, Colours of thin films-interference due to reflected light, Interference due to transmitted light, Fringes produced by a wedge shaped thin film, Newton's Rings by reflected light, Determination of wave length of sodium light and Refractive index of a transparent liquid by Newton's rings.

### Module III (12 Hours)

Diffraction: Fresnel and Fraunhofer diffraction - Fresnel's Explanation of Rectilinear Propagation of light- Zone plate, Diffraction at a straight edge, Fraunhofer Diffraction at a single slit, Plane Transmission Diffraction Grating, Resolving power of optical instruments; Dispersive power of a Grating, Determination of wavelength of light using Transmission Grating. Comparison between interference and Diffraction.

### Module IV (12 Hours)

Polarization of light, Polarization by reflection, Pile of Plate, Law of Malus, Double Refraction, Huygen's theory of double refraction in uniaxial crystal, Nicol Prism, Theory of production of Elliptically and Circularly Polarised light, Quarter wave plates, Half wave plate, Production and detection of Plane, Circularly and Elliptically polarized light.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Spectrometer – Refractive index of the material of a prism
2. Spectrometer – Dispersive power of a prism
3. Newton's Rings- wavelength of sodium light
4. Air Wedge - Diameter of a thin wire
5. Spectrometer -  $i$ - $d$  curve
6. Spectrometer -  $i$ - $i'$  curve
7. Spectrometer - Cauchy's constants assuming wavelengths
8. Spectrometer – Grating normal Incidence
9. To determine the wavelength of a laser source using diffraction of a single slit
10. To determine the wavelength of a laser source using diffraction of double slits
11. To determine angular spread of He-Ne laser using plane diffraction grating
12. Simulation experiments using ExpEYES-SEELAB/ Virtual lab/PhET simulations

### Core Compulsory Readings

1. N. Subrahmanyam and B. Lal, A Textbook of Optics (R/e), S. Chand, (2012).
2. Jenkins & White, Fundamentals of Optics (4/e), McGraw-Hill (2001).
3. Ajoy Ghatak, Optics (6/e), McGraw-Hill (2017)

### Core Suggested Readings

1. M. Born & E. Wolf, Principles of Optics, Cambridge University Press (1999)

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Discuss Fermat's principle.
2. Explain Young's double slit experiment.
3. Discuss coherence of a source.
4. Discuss Fresnel and Fraunhofer diffraction of light.

## Basic Electronics

Course Title	:	Basic Electronics
Semester	:	03
Course Code	:	KU03DSCPHY202
Course Type	:	DSC
Course Credits	:	4
Pre-requisites	:	Basic Physics

### Course Description:

- This course will introduce the band structure concept of conductors, insulators and semiconductors.
- Formation of pn junction will be discussed.
- Principles and operation of bipolar transistors will be explained.
- Characteristics of an ideal Op-amp will be discussed in this course.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Introduce the concepts of band structure of solids	R, U
2	Understand the basic concepts of pn junction formation	U, A
3	Understand the operation of a bipolar transistor and apply the idea in realizing the amplifier circuit	U, An, E
4	Understand the basics of operational amplifiers and digital electronics	U, A, E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	1	1	1	-	-	-	-	-
CO2	3	2	2	1	1	1	-	-	-	-	-
CO3	3	2	2	1	1	1	-	-	-	-	-
CO4	3	2	2	1	1	1	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Content

### Module I (9 Hours)

Introduction to conductors, semiconductors and insulators. band structure, Fermi level, mechanism of conduction in metals and semiconductors, mobility and conductivity, intrinsic and extrinsic semiconductors, doping, donor and acceptor levels, carrier lifetime.

### Module II (12 Hours)

PN junction formation, Basic semiconductor devices: PN junction, band structure in open circuit PN junction, depletion region, PN diode: IV characteristics and its temperature dependence, space charge capacitance, diode resistance, half-wave and full-wave rectifiers, ripple factor, Filters: L, C, RC, LC and LCR filters.

### Module III (12 Hours)

Bipolar transistors and operation: PNP and NPN transistors, transistor currents, active, saturation and cut-off regions, Common emitter amplifier, AC and DC analysis of transistor circuits, Amplifiers and differential amplifiers. Oscillators, Operating principles of FET, MOSFET.

### Module IV (12 Hours)

Operational amplifiers: Ideal op-amp characteristics, common-mode rejection ratio, inverting and non-inverting configurations, Op-amp based circuits: summing, scaling and averaging amplifier, logarithmic amplifier. Digital Electronics: Boolean algebra, Binary number system, Conversion between different number systems, De Morgan's theorem, Karnaugh Map, Logic gates.

### Module V\* - Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Characteristics of a semiconductor diode
2. Half wave & Full wave (2 diodes) Rectifiers - Study of ripple factor with and without filter (by soldering)
3. Bridge Rectifier- Study of ripple factor with and without filter (by soldering)
4. Voltage multiplier (Quadrupler) circuit (by soldering)
5. Voltage regulator using Zener diode after finding Zener voltage (Line and Load regulations)
6. Common Emitter characteristics of BJT
7. Single stage Common Emitter amplifier - Gain and Frequency response (by soldering)
8. Realization of basic logic gates (OR, AND & NOT) using transistors (by soldering)
9. Charging & discharging of a capacitor.
10. LCR resonance.

### Core Compulsory Readings

1. S. M. Sze, Semiconductor Devices, Physics and Technology
2. A. Malvino and D. J. Bates, Electronic principles
3. Ramakant A Gayakwad, Op-amps and Linear Integrated Circuits
4. T L Floyd, Digital Fundamentals

### Core Suggested Readings

1. J. Millman, C. C. Halkias and S. Jit. Electronic devices and circuits

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Explain the band structure of a solid.
2. Differentiate between extrinsic and intrinsic semiconductors.
3. Explain the process of formation of a pn junction.
4. Illustrate the operation of a transistor as an amplifier.

## Quantum Physics: Basics

Course Title	:	Quantum Physics: Basics
Semester	:	03
Course Code	:	KU03DSCPHY203
Course Type	:	DSC
Course Credits	:	4
Pre-requisites	:	Mechanics, Optics

### Course Description:

- This course will review the anomalies in classical physics and introduce the basic concepts of quantum mechanics.
- Wavelike properties of particles will be explained.
- The concept of Heisenberg's uncertainty relationships will be discussed and Schrodinger equation will be introduced.
- This course will illustrate Bohr model to explain the atomic structure.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Recall the concepts of classical physics and discuss the early anomalies in time and space description	R, U, An
2	Illustrate electron diffraction experiments and understand uncertainty relations	U, An
3	Learn the basics of quantum mechanics and understand the idea of probability density	U, An
4	Explain atomic spectra using quantum mechanics	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	1	1	1	-	-	-	-	-
CO2	3	2	2	1	1	1	-	-	-	-	-
CO3	3	2	2	1	1	1	-	-	-	-	-
CO4	3	2	2	1	1	1	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -



## Course Contents:

### Module I (12 Hours)

Review of classical physics; Early anomalies: The Deficiencies in the classical concepts of Time, Space, & Velocity, The perihelion precession of Mercury's orbit, The Michelson–Morley experiment, Failure of classical equipartition theorem - Heat capacities of an Ideal Gas; Blackbody Radiation - Appearance of Planck's constant  $h$ ; Photoelectric effect; X-ray diffraction; Compton effect; Photon - waves or particles?

### Module II (9 Hours)

The Wavelike properties of particles: de Broglie waves; Electron diffraction experiments; Uncertainty relationships for classical waves; Heisenberg uncertainty relationships; Wave packets; Group and Phase velocities; Probability and randomness; Probability amplitude.

### Module III (12 Hours)

Particle in a Box - Behavior of a wave at the boundary, reflected and transmitted wave, continuity at the boundary; Quantum mechanics; The Schrodinger equation - Time dependent and steady state forms; Linearity and superposition; Probabilities and normalization; Expectation values; Operators; Applications: Free particle, Infinite & finite potential energy well; Particle in a box (two dimension), Simple harmonic oscillator; Potential energy steps and potential energy barriers- Tunnel effect, Alpha decay, & Nuclear fusion.

### Module IV (12 Hours)

Basic properties of atoms; Thomson model; Rutherford scattering experiment; Rutherford model; Electron orbitals; Atomic spectra; Bohr model; Frank-Hertz experiment; Correspondence principle; Deficiencies of Bohr model; Nuclear motion - Fine structure; Atomic excitation.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Thomson's experiment – To determine  $e/m$  ratio of an electron
2. Frank Hertz experiment – To determine the ionization potential.
3. Photoelectric effect – Determination of Planck's constant (White light and filters or LEDs of different colours may be used)
4. Spectrometer - Hydrogen spectra.
5. Newton's law of cooling- Specific heat of a liquid
6. Stefan's constant - Black body radiation.
7. Determination of band gap energy in silicon
8. Determination of band gap energy in germanium.
9. Program to plot the Fermi distribution as a function of temperature.
10. Simulation experiments using ExpEYES-SEELAB/ Virtual lab/PhET simulations

### Core Compulsory Readings

1. Kenneth S Krane, Modern Physics (4/e), John Wiley & sons (2020)
2. Arthur Beiser, Concepts of Modern Physics (6/e), McGraw Hill (2003)

### Core Suggested Readings

1. The Feynman lectures on Physics (Vol - III).

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Discuss the failure of classical equipartition theorem.
2. Describe black body radiation.
3. Discuss Heisenberg's uncertainty relations.
4. Explain particle in a box problem.

## Introduction to Solid State Physics

<b>Course Title</b>	:	Introduction to Solid State Physics
<b>Semester</b>	:	03
<b>Course Code</b>	:	KU03DSCPHY204
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Electricity & Magnetism, Mechanics

### Course Description:

- This course will introduce the basics of crystal structure.
- Concepts of chemical bonding will be explained with the help of examples.
- Free electron theory and Hall effect will be discussed in detail.
- The concepts of electrons and holes in semiconductors will be discussed in the context of band structure.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Illustrate crystalline and amorphous solids with examples and discuss the reciprocal lattice space	R, U, An
2	Explain the concepts of phonons in crystal lattice and illustrate chemical bonding	U, An
3	Understand free electron theory and evaluate the thermal and electrical conductivity of metals.	U, An, E
4	Explain the basics of band theory in solids and evaluate the carrier dynamics in semiconducting materials	U, A, E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	1	1	1	-	-	-	-	-
CO2	3	3	1	1	1	1	-	-	-	-	-
CO3	3	3	1	1	1	1	-	-	-	-	-
CO4	3	3	1	1	1	1	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (9 hours)

Crystalline and amorphous solids; Fundamental lattice types; Simple crystal structures; SC, BCC, FCC and HCP structures; Directions, planes and Miller indices; Diffraction, Bragg's Law, Reciprocal Lattice.

### Module II (12 Hours)

Chemical Bonding (Ionic, covalent, hydrogen, metallic). Lattice Dynamics, Phonons. Brillouin zones. Group and phase velocity. Thermal Properties. Normal modes, Density of states, Einstein model, Debye theory.

### Module III (12 Hours)

Electrons in metals; Free electron theory; Free electron gas in 1D, 2D, 3D; Heat capacity. Electrical conductivity; Ohms law; Hall effect; Thermal conductivity; Applications of Hall effect; Nearly free electron approximation; Bloch theorem and band structure.

### Module IV (12 Hours)

Semiconductors; Intrinsic and extrinsic semiconductors; Electrons, Holes, Impurities; Band structure of semiconductors; Fermi level of intrinsic and extrinsic semiconductors; Fermi level and carrier concentration in semiconductors; Mobility of charge carriers; Electrical conductivity in semiconductors; Magnetic properties of materials. Concepts of Dia-, Para-, Ferro- and Antiferro- Magnetism.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Hall Effect in semiconductors – To determine the carrier concentration in the given specimen of semiconductor material.
2. Lee's disc- Thermal conductivity of a bad conductor
3. Thermal conductivity - Charton's Method
4. Four probe method – To study the bulk resistance and the band gap energy of the given semiconductor.
5. Beer-Lambart's Law
6. Characteristics of a semiconductor diode
7. Thin film deposition and characterization.
8. Magnetic hysteresis using B-H curve.
9. Magnetic susceptibility of dia- and para- magnetic materials.
10. Simulation experiments using ExpEYES-SEELAB/ Virtual lab/PhET simulations

### Core Compulsory Readings

1. C. Kittel, Introduction to Solid State Physics (8/e), John Wiley & Sons, Inc. (2004).
2. H. Ibach & H. Luth, Solid State Physics (3/e), Springer (2003).

### Core Suggested Readings

1. N. W. Ashcroft and D. N. Mermin, Solid State Physics, Harcourt Asia PTE LTD (2001).

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Discuss Miller indices in crystal structure.
2. Discuss lattice vibrations and derive the density of states in momentum space.
3. Explain free electron theory.
4. Explain Hall effect and discuss the main applications of Hall effect.

## Semester - IV

### Electromagnetic Theory I

<b>Course Title</b>	: Electromagnetic Theory-I
<b>Semester</b>	: 04
<b>Course Code</b>	: KU04DSCPHY201
<b>Course Type</b>	: DSC
<b>Course Credits</b>	: 4
<b>Pre-requisites</b>	: Electricity & Magnetism

#### Course Description:

- This course will review and analyze the dielectric properties of matter and the field of a polarized object.
- Basic concepts of magnetization and Ampere's law will be introduced.
- Faraday's law of electromagnetic induction will be discussed.
- The concepts of energy and momentum of electromagnetic waves will be discussed.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

#### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Understand and analyze the field of a polarized object and learn the concept of electric susceptibility	R, U, An
2	Illustrate magnetization in matter and learn the concept of magnetic susceptibility	U, An
3	Recall Ohm's law and understand electromagnetic induction	R, U, An
4	Explain Maxwell's equations in vacuum and matter and learn the physical implications of electromagnetic boundary conditions	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

#### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO1</b>	3	3	1	1	1	1	-	-	-	-	-
<b>CO2</b>	3	3	1	1	1	1	-	-	-	-	-
<b>CO3</b>	3	3	1	1	1	1	-	-	-	-	-
<b>CO4</b>	3	3	1	1	1	1	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (9 Hours)

Polarisation: Dielectrics - Field of a polarised objects- Bound charges - Field inside a Dielectric, Electric Displacement, Gauss's Law in presence of Dielectrics, Linear Dielectrics - electric susceptibility - Permittivity - Dielectric constant - Energy and Forces in Dielectrics.

### Module II (12 Hours)

Magnetic vector potential - Diamagnet - Paramagnets - Ferromagnets - Torque and Forces on magnetic Dipoles, Effect of magnetic field on Atomic Orbits - Magnetization, Field of a magnetised objects - Magnetic field inside matter - Ampere's law in magnetised Materials and applications - Magnetic Susceptibility, Permeability- Ferromagnetism.

### Module III (12 Hours)

Electromotive Force-Ohm's Law, Faraday's Law of Electromagnetic Induction - Induced electric Field - Inductance - Energy in Magnetic Fields, Maxwell's Equations in vacuum and matter - Boundary conditions, Continuity equation, Poynting Theorem, Conservation Laws-Maxwell's Stress Tensor.

### Module IV (12 Hours)

Waves in one dimension: Wave equation - Boundary Conditions - Polarisation, Electromagnetic waves in Vacuum - Wave equation for  $\mathbf{E}$  and  $\mathbf{B}$  - Monochromatic Plane Wave - Energy and Momentum in EM waves.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Searle's Vibration magnetometer- moment and ratio of moments
2. Verification of Thevenin's and Norton's theorem
3. Quincke's method – Susceptibility of a liquid at different concentrations.
4. Laser – Determination of refractive index of a mirror substrate.
5. Maxwell's LC bridge – Determination of R and L of a given coil and C of a condenser.
6. Carey Foster's bridge - unknown resistance.
7. Deflection magnetometer - determine the pole strength of a magnet.
8. Magnetic field along the axis of Helmholtz coil.
9. Simulation experiments using ExpEYES-SEELAB/ Virtual lab/PhET simulations

### Core Compulsory Readings

1. D. J. Griffiths, Introduction to electromagnetic theory (3/e)
2. Edward M. Purcell, Electricity and Magnetism - Berkeley Physics Course: Vol.2 (2/e)
3. Resnick and Halliday, Physics Vol. II

4. Arthur F Kip, Electricity and Magnetism

### Core Suggested Readings

1. Hugh D Young and Roger A Freedman, Electricity and Magnetism

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Explain the basics of electrical susceptibility.
2. Discuss magnetization in materials.
3. Explain Poynting theorem.
4. Explain energy and momentum conservation of electromagnetic waves in vacuum.



## Thermodynamics

<b>Course Title</b>	:	Thermodynamics
<b>Semester</b>	:	04
<b>Course Code</b>	:	KU04DSCPHY202
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Electricity & Magnetism, Mechanics

### Course Description:

- This course will introduce the concept of temperature and discuss the properties of ideal gas.
- Concepts of work and heat will be illustrated with the help of examples.
- The second law of thermodynamics and principle of heat engine will be discussed.
- The concepts entropy and thermodynamic potential will be introduced.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Illustrate microscopic and macroscopic point of view in thermodynamics	R, U, An
2	Explain the concepts of work and heat and discuss heat conduction	U, An
3	Understand the second law of thermodynamics and illustrate reversible and irreversible processes	U, An, E
4	Explain the concept of entropy and discuss Maxwell's relations	U, A, E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	1	1	1	-	-	-	-	-
CO2	3	3	2	1	1	1	-	-	-	-	-
CO3	3	3	2	1	1	1	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 Hours)

Macroscopic point of view - Microscopic point of view - Macroscopic and microscopic point of view - Macroscopic vs. microscopic point of view - scope of Thermodynamics - thermal equilibrium - zeroth law - concept of temperature - thermometers and measurement of temperature - ideal gas temperature - Celsius temperature scale - Celsius and Fahrenheit temperature scale - thermodynamic equilibrium - equation of state - intensive and extensive parameters.

### Module II (15 Hours)

Work-Quasistatic process - work in changing volume of a hydrostatic system - PV diagram - hydrostatic work depends on path - calculation of work for Quasistatic process - generalised work - composite systems - work and heat - Adiabatic work - internal energy Function - mathematical formulation of first law - concept of heat - concept of path and state function - differential form of first law - heat capacity and measurements - specific heat of water, the calorie - equations for a hydrostatic system - heat reservoir - heat conduction - heat convection - radiation - Kirchoff and Stefan - Boltzmann law, Equation of state of a gas - internal energy of a real gas - ideal gas - quasistatic adiabatic process - kinetic theory of the ideal gas.

### Module III (15 Hours) : The second law of thermodynamics, Carnot cycle, and Thermodynamic temperature scale

Conversion of work into heat and vice - versa - principle of heat engines, cyclic process - gasoline engine and its efficiency, Diesel engine and its efficiency - heat engine kelvin Planck statement of second law - refrigerator, clausius statement of second law - equivalence of both - reversibility and irreversibility - external - internal mechanical Irreversibility - external - internal thermal irreversibility - chemical irreversibility - conditions for reversibility - Carnot cycle - Carnot Refrigerator - Carnot's theorem and Corollary - the thermodynamic temperature scale - Absolute zero and Carnot efficiency - equality of ideal gas and thermodynamic temperatures.

### Module IV (15 Hours): Entropy, Thermodynamic potentials, and Statistical distributions

Entropy, thermodynamic potentials and open systems Reversible part of second law - Entropy - entropy of an ideal gas - T - S diagram - entropy and reversibility - entropy and Irreversibility - irreversible part of second law - heat and entropy in irreversible processes - entropy and non equilibrium states - principle of increase of entropy - entropy and disorder Thermodynamic potentials - Internal energy, Enthalpy - Helmholtz free energy, Gibbs function - Maxwell's relations, joule Thomson expansion - first order phase Transition, clausius clapeyron equation - clausius clapeyron equation and phase diagrams. Ideas of ensembles, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein distributions.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. Mark W Zemansky and Richard H Dittman, Heat and Thermodynamics (8/e)
2. Kenneth S Krane, Modern Physics (4/e) (An Indian Adaptation) -

3. E V Guha, Basic thermodynamics
4. SC Garg, RM Bansal, CK Ghosh, Thermal Physics, (2/e) McGraw-Hill
5. F. Reif, Fundamentals of Statistical and Thermal Physics, Waveland Press Inc.

### Core Suggested Readings

1. F. Reif, Statistical Physics, Berkeley Physics Course, Volume 5, Tata McGraw-Hill

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Explain the zeroth law of thermodynamics.
2. Discuss intensive and extensive parameters.
3. Explain adiabatic work and discuss mathematical formulation of first law of thermodynamics.
4. Discuss the principle of heat engines.

## Introduction to Astrophysics

<b>Course Title</b>	:	Introduction to Astrophysics
<b>Semester</b>	:	04
<b>Course Code</b>	:	KU04DSCPHY203
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Mechanics, Quantum Physics

### Course Description:

- This course will discuss the basic tools required in Astronomy.
- Interstellar activities will be discussed in detail.
- The course includes study of stellar evolution.
- Various galaxy types and structures will be an active part of the course.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Learn basic tools of astronomy and understand stellar classification.	U, A
2	Understand interstellar activities.	U, A
3	Learn stellar evolution.	U, An
4	Classify galaxy types and stellar population according to their properties.	U, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	-	2	1	-	-	-	2	-	-
CO2	3	3	-	2	1	-	-	-	2	-	-
CO3	3	3	-	2	1	-	-	-	2	-	-
CO4	3	3	-	2	1	-	-	-	2	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (18 Hours): Basic Tools of Astronomy

Stellar distance-relationship between stellar parallax and distance, brightness and Luminosity - relation between luminosity, brightness, and distance, Magnitudes - Apparent magnitude and brightness ratio - relationship between apparent magnitude and absolute Magnitude - Colour and temperature of the star - relationship between flux, luminosity, and Radius - stellar spectra - stellar classification - Hertzsprung Russell diagram - H - R diagram and stellar radius - H-R diagram and stellar luminosity - H-R diagram and stellar mass.

### Module II (12 Hours): Interstellar Medium

Nebulae, Emission Nebulae, Dark Nebulae, Reflection Nebulae, Molecular Clouds, Protostars, The Jeans Criterion.

### Module III (15 Hours): Stars

Star clusters, Red Giants and the H - R Diagram - The Death of Stars - The Asymptotic Giant Branch - Dredge - Ups - Mass Loss and Stellar Winds - Infrared Stars - The End of an AGB Star's Life - White Dwarf Stars - High-Mass Stars and Nuclear Burning - The End Result of High - Mass Stars' Evolution: Pulsars, Neutron Stars, and Black Holes.

### Module IV (15 Hours): Galaxies

Galaxy Types, Galaxy Structure, Stellar Populations, Hubble Classification of Galaxies, Observing Galaxies - Spiral Galaxies - Barred Spiral Galaxies- Elliptical Galaxies - Lenticular Galaxies, Active Galaxies and AGNs, Gravitational Lensing, Redshift, Distance, and the Hubble Law.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. Mike Inglis, Astrophysics is Easy: An introduction for the Amateur Astronomer, Springer.
2. H. Karttunen, P. Kröger, H. Oja, M. Poutanen, K. J. Donner, Fundamental Astronomy (5/e), Springer
3. Baidyanath Basusu M, An introduction to Astrophysics, Prentice Hall of India

### Core Suggested Readings

1. B.W. Carroll & D.A. Ostlie, Modern Astrophysics, Addison Wesley (1996)

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

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- Developing conceptual understanding
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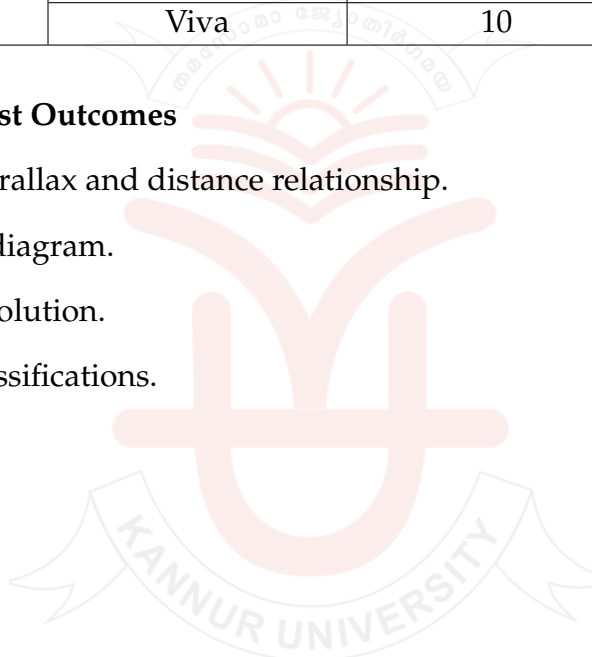
### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Describe stellar parallax and distance relationship.
2. Describe the H-R diagram.
3. Describe stellar evolution.
4. Discuss galaxy classifications.



## Introduction to Nuclear & Particle Physics

<b>Course Title</b>	:	Introduction to Nuclear & Particle Physics
<b>Semester</b>	:	04
<b>Course Code</b>	:	KU04DSCPHY204
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Quantum Physics

### Course Description:

- This course will help to identify nuclear constituents and general properties of nuclei and distinguish different nuclear models.
- Describe the phenomenon of radio activity.
- Discuss nuclear reactions including fission and fusion processes.
- Basic classification of elementary particles will be discussed.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Identify nuclear constituents and general properties of nuclei and distinguish different nuclear models.	U, An
2	Describe the phenomenon of radio activity.	U, An
3	Describe the nuclear fission and fusion processes.	U, An
4	Classify the elementary particles and relate their properties.	U, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	-	2	1	-	-	-	2	-	-
CO2	3	3	-	2	1	-	-	-	2	-	-
CO3	3	3	-	2	1	-	-	-	2	-	-
CO4	3	3	-	2	1	-	-	-	2	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (9 Hours): Nuclear Structure

Nuclear Composition; Nuclear properties- nuclear mass, nuclear size, magnetic moment, angular momentum; binding energy; liquid drop model; shell model; Nuclear force; Meson theory

### Module II (12 Hours): Nuclear Radioactivity

Radioactive decay; Half life; Conservation laws in radioactive decay; radioactive series; Alpha decay- tunnel theory of alpha decay; Beta decay; Gamma decay; resonance; Natural radioactivity; Mossbauer effect.

### Module III (12 Hours): Nuclear Reactions and Applications

Types of nuclear reactions; Reaction cross-section, Radioisotope production in nuclear reactions; Low-energy reaction kinematics; Fission; Fission reactors; Fusion; Fusion processes in stars, Fusion reactors; Applications of nuclear physics.

### Module IV (12 Hours): Elementary Particles

The four basic forces; Particles and antiparticles; Families of particles; symmetries and Conservation laws; Particle interactions and decays; Energy and momentum in particle decays and reactions; The Quark Model; The Standard Model and beyond.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Practicals (30 Hours): At least 6 Experiments to be performed

1. G.M counter – Plateau and statistics of counting.
2. G.M counter - operating voltage and to verify the distribution law satisfied by the radioactive decay.
3. Absorption coefficient of “gamma” rays – To determine the absorption coefficient of a given material for CS 137 gamma rays using GM counter.
4. Absorption coefficient of “beta” rays – To determine the Absorption coefficient of a given material for beta ray source using GM counter.
5. ESR spectrometer - Lande’s g factor
6. Program to calculate the half life of a radio active element.
7. Program to calculate the tunneling decay coefficient in alpha decay.
8. Simulation experiments using ExpEYES-SEELAB/ Virtual lab/PhET simulations

### Core Compulsory Readings

1. Arthur Beiser, Concepts of modern physics (7/e), TATA McGRAW-HILL.
2. Kenneth S. Krane, Modern Physics (4/e), John Wiley & sons.

### Core Suggested Readings



1. Nuclear Physics, D C Tayal, Himalaya Publishing House

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
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- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Describe the liquid drop model of nuclear structure.
2. Discuss the conservation laws in radio active decay
3. Describe the fusion process in stars.
4. Discuss the four basic forces and describe the classification of elementary particles.

## Semester - V

### Mathematical Physics I

<b>Course Title</b>	:	Mathematical Physics I
<b>Semester</b>	:	05
<b>Course Code</b>	:	KU05DSCPHY301
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Algebra, Differential and Integral Calculus

#### Course Description:

- This course aims to equip the students with the mathematical techniques used for developing strong background in the basic and advanced level problems.
- The course provides basic and advanced concepts in curvilinear coordinates, complex functions, and applications of complex theory.
- This paper also gives insights to special functions, tensors and group theory.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

#### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Solve physical problems using vector algebra.	R, U, An
2	Apply mathematical principles and concepts of matrices to solve practical problems.	U, An
3	Develop skill to solve problems based on complex variables.	U, An
4	Analyze and solve linear differential equations.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

#### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO1</b>	3	3	-	-	1	-	-	-	2	-	-
<b>CO2</b>	3	3	-	-	1	-	-	-	2	-	-
<b>CO3</b>	3	3	-	-	1	-	-	-	2	-	-
<b>CO4</b>	3	3	-	-	1	-	-	-	2	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 hours): Determinants, Matrices, Eigenvalue problems

Determinants - Homogeneous and Inhomogeneous Linear Equations - Cramer's rule - properties and applications of determinants, Matrices: Basic Properties - inner product- Orthogonal - Hermitian and Unitary Matrices, Diagonalization of Matrices -Simultaneous Diagonalization.

### Module II (15 hours): Tensors

Direct product, Tensor Analysis:Definition of Tensors - Covariant and Contravariant Tensors- Symmetry- Contraction - Direct Product - Quotient rule - Pseudo Tensors - Dual tensors - Metric Tensors - Kronecker Delta and Levi - Civita Tensors, Jacobians.

### Module III (15 hours): Vector Analysis

Vector algebra: vector operations-component form- Triple product- Position, Displacement, and Separation Vectors, Differential calculus:-Derivatives-Gradient-Divergence-Curl-Product rule-Second derivatives, Integral calculus:-Line, Surface, Volume integrals-Fundamental Theorem for Gradients-Divergence-Curls, Curvilinear Coordinates:-Polar, Cylindrical, and Spherical polar coordinates , Dirac delta function.

### Module IV (15 hours): Special Function

Special Functions: Gamma Function, Beta Function, Bessel Functions of First and Second Kinds: Generating Function, Recurrence Relations, Orthogonality, Neumann Function - Legendre Polynomials: Generating Function, Recurrence Relations, Rodrigue's Formula, Orthogonality - Associated Legendre Polynomials - Spherical Harmonics - Hermite Polynomials - Laguerre Polynomials.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

## Core Compulsory Readings

1. G.B.Arffen and H.J.Weber, Mathematical Methods for Physicists (6/e), Academic Press (2005)
2. A. W. Joshi, Matrices & Tensors in Physics (3/e), New Age International (2005).
3. K. F. Riley and Hobson, Mathematical Methods for Physicists and Engineers, Cambridge.
4. Michel Tabor, Chaos and Integrability in Nonlinear Dynamics, Wiley Eastern.
5. Sathyaprakash, Mathematical Physics, S. Chand & CO

## Core Suggested Readings

1. Pipes and Harvill, Applied Mathematics for Physicists and Engineers, McGraw Hill.
2. R. Courant and D. Gilbert, Methods of Mathematical Physics, Wiley Eastern.

## Teaching Learning Strategies

- Developing conceptual understanding

- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

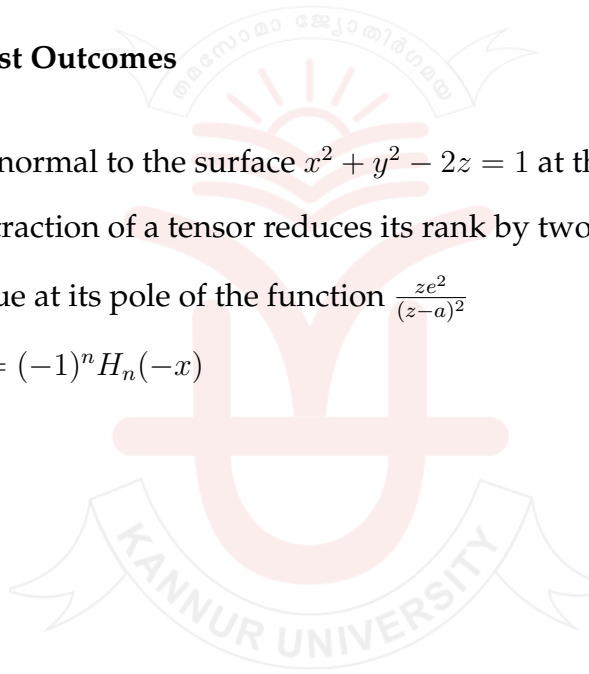
**Mode of Transactions**

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

**Sample Questions to test Outcomes**

1. Find a unit vector normal to the surface  $x^2 + y^2 - 2z = 1$  at the point  $P(1, 1, 1)$
2. Show that the contraction of a tensor reduces its rank by two.
3. Evaluate the residue at its pole of the function  $\frac{ze^z}{(z-a)^2}$
4. Prove that  $H_n(x) = (-1)^n H_n(-x)$



## Electromagnetic Theory II

<b>Course Title</b>	:	Electromagnetic Theory-II
<b>Semester</b>	:	05
<b>Course Code</b>	:	KU05DSCPHY302
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Electricity & Magnetism

### Course Description:

- This course will establish advanced concepts of electromagnetic theory and waveguiding.
- The basics of dipole radiation and antenna design will be discussed.
- The basic concepts in relativistic electrodynamics will also be covered.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain and discuss the propagation of electromagnetic waves through different media.	R, U, E
2	Explain waveguiding and supported modes.	U, An
3	Use radiation theory in developing different antennas structures.	U, An
4	Describe the basic formulations of relativistic electrodynamics.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	1	1	-	-	2	1	-
CO2	3	3	2	2	1	1	-	-	2	1	-
CO3	3	3	2	2	1	1	-	-	2	1	-
CO4	3	3	2	2	1	1	-	-	2	1	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (12 Hours)

Electromagnetic waves in linear media; The flow of electromagnetic Energy; Poynting Vector; Boundary conditions; Plane monochromatic waves; Polarization of plane waves- Linear, Circular, Elliptic etc.; Reflection and refraction of electromagnetic waves at a plane surface between dielectric media: normal incidence and oblique incidence; Brewster's angle, Critical angle, complex Fresnel coefficients; Reflection from a conducting plane.

### Module II (12 Hours)

Potentials and fields, Gauge Transformations: Lorentz and Coulomb Gauge, Retarded Potentials: Jefimenko's equations, The field of a moving point charge, Electric and Magnetic dipole radiations, Radiation from an arbitrary source, Power radiated by a point charge.

### Module III (9 Hours)

Radiation from Hertzian dipole; Half wave dipole antenna, Quarter wave monopole antenna; Antenna characteristics; Antenna arrays; Effective area and Fris equations.

### Module IV (12 Hours)

The special theory of relativity: Einstein's postulates, Geometry of relativity, Lorentz Transformations, Structure of space-time, Relativistic Mechanics: Proper time and proper velocity, Relativistic energy and momentum, Relativistic kinematics and dynamics, Relativistic electrodynamics: magnetism as a relativistic phenomena, Field transformations.

### Module V \*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Practicals (30 Hours): At least 6 Experiments to be performed

1. Plotting of the 2D functions in Python.
2. Mapping of 2D vector fields in Python.
3. Prepare codes to map electric and magnetic field lines.
4. Write a program to simulate the particle trajectory under Lorentz force law.
5. Write a program to plot reflection coefficients for TE modes.
6. Write a program to plot reflection coefficients for TM modes.
7. Write a program to calculate and plot the transmittance of a thin film of finite thickness.
8. Write a program to calculate and plot the transmittance as a function of thickness for a given material.
9. Write a program to calculate and plot the transmittance/reflection/absorption as a function of incident angle.

### Core Compulsory Readings

1. Capri A. Z. and Pant P.V., Introduction to Electromagnetics, Narosa Publications.

2. John R. Reitz, Frederic J. Milford and Robert W. Christy, Foundations of Electromagnetic Theory, Narosa Publications.
3. David. J. Griffiths, Introductions to Electrodynamics (4/e), Prentice Hall.
4. Chen. F. F., Introduction to Plasma Physics and Controlled Fusion, Plenum.
5. Jackson J.D, Classical Electrodynamics (3/e), John Wiley.
6. David Cheng, Field and Wave Electromagnetics (3/e), Pearson Education Asia.
7. Sadik, Electromagnetics.

### Core Suggested Readings

1. Puri S. P, Classical Electromagnetics (2/e), Tata McGraw Hill.
2. Laud B. B, Electromagnetics (3/e), Wiley Eastern.
3. Chopra K. K. and Agarwal G. C., Electromagnetic Theory (4/e), K. Nath and Co., Meerut.

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
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- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Explain Maxwell's equations.

2. Illustrate the formulations and relativistic effects in electrodynamics.
3. Describe the propagation of electromagnetic waves through waveguides.
4. Explain the concepts of reflection, refraction, and absorption of electromagnetic waves.
5. Describe the behavior of electromagnetic waves in different media, such as air, water, and glass.
6. Describe the behavior of electric fields and magnetic fields in free space.





## Quantum Physics: Applications

Course Title	:	Quantum Physics: Applications
Semester	:	05
Course Code	:	KU05DSCPHY303
Course Type	:	DSC
Course Credits	:	4
Pre-requisites	:	Quantum Physics: Basics

### Course Description:

- This course will discuss the quantum theory of hydrogen atom.
- Many electron systems will be discussed.
- The basics of statistical mechanics will be introduced along with the Planck's radiation law.
- Fundamentals of spectroscopic techniques will also be covered during this course.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Solve quantum theory of hydrogen atom	R, U, E
2	Understand the discrete energy level transitions and illustrate the fine structure of H atom	U, An
3	Learn the fundamentals of statistical mechanics and understand the three basic statistical distributions	U, An
4	Explain atomic spectra using quantum mechanics	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	-	-	2	-	-	-	-	-	-
CO2	3	3	-	-	2	-	-	-	-	-	-
CO3	3	3	-	-	2	-	-	-	-	-	-
CO4	3	3	-	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 Hours)

Quantum theory of hydrogen atom; Angular momentum of classical orbits; Angular momentum in quantum mechanics; Schrodinger equation for H-atom in spherical polar coordinates; Separation of variables; Hydrogen atom wave functions; Radial probability densities; Angular momentum and probability densities; Quantum numbers; Intrinsic spin; Stern – Gerlach experiment; Energy levels and radiative transitions; Zeeman effect; Fine structure.

### Module II (15 Hours)

Many electron atoms: Electron spin & Pauli's Exclusion principle; Symmetric and antisymmetric wave functions; Spin-orbit coupling; Total angular momentum; X-Ray transitions.

### Module III (15 Hours)

Statistical mechanics-basics; Three basic statistical distributions; Density of states; Maxwell - Boltzmann statistics; Molecular energies in an ideal gas; Quantum statistics; Rayleigh-Jeans formula; Plank's radiation law; Einstein's approach - stimulated emission; Specific heats of solids; Free electrons in metals; Dying stars.

### Module IV (15 Hours)

Spectroscopy: Regions of the spectrum; Microwave spectroscopy; The rotation of molecules; Rotational spectra; The rigid diatomic molecule; Intensities of spectral lines; The effect of isotopic substitution; The microwave oven; The vibrating diatomic molecule; The energy of diatomic molecule; The Simple Harmonic Oscillator. Introduction to Raman spectroscopy.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. Kenneth S Krane, Modern Physics (4/e), John Wiley & sons (2020)
2. Arthur Beiser, Concepts of Modern Physics (6/e), McGraw Hill (2003)
3. Colin N. Banwell and Elaine M McCash, Fundamentals of Molecular Spectroscopy (5/e), Tata McGraw-Hill (2013)

### Core Suggested Readings

1. The Feynman lectures on Physics (Vol - III).

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Solve Schrodinger equation for H-atom in spherical polar coordinates.
2. Explain Zeeman effect.
3. Discuss fine structure of H-atom.
4. Discuss stimulated emission.



## Numerical Methods in Physics

Course Title	:	Numerical Methods in Physics
Semester	:	05
Course Code	:	KU05DSCPHY304
Course Type	:	DSC
Course Credits	:	4
Pre-requisites	:	Mathematics for Physical Science

### Course Description:

- This course will provide a solid foundation in different numerical methods for solving complex problems.
- Students will be equipped to apply the techniques in their higher studies.
- This course serves as the foundation for advanced computational Physics and statistical data Analysis.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Understand and apply different methods to find the roots of nonlinear equations to solve problems.	U, A
2	Understand and apply different interpolation methods and curve fitting methods.	U, A
3	Understand different methods of numerical differentiation and integration and apply those methods to solve problems	U, A, E
4	Understand the methods to solve ordinary and partial differential equations.	U, A, E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	-	-	1	-	-	-	-	-	-
CO2	3	3	-	-	1	-	-	-	-	-	-
CO3	3	3	-	-	1	-	-	-	-	-	-
CO4	3	3	-	-	1	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

### **Module I (12 Hours) Roots of Equations**

Bi-Section Method, False Position Method, Newton-Raphson Method, Secant Method, Two Equation Newton-Raphson Method, Mullers Method, Gauss elimination method, Gauss elimination with pivoting, Gauss-Jordan method, Computing Matrix Inverse, Jacobi Iteration Method, Gauss-Seidel Method.

### **Module II (12 Hours) Curve Fitting**

Linear Interpolation, Lagrange Interpolation, Newton Interpolation, Interpolation with Equidistant Points, Forward, Backward difference Table, Fitting Linear Equation: Least Square Method, Fitting Polynomial Function.

### **Module III (12 Hours) Numerical differentiation and Integration**

Differentiating continuous functions: Forward difference only, Differentiating tabulated functions, Trapezoidal Rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Boole's Rule.

### **Module IV (9 Hours) Ordinary & Partial Differential Equations**

Taylor Series Method, Eulers Method, Rung Kutta Methods, Elliptic Equation: Laplace Equation, Parabolic Equation : Heat Equation.

### **Module V\* - Teacher Specific Module:**

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Root of a nonlinear equation using the bisection method
2. Root of an equation by false position method
3. Root of an equation by Newton-Raphson method
4. Root of a nonlinear equation by secant method
5. Root of a polynomial using Muller's method
6. Solution of first order differential equation using Runge-Kutta method
7. Integrate a given function using trapezoidal rule
8. Integrate a given function using the Simpsons 1/3 rule
9. Integrate a given function using the Simpsons 3/8 rule
10. Least square fitting.
11. Numerical interpolation using Newton and Lagrangian methods
12. Program to solve a system of linear equations using simple Gaussian elimination method
13. Solution of the first order differential equation at a given point using Euler's method
14. First derivative of tabulated function by difference table

### **Core Compulsory Readings**

1. E Balaguruswamy, Numerical Methods, McGraw Hill Education

### Core Suggested Readings

1. S. S. Sastry, Introductory method of Numerical analysis, Fifth Edition, PHI (2012).
2. V. N. Vedomurthy and N. Ch. S. N. Iyengar, Numerical methods, Vikas Publishing House, Pvt Ltd. New Delhi, India.
3. P. Ghosh, Numerical Methods with computer programs in C++, PHI learning Pvt Ltd.
4. F.B.-Hildebrand, Introduction to Numerical Analysis, Second Edition.
5. Richard Hamming, Numerical Methods for Scientists and Engineers.

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Find the root of a nonlinear equation using the bisection method
2. Integrate a given function using trapezoidal rule
3. Write a program to solve a system of linear equations using simple Gaussian elimination method

## Biophysics

Course Title	:	Biophysics
Semester	:	05
Course Code	:	KU05DSEPHY301
Course Type	:	DSE
Course Credits	:	4
Pre-requisites	:	Basic concepts of Physics & Biology

### Course Description:

- This course will introduce fundamentals of biophysics
- Students will have a solid understanding of protein structure determination.
- The course introduce neurotransmitters and synapses.
- Light absorption in biomolecules and mechanical properties of biomaterials will be discussed.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Learn the basics of biophysics and understand the essential physical process in a living organism.	U
2	Understand thermodynamics of living state.	U
3	Understand neurotransmittance and mechanical properties of biomaterials.	U, An
4	Learn basic structure determination of proteins using x-ray crystallography.	U, E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	1	1	-	-	1	2	-	-
CO2	3	3	1	1	1	-	-	1	2	-	-
CO3	3	3	1	1	1	-	-	1	2	-	-
CO4	3	3	1	1	1	-	-	1	2	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 Hours)

Fundamental building blocks of biological systems, Molecules essential for life, Water, proteins, lipids, carbohydrates, cholesterol, Nucleic acid, living state interactions, forces and molecular bonds, electric and thermal interaction, polarisations and induced dipoles, Casimir interactions, heat transfer in biomaterials, heat transfer mechanisms, heat equation, heat transfer through a living cell, Joule heating tissue.

### Module II (15 Hours)

Living state thermodynamics, thermodynamic equilibrium, First and second law of thermodynamics, measures of entropy, free expansion of gas, physics of many particle systems, Boltzmann factor in biology, DNA stretching, Brownian motion, Ficks laws of diffusion, Ficks law for growing bacterial cultures, Sedimentation of cell cultures.

### Module III (15 Hours)

Nerve impulses, Neurotransmitters and synapses, Passive and active transports in dendrites, Mechanical properties of biomaterials, Youngs, shear modulus and Poisson ratio, electrical stresses in biological membranes, Mechanical effects of microgravity during space flight, fundamentals of biomagnetic field sources- fundamentals, Passive electrical properties of living cells.

### Module IV (15 Hours)

Light absorption in biomolecules, Bioimpedance, Time harmonic current flow, Dielectric spectroscopy, Debye relaxation model, Cole equation, Fundamentals of protein folding, basic techniques for protein folding, protein crystallization, Vapor diffusion, sitting drop method, Hanging drop method, Basics of structure determination of proteins with X-ray crystallography, sample handling techniques.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. J. Claycomb, J. Quoc P. Tran, Introductory biophysics: Perspectives on the living state, Jones & Bartlett Publishers.
2. N. Arumugam, V. Kumaresan, Biophysics; Saras publication.
3. Philip Nelson, Biological Physics; W. H. Freeman & Company (2013).
4. Charis Ghelis, Protein Folding; Academic Press (1982).
5. McPherson, A., Preparation and Analysis of Protein Crystals (1982), John Wiley & Sons.

### Core Suggested Readings

1. Terese M. Bergfors, Protein Crystallization Techniques, Strategies and Tips, International University Line (1999)

### Teaching Learning Strategies

- Developing conceptual understanding



- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

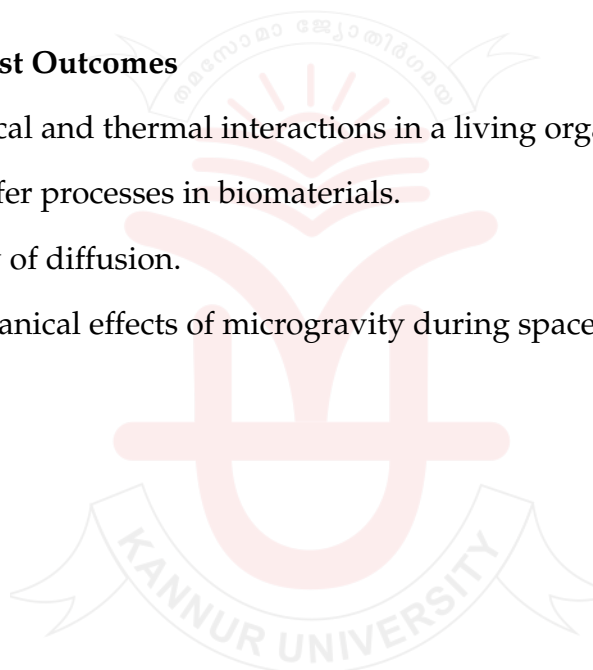
### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Discuss the electrical and thermal interactions in a living organism.
2. Discuss heat transfer processes in biomaterials.
3. Describe Ficks law of diffusion.
4. Describe the mechanical effects of microgravity during space flight.



## Python Programming

Course Title	:	Python Programming
Semester	:	05
Course Code	:	KU05DSEPHY302
Course Type	:	DSE
Course Credits	:	4
Pre-requisites	:	Basic Computational Skills

### Course Description:

- This course will equip the students with computational skills to visualize the physical concepts.
- The course will introduce necessary numerical techniques and the Python interface will be used to execute the algorithm.
- The data analysis part of the practicum components of the core courses will benefit from this course.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Develop skills in creating program sketches of scientific problems	R, U, An
2	Develop basic skills in logical thinking and programming	U, An
3	To make real-life scientific problems easier on a computer with user interaction and graphics	U, An, E
4	Visualize scientific concepts with advanced level data plotting	U, A, E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	1	1	-	-	1	2	-	-
CO2	3	3	1	1	1	-	-	1	2	-	-
CO3	3	3	1	1	1	-	-	1	2	-	-
CO4	3	3	1	1	1	-	-	1	2	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (13 Hours): Introduction to Python Programming

Introduction to Python language- Python interpreter -interactive and script modes-Variables and data types-Numbers, None, Sequences-string (create, access and manipulate string)-list (create, access and manipulate list objects)-tuple-Mutable and immutable variables-Operators and Operands-arithmetic, relational, logical and assignment operators-Expressions and Statements-Precedence of operators-Input and Output-Comments in python- File input/output-Programming exercises with applications in Physics.

### Module II (8 Hours): Functions in Python

Functions- Parameters and Arguments-Modules (NumPy and Matplotlib modules)-Use of Modules in Program (Import and From)-Python packages-Built-in and User defined functions- Composition of functions-Recursion-Vectorised functions- Programming exercises with applications in Physics.

### Module III (12 Hours): Conditional and Looping constructs in Python

Control flow structure- if, else-if and else-Nested condition- Looping Constructs- While and For loops- Nested loops-Break and Continue statements- Programming exercises with applications in Physics

### Module IV (12 Hours): Arrays and Matrices in Python; Data visualization

Creating arrays and Matrices using functions Arrange, Linspace, Zeros, Ones, Reshape-Arithmetic operations- cross product- dot product - Matrix inversion-Saving and Restoring arrays - Programming exercises with applications in Physics.

Plotting functions- Plot, Show, Subplot, Polar and Pie functions-Plotting Sine function-Derivative of a function- Programming exercises with applications in Physics.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Practicals (30 Hours): At least 2 exercises from each module:

Calculate the solar mass, Moment of inertia about center of mass (Sphere and Cylinder), Half-life period of a radioactive material, Calculate Rydberg's constant, Newton's law of gravitation, Heisenberg's uncertainty relation, Capacitor discharge in an RC circuit, Plot relativistic and classical momentum against velocity (velocity range  $0c$  to  $0.9c$ , where  $c$  is the velocity of light), Planck's law – plot Planck curves', Planetary motion - plot the actual orbits of the planet for three eccentricities, Projectile motion – plot  $x(t)$  and  $y(t)$  for different values of  $\theta$ , Emission lines of hydrogen atom using Rydberg's formula (wavelengths), Derivative of Sine function.

### Core Compulsory Readings

1. Charles Severance, Python for Informatics
2. Wesley J Chun, Core Python Programming, Pearson Education
3. David M. Beazley, Python Essential Reference, Pearson Education
4. B S Grewal, Numerical Methods in Engineering and Science, Khanna Publishers, New Delhi

5. S.S.Shastry, Introductory methods of numerical analysis, Prentice Hall of India (1983)

### Core Suggested Readings

1. Hans Petter Langtangen, A Primer on scientific Programming with Python, Springer

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and coding.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Discuss the data structure in Python
2. Explain the algorithm to find the roots of a transcendental equation
3. Analyze and debug the sample program given in Python data structure.

## Semester - VI

### Classical Mechanics

<b>Course Title</b>	:	Classical Mechanics
<b>Semester</b>	:	06
<b>Course Code</b>	:	KU06DSCPHY301
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Mechanics, Differential and Integral Calculus

#### Course Description:

- To provide basic and advanced concepts in classical mechanics
- To provide basic and advanced concepts in Lagrangian and Hamiltonian formulation
- This paper also gives insight to central force problems, theory of small oscillations, Kepler's problem, Rigid body dynamics and Euler's equations.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

#### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain the concepts of Lagrangian and Hamiltonian mechanics and use them to solve problems in mechanics.	R, U, An
2	Explain the concepts like generating functions, Poisson brackets and Hamilton-Jacobi equations.	U, An
3	Analyze the action-angle variables concepts to find the frequency of motion of the heavenly bodies.	U, An
4	Explain the theory of small oscillations and use Euler's equations of motions for rigid body dynamics.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

#### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO1</b>	3	3	1	-	2	-	-	-	-	-	-
<b>CO2</b>	3	3	1	-	2	-	-	-	-	-	-
<b>CO3</b>	3	3	1	-	2	-	-	-	-	-	-
<b>CO4</b>	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (18 hours)

Constraints and Generalized Coordinates; D'Alembert's Principle and Lagrange's Equations; Velocity Dependent Potentials; Simple Applications; Hamilton's Principle; Elementary Idea of Calculus of Variation; Euler-Lagrange Equation; Lagrange's Equation from Hamilton's Principle; Hamiltonian Function; Central Force Problem; Scattering in a central force field; Equivalent One-Dimensional Problem; Classification of Orbits; The Kepler Problem; Small Oscillations; Formulation of the Problem; Eigen value Equation; Normal Coordinates; Free Vibrations of a Linear Triatomic Molecule.

### Module II (15 hours)

Configuration Space and Phase Space; Legendre Transformation; Hamilton's Canonical Equations; Principle of Least Action; Applications of Hamilton's Equations: Two-dimensional Isotropic Harmonic Oscillator, Charged Particle in an Electromagnetic Field; Canonical Transformations – Examples; Infinitesimal Canonical Transformation; Poisson Brackets: Properties; Equation of Motion in Poisson Bracket Form; Angular Momentum Poisson Bracket Relations.

### Module III (12 hours)

Hamilton Jacobi Equation for Hamilton's Principal Function and Hamilton's Characteristic Function; Harmonic Oscillator Problem; Action Angle Variables; Hamilton Jacobi Formulation of Kepler Problem; Hamilton Jacobi Equation and Schrodinger Equation.

### Module IV (15 hours)

Space Fixed and Body Fixed Systems of Coordinates; Description of Rigid Body Motion; Direction Cosines; Euler Angles; Infinitesimal Rotations; Rate of Change of a Vector; Centrifugal and Coriolis Forces; Moment of Inertia Tensor; Euler's Equation of Motion.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

## Core Compulsory Readings

1. Goldstein, Classical Mechanics, (3/e), Pearson Education.
2. N. C. Rana and P. S. Joag, Classical Mechanics, Tata McGraw Hill.
3. R. G. Takwale and P. S. Puranic, Introduction to Classical Mechanics, Tata McGraw Hill..
4. V. B. Bhatia, Classical Mechanics, Narosa Publishers.
5. A.J. Griffiths, Classical Mechanics, McGraw Hill.

## Core Suggested Readings

1. Kiran C. Gupta, Classical Mechanics of Particles and Rigid Bodies, New Age International.

## Teaching Learning Strategies

- Developing conceptual understanding

- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

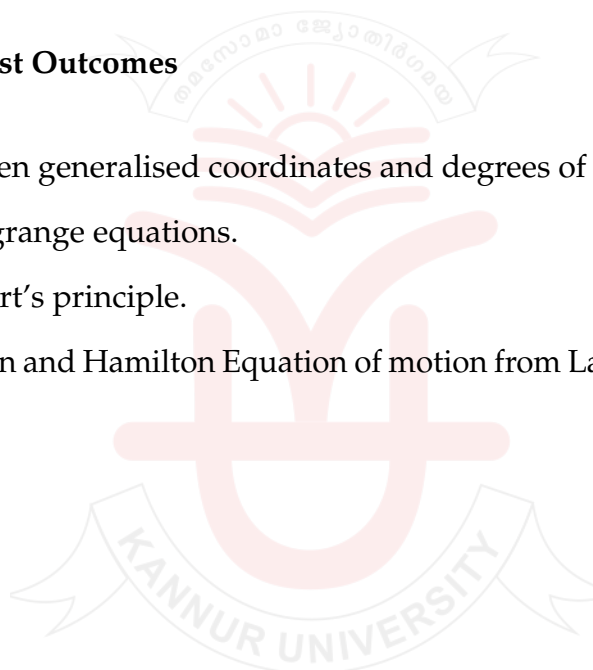
#### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

#### Sample Questions to test Outcomes

1. Distinguish between generalised coordinates and degrees of freedom.
2. Obtain Euler – Lagrange equations.
3. Explain D’Alembert’s principle.
4. Obtain Hamiltonian and Hamilton Equation of motion from Lagrangian using Legendre transformation.



## Advanced Electronics

Course Title	:	Advanced Electronics
Semester	:	06
Course Code	:	KU06DSCPHY302
Course Type	:	DSC
Course Credits	:	4
Pre-requisites	:	Basic Electronics

### Course Description:

- This course will introduce Op-Amp and advanced electronic circuits.
- Study of registers and counters will be conducted.
- Basic principles of communication methods will be discussed.
- Microprocessor architecture will be introduced.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Understand Op-Amp characteristics and applications	R, U
2	Learn the basics of analog to digital conversion	U, An
3	Understand the operation of communication systems	U, An, E
4	Learn microprocessor architecture and various operation modes	U, A, E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -



### **Module I (12 Hours)**

Linear applications of Op-amp: Instrumentation Amplifier, Voltage to current and Current to voltage converters, differentiator, and integrator, Comparators, Schmitt Triggers. Active Filters: Low-pass, High-pass, Band-pass Band-reject filters. Oscillators: Phase Shift and Wien-bridge Oscillators, Square, Triangular and Sawtooth waveform generators. Multivibrators: Astable and monostable multivibrators.

### **Module II (12 Hours)**

Multiplexer and Demultiplexer, Flip Flops and Timing Circuits, Different Types of Registers and Applications of Shift Registers, Counters: Synchronous Counters, Asynchronous Counters, Decade Counters and Mod 8 Ripple Counter, A/D and D/A Converters: R-2R Ladder and Successive Approximation Type ADC.

### **Module III (12 Hours)**

Communication systems, Importance of Modulation, Amplitude Modulation, Double and Single sideband techniques, Frequency modulation and Demodulation techniques, Bandwidth requirements, Pulse Modulation: Pulse amplitude modulation (PAM), Sampling process, Performance comparison of various sampling techniques, Pulse Code Modulation (PCM), Quantization, Delta modulation, Pulse position modulation (PPM), Pulse width modulation (PWM).

### **Module IV (9 Hours)**

Microprocessors, Microcontrollers and Microcomputers, 8085 Microprocessor, Various Operations of Microprocessors, Microprocessor Communication and Bus Timing, 8085 Bus Structure, Pin Diagram of 8085 MPU.

### **Module V\* - Teacher Specific Module:**

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Transistor characteristics and transistor as an amplifier
2. Phase shift oscillator
3. FET characteristics and amplifier using FET
4. Voltage regulation using transistors with feedback (Regulation characteristic with load for different input voltages)
5. Two stage RC coupled amplifier (I/O resistance with and without feedback).
6. Op-Amp: Square, triangular and saw-tooth wave generator
7. Integrator and Differentiator circuits using op-amp 741
8. Low-pass, High-pass, Band pass and band reject filters using op-amp 741
9. Schmitt trigger using op-amp 741
10. Astable and monostable using op-amp 741
11. Schmitt trigger using IC 555
12. Astable and monostable using IC 555

### Core Compulsory Readings

1. Ramakant A Gayakwad, Op-amps and Linear Integrated Circuits.
2. Jacob Millman & Chritos C. Halkias, Integrated Electronics.
3. Malvino & Leach, Digital Principles and Applications.
4. Dennis Roddy and John Coolen, Electronic Communications.
5. Ramesh Gaonkar, Microprocessor Architecture, Programming and Application with the 8085.
6. Paul B. Zbar and Malvine A. P., Basic Electronics, Tata McGraw Hill.
7. Begrat R. Brown J., Experiments for Electronic Devices and Circuits, Merrill International Series.
8. Buchla, Digital Experiments, Merrill International Series.
9. Jain R.P. and Anand M.M.S., Digital Electronics Practice Using ICs, Tata McGraw Hill.
10. Subramanian V. S., Experiments in Electronics, McMillan.
11. Poorna Chandra Rao and Sasikala B., Hand Book of Experiments in Electronics and Communication Engineering.

### Core Suggested Readings

1. J. Millman, C. C. Halkias and S. Jit. Electronic devices and circuits

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Design and construct an inverting amplifier using op-amp 741.
2. Design and construct a non-inverting amplifier using op-amp 741.
3. Design and construct a first order low pass filter.

## Modern Optics

Course Title	:	Modern Optics
Semester	:	06
Course Code	:	KU06DSCPHY303
Course Type	:	DSC
Course Credits	:	4
Pre-requisites	:	Fundamentals of Optics

### Course Description:

- To study theory, construction, working and different applications of Lasers.
- To understand the theory, construction, working and different application of optical fibers.
- Understand nonlinear optical phenomena like second harmonic generation, parametric amplification, self focusing etc.
- Understand the basics of Holography

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain the basics of LASER, the working principle of different varieties of LASERS, and their applications.	U, An
2	Describe the propagation of light through optical fiber, the relation between Numerical Aperture and Refractive indices, the types of optical fibers, and the attenuation mechanism.	U, An
3	Describe the basic principles and applications of holography	U, An, E
4	Illustrate nonlinear optics and explain the Harmonic generation, parametric amplification etc.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 Hours)

Introduction to lasers: Interaction of light with matter-Einsteins coefficients and their relations-light amplification, cavity, gain medium, rate equations, population inversion, lasing condition, level lifetime, spontaneous and stimulated emission. Dephasing time, line broadening mechanisms: homogeneous and inhomogeneous broadening, hole burning, spatial hole burning; examples of lasing systems: DFB and DBR lasers, semiconductor lasers, He-Ne laser, Raman laser, Brillouin laser, mode-locked lasers, Vertical Cavity Surface Emitting Lasers (VCSELs).

### Module II (9 Hours)

Fibre optics: Optical fibre, Total internal reflection, Propagation of light through optical fibre; Fractional refractive index; Numerical aperture; Classification of optical fibres; The three types of fibres; Applications; Fibre optic communication system; Merits of optical fibres.

### Module III (9 Hours)

Holography: Principle of holography; Recording and reconstruction; Holograms; Holography and photography; Important properties of holograms; Applications.

### Module IV (12 Hours)

Nonlinear Optics: Linear and Nonlinear Polarization, Wave Equation with driving polarization; Second and Third-order optical nonlinearities, Parametric vs non-parametric process; Intensity dependent refractive index; Introduction to four-wave mixing, Third harmonic generation, Phase matching techniques, Stimulated Raman Scattering, Stimulated Brillouin scattering, Electromagnetically Induced Transparency.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Cauchy's constants – Determination of Cauchy's constants of sodium light.
2. Laser – Diameter of a thin wire.
3. Laser – Determination of slit width.
4. Cornu's hyperbolic fringes – Determination of  $Y$ ,  $\sigma$  and  $K$  with Pyrex.
5. Cornu's elliptical fringes – Determination of  $Y$ ,  $\sigma$ ,  $K$  with glass.
6. Photo diode characteristics: To study the output characteristics of a photo diode
7. Solar cell – Spectral response and I-V characteristics
8. Ultrasonic Interferometer – To determine the velocity of ultrasonic waves in the given liquids
9. Optical fibre cable - Numerical aperture.
10. Optical fibre cable - divergence angle and attenuation.

### Core Compulsory Readings

1. Ajoy Ghatak, Optics (6/e), McGrawHill (2017)
2. Ajoy Ghatak & K. Thyagarajan, Introduction to Fiber Optics, Cambridge University Press (2018)
3. Robert Boyd, Nonlinear Optics (3/e), Elsevier (2009)

### Core Suggested Readings

1. M. Born & E. Wolf, Principles of Optics, Cambridge University Press (1999)

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Discuss population inversion and explain lasing in a gain medium.
2. Explain total internal reflection.
3. Discuss the principles of Holography.
4. Differentiate between parametric and non-parametric processes.

## Introduction to Nanomaterials

<b>Course Title</b>	:	Introduction to Nanomaterials
<b>Semester</b>	:	06
<b>Course Code</b>	:	KU06DSEPHY301
<b>Course Type</b>	:	DSE
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Introduction to Solid state physics

### Course Description:

- This course introduces the students to the world of nanomaterials.
- Physical and chemical properties of nanoparticles will be discussed.
- Quantum confinement effects and plasmon resonance will be illustrated through examples.
- Surface effects and energy minimization methods will also be discussed.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain the history and basics of nanomaterial research.	U, An
2	Describe size and shape dependent properties of nanoparticles	U, An
3	Learn and analyze the plasmonic response of nanomaterials	U, An, E
4	Understand various surface effects and surface energy stabilization mechanisms.	U, An E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	2	3	-
CO2	3	3	1	-	2	-	-	-	2	3	-
CO3	3	3	1	-	2	-	-	-	2	3	-
CO4	3	3	1	-	2	-	-	-	2	3	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 Hours)

Fundamentals of Nanomaterials, History of Nanotechnology, Feynman's vision on Nano Science & technology, bulk vs nanomaterials. Central importance of nanoscale morphology - small things making big differences, nanotechnology as nature's technology, clusters and magic numbers. nanoscale architecture. Recent developments, challenges and future prospects of nanomaterials.

### Module II (15 Hours)

Size and shape dependent properties of nanomaterials Size and shape dependent properties, Melting points and lattice constants. Surface Tension, density of states, Wettability - Specific Surface Area and Pore - Composite Structure -Mechanical properties. Optical properties: Basic principles of nanomaterials- increase in surface area to volume ratio and quantum confinement effect. Surface Plasmon resonance in metal nanoparticles and quantum size effect in Semiconductors, Electrical conductivity: Surface scattering, change of electronic structure, quantum transport. effect of microstructure.

### Module III (15 Hours)

Classification of nanomaterials: Classification based on the dimensionality. Zero-dimensional nanostructures: metal, semiconductor and oxide nanoparticles. One-dimensional nanostructures: nanowires and nanorods. two-dimensional nanostructures: thin films. Three-dimensional nanomaterials. Special Nanomaterials: Carbon fullerenes and carbon nanotubes. micro and mesoporous materials. core-shell structures. organic-inorganic hybrids.

### Module IV (15 Hours)

Surface science for nanomaterials, surface energy, Surface Energy minimization: Sintering Ostwald ripening and agglomeration. Energy minimization by Isotropic and anisotropic surfaces. Wulff plot, Surface energy, surface curvature and chemical potential. Surface energy stabilization mechanisms. Electrostatic stabilization - Point zero charge (p.z.c).Nernst Equation. Electric double layer. Electric potential at the proximity of a solid surface - Debye-Hückel Screening strength. Interaction between nanoparticles - Van der Waals attraction potential. DLVO Theory. static stabilization and electro static stabilization. Nucleation and growth of nuclei. critical radius, homogenous and heterogeneous nucleation.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

## Core Compulsory Readings

1. A.W. Adamson and A.P.Cast, Physical Chemistry of surfaces, Wiley Interscience. NY (2004).
2. G. Cao and Y. Wang, Nanostructures and Nanomaterials, 2nd Ed., Imperial College Press (2004).
3. R. Kelsall. L Hamley and M. Ceoghegan, Nanoscale Science and Technology, Wiley (2005).
4. K. J. Klabunde. R. M. Richards, Nanoscale Materials in Chemistry (2/e), Wiley (2009).



5. T. Pradeep, A text book of Nano Science and Technology, Tata McGraw-Hill Education (2012).

### Core Suggested Readings

1. G. Schmidt. Nanoparticles: From Theory to applications. Wiley-VCH (2004)
2. Malkiat S. Johal, Lewis E. Johnson, Textbook Series in Physical Sciences, CRC Press (2008)
3. G. Cao, Nanostructures & Nanomaterials; Synthesis, Properties & Application, Imperial College Press, 2004.

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Describe the basic characteristization methods for nanomaterials.
2. Explain the plasmonic response of a nanoparticle



## Energy Physics

Course Title	:	Energy Physics
Semester	:	06
Course Code	:	KU06DSEPHY302
Course Type	:	DSE
Course Credits	:	4
Pre-requisites	:	Introduction to Solid state physics

### Course Description:

- Main aim of the course is to provide basic knowledge on Energy resources and the need for conservation of energy.
- To make the students acquire an awareness of Solar energy, solar energy conversion and importance of solar energy in the present scenario.
- It is intended to help them grasp a broad outline of different energy sources like ocean energy, wind energy etc.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Understand Energy policy perspectives.	U, An
2	Classify technologies for conversion of solar energy resources.	U, An
3	Illustrate Photovoltaic conversion mechanism.	U, An, E
4	Explore various modes for ocean energy conversion.	U, An E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	2	3	-
CO2	3	3	1	-	2	-	-	-	2	3	-
CO3	3	3	1	-	2	-	-	-	2	3	-
CO4	3	3	1	-	2	-	-	-	2	3	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (18 Hours)

Overview of world energy scenario; Energy Demand- present and future energy requirements; Review of conventional energy resources - Coal, gas and oil reserves, Tar sands and Oil Shale, Nuclear energy; Global warming; Green House Gas emissions, impacts, mitigation; sustainability; United Nations Framework Convention on Climate Change (UNFCCC); Sustainable development; Kyoto Protocol; Conference of Parties (COP); Clean Development Mechanism (CDM); Prototype Carbon Fund (PCF).

### Module II (18 Hours)

Solar Energy -Solar radiation, its measurements and prediction; Solar thermal collectors- flat plate collectors, concentrating collectors; solar heating of buildings; solar still; solar water heaters; solar dryers; conversion of heat energy in to mechanical energy, solar thermal power generation systems. Photovoltaic Conversion -intrinsic, extrinsic and compound semiconductor; Absorption of light; Recombination process; p-n junction: homo and hetero junctions; Dark and illumination characteristics; Principle of photovoltaic conversion of solar energy, Figure of merits of solar cell; Efficiency limits.

### Module III (15 Hours)

Wind Energy -Wind energy conversion principles; General introduction; Power, torque and speed characteristics. Atmospheric circulations; factors influencing wind, wind shear, turbulence, wind speed monitoring; Betz limit; Types and classification of WECS, characteristics and applications.

### Module IV (9 Hours)

Ocean Energy - Ocean energy resources, ocean energy routes; Principles of ocean thermal energy conversion systems; ocean thermal power plants; Principles of ocean wave energy conversion and tidal energy conversion.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. B H Khan, Non- conventional energy resources, , Tata McGraw-Hill Publication (2006).
2. John Twidell and Tony Weir, Renewable Energy Resources, Routledge, Taylor& Francis (2015).
3. Chetan Singh Solanki, Solar Photovoltaics: Fundamentals, Technologies And Applications, PHI Learning (2015).

### Core Suggested Readings

1. G. D. Rai, Non-Conventional Energy Resources, Khanna Publishers (2008).
2. L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, (1990).
3. Renewable Energy, Bent Sorensen (2/e), Academic press, (2000).

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Describe the basic characteristics of a solar cell.
2. Explain the photovoltage generation process.
3. Discuss thin film solar cell technologies.



## Semester - VII

### Quantum Mechanics

<b>Course Title</b>	:	Quantum Mechanics
<b>Semester</b>	:	07
<b>Course Code</b>	:	KU07DSCPHY401
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Quantum Physics, Classical Mechanics

#### Course Description:

- Hilbert space formulation of the basic principles and the equation of motion are established.
- Concepts of linear vector spaces, matrices and the theory of angular momentum is given in a more detailed way.
- A unified view of the different formulation of non-relativistic quantum mechanics is established.
- Schrodinger's and Heisenberg's formulations appear merely as different representations, analogous respectively to the Hamilton-Jacobi theory and Hamilton's formalism in classical mechanics.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

#### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain the concepts of Linear vector space and the representation of vectors and operators in matrix form.	R, U, An
2	Describe the fundamental postulates of quantum mechanics and the concept of physical observable, and measurement of the complex state.	U, An
3	Explain the basic concepts of quantum dynamics. Describe different pictures like Schrodinger, Heisenberg and the interaction pictures.	U, An
4	Explain the quantum theory of angular momentum and use angular momentum algebra for physical systems by determining eigenvalues and eigenvectors associated with angular momentum.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

### Course Contents:

#### Module I (18 hours)

Linear Vector Space, Ortho Normal Basis, Unitary Space, Hilbert Space, Completeness, Closure Property, Operators: Different Types, Commuting operators, Dirac Notation, Matrix Representation of Vectors, Operators and Bases, Unitary Transformations, Change of Basis, Coordinate and Momentum Representation, Fundamental Postulates, The Equation of Motion, Schrodinger Pictures, Heisenberg Pictures, Interaction pictures, Uncertainty Principles, Time Energy Uncertainty Relation, Linear Harmonic Oscillator in Schrodinger and Heisenberg Pictures.

#### Module II (18 hours)

Definition of Angular Momentum, Eigen Values and Eigen Vectors, Angular Momentum Matrices, Pauli Spin Matrices, Orbital Angular Momentum, Angular Momentum and Rotation, Euler Angle, Addition of Angular Momentum, Clebsch Gordan Coefficients, Theory of Hydrogen Atom.

#### Module III (12 hours)

Space-time Symmetries, Displacement in Space and Time, Space Rotation, Space Inversion, Time Reversal, Identical Particles, Symmetric and Antisymmetric Wave Functions, Pauli's Exclusion Principle – Spin and Statistics, Two Electron Systems – Helium Atom.

#### Module IV (12 hours)

Variational Method for Bound States – Ground state of Helium Atom, Time Independent Perturbation Theory, Non-degenerate Case – Anharmonic Oscillator, Degenerate case – Stark and Zeeman Effects in Hydrogen Atom.

#### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. V. K. Thankappan, Quantum Mechanics, Wiley Eastern.
2. Ghatak and Lokanathan, Quantum Mechanics, MacMillan
3. Zettili, N, Quantum Mechanics: Concepts & Applications (2/e), Wiley (2009).
4. Griffiths, D J, Introduction to Quantum Mechanics, Pearson Education (2005).

### Core Suggested Readings

1. Bransden and Joachain, Introduction to Quantum Mechanics, ELBS.
2. G. Aruldas, Quantum Mechanics, PHI.

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Explain uncertainty principle.
2. Describe interaction picture for harmonic oscillator.
3. Explain Zeeman effect on the basis of quantum mechanics.
4. Explain the time independent perturbation theory.
5. Describe the concept of time reversal.
6. List the fundamental postulates of quantum mechanics

## Mathematical Physics II

<b>Course Title</b>	:	Mathematical Physics II
<b>Semester</b>	:	07
<b>Course Code</b>	:	KU07DSCPHY402
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Mathematical Physics I

### Course Description:

- This course aims to equip the students with the mathematical skill to solve problems in advanced physics.
- To provide basic and advanced concepts in Fourier series, Fourier and Laplace transforms, Applications of Fourier and Laplace problems in physical problems.
- This paper also gives insights to Green's functions for solving differential equations, integral equations, Green's functions, theory of groups and chaos.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Develop analytical skills to solve problems in different areas of physics using Fourier series, Fourier and Laplace transforms .	R, U, An
2	Use Laplace transform to solve differential equations.	U, An
3	Illustrate and apply concepts of group theory in physics problems.	U, An
4	Use the method Green's function to solve non-homogeneous linear differential equations.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	-	-	2	-	-	-	-	-	-
CO2	3	3	-	-	2	-	-	-	-	-	-
CO3	3	3	-	-	2	-	-	-	-	-	-
CO4	3	3	-	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 hours): Fourier Series and Integral Transforms

Fourier Series: General properties and Applications, Integral Transforms: Fourier Transform and Properties - Fourier Transform of Derivatives - Convolution Theorem, Laplace Transform and Properties - Laplace Transform of Derivatives - Convolution Theorem - Inverse Laplace Transform - Laplace Convolution Theorem.

### Module II (15 hours): Complex Variable Theory

Function of Complex Variables: Introduction- Argand diagram, Analytic Function - Cauchy - Riemann Conditions- Derivatives of a analytic function, Conformal Mapping, Cauchy's Integral Theorem: Contour Integrals- Cauchy's theorem and proof, Multiply Connected Regions, Cauchy's Integral Formula - Derivatives - Morera's Theorem - Cauchy's inequality - Taylor series and theorem, Laurent series and Theorem, Singularities - poles - meromorphic - entire functions- Branch point, Calculus of Residues- Residue Theorem, Evaluation of Definite Integrals.

### Module III (15 hours): Integral Equations and Green Functions

Integral Equations: Transformation of a Differential Equation into an Integral Equation - Integral Transforms and Generating Function methods - Separable Kernel - Neumann Series - Hilbert-Schmidt Theory, Green's function: Properties - One Dimensional Green's Function - Problems - Eigenfunction Expansion.

### Module IV (15 hours): Group Theory

Groups: Definition and Examples, Representation of Group: - Multiplication Table - Consequences -Symmetry Group of Square and Triangle - Permutation Group - Subgroups - Direct Product Groups - Isomorphism and Homomorphism - Cyclic Group - Factor Group Representation of a Group - Types of Representation - Schur's Lemmas - Orthogonality Theorem and Proof Geometrical Interpretation - Character of a Representation Character Table Basic Ideas of Continuous Groups - SU(2) and SU(3) Groups.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

## Core Compulsory Readings

1. G.B.Arften and H.J.Weber, Mathematical Methods for Physicists (6/e), Academic Press (2005)
2. A. W. Joshi, Group Theory for Physicists, Wiley Eastern.
3. Michel Tabor, Chaos and Integrability in Nonlinear Dynamics, Wiley Easte
4. Pipes and Harvill, Applied Mathematics for Physicists and Engineers, McGraw Hill.
5. Sathyaprakash, Mathematical Physics, S. Chand & CO

## Core Suggested Readings

1. K. F. Riley and Hobson, Mathematical Methods for Physicists and Engineers, Cambridge.



2. R. Courant and D. Gilbert, Methods of Mathematical Physics, Wiley Eastern

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Find the Fourier transform of the function  $f(t) = \sin(3t)/t$ .
2. Explain how Green's function relates to integral equations.
3. Describe Lie groups
4. Illustrate the representation of a group.
5. Explain the method of plotting logistic maps.

## Statistical Mechanics

Course Title	:	Statistical Mechanics
Semester	:	07
Course Code	:	KU07DSCPHY403
Course Type	:	DSC
Course Credits	:	4
Pre-requisites	:	Classical and Quantum Physics

### Course Description:

- This course aims at explaining the physical properties of matter in bulk on the basis of the dynamical behavior of its microscopic constituents.
- The paper brings macroscopic and microscopic worlds into a common formulation and introduces ensemble formalism.
- The basic ideas of quantum statistical mechanics and fundamentals of Ising theory will also be demonstrated.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain the macroscopic phenomena (any natural phenomena) in terms of the microscopic parameters or to bridge the microscopic and macroscopic worlds.	R, U, An
2	Elucidate the connection between the thermodynamic and statistical parameters.	U, An
3	Describe the different ensemble formalism and differentiate micro canonical, canonical and grand canonical ensembles.	U, An
4	Apply statistical mechanics as a tool to solve various physical situations related to classical and quantum mechanical systems with specific examples like Bose Einstein Condensation and black body radiation.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 hours) : Statistical Basis of Thermodynamics and Elements of Ensemble Theory

The macroscopic and microscopic states - Boltzmann relation between entropy and microstates - Connection between statistics and thermodynamics, Classical ideal gas, Gibbs paradox - The correct enumeration of microstates, Phase space, Liouville's theorem and its consequences, The microcanonical ensemble - Examples of calculation of microstates - Classical ideal gas - Simple Harmonic oscillator.

### Module II (18 hours): Canonical and Grand Canonical Ensemble Theory

Canonical Ensemble: Equilibrium between a system and reservoir- A system in the canonical ensemble - method of most probable values - Physical significance of statistical quantities in the canonical ensemble - Partition function for non - degenerate and degenerate systems - Density of states - The classical systems - Energy fluctuation in canonical ensemble - correspondence with the microcanonical ensemble, Equipartition theorem and virial theorem, A system of harmonic Oscillators. Grand Canonical Ensemble: Equilibrium between a system and a particle - energy reservoir, A system in Grand canonical ensemble - Physical Significance of statistical quantities - Examples in grand canonical ensemble, Classical ideal gas, a system of independent localised particles - Harmonic Oscillators, density and energy fluctuations in grand canonical ensemble correspondence with other ensembles.

### Module III (15 hours): Quantum Statistics

Limits of Classical Statistics - Quantum Statistics - Density of states - Bose - Einstein statistics - Fermi - Dirac statistics, An ideal gas in quantum mechanical micro canonical ensemble - An ideal gas in other quantum mechanical ensembles - Statistics of occupation numbers, Thermodynamic behaviour of an ideal Bose gas - Bose-Einstein condensation - Thermodynamics of the blackbody radiation, Thermodynamic behaviour of an ideal Fermi gas - Fermi temperature and Fermi energy - Magnetic behaviour of ideal Fermi gas - Pauli paramagnetism - Landau diamagnetism, Electron gas in metals.

### Module IV (12 hours): Phase Transition

Dynamical model of phase Transition, Lattice gas and binary alloys, Ising model in Zeroth approximations, Ising model in First approximation, critical exponents, Thermodynamic inequalities, Landau phenomenological Theory.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

## Core Compulsory Readings

1. R K Pathria, Paul D. Beale - Statistical Mechanics (4/e), Academic Press (2022)
2. Roger Bowley, Mariana Sánchez - Introductory Statistical Mechanics (2/e), Oxford University Press (2000)
3. Kerson Huang, Statistical Mechanics (2/e), John Wiley and Sons
4. Reif, Statistical Physics: Berkeley Physics Course Vol. 5, Tata Mcgraw Hill (2011).

## Core Suggested Readings

1. Mandl, Statistical Physics (2/e), John Wiley & Sons (1991).

## Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

## Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

## Sample Questions to test Outcomes

1. Describe macrostate and microstates.
2. State and explain Liouville's theorem.
3. Explain Gibb's paradox.
4. Obtain expression for probability of seeing a system in a canonical ensemble with energy  $E$ .
5. Explain the density fluctuation in grand canonical ensemble.
6. Describe Ising model.

## Photovoltaic Energy Conversion

<b>Course Title</b>	:	Photovoltaic Energy Conversion
<b>Semester</b>	:	07
<b>Course Code</b>	:	KU07DSEPHY401
<b>Course Type</b>	:	DSE
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Condensed matter physics

### Course Description:

- This course introduces the basics of photovoltaic energy conversion.
- To study theory, construction, working and different applications of solar cells.
- This course helps to understand various thin film solar cell technologies.
- Solar photovoltaic modules are also discussed.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain the basics of photovoltaic energy conversion.	U, An
2	Describe depletion layer formation and light matter interaction in a pn junction	U, An
3	Learn and analyze the basic characteristics of solar cells	U, An, E
4	Understand various solar cell technologies and investigate the current trends	U, An E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	2	3	-
CO2	3	3	1	-	2	-	-	-	2	3	-
CO3	3	3	1	-	2	-	-	-	2	3	-
CO4	3	3	1	-	2	-	-	-	2	3	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (9 Hours)

Solar Energy – The Solar Constant – Solar Intensity on Earth's Surface – Direct and Diffuse Radiation – Apparent Motion of Sun – Solar Insolation Data.

### Module II (12 Hours)

p-n Junction I-V Relation: Quantitative Analysis – p-n Junction under Illumination: Generation of Photo Voltage(PV) and Light Generated Current – I-V Equation for Solar Cells – Solar Cell Characteristics. Design of Solar Cells:Upper Limit of Solar Cell Parameters: Short Circuit Current, Open Circuit Voltage, Fill Factor and Efficiency –Losses in Solar Cells – Model of Solar Cells – Effect of Series and Shunt Resistance – Solar Radiation and Effect of Temperature on Solar Cell Efficiency – Solar Cell Design – Design for High Short Circuit Current – Choice of Junction Depth and Orientation – Minimization of Optical Losses and Recombination – Design for High Open Circuit Voltage –Design for High Fill Factor.

### Module III (12 Hours)

Thin Film Solar Cell Technologies: Generic Advantages of Thin Film Technologies –Materials for Thin Film Technologies – Thin Film Deposition Techniques – Common Features of Thin Film Technology – Amorphous Si Solar Cell Technology – Cadmium Telluride Solar Cell Technology – Thin Film Crystalline Solar Cells.

### Module IV (12 Hours)

Solar Photovoltaic Applications: Solar Photovoltaic (SPV) Modules – SPV from Solar Cells – Series and Parallel Connections – Mismatch in Cell Module – Mismatch in Series Connection – Hot Spots in Modules – Bypass Diode– Mismatch in Parallel Connection – Design and Structure of PV Modules – Number of Solar Cells – Wattage of Modules – PV Module Power Output – I-V Equation for PV Modules – I-V and Power Curves of Module – Effect of Solar Irradiation and Temperature.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Prepare a metal thin film using physical deposition technique.
2. To study the optical, structural, and surface morphological properties of the thin film provided.
3. Measure the change in in-plane and out-of-plane conductivity of a thin film with thickness.
4. From the given XRD data find the strain and particle size.
5. Using the given absorbance spectra of the dye find the degradation rate.
6. Study the Characteristics of Solar cell
7. Using PV system using a ready made PV cells, DC ammeter to find how wavelength of the light affect the electricity production

- From the given data of doped semiconductors find the absorption coefficient and variation in optical band gap.

### Core Compulsory Readings

- Chetan Singh Solanki, Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI, 2nd Edn,
- G. Busch and Schade, Lectures on Solid State Physics, Pergamon Press.
- B. O. Seraphin, Solar energy conversion, Springer.
- S. R. Das and K. L. Chopra, Thin Film Solar Cells, Springer.

### Core Suggested Readings

- Harold J. Hovel, Semiconductors and Semimetals-Vol.II, Academic Press.
- Martin A. Green, Solar Cells, Prentice Hall Series.
- Tom Markvart and Luis Castner, Handbook of Solar Cells, Springer.

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

- Describe the basic characteristics of a solar cell.
- Explain the photovoltage generation process.
- Discuss thin film solar cell technologies.
- List out the advantages of CdTe solar cell technology.

## Fiber Optics

Course Title	:	Fiber Optics
Semester	:	07
Course Code	:	KU07DSEPHY402
Course Type	:	DSE
Course Credits	:	4
Pre-requisites	:	Electromagnetic Theory

### Course Description:

- This course introduce the fiber optics technology.
- Concepts of optical waveguiding will be discussed.
- Concepts of optical modes and chromatic dispersion will be explained.
- Dispersion management in optical communication systems will be discussed.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Remember th concepts of total internal reflection and understand the importance of optical communication.	R, U
2	Explain the concepts of optical waveguiding and analyze supported modes.	U, An
3	Illustrate the mode propagation and evaluate the loss factors to minimize signal broadening	U, An, E
4	Explore various fiber optic technologies and learn loss compensation	U, A, E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	1	1	-	-	2	1	-
CO2	3	3	2	2	1	1	-	-	2	1	-
CO3	3	3	2	2	1	1	-	-	2	1	-
CO4	3	3	2	2	1	1	-	-	2	1	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -



## Course Contents:

### Module I (12 Hours)

Introduction, need for optical communication, salient features of optical fibers, ray theory of light guidance, numerical aperture, modes of a fiber, single and multimode fibers, step-index and graded-index fibers, fiber fabrication techniques Transmission characteristics of optical fibers, attenuation, pulse broadening mechanism, intermodal dispersion, bit rate - length product, material dispersion, electromagnetic wave analysis of light propagation in an infinitely extended medium, em waves in dielectrics, boundary conditions.

### Module II (12 Hours)

Electromagnetic analysis of planar optical waveguides, TE and TM modes, planar mirror waveguide, dielectric symmetric step- index, planar waveguide, symmetric and anti-symmetric modes, b-V curves, modal fields Power associated with modes of dielectric symmetric planar waveguide, asymmetric planar waveguide, single polarization single mode waveguide, excitation of guided modes by prism coupling technique, radiation modes, optical fiber waveguide, EH and HE modes, weakly guiding fibers, LP modes, mode cut-offs, b-V curves.

### Module III (9 Hours)

Optical fiber modes, field patterns, degeneracies, fractional power in the core, single mode fiber, cut-off wavelength, mode field diameter, bend loss, splice loss, waveguide dispersion, group delay Total chromatic dispersion, pulse broadening and chirping, dispersion in graded-index and multilayer fibers, optical fiber components and devices, directional coupler, power splitter, WDM coupler, polarization controllers, fiber Bragg gratings.

### Module IV (12 Hours)

Various types of fiber Bragg gratings, fabrication methods, applications, long period gratings, optical fiber amplifier, erbium doped fiber amplifier, dispersion management, dispersion shifted fiber, dispersion compensating fiber, sources for optical fiber communication, light emitting diode, internal and external quantum efficiencies, LED characteristics, laser diode Detectors for optical communication, p-i-n photodetector, APD, System design, dispersion and attenuation limited systems, BER, power budgeting of fiber link, recent advances .

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Measurement of numerical aperture
2. Measurement of spectral attenuation
3. Measurement of fiber loss
4. Characterization of detectors for optical fiber systems
5. Characterization of sources for optical fiber systems
6. Wavelength multiplexing in an optical fiber
7. Optical link design

8. Fiber parameters by scattering measurements
9. Optical fiber acoustic sensor
10. Holographic coupler for fibers
11. Analog link using optical fiber
12. Voice link using optical fiber
13. PAM signal transmission & reception
14. Propagation loss measurement
15. Bending loss measurement

### Core Compulsory Readings

1. Ghatak A & Thyagarajan K, Introduction to Fiber Optics, Cambridge University Press (1998)

### Core Suggested Readings

1. Capri A. Z. and Pant P.V., Introduction to Electromagnetics, Narosa Publications.
2. John R. Reitz, Frederic J. Milford and Robert W. Christy, Foundations of Electromagnetic Theory, Narosa Publications.
3. David. J. Griffiths, Introductions to Electrodynamics (4/e), Prentice Hall.
4. Laud B. B, Electromagnetics (3/e), Wiley Eastern.
5. Chopra K. K. and Agarwal G. C., Electromagnetic Theory (4/e), K. Nath and Co., Meerut.

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Describe optical fiber technology.
2. Discuss total internal reflection.
3. Discuss symmetric and asymmetric planar waveguides



## Thin Film Technology

Course Title	:	Thin Film Technology
Semester	:	07
Course Code	:	KU07DSEPHY403
Course Type	:	DSE
Course Credits	:	4
Pre-requisites	:	Solid state physics, Electromagnetic theory - I

### Course Description:

- This course explains the theory of thin film formation and various factors that affect the structure of thin films.
- Expert training in different thin film fabrication and characterization techniques will be provided.
- This course also covers important properties and application of thin films.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	1	4	3	2	5	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain the basics of thin films, the theory of thin film formation, and the various factors affecting the structure of thin films.	R, An
2	Illustrate the different techniques for thin film fabrication like vacuum evaporation, pulsed laser ablation, sputtering, chemical vapor deposition etc.	U, An
3	Describe how to measure the thickness of thin films and explain the different characterization techniques like XRD, Uv-Vis spectroscopy, SEM, TEM etc and study its theory, construction and working in detail.	U, An, E
4	Describe different applications of thin films in technology and daily life.	U, A, E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (12 Hours)

Thin Film Physics: Mechanism of Thin Film Formation, Formation Stages of Thin Films, Condensation and Nucleation, Thermodynamic Theory of Nucleation, Growth and Coalescence of Islands, Influence of Various Factors on the Final Structure of Thin Films, Crystallographic Structure of Thin Films.

### Module II (12 Hours)

Methods of Preparation/Synthesis of Thin Films: Vacuum Evaporation, Resistive Heating, Electron Beam Evaporation and Laser Beam Evaporation, Sputtering: Glow Discharge, Radio Frequency and Magnetron Sputtering, Chemical Methods: LCVD, PCVD and PECVD, Spray Method: Spray Hydrolysis and Spray Pyrolysis, Langmuir Blochet Technique, Sol-gel Deposition. Thickness Measurements, Resistance, Capacitance, Microbalance, Quartz Crystal Thickness Monitor, Optical Absorption, Multiple Beam Interference, Interference Colour and Ellipsometry Methods.

### Module III (9 Hours)

Characterization/ Analysis of Materials and Devices (Basic Principles), X-Ray Diffraction (XRD), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Energy Dispersive Analysis of X-rays (EDAX), UV-VIS Spectroscopy, Fourier Transform Infrared (FTIR) Spectroscopy, Electron Spin Resonance (ESR), X-ray Photoelectron Spectroscopy (XPS).

### Module IV (12 Hours)

Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM), Applications: Thin film resistors, Materials and Design of thin film resistors (Choice of resistor and shape and area), Trimming of Thin Film resistors, Sheet Resistance Control, Individual Resistor Trimming, Thin Film Capacitors, Thin Film Field Transistors, Fabrication and Characteristics, Thin Film Diodes.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

**Practicals (30 Hours):** At least 6 Experiments to be performed

1. Prepare a metal thin film using physical deposition technique.
2. To study the optical, structural, and surface morphological properties of the thin film provided.
3. Measure the change in in-plane and out-of-plane conductivity of a thin film with thickness.
4. From the given XRD data find the strain and particle size.
5. To find the average grain/crystallite size, unit cell parameters, micro-strain by recording the X-ray diffraction pattern of the given sample.
6. Using the given absorbance spectra of the dye find the degradation rate.

- Using PV system using a ready made PV cells, DC ammeter to find how wavelength of the light affect the electricity production
- From the given data of doped semiconductors find the absorption coefficient and variation in optical band gap.

### Core Compulsory Readings

- Maisel L. L and Glang R., HandBook of Thin Film Technology, McGraw Hill (1970)
- Chopra K. L., Thin Film Phenomena, McGraw Hill (1969).
- Goswami A., Thin Film Fundamentals, New Age Intemational Ltd. (1996).

### Core Suggested Readings

- Joy George, Preparation of Thin Films, Dekker.
- Khangaonkar P. R., An Introduction to Materials Characterization, Pen ram International Publishing.

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

- Explain the percolation limit of thin film formation.
- Discuss various surface topography techniques.
- Compare thermal evaporation and sputtering.

## Semiconducting Materials & Devices

Course Title	:	Semiconducting Materials & Devices
Semester	:	07
Course Code	:	KU07DSEPHY404
Course Type	:	DSE
Course Credits	:	4
Pre-requisites	:	Solid state physics, Electromagnetic theory - I

### Course Description:

- The course provides a description of basic and advanced level properties of semiconductor materials as well as their functioning in some of the applications.
- Students will learn the physical behaviour of bipolar junction transistors and field effect transistors by forming semiconductor junctions.
- The principle and working of optoelectronic devices such as solar cells, photodetectors, light emitting diodes etc. will also be elaborated.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain the basic and advanced properties of semiconductor materials.	R, An
2	Describe the importance of semiconductor materials in various device applications.	U, An
3	Illustrate working of bipolar junction transistors and field effect transistors on a semiconductor perspective.	U, An, E
4	Describe the principle and working of optoelectronic devices such as solar cells, photodetectors, light emitting diodes etc.	U, A, E

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -



## Course Contents:

### Module I (15 Hours)

Carrier Drift, Drift Current Density, Mobility Effects, Conductivity, Velocity Saturation, Carrier Diffusion, Diffusion Current Density, Total Current Density, Graded Impurity Distribution, Induced Electric Field, The Einstein Relation, Reciprocal Lattice, Bragg Reflection of Electron Waves, Brillouin Zones, Important Features of Energy Bands of Si, Ge and GaAs

### Module II (15 Hours)

Intrinsic, Extrinsic and Compensated Semiconductors, Electrons and Holes: Semiconductor Statistics, Electron and Hole Mobilities and Drift Velocities, Hall Effect and Magneto resistance, Quasi Fermi Levels: Generation and Recombination of Carriers, p-n Junction under Zero Bias Condition, Depletion Capacitance, Diffusion Capacitance, Tunneling and Tunnel Diodes, Junction Breakdown, Schottky Barriers, Ohmic Contacts.

### Module III (15 Hours)

Bipolar Junction Transistor: Principle of Operation, Doping Profile, Electron Diffusion Current in the Base, BJT as a Switch, Bipolar Transistors in Integrated Circuits, FET: Basic Principles, Surface Charge in Metal Oxide Semiconductor Capacitors, MOSFET: Principle of Operation, Charge Coupled Devices, Advanced MOS Devices.

### Module IV (15 Hours)

Crystalline Solar Cells, Conversion Efficiency, p-n Junction Solar Cells, Spectral Response –Equivalent Circuit. Amorphous Silicon Solar Cells, Photo Detectors, PIN Diode Detectors, Electroluminescence of Electromagnetic Waves in Two Level Systems, LEDs, Semiconductor Lasers: Optical Gain, Integrated Optoelectronics.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

## Core Compulsory Readings

1. Sze S. M., Physics of Semiconductor Devices, John Wiley & Sons, 2015.
2. Donald A. Neamen, Semiconductor Physics and Devices by, Fourth Edition, 2019.
3. Michael Shur, Physics of Semiconductor Devices, Prentice Hall of India, 2004.
4. Goswami A., Thin Film Fundamentals, New Age International Ltd. (1996)

## Core Suggested Readings

1. S. S. Islam, Semiconductor Physics and Devices, Oxford University Press, (2010).
2. Karl Hess, Advanced Theory of Semiconductor Devices, Prentice Hall of India.
3. Jasprit Singh, Semiconductor Devices: An Introduction, McGraw Hill, (2001).

## Teaching Learning Strategies

- Developing conceptual understanding



- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

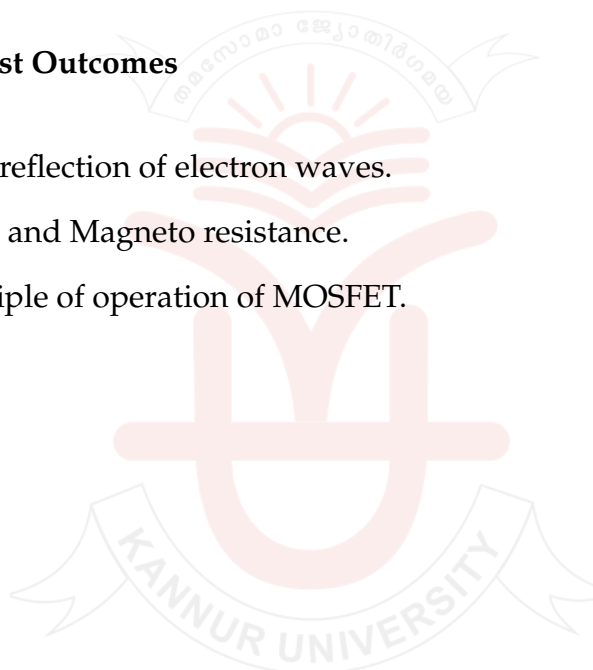
#### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

#### Sample Questions to test Outcomes

1. Explain the Bragg reflection of electron waves.
2. Discuss Hall effect and Magneto resistance.
3. Describe the principle of operation of MOSFET.



## Semester - VIII

### Research Methodology

<b>Course Title</b>	:	Research Methodology
<b>Semester</b>	:	08
<b>Course Code</b>	:	KU08DSCPHY401
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Basic research attitude, Language skills

#### Course Description:

- The basic aim of this course is to equip the students with necessary research tools for their Honours and/or future PhD works.
- This course helps researchers prepare their research plans, scope of the study, and to report the findings in an ethical manner.
- This course also provides an introduction to technical writing, complex graphics, and computer presentations with  $\text{\LaTeX}$

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

#### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Understand the importance of planning the research activities.	U, C
2	Develop efficiency in using research tools available.	An, E
3	Understand the ethical values in scientific research.	U, An
4	Learn intellectual honesty and scientific integrity.	A, An, C

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

#### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO1</b>	-	-	-	2	2	2	3	2	-	3	2
<b>CO2</b>	-	-	-	2	2	2	3	2	-	3	2
<b>CO3</b>	-	-	-	2	2	2	3	2	-	3	2
<b>CO4</b>	-	-	-	2	2	2	3	2	-	3	2

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 hours): Scientific Research and Methodology

Meaning and characteristics of research; Types of Research and importance of research activities; Planning and designing research activity; Definition, characteristics, rules and principles of scientific method; Hypothesis- Definition, types of hypothesis, sources of hypothesis and testing of hypothesis; Experimental design; Interpretation and generalization of research findings.

### Module II (15 hours): Scientific Writing

Importance and characteristics of scientific writing; Literature review, academic and general search engines, writing a literature review; Journals, scientific paper, review paper, short communication and rapid communication; Journal impact factor, citation index, h-index, g-index, hg- index, i10 index; Components of a scientific paper: title, abstract, key words, introduction, methodology, results and discussion, conclusion, references.

### Module III (15 hours): Ethics of Research in Science

Philosophy of Ethics; Research as the pursuit of truth: Moral philosophy, nature of moral judgment and reactions; Factors Contributing to unethical conduct in research: Competition, Claiming priority, Ranking, Prestige associated with journal impact factor, Poor infrastructure; Ethics of using AI tools - adapting novel tools and judging the upper limit of the usage.

### Module IV (15 hours): Scientific Conduct & Publication Ethics

Intellectual honesty & Research Integrity; Proper citation and acknowledgment; Author contribution types & Judging the Scientific impact; Scientific Misconduct: Fabrication, Falsification and Plagiarism (FFP); Examples of Fabrication and Falsification from literature; Plagiarism and Self-plagiarism; Plagiarism checking tools; Selective reporting: Cherry-picking data sets and misinterpretation; "Publish or Perish" culture: what to focus-quantity or quality of research publications; Evaluation of the integrity of a journal: Identifying predatory journals, Retraction Watch; The Role of UGC-CARE (Consortium for Academic Research and Ethics); The UGC-CARE Reference List of Quality Journals.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

## Core Compulsory Readings

1. K. Prathapan, "Research Methodology for Scientific Research" (Second Edition), iK International Publishers, New Delhi, (2023).
2. Academic Integrity and Research Quality, University Grants Commission, India (2021)
3. Good Academic Research Practices, University Grants Commission, India (2020)

## Core Suggested Readings

1. C. George Thomas, "Research Methodology and Scientific Writing" Springer (2021).
2. Chaddah, P.; Ethics in Competitive Research: *Do not get scooped to not get plagiarized* (2018)
3. Scientific Values: Ethical Guidelines and Procedures, Indian Academy of Sciences (2018)

4. UGC-CARE. Reference List of Quality Journals. <https://ugccare.unipune.ac.in/apps1/home>.

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Describe the importance of planning the research activity.
2. Describe the main components of a scientific article.
3. Discuss the factors contributing to unethical conduct in research.

## Advanced Quantum Mechanics

Course Title	:	Advanced Quantum Mechanics
Semester	:	08
Course Code	:	KU08DSCPHY402
Course Type	:	DSC
Course Credits	:	4
Pre-requisites	:	Quantum Mechanics, Classical Mechanics

### Course Description:

- To give a detailed description of the quantum theory of scattering.
- Concepts of time dependent problems are introduced and the transition probability of the particles to be found in the final state due to time dependent perturbation or disturbance is calculated.
- This course also deals with the probability of transitions due to constant perturbation, transition to continuum and transition probability due to harmonic perturbation.
- The relativistic wave equation and the failure to consider Klein-Gordon wave equation as the true relativistic wave equation is discussed.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain Spin-Orbit interaction and the Born-Oppenheimer approximation in semi classical approach and the quantum theory of spectrum of atom and molecules.	R, U, An
2	Apply the time dependent perturbation theory to calculate the transition probability between different stationary states due to constant perturbation, harmonic perturbation, transition to continuum states etc.	U, An
3	Illustrate the theory of Scattering.	U, An
4	Describe the concept of negative energy states, the relativistic wave equation, and the concepts like Bose-Einstein statistics and Fermi-Dirac statistics.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

### Course Contents:

#### Module I (12 hours)

Spin-Orbit Interaction, Fine Structure of Hydrogen Atom, Anomalous Zeeman Effect, The Hartree Equation for Atoms, Molecular Structure, Born-Oppenheimer Approximation, Molecular Orbital Method and Valence Bond Method, Hydrogen Molecule Ion and Hydrogen Molecule as Examples.

#### Module II (18 hours)

Time Dependent Perturbation Theory, Transition Probability, Constant Perturbation, Harmonic Perturbation, Interaction of an Atom with an Electromagnetic Field, Induced Emission and Absorption, Dipole Approximation, Born Approximation and Scattering Amplitude, Scattering: Scattering Cross Section and Scattering Amplitude, Low Energy Scattering by a Central Potential, Method of Partial Waves, Phase Shifts, Optical Theorem, Scattering by a Square Well Potential, The Born Approximation.

#### Module III (18 hours)

Relativistic Quantum Mechanics: Introduction, The First Order Wave Equations, Dirac Equations, Dirac Matrices, Solution of the Free Particle Dirac Equation, Spin of the Electron, Equation of Continuity, Non-relativistic Limit, Spin Orbit Coupling, Dirac Equation of Hydrogen Atom, Covariance of the Dirac Equation, Bilinear Covariants, The Hole Theory, The Weyl Equations for the Neutrino, The Second Order Wave Equations (The Klein-Gordon Equation, Wave Equation of the Photon, Charge Conjugation for Dirac and Klein-Gordon Equations), CPT Theorem.

#### Module IV (12 hours)

Quantization of Fields: Principles of Canonical Quantization of Fields, Lagrangian Density and Hamiltonian Density, Second Quantization of the Schrödinger Wave Field for Bosons and Fermions.

#### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. V. K. Thankappan, Quantum Mechanics, Wiley Eastern.
2. Ghatak and Lokanathan, Quantum Mechanics, MacMillan
3. Bransden and Joachain, Introduction to Quantum Mechanics, ELBS.
4. Zettili, N, Quantum Mechanics: Concepts & Applications (2/e), Wiley (2009).

5. Griffiths, D J, Introduction to Quantum Mechanics, Pearson Education (2005).

### Core Suggested Readings

1. Amit Goswami, Quantum Mechanics, Wm. C. Brown Publishers.

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Describe Spin orbit coupling.
2. Explain the reason why we need Dirac equation.

## Condensed Matter Physics

<b>Course Title</b>	:	Condensed Matter Physics
<b>Semester</b>	:	08
<b>Course Code</b>	:	KU08DSCPHY403
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Introduction to Solid State Physics

### Course Description:

- This course will introduce the advance concepts in band theory of solids.
- Explain theoretical concepts of semiconductors, dielectric, magnetic, and superconducting materials.
- Illustrate theories of heat capacity and superconductivity.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain the concept of band theory of solid and how to classify them.	R, U, E
2	Demonstrate the theoretical concepts of semiconductors, dielectric, magnetic, and superconducting materials.	U, An
3	Describe the concepts of different theories of specific heat capacity.	U, An
4	Explain the concepts of superconductivity theories and its application.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -



## Course Contents:

### Module I (15 Hours)

Review of band theory, Construction of Fermi surfaces. Electron orbits, Hole orbits and Open orbits. Calculation of Energy Bands: Tight Binding Method for Energy Bands, Wigner-Seitz Method, Pseudopotential method. Experimental method: De Haas-van Alphen effect. Introduction to Plasmons, Polaritons, and Polarons, Optical Reflectance, Kramers-Kronig relations, Electronic interband transitions, Excitons: Frenkel excitons, Mott-Wannier excitons, Raman effect in crystals.

### Module II (15 Hours)

Superconductivity: Occurrence of Superconductivity, Destruction of Superconductivity by Magnetic Fields, Meissner Effect, Thermodynamics of Superconductors, London Equation, Coherence Length, BCS Theory, Flux Quantization, Type I and Type II Superconductors. Superconductor tunneling: DC and AC Josephson effects. High-Temperature Superconductors.

### Module III (15 Hours)

Dielectrics and Ferroelectric: General Concept, Dielectric constant and Polarizability, Ferroelectric crystals, Displacive transitions: Soft optical phonons, Landau theory of the phase transition, First and second order phase transitions, Ferroelectric domains, Piezoelectricity, and Ferroelasticity.

### Module IV (15 Hours)

Magnetism: Diamagnetism and Paramagnetism, Classical and Quantum theories, Hund Rules, Van-Vleck and Pauli paramagnetism. Ferro magnetism and Antiferromagnetism, Curie-Weiss law, Heisenberg Model, Spin Wave, Magnetic Resonance.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. Charles Kittel, Introduction to Solid State Physics.
2. Ibach and Luth, Solid State Physics.
3. Marder, Condensed Matter Physics.
4. Ashcroft and Mermin., Solid State Physics.

### Core Suggested Readings

1. A J Dekker, Solid State Physics

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

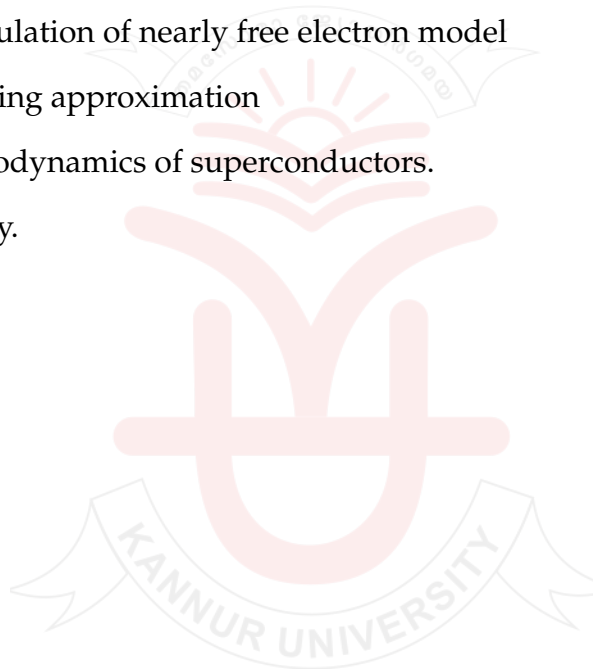
## Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

## Sample Questions to test Outcomes

1. Explain band structure of solids
2. Illustrate the formulation of nearly free electron model
3. Explain tight-binding approximation
4. Discuss the thermodynamics of superconductors.
5. Explain BCS theory.



## Nuclear Physics

<b>Course Title</b>	:	Nuclear Physics
<b>Semester</b>	:	08
<b>Course Code</b>	:	KU08DSCPHY404
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Quantum Mechanics, Statistical Mechanics

### Course Description:

- The main objective of the course is to provide a basic knowledge about nuclear models.
- To provide the concepts behind the nuclear forces.
- To explain scattering cross sections.
- To explain nuclear fission and fusion reactions and their characteristics.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Describe alpha, beta and gamma decay with corresponding selection rules.	U, E
2	Explain the basic knowledge of nuclear size, shape, binding energy. etc and also the characteristics of nuclear force.	U, An
3	Illustrate various nuclear models such as liquid drop model, shell model, collective model and Nilsson model.	U, An
4	Describe the concept of negative energy states, the relativistic wave equation, and the concepts like Bose-Einstein statistics and Fermi-Dirac statistics. Describe the types of nuclear reactions and its applications.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (18 Hours)

Nuclear size, Techniques for determining size, shape, mass and binding energy, semi empirical mass formula, Angular momentum and parity, nuclear electromagnetic moments, characteristics of nuclear force, the deuteron, Wave function, Spin and Parity, Magnetic dipole and electric quadrupole moment, Low energy Nucleon-nucleon scattering, Partial wave analysis of n-p scattering, determination of phase shift, Properties of nuclear force, Exchange force model, Yukawa hypothesis.

### Module II (12 Hours)

Liquid drop model and drawbacks, Fermi gas model, Experimental evidence for magic numbers, shell model, shell model potentials, spin-orbit potential, magnetic dipole moments, electric quadrupole moments, valence nucleons, success of shell model, Even Z-even N nuclei; Collective structure.

### Module III (18 Hours)

Theory of Alpha decay; Beta decay, Energy release in beta decay, Fermi theory of beta decay, Experimental tests of the Fermi theory, angular momentum and parity selection rules, parity violation in beta decay, Energetics of gamma decay, classical electromagnetic radiation, transition to quantum mechanics, angular momentum and parity selection rules, Internal conversion.

### Module IV (12 Hours)

Types of reactions and conservation laws, Energetics of nuclear reactions, reaction cross sections, compound nucleus reactions, Nuclear fission, characteristics of fission, energy in fission, Nuclear fusion: basic fusion processes, characteristics of fusion, solar fusion.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. Harald Enge, Introduction to Nuclear Physics.
2. Kenneth S Krane, Introductory Nuclear Physics.
3. Roy R. K. and Nigam P. P., Nuclear Physics, Tata McGraw Hill.

### Core Suggested Readings

1. J. S. Lilley, Nuclear Physics: Principles and Applications, John Wiley.

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

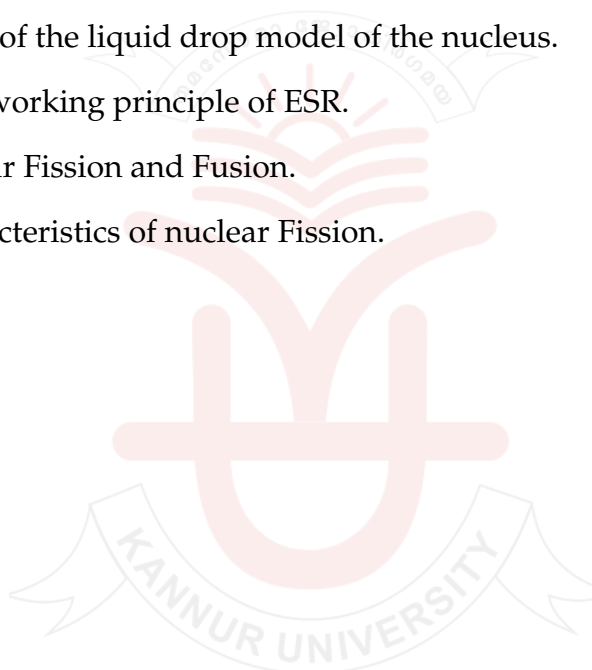
### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Explain natural radioactivity.
2. Describe Yukawa's theory of nuclear reaction.
3. List the drawback of the liquid drop model of the nucleus.
4. Explain the basic working principle of ESR.
5. Distinguish nuclear Fission and Fusion.
6. Describe the characteristics of nuclear Fission.



## Semester - IX

### Atomic & Molecular Physics

<b>Course Title</b>	: Atomic & Molecular Physics
<b>Semester</b>	: 09
<b>Course Code</b>	: KU09DSCPHY501
<b>Course Type</b>	: DSC
<b>Course Credits</b>	: 4
<b>Pre-requisites</b>	: Advanced Quantum Mechanics

#### Course Description:

- To give a detailed account of the spectra of hydrogen like atoms, spectra of alkali metals, and spectra of many electron systems.
- Explain the relativistic corrections to energy eigenvalues.
- To understand the theoretical formulation of many electron systems and coupling schemes for electronic angular momenta.
- To study light-matter interaction.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

#### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	To give a detailed account of the spectra of hydrogen like atoms, spectra of alkali metals, and spectra of many electron systems.	U, E
2	Explain the relativistic corrections to energy eigenvalues.	U, An
3	To establish the theoretical formulation of many electron systems and coupling schemes for electronic angular momenta.	U, An
4	Provides the knowledge of rotational and vibrational spectra of polyatomic molecules and to elucidate their structure through microwave and infrared spectroscopy.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

#### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO1</b>	3	3	1	-	2	-	-	-	-	-	-
<b>CO2</b>	3	3	1	-	2	-	-	-	-	-	-
<b>CO3</b>	3	3	1	-	2	-	-	-	-	-	-
<b>CO4</b>	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 Hours)

The concept of atom - Experimental and theoretical proofs for the existence of atoms; The structure of atoms - Basic concepts of integral and differential cross-sections; Scattering experiments - Thomson's & Rutherford's atomic models; Bohr's atom model; Frank - Hertz experiment; Schrodinger equation for One-electron system - Hydrogen atom; Quantum numbers and wave functions; Energy levels and spectra; The normal Zeeman effect; Relativistic correction of energy terms; Electron spin and Stern-Gerlach experiment; Spin-Orbit Coupling and Fine Structure; Anomalous Zeeman Effect; Hyperfine Structure; Lamb Shift.

### Module II (15 Hours)

Atoms with more than one electron - The helium atom; Symmetry of the wave function; The Pauli principle; Helium spectrum; Building-up principle of the electron shell for larger atoms; Alkali atoms; Theoretical models for multi electron atoms - The model of Independent electrons, The Hartree method, Hartree-Fock method, Configuration interaction; Coupling schemes for electronic angular momenta; Electron configuration and atomic states.

### Module III (15 Hours)

Interaction of Atoms with radiation - Electric dipole transition; Induced and spontaneous transitions; Einstein coefficients; Transition probabilities; Matrix elements; Transition probabilities for absorption and induced emission; Selection rules; Higher order multipole transitions & Magnetic dipole transitions; Spectral lines and line broadening mechanisms; Principle of lasing - Threshold Condition; Generation of population inversion; Optical resonators; The quality factor of resonators; Different Types of Lasers (Solid-state lasers, Semiconductor Lasers, Gas lasers).

### Module IV (15 Hours)

Born-Oppenheimer approximation; The rigid rotor; Centrifugal Distortion; The influence of the electron motion; Vibrations of diatomic molecules; Simultaneous rotation and vibration; Spectra of diatomic molecules; Vibrational-Rotational transitions - P- and R-transitions; Electronic transitions; The Rotational structure of electronic transitions - The Fortrat-Diagrams; The Vibrational structure and the Franck-Condon principle; Rotation of polyatomic molecules; Principal moments of inertia; Rotation of symmetric top molecules; Vibrations of poly atomic molecules; Couplings between vibrations and rotations for poly atomic molecules; Rotational structure of vibrational bands; Raman spectroscopy - classical and quantum theory; Optical Cooling and Trapping of Atoms (Optional).

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. W Demtröder, Atoms Molecules and Photons (3/e), Springer (2018)
2. B. H. Brandsen and C. J. Joachain, Physics of atoms and molecules (2/e), Pearson Education (2008)

### Core Suggested Readings

1. L D Landau and E M Lifshitz, Quantum Mechanics (Non-relativistic Theory) Course on Theoretical Physics-Vol 3 (3/e), Butterworth Heinemann (1977)

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Explain spin-orbit coupling.
2. Explain Raman effect
3. Distinguish between Zeeman effect and Stark Effect
4. Explain the spectra of Hydrogen like atoms
5. Discuss the theory of the vibrational spectrum of a molecule.
6. Explain rotational Raman spectra of rigid diatomic molecules.



## Nanophotonics

<b>Course Title</b>	:	Nanophotonics
<b>Semester</b>	:	09
<b>Course Code</b>	:	KU09DSCPHY502
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Electromagnetic theory, Quantum physics

### Course Description:

- This course will cover the interaction of light with nanoscale features on objects.
- The course will include mathematical foundations, including those of plasmonics and metamaterials, as well as a review of applications of nanophotonics and recently-published progress in the field.
- Ways to focus light and image objects beyond the diffraction limit will be presented.
- Explain stellar evolution.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Understand how scattering from small particles depends on particle size, shape, and composition.	R, U, An
2	To be familiar with the ways to numerically model light at the nanoscale.	U, An
3	Explain how both localized surface plasmons and surface plasmon polaritons can be used to concentrate light into nanoscale volumes.	U, An
4	Explain what optical metamaterials are and how they can be used to image objects with sub- diffraction-limit resolution.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	2	2	-	-	-	-
CO2	3	3	1	-	2	2	2	-	-	-	-
CO3	3	3	1	-	2	2	2	-	-	-	-
CO4	3	3	1	-	2	2	2	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 hours)

What is nanophotonics?; Review of electromagnetism fundamentals; Finite difference time domain modeling method; Interaction of light with dipolar nanoparticles; Radiation reaction correction for particle polarizability; Lorentzian and Fano lineshapes; Relationship between classical and quantum mechanical dipoles.

### Module II (15 hours)

Interaction of light with wavelength-scale particles; Coupled (discrete) dipole approximation modeling method; Mie scattering; Quadrupole approximations; Optical tweezers / optical manipulation of nanoparticles; Photonic crystals.

### Module III (15 hours)

Interaction of light with plasmonic metals; Surface plasmon polaritons; Localized surface plasmons; Optical antennas; Purcell effect; Transmission through nanoscale apertures.

### Module IV (15 hours)

Near-field scanning optical microscopy; Physical and mathematical foundations of the diffraction limit; Metamaterials, including double-negative media, hyperbolic metamaterials, transformation optics, and metasurfaces; Super-resolution microscopy, including multiphoton, STED, structured illumination, synthetic aperture, fluorescent localization (PALM/STORM), and confocal.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. L. Novotny and B. Hecht, Principles of Nano-Optics, 2nd edition, Cambridge University Press (2012)
2. C. F. Bohren and D. R. Huffman, Absorption and Scattering of Light by Small Particles, Wiley (1998).

### Core Suggested Readings

1. J. D. Joannopoulos, S. G. Johnson, J. N. Winn, and R. D. Meade, Photonic Crystals: Molding the Flow of Light (2/e), Princeton University Press (2008).
2. J. Goodman, Fourier Optics, Roberts & Company (2005).
3. D. J. Griffiths, Introduction to Quantum Mechanics, Prentice Hall (1995).

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

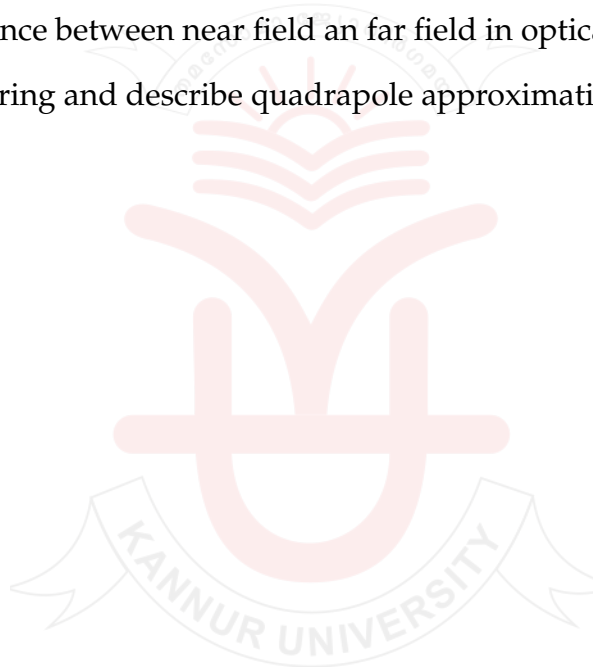
## Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

## Sample Questions to test Outcomes

1. Describe the physical implications of diffraction limit of light.
2. Explain the difference between near field and far field in optical microscopy.
3. Explain Mie scattering and describe quadrupole approximations.



## Quantum Field Theory

Course Title	:	Quantum Field Theory
Semester	:	09
Course Code	:	KU09DSCPHY503
Course Type	:	DSC
Course Credits	:	4
Pre-requisites	:	Advanced Quantum Mechanics

### Course Description:

- Quantum Field Theory (QFT) is a fundamental theoretical framework that combines classical field theory, quantum mechanics and special relativity.
- This course provides a comprehensive introduction to the principles and techniques of QFT, which are essential for understanding the behaviour of fundamental particles and interactions in the universe.
- This course will be helpful for students who are interested in high-energy physics and/or condensed matter theory in future.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	To understand the quantization of fields and the significance of field operators.	U, E
2	To explore the concept of symmetries and conservation laws in field theory.	U, An
3	Introduces the relativistic effects in quantum mechanics and learns to deal large degrees of freedom.	U, An
4	Understand Quantum Field Theory applications in various branches of physics.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 hours): Why quantum field theory

Principle of locality: Review of classical field theory; Action principle, Lagrangian and Hamiltonian; Symmetry and Noether's theorem; Implications of relativistic symmetry What is wrong with relativistic quantum mechanics; Special relativity plus quantum mechanics ; Continuum limit of discrete systems; Many condensed matter applications.

### Module II (15 hours): Free scalar field theories & Interactions

Klein-Gordon field as harmonic oscillator; Canonical quantization of a free scalar field; Particle interpretation; Propagators; Complex scalar fields. Path integrals for quantum mechanics; Path integral for quantum scalar fields; Perturbation theory: Feynman diagrams; Cross section and scattering matrix.

### Module III (15 hours): Dirac Theory

Dirac equation and its Lorentz covariance; Canonical quantization; Spin and statistics; Discrete symmetries; Path integrals for Dirac fields.

### Module IV (15 hours): Maxwell theory & Quantum electrodynamics

Maxwell theory; Gauge symmetry; Canonical quantization; Path integral quantization; Quantum electrodynamics; Feynman rules; Elementary processes; Compton and inverse Compton scatterings.

### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. Peskin, Michael E., and Daniel V. Schroeder. An Introduction to Quantum Field Theory. CRC Press (1995).
2. Steven Weinberg, The Quantum Theory of Fields, Volume 1: Foundations. Cambridge University Press (2005).
3. L. H. Ryder, Quantum field theory, Cambridge University Press (1996).
4. Tom Lancaster, Stephen J. Blundell, Quantum Field Theory for the Gifted Amateur, Oxford Press (2015)

### Core Suggested Readings

1. A. Lahiri & P.B. Pal, A First Book of Quantum Field Theory, Alpha Science International Ltd (2005)

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. State the Noether's theorem and show that a conserved current implies a conserved charge in the Lagrangian formulation of the classical field theory.
2. Obtain the inhomogenous Maxwell's equation of motion from the Lagrangian density,

$$\mathcal{L} = -\frac{1}{4}F^{\mu\nu}F_{\mu\nu} - j^\mu A_\nu.$$

3. Using Wick theorem, evaluate

$$\langle 0|T(\phi^4(x)\phi^4(y))|0\rangle$$

4. Draw Feynmann diagram for electron-positron annihilation into a muon-antimuon pair.
5. What is "Normal Ordering" in QFT ?



## Particle Physics & Astrophysics

<b>Course Title</b>	:	Particle Physics & Astrophysics
<b>Semester</b>	:	09
<b>Course Code</b>	:	KU09DSCPHY504
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Quantum physics

### Course Description:

- This course will explain nuclear interactions and discuss particle and energy exchange associated with strong and weak interaction.
- Describe the concept of resonance and the detection of the resonant particles
- Illustrate the conservation laws and intrinsic quantum numbers like baryon, strangeness, isospin, third components of isospin etc.
- Explain stellar evolution.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Explain strong nuclear force and describe the concept of resonance and the detection of the resonant particles using resonance production experiment and the resonance formation in experiment.	R, U, An
2	Illustrate the conservation laws and intrinsic quantum numbers like baryon, strangeness, isospin, third components of isospin etc.	U, An
3	Describe the basic building block of matter and their discovery and explain the theory of the standard model of particle physics.	U, An
4	Explain the absolute and apparent magnitudes, the Harvard model of the classification of the stars, and the Hertzsprung – Russel Diagram for the representation of the stars.	U, A, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

### Course Contents:

#### Module I (18 hours)

Strong and Weak Nuclear Forces, Yukawa's Proposal, Pair Production, Properties and Modes of Decay of Pions and Muons, The Muon, The Real Pion, Isotopic Spin, Strange Particles, GellMann-Nishijima Formula, Extremely Short-Lived Particles, Resonances and Their Quantum Numbers with Special Reference to Pions, Nucleon Scattering, Conservation Laws, Intrinsic Quantum Numbers Associated with Elementary Particles, Theory of Weak Interaction, Parity Non-conservation, The TCP Theorem, Unification of Weak Electromagnetic Interaction, The Glashow-Weinberg-Salam Model.

#### Module II (15 hours)

Quark Model, The Sakata Model, The Eight-Fold way, Gell-Mann-Okubo and Coleman-Glashow Equations, Quarks and Quark Models, Different Types, The Confined Quarks, Experimental Evidence for the Existence of Quarks, Coloured Quarks, Charm, Truth and Beauty.

#### Module III (12 hours)

Absolute Magnitude and Distance Modulus, Colour Index of Stars, Luminosities of Stars, Stellar Parallax and Units of Stellar Distance, Celestial Sphere and Celestial Coordinate Systems, Harvard System of Classification of Stars, Spectroscopic Parallax, The Hertzsprung – Russell Diagram.

#### Module IV (15 hours)

Interstellar Dust and Gas, The Formation of Protostars, Pre-main Sequence: Evolution, Evolution of the Main Sequence, Late Stages of Degenerate Matter, The Chandrasekhar Limit, The Cooling of White Dwarfs, Neutron Stars, Pulsars, Quasars, Black Holes, Comets, Asteroids and Meteorites, The Formation of the Solar System.

#### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. G. D. Coughlan and J. E. Dodd, The Ideas of Particle Physics (3/e), Cambridge University Press (1991).
2. Yuval Ne'eman and Yoram Kirsh, Particle Hunters (2/e), Cambridge University Press (1996).
3. Baidyanath Basu, An Introduction to Modern Astrophysics (2/e), Prentice Hall of India.



4. Bardley W. Carrol & Dale A. Ostile, An Introduction to Modern Astrophysics (2/e), Addison Wesley.
5. David Griffith, Introduction to Elementary Particle Physics, John Wiley & Sons.

### Core Suggested Readings

1. M. P. Khanna, Introduction to Particle Physics, Prentice Hall of India.

### Teaching Learning Strategies

- Developing conceptual understanding
- Using visual aids and real-world applications
- Emphasizing problem solving skills
- Promoting active learning

### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Describe strong and weak nuclear forces.
2. Explain quark models.
3. Describe H-R diagram.

## General Theory of Relativity

<b>Course Title</b>	:	General Theory of Relativity
<b>Semester</b>	:	09
<b>Course Code</b>	:	KU09DSCPHY505
<b>Course Type</b>	:	DSC
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Classical Mechanics, Mathematical Physics

### Course Description:

- This course aims to develop a thorough understanding of the fundamental principles and concepts of General Theory of Relativity (GTR), including the geometric nature of gravitation.
- This course will help the students to master the mathematical tools and techniques used in GTR, such as tensor calculus and differential geometry.
- The experimental and observational evidence supporting GTR, such as the bending of light, perihelion precession of Mercury, and gravitational redshift will be discussed during this course.
- The derivation, solutions, and physical implications of Einstein's field equations will be explained.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Develop a deep understanding of the core principles and equations of GTR, including the concept of spacetime curvature.	U, E
2	Apply advanced mathematical techniques to derive and solve Einstein's field equations and analyze the properties of spacetime.	A, An
3	Critically evaluate the experimental and observational evidence for GTR and understand its significance in the broader context of physics.	An, E
4	Establish theoretical knowledge and problem-solving skills necessary for pursuing research in general relativity and related areas.	A, C

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	1	-	2	-	-	-	-	-	-
CO2	3	3	1	-	2	-	-	-	-	-	-
CO3	3	3	1	-	2	-	-	-	-	-	-
CO4	3	3	1	-	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

### Course Contents:

#### Module I (15 hours): Special Relativity & Tensor Calculus

The spacetime interval; the metric; Lorentz transformations ; spacetime diagrams; vectors; the tangent space; dual vectors; tensors; tensor products; the Levi-Civita tensor; index manipulation; electromagnetism; differential forms – Hodge duality; worldlines; energy-momentum tensor; perfect fluids; energy-momentum conservation.

#### Module II (15 hours): Riemannian Geometry

Maps charts and atlases; manifolds; differentiation of vectors; coordinate bases; the tensor transformation law; partial derivatives are not tensors; canonical form of the metric; Riemann normal coordinates; tensor densities; volume forms and integration; covariant derivatives and connections; the Christoffel connection; parallel transport; geodesics; the Riemann curvature tensor; symmetries of the Riemann tensor; the Bianchi identity – Ricci and Einstein tensors ; Weyl tensor; Geodesic deviation equation.

#### Module III (15 hours): Einstein's equation & blackholes

Principle of Equivalence, Principle of General Covariance, gravitation as space time curvature; the Newtonian limit – physics in curved spacetime; Derivation of Einstein field equation, Schwarzschild blackhole solutions, Birkhoff's theorem; geodesics of Schwarzschild; Deflection of light by sun, perihelion precession; Symmetries and Killing vectors.

#### Module IV (15 hours): Cosmology

Homogeneity and isotropy; the Robertson-Walker metric; forms of energy-momentum; Friedmann equations; cosmological parameters; evolution of the scale factor; redshift; Hubble's law.

#### Module V\*: Teacher Specific Module:

Area of content, transaction and evaluation are decided by the Faculty.

### Core Compulsory Readings

1. J. B. Hartle, Gravity: An introduction to Einstein's General Relativity, Benjamin Cummings (2003).
2. Gravitation and Geometry: An Introduction to General Relativity, Sean Carroll.
3. Gravitation- Charles W. Misner, Kip S. Thorne, and John Archibald Wheeler (Princeton University Press 2017).
4. Weinberg S, Gravitation and Cosmology: Principles and Applications of The General Theory of Relativity, (Wiley, 2013)

5. Narlikar J V, 'An Introduction to Relativity', (Cambridge University Press, 2010).
6. General Relativity, Robert Wald.

### Core Suggested Readings

1. General Relativity: An Introduction for Physicists M. P. Hobson , G. P. Efstathiou (cambridge Press 2005).

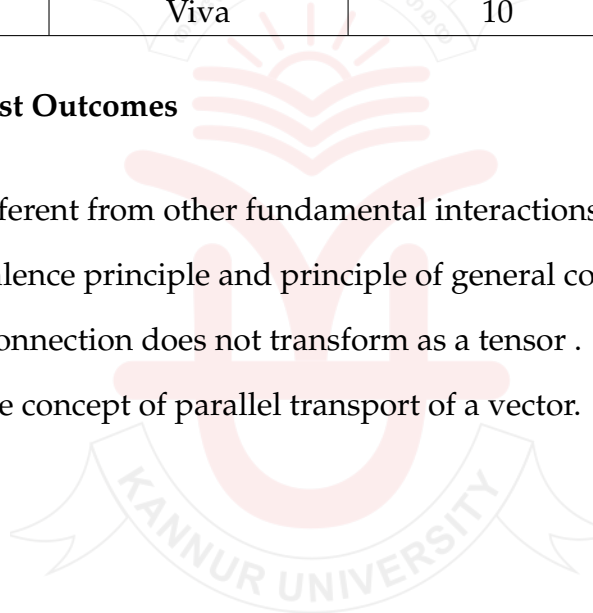
### Mode of Transactions

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. How gravity is different from other fundamental interactions in physics?
2. Explain the equivalence principle and principle of general covariance.
3. Prove that affine connection does not transform as a tensor .
4. Describe briefly the concept of parallel transport of a vector.



The logo of Kannur University is centered in the background. It features a stylized sun with rays rising above a large letter 'U'. The sun and 'U' are rendered in a light pink color. Above the sun is a banner with Malayalam text, and below the 'U' is another banner with the text 'KANNUR UNIVERSITY'.

**DEPARTMENT OF PHYSICS**

**FOUNDATION COURSES**

# Multi Disciplinary Courses (MDCs)

## Sky and Beyond

Course Title	:	Sky and Beyond
Semester	:	01
Course Code	:	KU01MDCPHY101
Course Type	:	MDC
Course Credits	:	3
Pre-requisites	:	High school level science

### Course Description:

- This course provides a comprehensive overview of astronomy.
- Topics ranging from the formation of the solar system to the evolution of stars and galaxies are discussed.
- This course aims to provide a deeper understanding of the cosmos and its wonders, from the smallest planets to the largest galaxies.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	0	3	3	0	3	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Understanding the Foundations of Astronomy	U
2	Understand the constituents and formation of the solar system	U
3	Understand and explore Galaxies and Cosmology	U
4	Understanding Stellar Evolution	U

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	-	-	1	1	-	-	-	-	1
CO2	3	2	2	-	-	1	1	-	-	-	-	1
CO3	3	2	2	-	-	1	1	-	-	-	-	1
CO4	3	2	2	-	-	1	1	-	-	-	-	1

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 Hours)

Ancient Astronomy- Astronomy around the World, Methods of Astronomy and Astrophysics –The Scientific Method - Scope of Astronomy, Brightness Measurement, Distance Measurement-Measurement of Distances Within Solar System, Method of Parallax, The Method of Luminosity Distance.

### Module II (12 Hours)

Astronomical Instruments - Optical Telescopes, Radio Telescopes, Space Telescopes - Hubble Space Telescope; Night Sky: Stars and Planets in Night Sky, Comets and Meteors, Familiarization with Common Constellations, Eclipses, Phases of the Moon.

### Module III (18 Hours)

Formation of the Solar System; The Sun: Photosphere, Chromosphere, Solar Corona, Prominences, Sunspots and Solar Cycle, Solar Flares; The planets of the Solar System: Kuiper Belt, Oort Cloud; Classification of Stars: Spectral Types of Star, The Harvard Classification System, Hertzsprung—Russell Diagram; Milky Way Galaxy - Size, Shape and Structure of the Milky Way; Hubble Classification of Galaxies, Expanding Universe; Big Bang Models of the Universe, The Cosmic Microwave Background; Extrasolar Planetary Systems, Habitable Planets.

## Core Compulsory Readings

1. K. D. Abhayankar, Astrophysics: Stars and Galaxies, University Press (2001).
2. Baidyanadh Basu, An Introduction to Astrophysics, PHI Learning Private Limited (2010).
3. Introduction to Astronomy and Cosmology, Ian Morison, Wiley (2008)

## Core Suggested Readings

1. John Chambers and Jacqueline Mitton, From Dust to Life: The Origin and Evolution of our Solar System, , Princeton University Press (2017)
2. Weinberg, S. The First Three Minutes: A Modern View of The Origin Of The Universe, Basic Books, (1993)

## Teaching Learning Strategies

- Interaction with learners
- Group presentation
- Individual presentation
- Assignment

## Mode of Transactions

- Practical demonstration
- Black Board

- Power Point
- Smart class room

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	





## Medical Physics: Bridging Science & Healthcare

Course Title	:	Medical Physics: Bridging Science & Healthcare
Semester	:	02
Course Code	:	KU02MDCPHY101
Course Type	:	MDC
Course Credits	:	3
Pre-requisites	:	Nil

### Course Description:

- This course aims to give a historical overview of medical physics.
- Holistic approach to the key milestones in the field will be followed.
- Latest developments and trends in the area of nuclear medicine, cardiology, and cancer treatment will be covered in the course.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	0	3	3	0	3	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Understand the historical development of the area	U
2	Learn the simplified picture of the latest developments in the area of medical physics	U
3	Understand the impact of physics in society through the latest technological developments in medical physics	An
4	Obtain a glimpse of the emerging technologies, including generative AI and robotic surgery, in the field	U, An

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	1	2	-	-	1	1	-	-	-	-	1
CO2	-	1	2	-	-	1	1	-	-	-	-	1
CO3	-	1	2	-	-	1	1	-	-	-	-	1
CO4	-	1	2	-	-	1	1	-	-	-	1	1

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 Hours)

Overview of Medical physics: Historical development - Discovery of X-rays by Wilhelm Roentgen (1895) as the starting point; Key milestones in the revolution of Medical Physics - Commercial X-ray computed tomography and Intensity-modulated radiotherapy for curing cancers; History of radio iodine therapy; History of Nuclear medicine imaging, History of positron emission tomography (PET) and electrical impedance tomography; Medical physics in cardiology; Electricity within the human body.

### Module II (18 Hours)

Basic principles of X-ray imaging and computed tomography (CT) scans; How X-rays are generated; Ultrasound imaging: seeing with sound; What is Ultrasound? Images from echoes - ultra sound scanner; Optics to see around the corners: Bending of light rays; Optical fibers as light guides; Optical fibers in endoscopic applications; Different types of endoscopes; Lasers in surgery: What is a Laser beam? Power density of laser; Absorption and heating; Photocoagulation and photovaporization; Pulsed lasers; Laser surgery - selective absorption; Lasers in dermatology; Laser surgery on the eye; Radiation therapy: Killing tumors with radiation; Basics of magnetic resonance imaging (MRI), How MRI maps the body; MRI in breast cancer detection; Brain mapping and functional MRI; Overview of the safety concerns related to above techniques.

### Module III (12 Hours)

Emerging Technologies: Robotic surgery and virtual reality in operation room; Photodynamic therapy; Optical coherence tomography (OCT); 4D ultrasound imaging; Artificial intelligence in diagnostic imaging; Proton therapy; Helium ion therapy.

## Core Compulsory Readings

1. Suzanne Amador Kane & Boris A. Gelman, Introduction to Physics in Modern Medicine, CRC Press (2020)
2. Steve Webb, The contribution, history, impact and future of physics in medicine, Acta Oncologica, 2009, 48, 169-177; DOI: 10.1080/02841860802244158
3. Roger Muncaster, Medical Physics, Stanley Thornes Publishers (1996)

## Core Suggested Readings

1. J E Robert, Meandering in Medical Physics - A personal account of hospital physics, CRC Press (1999)

## Teaching Learning Strategies

- Interaction with learners
- Group presentation
- Individual presentation
- Assignment

## Mode of Transactions

- Practical demonstration
- Black Board
- Power Point
- Smart class room

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	



# Skill Enhancement Courses (SECs)

## Scientific Writing

Course Title	:	Scientific Writing
Semester	:	4
Course Code	:	KU04SECPHY201
Course Type	:	SEC
Course Credits	:	3
Pre-requisites	:	Basic knowledge of text editing

### Course Description:

- This course aims to introduce the scientific writing process.
- Introduce  $\LaTeX$  as the writing tool.
- Basic data representation methods in  $\LaTeX$  will be introduced.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
2	1	3	2	2	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Learn the strategies for clear and concise scientific writing	U, C
2	Understand the elements and organization of a scientific article	U, C
3	Use $\LaTeX$ for document creation and formatting	C
4	Develop data representation skills and learn bibliography management	U, A

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	-	3	1	-	2	3	2	3	1	-
CO2	-	-	-	3	1	-	2	3	2	3	1	-
CO3	-	-	-	3	1	-	2	3	2	3	1	-
CO4	-	-	-	3	1	-	2	3	2	3	1	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (18 Hours)

Introduction to Scientific Writing: Importance and characteristics of scientific writing; Clarity and Conciseness: Strategies for clear and concise writing; Organization and Structure: Elements of a scientific paper/report (Abstract, Introduction, Methods, Results, Discussion, Conclusion, References); Research proposal writing - flowchart; Literature review, methodology and preliminary data presentation, statement of limitations and expected deliverables; Scientific ethics and misconducts reported in the scientific world; How to identify fabricated data sets.

### Module II (12 Hours)

L<sup>A</sup>T<sub>E</sub>X Introduction: Installing L<sup>A</sup>T<sub>E</sub>X and understanding its components; Basic document creation and formatting in L<sup>A</sup>T<sub>E</sub>X; Mathematics and Equations in L<sup>A</sup>T<sub>E</sub>X; Cross-referencing and labels in L<sup>A</sup>T<sub>E</sub>X documents.

### Module III (15 Hours)

Figures and Tables in L<sup>A</sup>T<sub>E</sub>X: Including graphics and tables in scientific documents; Citations and Bibliography Management: Introduction to BibTeX for handling references; Writing Scientific Presentations: Creating slides using L<sup>A</sup>T<sub>E</sub>X beamer class.

## Core Compulsory Readings

1. Michael Alley, The Craft of Scientific Writing
2. Angelika H. Hofmann, Scientific Writing and Communication: Papers, Proposals, and Presentation

## Core Suggested Readings

1. Leslie Lamport, LaTeX: A Document Preparation System
2. G M Whitesides, Writing a paper, Adv. Mater, 16, 15 (2004)

## Teaching Learning Strategies

- Interaction with learners
- Group presentation
- Individual presentation
- Assignment

## Mode of Transactions

- Practical demonstration
- Black Board
- Power Point
- Smart class room

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Describe the main elements of a scientific article.
2. State the importance of systematic data analysis in a research project.



## Scientific Computing

Course Title	:	Scientific Computing
Semester	:	5
Course Code	:	KU05SECPHY301
Course Type	:	SEC
Course Credits	:	3
Pre-requisites	:	Basic knowledge of computation

### Course Description:

- This course aims to introduce the basics of scientific computing.
- Introduce numerical methods to solve problems.
- Basic programming methods will be introduced.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
2	1	3	2	2	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Learn the strategies of numerical methods	U, C
2	Understand the elements of programming in C	U, C
3	Use numerical methods to solve problems in physics/chemistry	C
4	Acquire good programming skill and develop good data representation strategies	U, A

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	2	-	2	2	-	-	-	-	-	-
CO2	1	2	2	-	2	2	-	-	-	-	-	-
CO3	1	2	2	-	2	2	-	-	-	-	-	-
CO4	1	2	2	-	2	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 Hours): Numerical Methods

Introduction to numerical methods, Distinguishing analytical and numerical methods - Curve fitting: Principle of least squares, Least square fitting of a straight line - Interpolation: Finite difference operator, Newton's forward difference interpolation formula, difference table. Solution of differential equations: Euler's method, Runge - Kutta method (Second order) - Taylor's Series expansion of  $\sin x$  and  $\cos x$ , First and second derivative by Numerical differentiation - Solution of algebraic equations: Bisection method-Newton-Raphson method, Numerical integration by Trapezoidal and Simpson's (1/3) method.

### Module II (15 Hours): Programming in C

Introduction to C-Language, algorithm, flowchart, Constants and variables-data types-variable declarations - assignments and expressions - input and output statements - Arrays - conditional statements - control flow statements-loops, Structures, Pointers, writing files into a file, extracting data from files, C- libraries.

### Module III (30 Hours): Practical

1. Write and execute c programmes for straight line fitting using Least square fitting.
2. Write and execute c programmes for interpolation for a given data set.
3. Write and execute c programmes for extrapolation for a given data set.
4. Write and execute a program for finding solutions for differential equations using Euler's method.
5. Write and execute a program for finding solutions for differential equations using Runge - Kutta method.
6. Write and execute c programmes to find the numerical solution of equations by Bisection method.
7. Write and execute c programmes to find the numerical solution of equations by Newton-Raphson method.
8. Write and execute c programmes to do Numerical differentiation using difference table
9. Write and execute c programmes to do Numerical integration.
10. Write and execute c programmes to check convergence or divergence of power series.
11. Write and execute c programmes for simulating a freely falling body.
12. Write and execute c programmes for simulation of projectile motion.

### Core Compulsory Readings

1. William R Gibbs, Computation in modern physics, World Scientific (1994)
2. S. S. Shastry, Introductory methods of numerical analysis (5/e), Prentice Hall of India

### Core Suggested Readings

1. V. K. Mittal, R. C. Verma and S. C. Gupta, Computational Physics, Ane Books

### Teaching Learning Strategies

- Interaction with learners
- Group presentation
- Individual presentation



- Assignment

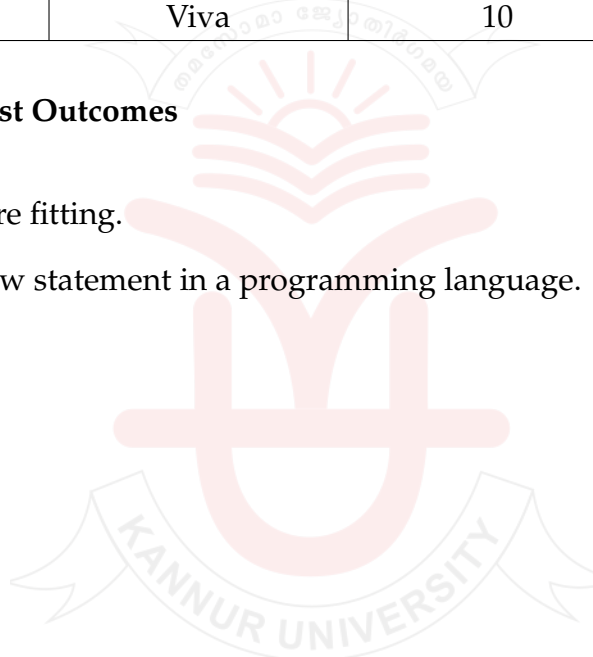
### Mode of Transactions

- Practical demonstration
- Black Board
- Power Point
- Smart class room

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

1. Explain least square fitting.
2. Discuss control flow statement in a programming language.



## Data Analysis & Visualization

<b>Course Title</b>	:	Data Analysis & Visualization
<b>Semester</b>	:	6
<b>Course Code</b>	:	KU06SECPHY301
<b>Course Type</b>	:	SEC
<b>Course Credits</b>	:	3
<b>Pre-requisites</b>	:	Scientific computing

### Course Description:

- This course aims to introduce the basics of data analysis.
- Introduce various data visualization methods.
- Basic programming methods will be introduced.

Credits			Teaching Hours/Week			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
2	1	3	2	2	4	50	50	100

\*L/T = Lecture/Tutorials; P/I = Practical/Internship; CE = Continuous Evaluation; ESE = End Semester Evaluation.

### Course Outcome:

CO No.	Expected Outcome	Learning Domains
1	Learn the strategies of data analysis	U, C
2	Understand the elements of programming in C/python	U, C
3	Use numerical methods to analyze experimental data	C
4	Acquire good programming skill and develop good data representation strategies	U, A

\*Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C)

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	2	-	2	2	-	-	-	-	-	-
CO2	1	2	2	-	2	2	-	-	-	-	-	-
CO3	1	2	2	-	2	2	-	-	-	-	-	-
CO4	1	2	2	-	2	2	-	-	-	-	-	-

\*Correlation Level: Substantial/High = 3, Moderate/Medium = 2, Low = 1, Nil = -

## Course Contents:

### Module I (15 Hours)

Data Analysis: Fast-Fourier transform, Spline interpolation of data, chi-square distribution and numerical error analysis. Theory of distribution functions and generating trial data using normal, log-normal and exponential functions.

### Module II (15 Hours)

Data Visualization: Multiple plots-Polar plot-Pie charts, Plotting mathematical functions, Power series, Fourier series, 2D plots, 3D plot-surface and line plots.

### Module III (30 Hours): Practical

1. Straight line fitting using Least square fitting.
2. Interpolation for a given data set.
3. Extrapolation for a given data set.
4. Finding solutions for differential equations using Euler's method.

### Core Compulsory Readings

1. Python for Education - B P Ajithkumar

### Core Suggested Readings

1. V. K. Mittal, R. C. Verma and S. C. Gupta, Computational Physics, Ane Books
2. S. S. Shastry, Introductory methods of numerical analysis (5/e), Prentice Hall of India

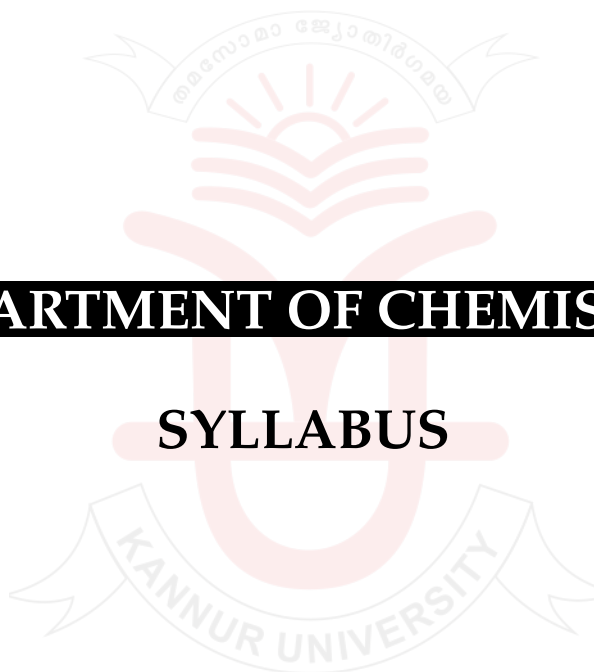
### Teaching Learning Strategies

- Interaction with learners
- Group presentation
- Individual presentation
- Assignment

### Mode of Transactions

- Practical demonstration
- Black Board
- Power Point
- Smart class room

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	



**DEPARTMENT OF CHEMISTRY**

**SYLLABUS**



**KANNUR UNIVERSITY**

**FIVE YEAR INTEGRATED MASTERS PROGRAMME**

**(FYIMP)**

**SYLLABUS**

**MAJOR DISCIPLINE**

**CHEMISTRY**

**SCHOOL OF CHEMICAL SCIENCES**

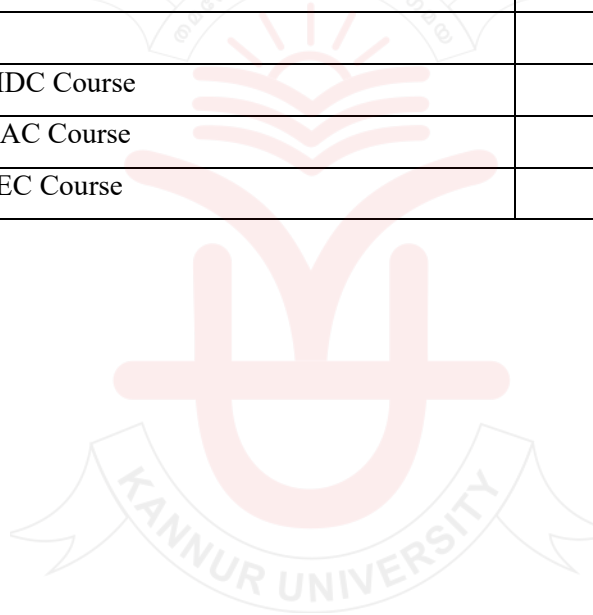
**SWAMI ANANDATHEERTHA CAMPUS**

**PAYYANUR**

**JUNE 2024**

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## BOARD OF STUDIES

NO	NAME	DESIGNATION
1	Prof.(Dr.) Sudheesh S	Professor and HoD Department of Chemistry Kannur University
2	Prof.(Dr.) Haridas K. R	Professor Department of Chemistry Kannur University
3	Dr. Baiju K V	Associate Professor Department of Chemistry Kannur University
4	Dr. Biju A R	Associate Professor Department of Chemistry Kannur University
5	Dr. Shima P. D	Assistant Professor Department of Chemistry Kannur University
6	Dr. Anjali Devi J S	Assistant Professor Department of Chemistry Kannur University
7	Dr. Anjali Paravannoor	Assistant Professor (On Contract) Department of Chemistry Kannur University
8	Dr. Nijisha P	Assistant Professor (On Contract) Department of Chemistry Kannur University
9	Dr. Mili C. N	Assistant Professor (On Contract) Department of Chemistry Kannur University

## Programme Outcomes (POs)

<b>PO1</b>	<b>Critical Thinking:</b> Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
<b>PO2</b>	<b>Problem Solving:</b> Identify, formulate, conduct investigations, and find solutions to problems based on in-depth knowledge of relevant domains.
<b>PO3</b>	<b>Communication:</b> Speak, read, write and listen clearly in person and through electronic media in English/Language of the discipline, and make meaning of the world by connecting people, ideas, books, media and technology.
<b>PO4</b>	<b>Responsible Citizenship:</b> Demonstrate empathetic social concern, and the ability to act with an informed awareness of issues.
<b>PO5</b>	<b>Ethics:</b> Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
<b>PO6</b>	<b>Self-directed and Life-long Learning:</b> Acquire the ability to engage in independent and life-long learning in the broadest context of socio- technological changes.
<b>PO7</b>	<b>Environmental Sustainability and Global Perspective:</b> Develop an understanding of global standards to foster a legal environment. Learn and practice to critically analyse the legal issues from local, national and international concerns.
<b>PO8</b>	<b>Network and Collaborative skills:</b> To be collaborate and network with scholars in an educational institution, professional organizations, research organizations and individuals in India and abroad

## Programme Specific Outcomes (PSOs)

<b>PSO1</b>	Use theoretical concepts and principles in physical sciences (Physics/Chemistry) with specific emphasis on advanced material science to cater to the real-world problems.
<b>PSO2</b>	Apply mathematical techniques to solve and interpret the results of various physical/chemical systems.
<b>PSO3</b>	Illustrate the methodology required for the execution of physical/chemical experiments and analyze the experimental results with the corresponding interpretations
<b>PSO4</b>	Develop communication skills to explain the basic concepts to both specialized and nonspecialized audiences.



## COURSE CATEGORY CODES

SL.NO	NAME OF COURSE	CODES
1	Ability Enhancement Course	AEC
2	Multi-Disciplinary Course	MDC
3	Discipline Specific Core	DSC
4	Discipline Specific Elective	DSE
5	Value Added Courses	VAC
6	Skill Enhancement Course	SEC



**KANNUR UNIVERSITY**  
**SCHOOL OF CHEMICAL SCIENCES**  
**Swami Anandatheertha Campus, Payyanur**  
**Five Year Integrated Masters Programme (FYIMP)**  
**Curriculum Framework (Effective from 2024 admissions)**

Semester	Course Code	Course Name	Credits		
			L/T	P	Total
<b>SEM-I</b>	KU01DSCCHE101	Fundamentals of Chemistry-I	4	0	4
	DSC-B1		4		4
	DSC-C1		4		4
	AEC-1		3		3
	AEC-2		3		3
	MDC-1		3		3
	<b>Maximum Credit in Semester I = 21</b>				
<b>SEM-II</b>	KU02DSCCHE102	Fundamentals of Chemistry-II	4	0	4
	KU02DSCCHE103	Coordination Chemistry-I	4	0	4
	DSC-B2/C2		4	0	4
	DSC-B3/C3		4	0	4
	AEC-3		3	0	3
	MDC-2		3	0	3
	<b>Maximum Credit in Semester II = 22</b>				
<b>SEM-III</b>	KU03DSCCHE201	Physical Chemistry-I	4	0	4
	KU03DSCCHE202	Introduction to Organic Chemistry	4	0	4
	KU03DSCCHE203	Coordination Chemistry-II	4		4
	KU03DSCCHE204	Inorganic Chemistry Practical-I	0	4	4
	MDC-3	Kerala Studies	3	0	3
	VAC-1		3	0	3
	<b>Maximum Credit in Semester III= 22</b>				
<b>SEM-IV</b>	KU04DSCCHE205	Conceptual Organic Chemistry	4	0	4
	KU04DSCCHE206	Physical Chemistry-II	4	0	4
	KU04DSCCHE207	Coordination Chemistry-III	4	0	4
	KU04DSCCHE208	Physical Chemistry Practical-I	0	4	4

	SEC-1		3	0	3
	VAC-2		3	0	3
		<b>Maximum Credit in Semester IV = 22</b>			
<b>SEM-V</b>	KU05DSCCHE301	Organic Chemistry Practical-I	0	4	4
	KU05DSCCHE302	Reactive Organic Chemistry	4	0	4
	KU05DSCCHE303	Physical Chemistry III	4	0	4
	KU05DSCCHE304	Inorganic Practical-II	0	4	4
	KU05DSECHE305	(1) Polymer Chemistry	4	0	4
	KU05DSECHE306	(2) Medicinal Chemistry			
	SEC-2		3	0	3
		<b>Maximum Credit in Semester V = 23</b>			
<b>SEM-VI</b>	KU06DSCCHE307	Organometallic Chemistry	4	0	4
	KU06DSCCHE308	Theoretical Chemistry-I	4	0	4
	KU06DSCCHE309	Physical Chemistry Practical-II	0	4	4
	KU06DSECHE310	(1) Environmental Chemistry	4	0	4
	KU06DSECHE311	(2) Nano medicine and Drug Delivery			
		SEC-3		3	0
	INTERNSHIP		0	4	4
		<b>Maximum Credit in Semester VI = 23</b>			
<b>Students exiting after 3 years- awarded UG degree with Major A</b>					
<b>SEM-VII</b>	KU07DSCCHE401	Spectroscopy-I	4	0	4
	KU07DSCCHE402	Progressive Organic Chemistry	4	0	4
	KU07DSECHE403	Organic Chemistry Practical II	0	4	4
	KU07DSECHE404	(1) Super Capacitors for electrochemical energy storage.	4	0	4
	KU07DSECHE405 <b>ORB4/C4</b>	(2) Supramolecular Chemistry			
	KU07DSECHE406 KU07DSECHE407 <b>ORB5/C5</b>	(1) Food Chemistry (2) Nuclear Chemistry	4	0	4
	MOOC1/ONLINE		4	0	4

		<b>Maximum Credit in Semester VII = 24</b>			
<b>SEM-VIII</b>	KU08DSCCHE408	Group Theory	0	4	4
	KU08DSECHE409	(1) Forensic Chemistry and Toxicology	4	0	4
	KU08DSECHE410	(2) Catalysis, Kinetics and Solutions			
	KU08DSECHE411	(3) Instrumentation Techniques			
	MOOC/ONLINE2		4	0	4
	PROJECT	Project (12 credits)	12	0	12
	KU08DSECHE412	(1) Computational Chemistry	4	0	4
	KU08DSECHE413	(2) Ceramics and Composite Materials	4	0	4
	KU08DSECHE414	(3) Analytical Chemistry (4) Advanced Electrochemistry	4	0	4
	KU08DSECHE415				
		<b>Maximum Credit in Semester VIII = 20</b>			
<b>SEM-IX</b>	KU09DSCCHE416	Spectroscopy-II	4	0	4
	KU09DSCCHE417	Theoretical Chemistry-II	4	0	4
	KU09DSCCHE418	Statistical Mechanics and Nonequilibrium Thermodynamics	4	0	4
	KU09DSCCHE419	Advanced Organic Laboratory	4	0	4
	KU09DSCCHE420	Bioinorganic Chemistry	4	0	4
		<b>Maximum Credit in Semester IX= 20</b>			
<b>SEM-X</b>		RESEARCH			20
		<b>Maximum Credit in Semester X = 20</b>			

## SEMESTER I

### Department of Chemistry: Discipline Specific Core

#### Fundamentals of Chemistry I

<b>Course Title</b>	:	Fundamentals of Chemistry I
<b>Course Code</b>	:	KU01DSCCHE101
<b>Course Type</b>	:	DSC-A1
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Atomic models, basic organic concepts, elements

#### **Course Objectives:**

- ... To study the various atom models, structure and understand the important features of the quantum mechanical model of the atom.
- ... To study the periodic properties of elements.
- ... To explain the basic concepts of organic chemistry
- ... To predict the geometry of simple molecule and explain the different types of hybridisation and draw shapes of simple covalent molecules.

Credit			Teaching Hours			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

#### **Course outcomes:**

C01	Apply Bohr atomic model to explain atomic spectrum, electronic configurations, atomic behavior, and characteristics.
C02	Describe the significance of organic chemistry, catenation, hybridisation and electron displacement patterns in organic molecules.
C03	Apply the bonding concepts to molecules.
C04	Utilize mechanisms to illustrate and solve simple chemical reactions involving reactive intermediates.
C05	Analyse periodic trends, periodic properties, and the relationship between electronic configuration and the chemical reactivity of elements, including the formation of chemical bonds.

### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	2	3	3	2	2	3	1	1
CO2	3	3	2	3	2	3	3	2	2	3	1	1
CO3	3	3	2	3	3	2	3	2	2	3	1	1
CO4	3	3	3	2	3	3	3	2	2	3	1	1
CO5	3	3	3	2	3	3	3	2	2	3	1	1

### Contents:

#### Module I: Atomic Structure

15 Hours

1.1 Bohr model of hydrogen atom, 1.2 atomic spectrum of hydrogen atom, 1.3 Bohr's equation for the energy of electron in hydrogen atom, 1.4 explanation using Bohr atom model, 1.5 limitations of Bohr atom model, 1.6 photoelectric effect, 1.7 dual nature of matter, 1.8 de Broglie equation, 1.9 Heisenberg's Uncertainty Principle and its significance, 1.10 Concept of orbit and orbital, 1.11 Quantum numbers and their significance, 1.12 Pauli's Exclusion Principle, 1.13 Hund's rule of maximum multiplicity, 1.14 Aufbau principle-electronic configuration of atoms (Up to atomic number 30), 1.15 Nodal planes in atomic orbitals, 1.16 Zeeman effect, 1.17 shapes of s, p and d orbitals- energy level diagram of a multielectron atom, 1.18 Schrodinger wave equation (derivation not expected), 1.19 wave functions, 1.20 significance of  $\Psi$  (psi) and  $\Psi^2$ .

#### Module II: Chemical Bonding

15 Hours

2.1 Ionic bond – nature of ionic bond, 2.2 properties of ionic compounds, radius ratio and coordination number, 2.3 factors favouring the formation of ionic compounds. 2.4 Covalent bond, 2.5 hybridisation and shapes of simple molecules ( $\text{BeF}_2$ ,  $\text{PCl}_3$ ,  $\text{SF}_6$ ,  $\text{CH}_4$ , Ethane, ethene and ethyne), 2.6 VSEPR theory- shapes of molecules and ions ( $\text{NH}_3$ ,  $\text{XeF}_6$ ,  $\text{ClF}_3$ ,  $\text{NH}_4^+$ ,  $\text{H}_3\text{O}^+$ ), 2.7 Lattice energy, 2.8 Born-Landé equation- lattice enthalpy, 2.9 Born-Haber cycle and its applications, 2.10 solvation enthalpy and solubility of ionic compounds, 2.11 molecular orbital energy diagram of homo and hetero diatomic molecules ( $\text{N}_2$ ,  $\text{O}_2$ ,  $\text{CO}$  and  $\text{NO}$ ), 2.12 bond strength and bond energy, 2.13 Polarisation of covalent bond, 2.14 polarising power and polarizability of ions, 2.15 Fajan's rule, 2.16 Dipole moment – percentage ionic character from dipole moment, 2.17 Metallic bonding – band theory, 2.18 Weak chemical forces – hydrogen bond, inter and intramolecular hydrogen bonds, 2.19 effects of hydrogen bonding, 2.20 van der Waals forces.

**Module III: Basic concepts of organic chemistry****15 Hours**

3.1 Symbols, formulae, 3.2 Chemical equations, classification (periodic classification of elements, classification of organic compounds into homologous series), 3.3 qualitative and quantitative analysis, 3.4 IUPAC nomenclature of organic compounds, 3.5 Carbon: catenation and hybridizations (with examples Ethane, ethene, ethyne) 3.6 Polarity of bonds (basic concepts): Homolysis and heterolysis with examples, 3.7 Electron displacement effects, 3.8 Inductive effect: Influence of inductive effect in the acidity of carboxylic acids, 3.9 Resonance effect (delocalization, contributing structures, and stability) 3.10 Hyperconjugation Reactive intermediates: Formation, structure and stability of carbocations, carbanions, and free radicals, 3.11 Synthetic methodologies, condensation, addition, examples, 3.12 Separation and purification techniques – Filtration, Crystallization and precipitation, 3.13 concept of solubility product as applied in group separation of cations – problems, 3.14 Fractional distillation, 3.15 Solvent extraction.

**Module IV: Chemistry of elements****15 Hours**

4.1 Modern periodic law – Long form periodic table, 4.2 Classification of elements as s, p, d & f block, 4.3 Classification- Metal, Non-metals & metalloids, 4.4 Diagonal relationship and anomalous behaviour, 4.5 periodicity in properties: Atomic and ionic radii - ionization enthalpy - electron affinity (electron gain enthalpy) – electronegativity, 4.6 Electronegativity scales: Pauling Scale, 4.7 Effective nuclear charge, 4.8 Slater rule and its applications, 4.9 Valency and oxidation state with examples, 4.10 Nomenclature of elements with atomic number greater than 100.

**References**

1. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Vikas Publishing Co. Jalandhar, 2013.
2. J. D. Lee, Concise Inorganic Chemistry, 5th Edition, Chapman & Hall, 2009.
3. P. W. Atkins and J. de Paula, Physical Chemistry, 11th Edition, Oxford University Press, 2018.
4. Morrison, R.T., Boyd, R.N. & Bhattacharjee, S.K. Organic Chemistry, 7th ed., Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
5. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons, 2014.
6. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.

7. F. A. Cotton, G. Wilkinson and P. L. Gaus, Basic Inorganic Chemistry, 3rd edn., John Wiley, 2007.
8. D. F. Shriver and P. W. Atkins, Inorganic Chemistry, 4th edn., Oxford University Press, 2006.

### Teaching Learning Strategies

- ... Provide updated Lecture Sessions
- ... Promote Interactive Sessions including discussions and demonstrations.
- ... Provide experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding.
- ... Encourage students to ask questions during or after the lectures

### MODE OF TRANSACTION

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes.

1. Explain the Bohr model of the hydrogen atom
2. Predict the hybridization and shapes of simple molecules ( $\text{BeF}_2$ ,  $\text{PCl}_3$ ,  $\text{SF}_6$ )
3. Distinguish between homolysis and heterolysis with examples
4. Describe the terms ionization enthalpy, electron affinity, and electronegativity.



## SEMESTER II

### Department of Chemistry: Discipline Specific Core

#### Fundamentals of Chemistry II

<b>Course Title</b>	:	Fundamentals of Chemistry II
<b>Course Code</b>	:	KU02DSCCHE102
<b>Course Type</b>	:	DSC A2
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Different forms of matter, bonds, basics of analytical chemistry

#### **Course Objectives:**

- ... To explore the various forms substances can take -solid, liquid and gas and emphasize their properties and transitions based on temperature and pressure changes.
- ... To examine the fundamental reactions involving carbon compounds, focusing on key mechanisms and types of reactions
- ... To explain the basic concepts in Analytical Chemistry and to introduce techniques and principles essential for chemical analysis.
- ... To understand the significance of chemistry in everyday life

Credit			Teaching Hours			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

#### **Course outcomes:**

C01	Describe the fundamental principles governing the behaviour of different states of matter.
C02	Predict and classify various types of organic reactions based on their mechanisms.
C03	Compare and distinguish the properties of solids, liquids, and gases.
C04	Apply the basic principles of analytical chemistry in preparation of standard solutions, titrations and in the data analysis.
C05	Analyse the importance of chemistry in everyday life

**Mapping of Course Outcomes to POs/PSOs:**

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	2	3	3	2	2	3	1	1
CO2	3	3	2	3	2	3	3	2	2	3	1	1
CO3	3	3	2	2	3	2	2	2	2	3	1	1
CO4	3	3	3	2	3	3	2	2	2	3	1	1
CO5	3	3	3	2	3	3	3	2	2	3	1	2

**Contents:****Module I: States of matter****15 Hours**

1.1 Matter and its different states, 1.2 Intermolecular Forces: dipole-dipole interaction, Dipole-induced dipole interaction and induced dipole-induced dipole interaction, 1.3 Ion-dipole interaction, 1.4 Hydrogen bonding: intra and intermolecular hydrogen bonds- effect on physical properties, 1.5 Gaseous state, 1.6 postulates of Kinetic theory, 1.7 Ideal and real gas behavior, 1.8 compressibility factor deviation from ideal behavior, 1.9 van der Waals equation (No derivation), 1.10 Liquid state, 1.11 Properties of liquids: Vapour pressure, boiling point, Surface tension, Viscosity, 1.12 Solid state, 1.13 Types of Solids: Crystalline and amorphous solids, 1.14 Ionic solids, 1.15 Unit cell, 1.16 Crystal systems, 1.17 Bravais lattices.

**Module II: Introduction to organic reactions****15 Hours**

2.1 Reactions of alcohols, 2.2 aldehydes, 2.3 ketones, 2.4 carboxylic acids, 2.5 nitro compounds, 2.6 Representation of organic molecules: Projection formula (Fischer, Sawhorse, wedge, Newman), 2.7 Types of reagents: Electrophiles and nucleophiles, 2.8 Addition reactions: Markovnikov's addition, 2.9 peroxide effect, 2.10 Elimination reactions: E1 and E2 mechanism, 2.11 Substitution reactions (SN1, SN2 reactions of alkyl halides only), 2.12 Polymerization reactions, 2.13 Addition Polymerization (polyethylene, PVC) and Condensation polymerization (Nylon 6,6, polyester).

**Module III: Analytical methodologies and Data analysis****15 Hours**

3.1 Fundamental concepts -mole, molarity, molality, ppm, 3.2 primary standard – secondary standard, 3.3 quantitative dilution – problems, 3.4 Acid-base titrations, 3.5 titration curve, 3.6 pH indicators, 3.7 Redox titrations: titration curve- titrations involving  $\text{MnO}_4^-$  and  $\text{Cr}_2\text{O}_7^{2-}$ , redox indicators, 3.8 Complexometric titrations- EDTA titrations, titration curves, indicators, 3.9 gravimetric analysis, 3.10 Units, 3.11 significant digits- rounding, 3.12 scientific and

prefix notation, 3.13 graphing of data, 3.14 Precision and accuracy, 3.15 types of errors 3.16 Ways of expressing precision, 3.17 Ways to reduce systematic errors, 3.18 reporting analytical data, 3.19 Statistical treatment of analytical data, 3.20 population and samples, 3.21 Mean and standard deviation 3.22 distribution of random errors, 3.23 confidence limits, 3.24 tests of significance.

#### **Module IV: Chemistry in daily Life**

**15 Hours**

4.1 Chemicals in medicines – Classification of drugs- analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines (examples each), 4.2 Psychotropic drugs - Tranquilizers, Antidepressants, and Stimulants with examples (Structures Not needed). 4.3 Drug addiction and abuse, Prevention and treatment, 4.4 Chemicals in food- preservatives, 4.5 artificial sweetening agents, 4.6 elementary idea of antioxidants, 4.7 cleansing agents- soaps and detergents (examples each), cleansing action, 4.8 paints- varnishes- textiles- dyes- fuels etc (one example each), 4.9 Fertilizers – Introduction. 4.10 Types of fertilizers - Natural, Synthetic, 4.11 NPK fertilizers, 4.12 Excessive use of fertilizers and its impact on the environment, 4.13 Bio-fertilizers and Organic Manures. 4.14 Pesticides – Introduction, 4.15 Classification (Brief idea only), 4.16 Insecticides, 4.17 Fungicides, 4.18 Herbicides (Structures not needed), 4.19 Excessive use of pesticides, 4.20 Environmental hazards, 4.21 Biopesticides

#### **References**

1. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, Fundamentals of Analytical Chemistry, 8th Edition, Brooks/Cole, Thomson Learning, Inc., USA, 2004.
2. Vogel's Textbook of Quantitative Chemical Analysis, 6th Edn., Pearson Education Ltd.
3. Morrison, R.T., Boyd, R.N. & Bhattacharjee, S.K. Organic Chemistry, 7th ed., Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
4. Graham Solomon, T.W., Fryhle, C.B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons, 2014.
5. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
6. Puri, Sharma and Pathania, "Principles of Physical Chemistry", 47<sup>th</sup> Edition, Vishal Publishing Co, 2020.
7. K. L. Kapoor, "A Textbook of Physical chemistry", Volume 1, Macmillan India Ltd
8. Tisdale, S.L., Nelson, W.L. and Beaton, J. D. Soil Fertility and Fertilizers, Macmillan Publishing Company, New York, 1990.
9. Buchel, K.H. Chemistry of Pesticides, John Wiley & Sons, New York, 1983. .

10. Gowariker V.R., Viswanathan N.V. and Jayader Sreedhar, Polymer Science, Wiley Eastern Ltd., 1987.
11. H. Singh, V.K Kapoor, Organic Pharmaceutical Chemistry, VallabPrakasan, 2011.
12. T Coultate, Food: The Chemistry of Its Components, 6th Edition, RSC. 2015.

## KU02DSCCHE103-COORDINATION CHEMISTRY- I

### Module 1

Introduction-Double salts and Coordination compounds.Nomenclature.Effective Atomic Number (EAN).Types of ligands.Chelates.Chelate and Macrocyclic effects. Stereo chemistry of coordination compounds with coordination numbers 2 to 6. Isomerism in coordination compounds, Optical and Geometrical Isomerism.Classification of complexes based on coordination numbers and possible geometries,  $\sigma$  and  $\pi$  bonding ligands such as CO, NO, CN-R<sub>3</sub>P, and Ar<sub>3</sub>P.

### Module 2

Stability of complex ions-stability constants. Kinetic and Thermodynamic stability, Stepwise and overall stability constants, Factors affecting the stability of complexes. Irving William order of stability. Application of complex formation in qualitative and quantitative analysis.

### Module 3

Reactivity of metal complexes-Labile and inert complexes, Taube mechanism, Kinetics and mechanism of octahedral substitution- water exchange, dissociative, associative and interchange mechanisms, Ligand substitution reactions SN<sup>1</sup> and, SN<sup>2</sup>. ligand substitution reactions in square planar and Octahedral complexes, acid hydrolysis, base hydrolysis, SN<sup>1</sup>CB mechanism.

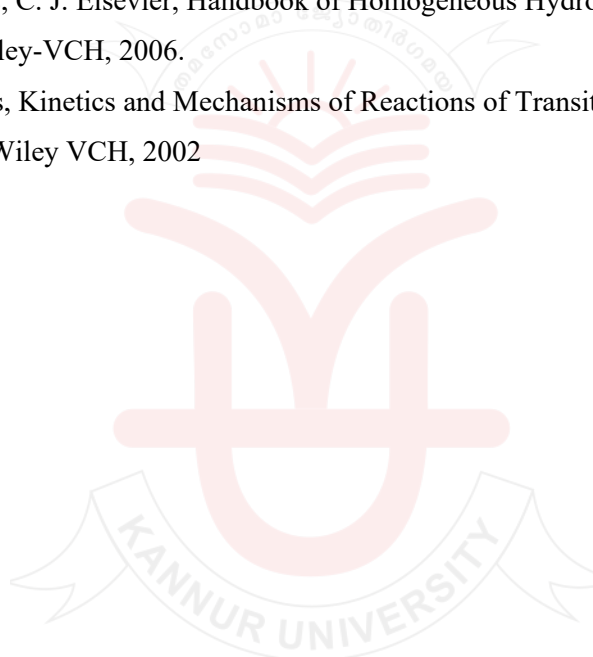
### Module 4

Electron transfer reactions: Outer sphere mechanism – Marcus' theory, inner sphere and outer sphere reactions, two electron transfer and intramolecular electron transfer reactions, Trans effect and applications of trans effect Theories of trans effect-polarization and  $\pi$ -bonding theory

### References

1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edition, Wiley India Pvt. Ltd., New Delhi, 2009 (Reprint).
2. J.E. Huheey, E.A. Keitler and R.L. Keitler, Inorganic Chemistry–Principles of Structure and Reactivity, 4th Edition, Pearson Education, New Delhi, 2013.

3. D.F. Shriver and P. Atkins, Inorganic Chemistry, 5th Edition, Oxford University Press, New York, 2010.
4. J.D. Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press, New Delhi 2008.
5. R. Gopalan and V. Ramalingam, Concise Coordination Chemistry, 1st Edition, Vikas Publishing House, New Delhi, 2001.
6. W. Pfennig, Principles of Inorganic chemistry. John Wiley & Sons, 2015.
7. K.F. Purcell, J.C. Kotz, Inorganic Chemistry, Holt-Saunders, 1977.
8. B.E. Douglas, D.H. McDaniel, J. J. Alexander, Concepts and Models of Inorganic Chemistry, 3rdEdn., Wiley-India, 2007.
9. J. G. de Vries, C. J. Elsevier, Handbook of Homogeneous Hydrogenations, 3 Volumes, Wiley-VCH, 2006.
10. R. G. Wilkins, Kinetics and Mechanisms of Reactions of Transition Metal Complexes, Wiley VCH, 2002



## SEMESTER III

### KU03DSCCHE201-PHYSICAL CHEMISTRY-1

#### Module 1 Gases state

Gas laws – The general gas equation – Mixture of gases – Dalton's Law – Mole fraction and partial pressure – calculation of partial pressure – The Kinetic model of gases – Molecular Speeds – Maxwell's distribution of molecular speeds – Calculation of most probable velocity, average velocity and root mean square velocity – Average kinetic energy – Collision diameter – Mean free path, Collision number and collision frequency – Degrees of freedom of a gaseous molecule – Principle of equipartition of energy and contribution towards heat capacity of an ideal gas.

Real gases – Molecular attractions – The compression factor – virial equation of state – Van der waals equation expressed in virial form – calculation of Boyle's temperature – Isotherm of real gases and their comparison with Van der waals isotherms – continuity of states – critical phenomenon – critical constants of a gas and its determination – Determination of molecular mass by limiting density method – Principle of corresponding states – Liquefaction of gases by Joule Thomson effect and adiabatic demagnetization.

#### Module 2 Liquid State

Liquid State: Introduction - Vapour pressure, surface tension and viscosity – Explanation on the basis of intermolecular attraction. Refraction: Refractive index Solutions: Kinds of solutions – Raoult's law -Solubility of gases in liquids – Henry's law and its applications – ideal and ideal dilute solution, Liquid mixtures- excess functions and regular solutions. Colligative properties - Relative lowering of vapour pressure – Elevation of boiling point – Depression in freezing point-Osmotic pressure - Laws of osmotic pressure – Reverse osmosis and its applications -Impact on Biology - Determination of molecular mass using colligative properties.

Colloidal Chemistry- True solution, colloidal solution and suspension. Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples. Purification of colloids by electrodialysis and ultrafiltration. Properties of colloids: Brownian movement – Tyndall effect – Electrophoresis. Origin of charge and stability of colloids – Coagulation - Hardy Schulze rule – Protective colloids - gold number.Emulsions.Applications of colloids: Delta formation, medicines, emulsification, cleaning action of detergents and soaps.

#### Module 3 Solid state

Solid State: Introduction - Isotropy and anisotropy - Symmetry elements in crystals – The seven crystal systems – space lattice, unit cell, Miller indices - Bravais lattices – Bragg's equation (derivation required) and its applications. Defects in solids: Non-stoichiometric and stoichiometric defects - Schottky and Frenkel defects- Extrinsic and intrinsic defects – Metal excess and metal deficiency - Structure of ionic compounds of the type AX (NaCl, CsCl, ZnS) and AX<sub>2</sub> (CaF<sub>2</sub>, Na<sub>2</sub>O) Defects in crystals – stoichiometric and non-stoichiometric defects, extrinsic and intrinsic defects. Electrical conductivity, semiconductors, n-type, p-type, Superconductivity (Elementary ideas)Liquid crystals and its thermographic behaviour. Classification, structure of smectic, nematic, and cholesteric phases.

#### **Module 4 Thermodynamics-I**

The first Law – the basic concepts – System – surrounding – process – open, closed and isolated system – Isothermal, Isochoric and Isobaric process – work – Heat – Energy – Internal energy – The statement of first law – the conservation of energy – Expansion work – general expression of work – free expansion – Expansion against constant pressure – reversible expansion – Heat capacity at constant volume (C<sub>v</sub>) and at constant pressure (C<sub>p</sub>) – relation between C<sub>p</sub> and C<sub>v</sub> – Thermodynamic derivation – Enthalpy definition and measurement – Adiabatic change –work of adiabatic change.

Thermo chemistry – Standard enthalpy changes – Enthalpies of physical change – Enthalpy of vapourisation, enthalpy of transition and enthalpy of fusion – enthalpy chemical changes – Thermo chemical equation – Standard enthalpy of reaction, combustion and formation – Temperature dependence of reaction enthalpies Kirchoff's law. The First Law – State functions and exact differentials – state and path functions – exact and inexact differentials – internal pressure – measurement of internal pressure – Joule experiment Changes in enthalpy at constant volume – isothermal compressibility – Joule – Thomson effect – inversion temperature.

#### **References**

- 1, Puri, Sharma and Pathania, "Principles of Physical Chemistry", 48th Edition, Vishal Publishing Company
2. F Daniels and R AAlberty, "Physical Chemistry", 3rd ed. John Wiley and Sons, Inc., New.
3. Barrow, G.M. "Physical Chemistry", Tata McGraw-Hill (2007).
4. Castellan, G.W. "Physical Chemistry",4th Ed. Narosa Publishing House (2018).
5. K. L. Kapoor, "A Textbook of Physical chemistry", Volume 5, 4th edition, Macmillan India Ltd.,

6. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd.
7. GurdeepRaj, Advanced Physical Chemistry, Goel Publishing House.
8. I.N. Levine, Physical Chemistry, Tata McGraw Hill
9. K. J. Laidler, Chemical kinetics, 3rd edn, Pearson education, 2004.
10. L V Azaroff, "Introduction to Solids", McGraw Hill.
11. N B Hannay, "Solid State Chemistry", Prentice Hall.
12. Anthony R. West, "Solid State Chemistry and its Applications", Wiley Eastern.
13. R. P. Rastogi, R. R. Misra, An Introduction to Chemical Thermodynamics, 6th edn., Vikas Pub. Pvt. Ltd. (2003).

### KU03DSCCHE202- Introductory Organic Chemistry

<b>Module 1</b>	<b>Isomerism</b>	<b>15 Hours</b>
Structural isomerism, geometrical isomerism, Optical isomerism, optical activity and its applications. Specific terms: diastereomers, enantiomers, meso compounds. Stereoselective, stereospecific and regioselective syntheses. Resolution and racemization. Walden inversion. Absolute and relative configurations. R and S notation. Guidelines. Cis and trans isomerism. E and Z designations. Applications of isomerism		
<b>Module 2</b>	<b>Chemistry in action</b>	<b>15 Hours</b>
Oils and fats: properties, hydrogenation of oils. Analysis of oils and fats. Saponification and iodine values and their determinations. Manufacture of vegetable oils. Soaps and detergents: materials, their purposes. Manufacturing process. Action of soaps and detergents. Dyes and pigments. Theory of colour and constitution. Classification of dyes, natural dyes and methods of extraction. Mordants and their applications. Characteristic colours and their compositions. Preparation and uses of Azo dyes and indigo. Paints and organic coatings. Essential oils.		
<b>Module 3</b>	<b>Chemistry of natural products</b>	<b>15 Hours</b>
Alkaloids: Occurrence and extraction, General properties of alkaloids. Exhaustive methylation. Structure and isolation of Conine, Pterine, Nicotine and Atropine. Terpenes: Isoprene rule. Classification, isolation and general properties. Structure and isolation of Citral, Geraniol, Limonene, Menthol and Camphor. Uses and biological activities of alkaloids and terpenes. Medicinal importances and toxicity.		
<b>Module 4</b>	<b>Bioorganic chemistry</b>	<b>15 Hours</b>



Amino Acids, nomenclature, preparation, physical and chemical properties. Peptides and Polypeptides. Proteins: classification. Primary and secondary structures. The polypeptide chain. Tertiary and quaternary structures. Enzymes and its mechanism of action. Co-Enzymes. Cofactors and prosthetic groups. Denaturation and degradation of proteins. Sources and functions of proteins. DNA and RNA. Structure and their biological functions.

### References

1. A Text book of Organic Chemistry- 3<sup>rd</sup> Edn.-R.K. Bansal, (New Age, New Delhi) 1997.
2. A Text book of Organic Chemistry-Tewari, Vishnoi and Mehrotra (Vikas, New Delhi) 1998.
3. Chemistry of Natural Products – Vol-I & II – O. P. Agarwal (Goel Gorakhpur), 1985.
4. Chemistry of Natural Products: A Unified Approach-N R Krishnaswamy (University Press) 1999
5. Mechanism and Theory in Organic Chemistry-Lowry and Richardson Harper and Row, 1987.
6. Medicinal Chemistry- G. R. Chatwal (Himalaya) 2002.
7. Natural Products Chemistry, Vol-I & II- G.R. Chatwal (Himalaya), 1990.
8. Organic chemistry – J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford Press)
9. Organic Chemistry 4th Edn.–S.H. Pine et al (McGraw-Hill, London) 1987.
10. Organic Chemistry, Vol I & II, I.L. Finar (Longmann ELBS, London), 1973.
11. Organic Chemistry-P.Y. Bruice (Pearson Education Pvt. Ltd. New Delhi) 2002
12. Organic Chemistry-Vol.-I & II-Mukherji, Singh and Kapoor (Wiley Eastern, New Delhi) 1985.
13. Organic Reaction Mechanisms- Bansal (Tata McGraw Hill, New Delhi) 1978.
14. Principles of Drug Action- II Ed. A. Goldstein Lewis Arnold & Suner M. Kalman (Wiley Int. Ed.)
15. Stereochemistry of carbon compounds, Ernest Eliel, Tata McGraw Hill, 2001.
16. Stereochemistry, Conformation and Mechanism-P.S. Kalsi (Wiley Eastern, New Delhi) 1993.

## KU03DSCCHE203-COORDINATION CHEMISTRY- II

### Module 1

Theories of bonding in transition metal complexes– Werners Theory, Valence Bond theory. Application to some complexes, Hybridization in tetrahedral, square planar and octahedral complexes – explanation of magnetic properties based on VBT.Limitations of VBT.

### Module 2

Crystal field theory, Crystal field stabilization energy (CFSE), Pairing energy, concept of weak and strong fields, Spectrochemical series.Crystal field splitting in octahedral, tetrahedral, square planar, square pyramidal and trigonal bipyramidal geometries. Crystal field splitting in tetragonally distorted octahedral geometry, Jahn-Teller distortion in Cu (II) complexes. Factors affecting the magnitude of crystal field splitting.

### Module 3

Factors influencing CFSE, Effect of CFSE in ionic radii, Lattice energy and enthalpy of first row transition elements.Explanation of colour, spectral and magnetic properties.Limitations of CFT

### Module 4

MO theory, evidence for metal ligand covalency, Energy level diagrams-MO diagram of complexes of octahedral, tetrahedral and square planar complexes (sigma bonding only), Evidences for metal-ligand overlap; sigma and pi bonding in complexes. Molecular Orbital theory - diagrams for octahedral complexes with  $\pi$ -bonding, experimental evidences for  $\pi$  - bonding.

### References

1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edition, Wiley India Pvt. Ltd., New Delhi, 2009 (Reprint).
2. J.E. Huheey, E.A. Keitler and R.L. Keitler, Inorganic Chemistry–Principles of Structure and Reactivity, 4th Edition, Pearson Education, New Delhi, 2013.
3. D.F. Shriver and P. Atkins, Inorganic Chemistry, 5th Edition, Oxford University Press, New York, 2010.
4. J.D. Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press, New Delhi 2008.
5. R. Gopalan and V. Ramalingam, Concise Coordination Chemistry, 1st Edition, N Vikas Publishing House, New Delhi, 2001.
6. B. D. Gupta, A. J. Elias Basic Organometallic Chemistry, Concepts, Synthesis and Applications, 2nd Edition, University Press

7. I. Bertini, H. B. Gray, S. J. Lippard, J. S. Valentine, Bioinorganic chemistry, University Science Books, 1994.
8. J. A. Cowan, Inorganic Biochemistry: An Introduction, VCH Publishing, 1993.
9. W. Kaim, B. Schwederski, B. Bioinorganic chemistry: Inorganic Elements in the Chemistry of Life, Wiley, 2006
11. G. A. Lawrance, Introduction to Coordination Chemistry, John Wiley & Sons Ltd, 2010.
12. C. E. Housecroft, A. G. Sharpe, Inorganic Chemistry, Pearson, 2012.

### **KU03DSCCHE204-Inorganic chemistry Practical I**

#### **Module 1 Volumetric analysis**

##### **0. Introduction to volumetric analysis**

- (i) Relation of acid-base titrations with real life situations like estimation of citric acid in citrus fruits like lemon, orange etc.
- (ii) Equivalent and molecular mass of compounds. Normality and Molarity – Primary standards. Preparation of standard solution – Principles of volumetric analysis.
- (iii) For acidimetry, alkalimetry and permanganometry two burette method may be used and for other volumetric analyses conventional methods can be used.

##### **1. Acidimetry and Alkalimetry**

- a. Estimation of NaOH using standard  $\text{Na}_2\text{CO}_3$  (two burette method).
- b. Estimation of HCl using standard oxalic acid (two burette method).
- c. Estimation of bicarbonate and carbonate in a mixture.

##### **2. Permanganometry**

- a. Estimation of oxalic acid – using standard Mohr's salt (Two burette method).
- b. Estimation of  $\text{Fe}^{2+}$  using standard oxalic acid (two burette method).
- c. Estimation of  $\text{Ca}^{2+}$
- d. Estimation of nitrite.
- e. Estimation of percentage of Mn in pyrolusite.
- f. Estimation of hydrogen peroxide.

##### **3. Dichrometry**

- a. Estimation of  $\text{Fe}^{2+}$  - External indicator.
- b. Estimation of  $\text{Fe}^{3+}$  - Reduction of  $\text{SnCl}_2$ -Internal indicator.
- c. Estimation of  $\text{Fe}^{2+}$  using internal indicator.

##### **4. Iodometry and iodimetry**

- a. Estimation of  $\text{Cu}^{2+}/\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
- b. Estimation of Potassium dichromate/ $\text{Cr}^{3+}$
- c. Estimation of  $\text{As}_2\text{O}_3/\text{As}^{3+}$

**5. Precipitation titration – using adsorption indicators**

- a. Estimation of chloride in neutral medium.

**6. Complexometry**

- a. Estimation of  $\text{Mg}^{2+}$
- b. Estimation of  $\text{Zn}^{2+}$
- c. Determination of total hardness of water

**7. Practical applications of titration in real life**

- a. Estimation of citric acid in lemon or orange.
- b. Determination of acetic acid content in Vinegar by titration with NaOH.
- c. Determination of alkali content in antacid tablets by titration with HCl.
- d. Determination of COD of water samples
- e. Determination of hardness of water
- f. Rancidity of oils by iodometry.

**Module 2 Gravimetric analysis:**

Introduction to gravimetric techniques and its highlights.

1. Determination of water of hydration in crystalline barium sulphate.
2. Determination of  $\text{Ba}^{2+}$  as  $\text{BaSO}_4$
3. Determination of sulphate as  $\text{BaSO}_4$
4. Determination of  $\text{Fe}^{2+}$  as  $\text{Fe}_2\text{O}_3$
5. Determination of  $\text{Ca}^{2+}$  as  $\text{CaCO}_3$
6. Estimation of  $\text{Ni}^{2+}$  as Nickel dimethylglyoximate.
7. Determination of  $\text{Cu}^{2+}$  as cuprous thiocyanate.
8. Determination of  $\text{Mg}^{2+}$  as magnesium oxinate.

**Module 3 Inorganic Qualitative Analysis:**

**(1) Systematic qualitative analysis of a mixture containing two cations and two anions by semi-micro method**

Study of the reactions of the following ions with a view to their identification and confirmation:

Lead, Silver, Mercurous mercury, Mercuric mercury, Bismuth, Copper, Tin, Antimony, Iron, Aluminium, Chromium, Zinc, Manganese, Cobalt, Nickel, Barium, Strontium, Calcium, Magnesium, and Ammonium.

Carbonate, Acetate, Oxalate, Fluoride, Chloride, Bromide, Iodide, Nitrate, Sulphate, Borate, Phosphate, Chromate, Arsenate, Arsenite.

**Note : Minimum ten mixtures should be analyzed and recorded.**

#### **Module 4 Preparations:**

[Any three of the following inorganic preparations]

- (1) Ferrous ammonium sulphate.
- (2) Tetraamminecopper(II) sulphate.
- (3) Potassium trisoxalatochromate(III).
- (4) Potassium alum  $KAl(SO_4)_2 \cdot 12H_2O$
- (5) Hexaamminecobalt(III) chloride.

#### **Reference**

1. C. N. R. Rao, U. C. Agarwal, Experiments in General chemistry, Affiliated East-West Press, 1973
2. G H Jeffery, J Bassett, J Mendham, R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5<sup>th</sup>Edn, Longman, 1989.
3. A. I. Vogel, G. Svehla: Vogel's Qualitative Inorganic Analysis, 7<sup>th</sup>Edn, Longman, 1996.
4. W. L. Jolly, The Synthesis & characterization of Inorganic Compounds, Prentice Hall. 1970
5. G. Pass, H. Sutcliffe, Practical Inorganic Chemistry; John Wiley and Sons, 1979.
6. D.M Adams, J.B. Raynor, Advanced Practical Inorganic Chemistry; Wiley, 1965.
7. G. Brauer, Hand Book of Preparative Inorganic Chemistry, 2<sup>nd</sup>Edn, Vols, 1-2. Academic Press, 1963.

## SEMESTER -IV

### KU04DSCCHE205-Conceptual Organic Chemistry

#### Module 1 Theoretical Organic Chemistry

15 Hours

Localized and delocalized chemical bondings, resonance, bond energy, polarizability, Molecular Orbital Theory, Huckel MOT, Its assumptions, limitations and applications. Aromaticity- Types of aromaticities – anti- aromaticity, homo-aromaticity, non-aromaticity. Examples and comparison of properties, Aromaticity of four, five and six membered heterocyclic compounds, fused rings, charged rings and annulenes. Hammett equation and plots –Limitations of and deviations from Hammett plots, Significance and applications of Hammett plots. Electronic and steric effects. Influence of structural features on acidity, basicity and reactivity of organic compounds. Electron displacement effects - inductive, electromeric, mesomeric (resonance) and hyperconjugation

#### Module 2 Path of Organic Reactions

15 Hours

Carbocations: Generation, structure, detection, stability and reactions of carbocations, Classical and non-classical carbocations. Carbanions: Geometry, occurrence and properties of carbanions, factors affecting the stability of carbanions, main reactions of carbanions, carbon acids. Radicals: Carbon free radicals: Generation, stability and reactions of radicals. Diradicals: Structure and generation of carbenes, addition and insertion reactions and rearrangement reactions of carbenes. Structure of nitrene, generation and reactions of nitrene. Formation and reactions of benzyne, chemistry of enolates and enamines. Nucleophilic substitution : SN1, SN2 and SNi reactions-mechanisms stereochemistry - effect of solvent, structure of substrate, nucleophilicity of the reagent [nucleophile] and nature of the leaving group. 3.2 Elimination reactions: E1, E2 and E1cB reactions and mechanisms: Hofmann and Saytzeff rules. Elimination vs Substitution, Synthesis of Crown Ethers

#### Module 3 Stereochemistry

15 Hours

Introduction to isomerism: Chirality of molecules devoid of chiral centres:, restricted rotation and asymmetry, Atrop isomerism. Molecules with planar chirality: annulenes, enantiomeric and diastereomeric excess. Reactivity in acyclic compounds, stereochemistry of cycloalkanes and cyclohexane, fused rings and bridged compounds. Cram-Chelate, Felkin-Ahn, anti-Felkin, Houk models, Cieplak and cation coordination models. Stereochemistry of allenes, spirans, metallocenes and helicenes. Stereo selective synthesis, asymmetric synthesis, chiral auxiliaries, methods of asymmetric induction. Stereochemistry of organic compounds

other than carbon centre. Introduction to optical rotation and optical rotatory dispersion, circular dichroism, Cotton effect and their application in assigning configuration and conformation, octant and axial haloketone rules

#### **Module 4 Methods of Organic Synthesis**

**15 Hours**

Applications of the Green strategies in organic synthesis, Definition, need for Green chemistry, evolution of Green Chemistry, principles of Green Chemistry. Classification of organic reactions under Green chemistry principles. Atom economic and non-toxic byproduct reactions: rearrangements, Alternative/Green Solvents for Organic Synthesis, Water, Ionic liquids, Supercritical liquids and PEG. Microwave assisted organic synthesis, examples, advantages and disadvantages, Phase transfer catalysis, Protective groups in organic synthesis, protection of hydroxyl, carboxyl, carbonyl, amino groups. Protection of carbon-carbon multiple bonds. Illustration of deprotection in synthesis. Organic reaction pathways, factors affecting the reaction yields, design of reaction conditions, solvents and apparatus, monitoring of reactions, Thin layer chromatography, search of solvent combinations and ratio, purification, methods for determination of reaction mechanism

#### **References:**

1. A Guidebook to Mechanisms in Organic Chemistry, P. Sykes, Pearson Education
2. Advanced Organic Chemistry: Part A: Structure and Mechanisms, Francis A. Carey, Springer, Sundberg, Richard J
3. Dynamic Stereochemistry of Chiral Compounds Principles and Applications, Christian Wolf, RSC publications
4. Green Chemistry: An introductory text by Mike Lancaster, RSC publishing, 2nd Edition, 2010
5. Green Chemistry: Theory and Practice by Paul T. Anastas and John C. Warner, Oxford University Press, Oxford, 1998
6. Introduction to stereochemistry, Andrew Clark, RSC publications
7. Introduction to stereochemistry, K. Mislow, Dower Publications
8. Introduction to strategies for organic synthesis, Starkey L S, John Wiley and Sons
9. Mechanism and theory in organic chemistry, H. Lowry and K. S. Richardson, Second edition, Harper & Row, New York, 1981
10. Modern methods of Organic Synthesis, Carruthers and I. Coldham, First South Asian Edition 2005, Cambridge University Press
11. Organic Chemistry (fifth Edn.) Robert Thronton Morrison, Robert Neilson Boyd, S.K Bhattacharjee, Pearson Education

12. Organic Chemistry Vol. I (Sixth Edn.) and Vol. II (Fifth Ed.,) by I L Finar, Pearson Education
13. Organic Chemistry, Leroy G. Wade, Pearson Education
14. Organic Chemistry, P. Y. Brice, Pearson Education
15. Organic stereochemistry, M.J.T. Robinson, Oxford Publications
16. Organic Synthesis, Michael B Smith, 2nd Edition, 2005
17. Organic synthesis: Special techniques, V.K. Ahluwalia and R. Agagrwal, Narosa
18. Phase Transfer Catalysis in Organic Synthesis, William P. Weber, .George W Gokel, Springer - Verlag
19. Principles of Organic Chemistry, T. A. Geissman, W.H. Freeman & Co Ltd; 4th edition, 1977
20. Stereochemistry of carbon compounds, Ernest Eliel, Tata McGraw Hill, 2001
21. The Search of organic reaction pathways, P. Sykes, John Wiley & Sons

### **KU04DSCCHE206-PHYSICAL CHEMISTRY-II**

#### **Module 1 Thermodynamics-II**

The Second Law – the concepts – Spontaneous and non-spontaneous process – statement of second law – Entropy – Thermodynamic definition – Entropy as a state function – Carnot cycle – the Thermodynamic scale of temperature – Entropy changes accompanying phase transitions –variation of entropy with temperature – the Helmholtz and Gibbs free energies – their significance– Maxwell’s relations – Criteria of spontaneity – Gibbs – Duhem equation – Clausius –Clapyeyron equation applicable to solid – liquid, solid-vapour and liquid-vapour equilibria.

Third Law of thermodynamics – The Nernst heat theorem – Absolute entropy – Calculation of absolute entropies of solids, liquids and gases.

#### **Module 2: Surface chemistry and Colloidal state**

Multilayer adsorption- BET theory, Use of BET isotherms for surface area determination. Application of Langmuir adsorption isotherm in surface catalysed reactions, the Eley-Rideal mechanism and the Langmuir-Hinshelwood mechanism, flash desorption. Macromolecules: Different averages, methods of molecular mass determination - osmotic, viscosity, sedimentation and light scattering methods.

Adsorption – types, adsorption of gases by solids – factors influencing adsorption – Freundlich adsorption isotherm – Langmuir adsorption isotherm –derivation of Langmuir adsorption isotherm. Use of Langmuir for surface area determination.



Types of solutions – true, colloid and suspensions, Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples, Purification of colloids – Ultra filtration and electro dialysis.

Optical and electrical properties of colloids: Brownian movement, Tyndall effect, Electrophoresis. Electrical double layer and zeta potential. Coagulation of colloids, Hardy-Schulz rule. Micelles and critical micelle concentration, sedimentation and streaming potential.

### **Module 3: Ionic and Chemical equilibria**

Introduction – Concepts (Lowry-Bronsted and Lewis concept) of acids and bases, relative strength of acid-base pairs, influence of solvents, Dissociation constants – acids, bases, and polyprotic acids. Ostwald's dilution law. Degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water- pH. Effects of solvents on ionic strength. Buffer solutions – Mechanism of buffer action, Henderson equation. Hydrolysis of salts (concepts only).

Law of mass action, thermodynamic derivation of law of chemical equilibrium. Relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and thermodynamic derivation of relations between the various equilibrium constants  $K_p$ ,  $K_c$  and  $K_x$  (using chemical potential). Van't Hoff's equation - Le Chatelier principle (quantitative treatment). Homogeneous and heterogeneous equilibria.

### **Module 4: Chemical kinetics**

Arrhenius equation, concept of activation energy, Collision theory - kinetic theory of collisions, steric factor. Types of complex reactions - consecutive reactions, opposing reactions, parallel reactions, Chain reactions, steady state approximation. Catalysis: Homogeneous catalysis, enzyme catalysis – Heterogeneous catalysis – Surface catalysis, Elementary idea about Autocatalysis.

Theories of reaction rates: - potential energy surfaces. Conventional transition state theory, Comparison of the collision theory and conventional transition theories. Thermodynamic formulation of the reaction rate-Eyring equation. Significance of  $\Delta G^\ddagger$ ,  $\Delta H^\ddagger$  and  $\Delta S^\ddagger$ , volume of activation. Effect of pressure and volume on velocity of gas reactions. Reactions in solution: Effect of solvent on reaction rate, cage effect, effect of dielectric constant and ionic strength on reaction rate - Bronsted-Bjerrum equation.

### **References**

1. Gurdeep Raj, Advanced Physical Chemistry, Goel publishing house.

3. Glasstone and Lewis, Elements of Physical Chemistry, Macmillan
4. S. H. Marron and J. B. Lando, Fundamentals of Physical Chemistry, Macmillan Ltd.
5. G. K. Vemulapalli, Physical Chemistry, Prentice-Hall of India Pvt. Ltd.
  
6. Puri, Sharma and Pathania, "Principles of Physical Chemistry", 48th Edition, Vishal Publishing Company
7. Castellan, G.W. "Physical Chemistry", 4th Ed. Narosa Publishing House (2018).
8. K. L. Kapoor, "A Textbook of Physical chemistry", Volume 5, 4th edition, Macmillan India Ltd.,
9. R P W Atkins, "Physical Chemistry", Oxford University Press (12th Edition)
10. Barrow, G.M. "Physical Chemistry", Tata McGraw-Hill (2007).
11. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd
12. Puri, Sharma and Pathania, "Principles of Physical Chemistry", 48th Edition, Vishal Publishing Company
13. F Daniels and R A Albery, "Physical Chemistry", 3rd ed. John Wiley and Sons, Inc., New.
14. Castellan, G.W. "Physical Chemistry", 4th Ed. Narosa Publishing House (2018).
15. K. L. Kapoor, "A Textbook of Physical chemistry", Volume 5, 4th edition, Macmillan India Ltd.,
16. D. A. McQuarrie, J. D. Simon, Physical Chemistry – A molecular Approach, Viva Books Pvt. Ltd.

### KU04DSCCHE207-COORDINATION CHEMISTRY III

#### Module 1.

Spectroscopic Term symbols for  $d^n$  ions - derivation of term symbols and ground state term symbol, Hund's rule; Selection rules – break down of selection rules, spin-orbit coupling, band intensities, weak and strong field limits- correlation diagram; Energy level diagrams; Orgel and Tanabe-Sugano diagrams; Evaluation of  $Dq$  and  $B$  values.

#### Module 2

Spectral properties of metal complexes-d-d transition, splitting of terms in weak and strong octahedral and tetrahedral fields, Nephelauxetic effect, Racah parameters, selection rules for electronic transitions, Electronic spectra of metal complexes and their interpretation. electronic absorption spectrum of  $d^1$  to  $d^9$  ions Charge transfer spectra. Charge transfer

spectra e.g.  $\text{KMnO}_4$ ,  $\text{K}_2\text{Cr}_2\text{O}_7$  (Elementary idea), Electronic spectra of lanthanide and actinide complexes.

### Module 3

Optical activity of coordination compounds, ORD and CD, Cotton effect and applications. IR spectra of metal complexes, NMR spectroscopy for structural investigation of diamagnetic metal complexes from chemical shift and spin-spin coupling. EPR spectra of metal complexes – hyperfine splitting, g-values, zero field splitting and Kramer's degeneracy. Applications to copper (II) complexes. Mossbauer spectra – application to iron complexes, Mossbauer effect, hyperfine interactions, isomer shift, electric quadrupole and magnetic hyperfine interactions. Importance of molar conductance measurements in coordination chemistry.

### Module 4

Magnetic properties of complexes - Types of magnetic behaviour, spin-only magnetic moment, calculation of magnetic moments. paramagnetic and diamagnetic complexes, diamagnetic corrections, molar susceptibility, Gouy method for the determination of magnetic moment of complexes, Temperature dependence of magnetism- Curie's law, Curie-Weiss law, temperature independent paramagnetism (TIP)

### References

1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edition, Wiley India Pvt. Ltd., New Delhi, 2009 (Reprint).
2. J.E. Huheey, E.A. Keitler and R.L. Keitler, Inorganic Chemistry–Principles of Structure and Reactivity, 4th Edition, Pearson Education, New Delhi, 2013.
3. D.F. Shriver and P. Atkins, Inorganic Chemistry, 5th Edition, Oxford University Press, New York, 2010.
4. J.D. Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press, New Delhi 2008.
5. R. Gopalan and V. Ramalingam, Concise Coordination Chemistry, 1st Edition, Vikas Publishing House, New Delhi, 2001.
6. B. D. Gupta, A. J. Elias Basic Organometallic Chemistry, Concepts, Synthesis and Applications, 2nd Edition, University Press
7. I. Bertini, H. B. Gray, S. J. Lippard, J. S. Valentine, Bioinorganic chemistry, University Science Books, 1994.
8. J. A. Cowan, Inorganic Biochemistry: An Introduction, VCH Publishing, 1993.

9. W. Kaim, B. Schwederski, B. Bioinorganic chemistry: Inorganic Elements in the Chemistry of Life, Wiley, 2006.

### **KU04DSCCHE208-PHYSICAL CHEMISTRY PRACTICALS-I**

#### **Module 1 Chemical Kinetics and Distribution law 30hrs**

1. Determination of specific reaction rate of the hydrolysis of methyl acetate catalysed by hydrogen ion at room temperature.
2. Determination of overall order of saponification of ethyl acetate.
3. Determination of distribution coefficient of iodine between water and carbon tetrachloride.
4. Determine the distribution coefficient of benzoic acid in toluene and water.

#### **Module 2 Electrochemistry and Colorimetry 30hrs**

1. Determination of concentration of HCl conductometrically using standard NaOH solution.
2. Determination of concentration of acetic acid conductometrically using standard NaOH solution.
3. Preparation of alkaline buffer solutions.
4. pH metric titration of weak acid (acetic acid) with strong base NaOH and calculation of dissociation constant.
5. Verification of Beer-Labert law for  $\text{KMnO}_4$ ,  $\text{K}_2\text{Cr}_2\text{O}_7$  and determination of the concentration of the given solution.

#### **Module 3 Adsorption and Phase rule 30hrs**

1. Adsorption of acetic acid, oxalic acid on animal charcoal, verification of Freundlich isotherm.
2. Determination of CST of phenol – water system.
3. Determination of Transition temperature of salt hydrates (Sodium thiosulphate, sodium acetate)
4. Determination of unknown concentration of KCl/Succinic acid using CST method
5. Construction of phase diagram of simple eutectics (Naphthalene-Biphenyl System)

#### **Module 4 Molecular weight determination 30hrs**

1. Determination of molecular weight by Rast's method
2. Determination of identity of two compounds by mixed melting points. (Using naphthalene, biphenyl or camphor as solvent and acetanilide, p-dichlorobenzene etc. as solute).

## References

1. A.I.Vogel - A Text Book of Qualitative Analysis including semi-micro methods
2. V.V.Ramanujan – Semi micro Qualitative Analysis.
3. A.I.Vogel – A Text Book of Quantitative Inorganic Analysis.
4. A.I.Vogel - Elementary Practical Organic Chemistry.
5. A.O.Thomas – Practical Chemistry for B.Sc Chemistry.
6. A Findlay – Practical Physical Chemistry.
7. R.C.Das& E Behara – Experimental Physical Chemistry.
8. N.K.Vishnoi – Advanced Practical Chemistry.



## SEMESTER V

### KU05DSCCHE301-Organic Chemistry Practical I

#### **Module 1** **Distillation**

Simple distillation, vacuum distillation, fractional distillation, boiling point determination of compounds.

#### **Module 2** **organic Preparations**

Bromination, Nitration, Diazotization, Acetylation, TLC, melting point determination, recrystallization.

#### **Module 3** **Solvent Extraction**

1. Aniline from water. 2. Methyl benzoate from water. (Use ether and record the yield recovery)

#### **Module 4** **Reactions of Organic Compounds**

Functional group determination: 1. Phenols. 2. Nitro compounds. 3. Amines. 4. Halogen compounds. 5. Aldehydes and ketones. 6. Carboxylic acid. 7. Carbohydrates. 8. Amides. 9. Esters. 10. Hydrocarbons.

#### **References**

1. B. S. Furniss, A. J. Hannaford, P. W. G. Smith, A. R. Tatchell, Vogel's Textbook of Practical Organic Chemistry, 5th Edn., Pearson Education, Noida, 2014.
2. F. G. Mann, B. C. Saunders, Practical Organic Chemistry, 4th Edn., Pearson Education, Noida, 2011.
3. Arthur I. Vogel, Elementary Practical Organic Chemistry- Small Scale Preparations, 2nd Edn., Pearson Education, Noida, 2013.
4. V. K. Ahluwalia, S. Dhingra, Comprehensive Practical Organic Chemistry, Universities Press, Hyderabad, 2004.

### KU05DSCCHE302- Reactive Organic Chemistry

#### **Module 1** **Reaction Mechanisms** **15 hrs**

Mechanisms of nucleophilic aliphatic substitution, electrophilic aliphatic and aromatic substitution. Mechanisms of organic reactions: Michael, Stobbe, Darzen, Dakin, Mannich and Cannizzarro reactions. Condensation reactions: Mechanisms and applications of Aldol, Benzoin, Knoevenagel condensation and Claisen condensations. Coupling reactions: Mechanisms and applications of Negishi, Sonogashira, Heck, Suzuki and Ullmann coupling

reactions. Oxidation and Reduction reactions: Mechanisms and applications Baeyer-Williger and Oppenauer oxidations, Birch reduction.

**Module 2** **Rearrangement reactions** **15 hrs**

Amine formation reactions: Mechanisms and application of Hoffmann, Lossen, Schmidt and Curtius rearrangements. Reactions involving migration of groups: Mechanisms and application of Dienone-phenol, Fries, Fischer – Hepp and Classien rearrangements. Reactions involving insertions: Mechanisms and application of Beckmann, Demjanov, Benzilic acid, Favorskii and Di- $\pi$  methane rearrangements. Reactions involving formation of new groups: Mechanisms and application of Bamberger, Wagner- Meerwein and von Richter rearrangements. Reactions involving Nitrogen groups: Mechanisms and application of rearrangement reactions: Sommelet- Hauser and Stevens rearrangements

**Module 3** **Heterocyclic chemistry** **15 hrs**

Introduction to heterocyclic compounds, Nomenclature of Heterocyclic compounds, Preparation, properties and reactions of Furan, Pyrrole, Thiophene and Pyridine. Synthesis and reactions of Indole, Quinoline and Isoquinoline. Biologically important heterocycles, three and four membered heterocycles. Five membered heterocyclic compounds: Synthesis and reactions of pyrrole furan and thiophene, Six membered heterocyclic compounds: Synthesis and reactions of pyridine, pyran and thiopyran Fused rings: Synthesis and reactions of indole, quinoline, isoquinoline and benzofuran, Heterocyclic compounds with more than one hetero atoms: chemistry of pyrimidines and purines, synthesis of imidazole, pyrazole and oxazole

**Module 4** **Photochemistry and Pericyclic reactions** **15 hrs**

Organic photochemistry: photochemical reactions, photo addition, photo oxidation, photo rearrangement, photo dissociation, photo-cyclization. Photochemistry of carbonyl compounds, alkenes and dienes, Photochemistry of aromatic compounds Barton and Hoffman-Lofferty reactions, applications of photochemistry. Pericyclic reactions: classification, cycloadditions, electrocyclic, sigmatropic, chelotropic and group transfer reactions. Claisen, Cope and Diels-Alder reactions. Their stereochemical aspects, dipolar cycloadditions and their utility in organic synthesis. The ene- reactions, Chelotropic reaction, Dirotropic reaction, applications of pericyclic reactions

**References**

1. Advanced Organic Chemistry, Part B: Reaction and Synthesis, F.A. Carey and R. S. Sundberg, 5th Edition, Springer

2. Chemistry of Heterocyclic Compounds, Rakesh Kumar Parashar, and BeenaNegi, Ane Books Pvt Ltd
3. Chemistry of the Carbonyl Group - A Step-by-Step Approach to Understanding Organic Reaction Mechanisms, Timothy K. Dickens, Stuart Warren, Wiley
4. Frontier orbital and symmetry controlled pericyclic reactions, Ratan Kumar Kar, Books & Allied Ltd, 2009
5. Heterocyclic Chemistry at a Glance, John A. Joule, Keith Mills, John Wiley & Sons, Ltd, 2013
6. Heterocyclic chemistry, J.A. Jouis and K. Mills, fifth edn, Wiley
7. Heterocyclic Chemistry, Raj K. Bansal, New Age International, 2020
8. Heterocyclic chemistry, Thomas L. Gilchrist, Pearson Education
9. March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure, Michael B. Smith, 7th Edn, Wiley
10. Microwave Assisted Organic Synthesis, J.P. Tierney and P. Lidstrom, B Lack-Well publishers
11. Name Reactions: A Collection of Detailed Mechanisms and Synthetic Applications, Jie Jack Li, Fifth Edition, Springer
12. Organic Chemistry: Theory, Reactivity and Mechanisms in Modern Synthesis, Pierre Vogel and Kendall N. Houk, Wiley -VCH
13. Organic Name Reactions and Unified Approach, GoutamBrahmachari, Narosa publishers
14. Organic Photochemistry, J.M Coxon, B Halton, Cambridge University Press
15. Organic Reactions and their Mechanisms, A. Mohamed Sikkander Noor ShawalNasri, Viva Books
16. Pericyclic Reactions, G. Gill, Chapman and Hall
17. Photochemistry And Pericyclic Reactions, Jagdamba Singh, Jaya Singh, New age international
18. Photochemistry of Organic Compounds: From Concepts to Practice. P. Klán, J. Wirz Wiley, Chichester, 2009
19. Principles of Organic Chemistry, Norris James F, MJP Publishers
20. Principles of organic Synthesis, R.O.C Norman, J.M.C. Frsnz, ELBS
21. Reaction mechanisms in organic synthesis, Parashar, John Wiley and Sons
22. Reactions Rearrangements And Reagents, S N Sanyal, BharatiBhawan Publishers & Distributors



23. Textbook of organic name reactions, Kashaw S.K. Atithi books
24. Textbook of Pericyclic Reactions Concept and Application, K.C Majumdar, P. Biswas, Medtech publishers

### **KU05DSCCHE303-PHYSICAL CHEMISTRY III**

#### **Module 1 Electrochemistry-I**

Ionic nobilities, influence of pressure and temperature on ion conductance, Walden's equation, abnormal ion conductance. Derivation of Debye-Huckel-Onsager equation, validity of Debye-Huckel-Onsager equation for aqueous and nonaqueous solution. Conductance ratio and Onsager equation, dispersion of conductance at high frequencies, Debye-Falken effect. Debye-Huckel limiting law and its various forms and qualitative and quantitative tests, osmotic coefficient, ion association and dissociation constant, tripple ion and conductance minima, equilibria in electrolytes. Solubility product principle, solubility in presence of common ion, activity coefficient and solubility measurement.

#### **Module 2 Electrochemistry-II**

Equilibrium Electrochemistry: Electrode potential. electrochemical cell, Concentration cell. Thermodynamic properties from EMF data, Activity and activity coefficient determination for electrolytes, Ion selective electrodes, Determination of pH, Glass electrode Potentiometric titration, Redox indicators, Storage cells

#### **Module 3 Electrodictics**

Dynamic electrochemistry: Electrical double layer electric capillary, Lippmann potential, membrane potential. Electrolytic polarization, dissolution and decomposition potential, concentration polarization. Theories of over voltage, Hydrogen and Oxygen over voltages, Butler-Volmer equation for simple electron transfer reaction. Exchange current density, Tafel equation and its significance.

#### **Module 4 Phase Equilibria**

Phase equilibria, criteria, derivation of phase rule. One component system – water and sulphur systems. Two component systems- Simple Eutectic; Lead- Silver system. Application to metallurgy-Pattinson's process. Two component systems: Euetectic systems, System with congruent melting point, compounds with incongruent melting point, solid solutions, systems with partially miscible solid phase, liquid phase are partially miscible, Introduction to three-component system and its graphical representation, hydrate formation, compound formation. Thermal evaporation, transition point and double salt formation, salting out effect, liquid- liquid equilibria

## References

1. Introduction to Electrochemistry, S. Glasstone, D. Van Nostrand.
2. Modern Electrochemistry, J.O.M. Bockris and A.K.N. Reddy, Plenum
3. Physical Chemistry, Daniels and Alberty, John Wiley.
4. The Principles of Electrochemistry, D. A. Mc Innes, Dover Publishers
5. The Principles of Electrochemistry, D.R. Crow, Chapman and Hall
6. Theoretical electrochemistry, L.I. Antrhopov, Mir publishers.
7. Thermodynamics for chemists, S. Glasstone, Affiliated East West publication
8. Thermodynamics, Lewis and Randall, McGraw Hill.
9. D. R. Crow, Principles and Applications of Electrochemistry, Blackie Academic and Professional, 4th Edn., 1994.
10. J.O.M. Bokris and A.K.N. Reddy, Modern Electrochemistry, Plenum Press, 1973.
11. Introduction to Electrochemistry, S. Glasstone, D. Van Nostrand.
12. Modern Electrochemistry, J.O.M. Bockris and A.K.N. Reddy, Plenum
13. Physical Chemistry, Daniels and Alberty, John Wiley.
14. An Introduction to chemical thermodynamics, Rastogi and Misra, Vikas publishing.
15. G.W. Castellan, Physical Chemistry, Addison-Lesley Publishing
16. Phase Equilibria, Phase Diagrams and Phase Transformations: Their Thermodynamic Basis by Mats Hillert
17. Phase Equilibria: Basic Principles, Applications, Experimental Techniques By Arnold Reisman

## KU05DSCCHE304-Inorganic Chemistry Practical-II

### Module 1 Mixture Analysis

Separation and identification of four metal ions of which two are rare/ less familiar cations such as Tl, W, V, Se, Te, Ti, Ce, Th, Zr, U, Mo, and Li (interfering acid radicals not present).

Confirmation by spot test. [**Minimum 10 mixtures are to be recorded**]

### Module 2 Volumetric estimation

- a) EDTA - Al, Ca, Cu, Ni, Co, Hardness of water
- b) Cerimetry - Fe(II), nitrate
- c) Estimation of Dissolved Oxygen by Winkler's method

[**A minimum of 5 experiments to be recorded**]

### Module 3 Preparation

Preparation of the metal complexes, checking metal content and their physicochemical characterization using spectroscopic (UV-Visible, IR) studies / thermal (TG, DTA), Magnetic susceptibility studies / XRD data:

Nickel(dimethyl glyoxime), Potassiumtrioxalatochromate(III), Tetraammoniumcopper(II) sulphate and Hexaamminecobalt(III) chloride, and Potassiumhexathiocyanatochromate(III).

**[A minimum of 5 experiments to be recorded]**

#### **Module 4**

1) Quantitative separation of binary mixtures and estimation of components by volumetric, gravimetric, colorimetric, and electroanalytical methods:

Cu(II), Ni(II), Fe(III), Mg(II), Al(III), Ca(II), Ba(II) and Zn(II).

2) Analysis of ores

a) Analysis of brass

b) Analysis of solder

3) Synthesis of any two of the following metal oxide nanomaterials and their characterization using X-ray, microscopic or spectrochemical methods.

... ZnO / TiO<sub>2</sub>/ Co<sub>3</sub>O<sub>4</sub>/ Co(OH)<sub>2</sub> / NiO / FeO etc. (Any two)

**[A minimum of 10 experiments to be recorded]**

#### **Reference**

- 1) G H Jeffery, J Bassett, J Mendham, R. C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5<sup>th</sup>Edn, Longman,1989.
- 2) A. I. Vogel, G. Svehla: Vogel's Qualitative Inorganic Analysis, 7<sup>th</sup>Edn, Longman,1996.
- 3) J. Derek Woollins, Inorganic Experiments,3rd edn., Wiley-VCH,2009
- 4) D.M Adams, J.B. Raynor, Advanced Practical Inorganic Chemistry; Wiley,1965
- 5) W L Jolly, Preparative Inorganic Reactions, Interscience publishers. NewYork, 1964.
- 6) D. A. Skoog and D. M. West, Analytical Chemistry: An Introduction, Saunders CollegePublishing, 4th edition, 1986.
- 7) W. G. Palmer, Experimental Inorganic Chemistry, Cambridge University Press, 1954.
- 8) T. Pradeep, Textbook of Nanoscience and Nanotechnology,McGraw Hill India, 2012
- 9) Robert Vajtai, Springer Handbook of Nanomaterials (Springer Handbooks), Springer, 2013.
- 10) V. Ramanujam, Inorganic Semi micro Qualitative analysis, 3rd edition, The NationalPublishing House, Chennai,1974.

## KU05DSECHE305-POLYMER CHEMISTRY

### MODULE 1

Polymer Nomenclature - Classification Of Polymers - Natural And Synthetic Polymers - Organic And Inorganic Polymer - Linear, Branched And Cross Linked Polymers - Thermoplastic And Thermosetting Plastics – Elastomers And Fibres – Homopolymer And Copolymer - Synthetic Routes And Applications Of Polymer.

### MODULE 2

Properties Of Polymers – Average Molecular Weight- Number Average, Weight Average, Sedimentation Average And Viscosity Average Molecular Weight- Polydispersity and Polydispersity Index – Degree Of Polymerization.

Glass Transition Temperature - Definition And Importance Of Glass Transition Temperature, Factors Affecting Glass Transition Temperature.

### MODULE 3

Polymerization Techniques – Addition Polymerization – Free Radical Polymerization; Initiation, Propagation and termination- Coordination Polymerization; Mechanism And Advantage of Ziegler Natta catalysis - Ionic Polymerization - Condensation Polymerization.

### MODULE 4

Synthesis and applications of polyethylene, polypropylene, PVC, polystyrene, polyurethane, phenolic and epoxy resin – synthetic rubber – Buna-S, Buna-N, Neoprene and butyl rubber – Biodegradability of polymers.

### REFERENCE

1. A textbook of Polymer Chemistry – F.W. Billmeyer.
2. Polymer Chemistry – V.R Gowarikar.
3. Polymer Chemistry – B.K Sharma.
4. Principles of Polymer Chemistry – P.J Flory
5. Polymer Chemistry – Raymon b sepmour

## KU05DSECHE306-MEDICINAL CHEMISTRY

### Module 1 The Drug chemistry

15 hrs

History and development of medicinal chemistry, importance of chemistry in pharmacy, molecular pharmacology, physicochemical properties in relation to biological action, ionization, solubility, partition coefficient, protein binding, chelation, bioisosterism, different classes of drugs. Introduction to herbal medicine. Introduction to the chemistry of

antibiotics. Introduction to the chemistry of homeopathy. Introduction to nanomedicine. Physico-chemical properties of organic medicinal agents, chemistry of prodrugs,

**Module 2 The Drug metabolism**

**15 hrs**

General principle of drug action. Phase I and Phase II. Factors affecting drug metabolism including stereo chemical aspects. Drugs acting on autonomic nervous system. Chemistry of sedatives and hypnotic drugs. Introduction to psycho active drugs, drug action, drug delivery systems, Enzyme inhibitors in medicine, Pharmacokinetics, drug absorption, distribution. Drugs acting on Central Nervous System. Drug receptors, drug receptor interactions. Structure activity relationships (SAR and QSAR), mechanism of drug action. Non specific action of drugs. Toxicology

**Module 3 The Drug synthesis**

**15 hrs**

Drug discovery and design, Hansch analysis, Craig plot, Free Wilson analysis, Biosynthesis and catabolism of catecholamine and acetylcholine. Various approaches used in drug design. Hammett's electronic parameter, Taft's steric parameter and Hansch analysis. Methods of purification. Concept and applications of combinatorial chemistry, solid phase and solution phase synthesis. Spectroscopic characterizations. Pharmacophore modeling and docking techniques.

**Module 4 Specialty Drugs**

**15 hrs**

Synthesis and action of penicillin, Chemistry of synthesis of ibuprofen, Paracetamol, Epinephrine, Phenylephrine, Dopamine, Methyldopa, Clonidine, Dobutamine, Isoproterenol, Terbutaline, Salbutamol, Bitolterol, Naphazoline, Oxymetazoline and Xylometazoline. Examples of Alpha and Beta adrenergic blockers, Antipsychotics and Anticonvulsants. Drugs acting on Central Nervous System, General anaesthetics, Narcotic and non-narcotic analgesics

**Reference:**

1. Active Pharmaceutical Ingredients: Development, Manufacturing, and Regulation (Drugs and the Pharmaceutical Sciences), Taylor & Francis
2. Fundamentals of Medicinal Chemistry, G. Thomas, Wiley
3. Introduction to Medicinal Chemistry, G.L. Patrick, Oxford
4. An Introduction to Medicinal Chemistry, Patrick, Graham, Oxford; Fifth edition (2013)
5. Medicinal chemistry, D. Sriram, Yogeewari.P, Pearson; 2nd edition (2010)
6. Medicinal Chemistry, A. Kar, New Age international
7. Medicinal Chemistry, An introduction, G. Thomas, Wiley

8. Medicinal Chemistry, D. Sriram, P. Yogeewari, Pearson, Education
9. Pharmaceutical Organic Chemistry, Bhasin, S. K, Elsevier.
10. Pharmacology and pharmacotherapeutics, Sataskar R.S. Bhandakan, S.D. and Ainapure S.S., Popular Prakashan, Mumbai
11. Principles of Organic Medicinal Chemistry, R.R. Nadendla, New Age
12. Principles of organic medicinal chemistry by Nadendla Rama Rao
13. Rang and Dale's Pharmacology, Rang H. P., Dale M. M., Ritter J. M., Flower R. J. Churchill Livingstone Elsevier



## SEMESTER VI

### KU06DSCCHE307-ORGANOMETALLIC COMPOUNDS

#### Module 1. Introduction

15 hours

Introduction. Classification based on the nature of metal-carbon bond. Hapticity in Organometallic compounds, 18- electron rule, numerical problems, and stability, Application of 18 electron rule to predict M-M bond. Factors favouring the formation of metal-metal bonds, preparation, properties, structure and uses of mononuclear (Ni, Fe), binuclear (Fe, Mn, Co) and trinuclear (Fe) metalcarbonyls - Preparation, properties, structure and bonding of Ferrocene. aromaticity and reactions (acetylation, alkylation). Metal-alkene complexes - Preparation and structure of Zeise's salt

#### Module 2 Structure and Bonding

15 hours

Organometallic Compounds-Synthesis, Structure and Bonding, Ligands and their bonding with metals: CO, CN, NO, N<sub>2</sub>, H<sub>2</sub>, alkene, alkyne, PR<sub>3</sub>, arenes, dienes, allyl, carbenes - carbynes (Fischer and Schrock), Preparation of metal nitrosyl, dinitrogen, alkyl, aryl, alkene, alkyne, carbenes - carbynes, arene and phosphine complexes, 18 electron rule, Bridging and non-bridging (Polynuclear) metal carbonyls, Wade-Mingos rules. Cyclopentadienyl complexes - fluxionality.

#### Module 3 Reactions

15 hours

Reactions of Organometallic Compounds and Catalysis- Unique reactions in organometallic chemistry: Oxidative addition (concerted and step-wise, Caryl-H activation - orthometallation), reductive elimination, migratory insertion (1,1 and 1,2),  $\beta$ -hydride abstraction/elimination. Agostic interactions,  $\sigma$ -bond metathesis Zr(IV) and Lu(III), Preparation and structure of mononuclear carbonyls- Mo(CO)<sub>6</sub>, Fe(CO)<sub>5</sub> and Ni(CO)<sub>4</sub>, Polynuclear carbonyls, bridged carbonyls, and bonding in metal carbonyls - Mn<sub>2</sub>(CO)<sub>10</sub> and Fe<sub>2</sub>(CO)<sub>9</sub>. Synergic effect and use of IR data in metal carbonyls to explain extent of back bonding.

#### Module 4 Catalysis

15 hours

Catalytic properties of organometallic compounds-Homogeneous/Heterogeneous catalysis: Tolman catalytic loops, Hydrogenation by Wilkinson Catalyst, Olefin isomerization, Wacker process, Hydroformylation (Co & Rh), Monsanto & Cativa acetic acid process, Ziegler-Natta Polymerization including metallocene based Zr catalyst, Water gas shift reaction, the Fischer-Tropsch reaction (synthesis of gasoline) Grubbs (I generation & II Generation) and Schrock catalysts - Preparation and characteristics, Olefin metathesis.

## References

1. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 6th Edition, Wiley India Pvt.Ltd., New Delhi, 2009 (Reprint).
2. J.E. Huheey, E.A. Keitler and R.L. Keitler, Inorganic Chemistry–Principles of Structure and Reactivity, 4th Edition, Pearson Education, New Delhi, 2013.
3. D.F. Shriver and P. Atkins, Inorganic Chemistry, 5th Edition, Oxford University Press, New York, 2010.
4. J.D. Lee, Concise Inorganic Chemistry, 5th Edition, Oxford University Press, New Delhi 2008.
5. B. D. Gupta, A. J. Elias Basic Organometallic Chemistry, Concepts, Synthesis and Applications, 2nd Edition, University Press, 2010
6. K.F. Purcell, J.C. Kotz, Inorganic Chemistry, Holt-Saunders, 1977.
7. F. Basolo, R.G. Pearson, Mechanisms of Inorganic Reaction, John Wiley & Sons, 2006.
8. P. Powell, Principles of Organometallic Chemistry, 2ndEdn., Chapman and Hall, 1988.
9. Robert H. Crabtree, The Organometallic Chemistry of the Transition Metals, 4thEdn., Wiley Interscience, 2005.
10. Sumit Bhaduri, Doble Mukesh, Homogeneous Catalysis: Mechanism and Industrial Applications, Wiley Interscience, 2000.
11. Astruc, D.; Organometallic Chemistry and Catalysis, Springer Verlag, 2007.
12. Organometallic Chemistry, R C Mahraotra, A Singh, New age international

## KU06DSCCHE308-THEORETICAL CHEMISTRY –I

### Unit-I Brief History and Formulation of Quantum Mechanics

15 Hours

Origin of quantum mechanics, Explanation of photo electric effect, Electron-diffraction experiments and wave nature of electrons, de Broglie matter waves, Heisenberg's uncertainty principle, Deduction of Schrödinger equation from classical wave equation Postulates of Quantum Mechanics: Wave function ( $\Psi$ ) and the physical significance of  $\Psi^2$ , Rules of proper behavior, Normalization of wavefunction and its physical significance, Quantum mechanical operators, their derivation, and properties, Hermitian operators, Commutation of operators and its physical significance, Eigen function and Eigen value, Expectation value, Time-independent and time-dependent Schrödinger Equations, Method of separation of variables.

### Unit-II Particle in Box Particle in a box Problem

15 Hours



Free particle, The particle in a one-dimensional box, Extension of this model into two- and three- dimensional boxes; Application of Method of separation of variables to solve the problems of multi-dimensional boxes, Degeneracy, Symmetry breaking, Treatment of more than one particle (non-interacting) in a box. Applications. Finite-barrier model and the concept of quantum mechanical tunnelling.

### **Unit –III Harmonic Oscillator**

**15 Hours**

Harmonic Oscillator: Quantum mechanical model for molecular vibrations, Derivation of Schrödinger equation. Wave functions and energies, Hermite equation and Hermite Polynomials, Recursion formula, Application to vibrational spectroscopy. Anharmonic oscillator and its significance in vibrational spectroscopy.

### **Unit –IV Rigid Rotor**

**15 Hours**

Rigid Rotor: Quantum mechanical model for rotational motion. Planar rigid rotator (Particle on a ring), The wave equation in spherical polar coordinates, The  $\Phi$ -equation and its solution, Nonplanar rigid rotator (particle on a sphere), Separation of the Schrödinger equation into  $\Phi$ -equation  $\Theta$ -equation and their solutions, Legendre and Associated Legendre equations, Legendre and Associated Legendre polynomials, Spherical harmonics ( $Y$ ), Polar plots of  $Y$ , Angular momentum operators  $L$  and  $L^2$ . Quantization of angular momentum,  $L_x$ ,  $L_y$ , and  $L_z$  and  $L^2$ . Commutation relationships of various angular momentum operators and their physical significance. The concept of space quantization of angular momenta.

### **References**

1. Introduction to Quantum Mechanics, L. Pauling and W.B. Wilson, McGraw Hill
2. D. A. McQuarrie, Quantum Chemistry, 3rd ed., Univ. Sci. Books, Mill Valley, California, 1983.
3. I. N. Levine, Quantum Chemistry, 6th ed., Pearson Education, London, 2008.
4. P. W. Atkins, R.S Friedman, Molecular Quantum Mechanics, 5th ed., OUP, Oxford, 2012.
5. J. P. Lowe, Quantum Chemistry 3rd ed., Academic Press, New York, 2008.
6. A. Szabo, N. S. Ostlund, Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory, Dover Book ed., Mc.Graw-Hill, New York, 1982.
7. P.W. Atkins, Physical Chemistry, 8th ed., Wiley, New York, 2006.
8. R. K. Prasad, Quantum Chemistry, 3rd ed., New Age International, 2006.
9. D. J. Griffiths, Introduction to Quantum Mechanics, 2nd ed., 2004.
10. J. J. Sakurai, Modern Quantum Mechanics, 2nd ed., 2010.

## KU06DSCCHE309- PHYSICAL CHEMISTRY PRACTICAL II

### **Module 1 Distribution methods 30 hrs**

Distribution law: Partition of iodine between water and carbon tetrachloride, Equilibrium constant of simple reaction, concentration of unknown KI, partition studies, determination of equilibrium constant, hydrolysis constant, association studies, Solid and liquid equilibria:

### **Module 2 Phase equilibria studies 30 hrs**

1. Construction of phase diagram of simple eutectics, systems with congruent melting points and solid solutions
2. Determination of composition of unknown mixtures, analytical and synthetic methods for the determination of solubilities and heat of solution: Partially miscible liquids: Critical solution temperature, influence of impurities on the miscibility temperature, determination of composition of unknown mixtures, Completely miscible liquid systems
3. Construction of phase diagrams of two component liquid systems, Zeotropic and azeotropic.
4. Three component systems: With one pair of partially miscible liquids, construction of phase diagrams and tie lines, compositions of homogenous mixtures, heat of solution from solubility data, analytical and graphical method.

### **Module 3 Molecular weight determination & refractometry 30 hrs**

1. Molecular Weight determination: Rast and transition temperature method, molecular weight of a solid using a solid solvent by cooling curve method, molecular weight determination by study of depression in transition temperature, cryoscopic study
2. Refractometry: Determination of molar refractions of pure liquids, determination of composition of mixtures.
3. Viscosity: Determination of viscosity of pure liquids, composition of binary liquid mixtures determination of molecular weight of a polymer.

### **Module 4 Electrochemical and spectrochemical studies 30 hrs**

1. Potentiometry: Electrode potentials of Zn and Ag electrodes-determination of standard potentials, determination of mean activity co-efficient of an electrolyte at different molalities by EMF method, dissociation constant measurement, determination of strength of a given solution, potentiometric titration.
2. Potentiometry: determination of stability constant of  $\text{Cu}^{2+}$  and ethelenediamine
3. Flame photometry: quantitative determination of  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Li}^+$  and  $\text{Ca}^{2+}$  ions

4. Polarography: determination of number of components and concentration ( $\text{Cd}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ , etc.)
5. UV-Vis. Spectrophotometer: determination of the order of a reaction
6. Colorimetry: quantitative determination of the components of a binary mixture
7. Computer applications in chemistry a) Chem draw/ ISIS sketches for reaction and mechanism (minimum 3 Nos) b) C++ programming for the calculation of thermodynamic parameters

#### References:

1. A Text Book of Quantitative Inorganic Analysis, A.I. Vogel, Pearson Education
2. Experimental Inorganic Chemistry, W.G. Palmer, Cambridge University Press.
3. Experimental Physical Chemistry, D.P. Shoemaker and C.W. Garland, McGraw-Hill.
4. Experimental Physical Chemistry, F. Daniels and J.H. Mathews, Longman.
5. Experimental Physical Chemistry, V.d. Ahuwale and parul, New age International.
6. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt and J.A. Dean, AEWt Press.
7. Practical Physical Chemistry A M James, J A Churchil
8. Practical Physical Chemistry, A. Finlay and J. Akitchener, Longman
9. Practical Physical Chemistry, D.M. James and F.E. Prichard, Longman

#### Environmental Chemistry

<b>Course Title</b>	:	Environmental Chemistry
<b>Course Code</b>	:	<b>KU06DSECHE310</b>
<b>Course Type</b>	:	DSE
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Basics concepts in environmental science, Fundamentals of analytical and instrumentation techniques

#### Course Objectives

1. To impart awareness on public health, waste management and pollution
2. To introduce various environmental policies laws and regulations that are relevant to environmental protection
3. To understand the interconnections between different sectors of the environment (soil, water, atmosphere) and the effect of human activities on these causing pollution and other impacts

4. To apply the knowledge on analytical chemistry to environmental processes and samples

Credit			Teaching Hours			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	60	0	60	50	50	100

### Course Outcome

<b>CO1</b>	Acquire theoretical knowledge and understanding of fundamental concepts of environmental technology
<b>CO2</b>	Understand the impact of human and natural impacts on atmosphere and ecosystem
<b>CO3</b>	To understand the type and sources of air, water and soil pollution
<b>CO4</b>	To acquire knowledge on air, water and soil pollution control measures
<b>CO5</b>	Acquire knowledge about advanced instrumentation facilities used for environmental chemical analysis

### Mapping of course Outcomes with POs/PSOs

	PS O1	PSO 2	PSO 3	PSO4	PO 1	PO 2	PO3	PO4	PO5	PO 6	PO7	PO 8
<b>CO1</b>	3				3	3	2	2	2	3	1	2
<b>CO2</b>	3				3	3	2	2	2	3	1	2
<b>CO3</b>	3				3	3	2	2	2	3	1	2
<b>CO4</b>	3				3	3	2	2	2	3	1	2
<b>CO5</b>	3				3	3	2	2	2	3	1	2

3 - Well correlated, 2 - Not well correlated but it has agreeable correlation, 1 - No correlation

### Course Contents

#### Module I: Introduction to Environmental Chemistry

15hrs

1.1 Definition, scope and importance of environmental science, 1.2 Components of environment: atmosphere, hydrosphere, lithosphere and biosphere, 1.3 Fundamentals of ecology and ecosystem, 1.4 Natural resources, 1.5 Effects of human activities on environment: agriculture, housing, industry, mining and transportation activities, 1.6

Environmental impact assessment, 1.7 Environmental policies, 1.8 Environmental law and regulations.

**Module II: Environmental Pollution** **15hrs**

2.1 Types of air pollutants: primary and secondary air pollutants, Gaseous, solid and bio pollutants, 2.2 Acid rain and its ecological effects, 2.3 ozone depletion, 2.4 Greenhouse effect and global warming, 2.5 Thermal pollution impacts of air pollution on human being, plants, materials, buildings and climate, 2.6 Control measures of air pollution, 2.7 Sources of noise pollution - Indoor and outdoor noise pollution, 2.8 Impact of noise pollution on plants and animals. 2.9 control measures of noise pollution.

**Module III: Water and Soil Pollution** **15hrs**

3.1 Water pollution: soluble metals, soaps and detergents, insecticides and pesticides, 3.2 Control of water pollution., 3.3 Sources of soil pollution, 3.4 Soil pollution: ground water, heavy metal poisoning, 3.5 Industrial pollution, agriculture pollution, 3.6 Radiation and radioactive pollution. 3.7 Marine and coastal pollution, 3.8 Sources of marine pollution, control measures, 3.9 Pollution status of coastal and ocean waters.

**Module IV: Environmental Chemical Analysis** **15 hrs**

4.1 Instrumental methods used for the analysis of atmospheric aerosols, sound pollution and radioactive pollution. 4.2 Analysis of drinking water for total oxygen content, turbidity, and organics. 4.3 Chromatography technique is used for the detection of organic compounds, 4.4 Instrumental methods in environmental chemical analysis - chemiluminescence spectroscopy, FT-IR spectroscopy, atomic absorption spectroscopy.

**References**

1. Environmental Chemistry a global perspective, G.W. vanLoon and S.J. Duffy, Oxford University Press.
2. Environmental chemistry, A.K. Bhagi and G.R. Chatwal, Himalaya Publishing House
3. Environmental Chemistry, Ian Williams, John Wiley & Sons
4. Environmental chemistry, Peter O'Neill, Blackie Academics
5. Fundamental concepts of Environmental chemistry G.S. Sodhi, Narosa publications
6. C. Baird, Environmental Chemistry, W. H. Freeman and Company, 1998.
7. D. W. Hawker, D. W. Conell, M. Warne, P. D. Vowles: Basic Concepts of Environmental Chemistry, Lewis Publishers, Inc..1997.

**Teaching Learning Strategies**

... Provide updated Lecture Sessions

- ... Promote Interactive Sessions including discussions and demonstrations.
- ... Provide experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding.
- ... Encourage students to ask questions during or after the lectures

### Mode of Transaction

- ... Lectures, seminars, discussions, and demonstrations

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes

- 1 Explain the various types of spectroscopic techniques used for environmental analysis
- 2 Explain the chemistry of chlorofluorocarbons in depleting the ozone layer.
- 3 Discuss the major objectives of environmental pollution monitoring.
- 4 Discuss your views on the global perspective of Environmental pollution.
- 5 Write a short note on adverse effects of acid rain.

### Nanomedicine and Drug delivery

<b>Course Title</b>	: Nanomedicine and Drug delivery
<b>Course Code</b>	: <b>KU06DSECHE311</b>
<b>Course Type</b>	: DSE
<b>Course Credits</b>	4
<b>Pre-requisites</b>	Basic awareness on Biochemistry and properties of nanomaterials

### Course Objectives:

- ... To get an overview of the exciting and emerging discipline of nanomedicine.

- ... To understand the specific aspects of nanomaterials as applied to biology and medicine
- ... To learn about the essential role of nanosensors in medical field.
- ... To understand the role of controlled, and targeted delivery systems for drugs and genetic materials using polymeric systems, colloidal drug delivery systems.
- ... To develop knowledge on different properties and structure of nanocarriers used for drug delivery

Credits			Teaching Hours			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

#### Course Outcome:

<b>C 01</b>	Summarise the background and history of Nanomedicine
<b>C 02</b>	Examine the role of nanosensors in medical field
<b>C 03</b>	Apply the principles and technology in the design of controlled release drug delivery systems.
<b>C 04</b>	List the criteria for selection of a drugs and nanocarriers for the development of novel drug delivery systems
<b>C 05</b>	Interpret the formulation of novel nanoparticles-based drug delivery systems

#### Mapping of Course Outcomes to POs/PSOs:

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
<b>CO1</b>												
<b>CO2</b>												
<b>CO3</b>												
<b>CO4</b>												

#### Module 1

15 hrs

**Essential molecular biology and the idea of Nano-Medicine:** 1.1 Molecular Cell Biology: Cell- Structure & Function of Cell Membrane, Different cell types and their Functions, Sub-cellular Organelles and their Functions, Nucleotide- Structure and Functions of DNA & RNA. Biologically important nucleotide, protein synthesis, unnatural amino acid, 1.2

Mechanistic understanding of various diseases and target identification for early detection 1.3 History of the nanomedicine – The Biological and Mechanical Traditions – Nano-medicine – 1.4 Taxonomy – Bio-Pharmaceuticals – 1.5 Implantable Materials – Implantable Devices – 1.6 Surgical Aids – 1.7 Diagnostic Tools – Genetic Testing – Imaging – Nanoparticles Probe – 1.8 Case Analysis – 1) Respirocytes – Mechanical Artificial Red Cells – 2) Using DNA as a construction medium.

## **Module 2**

**15 hrs**

**Fundamentals of Nano pharmaceuticals:** 2.1 Nano pharmaceuticals in clinical translatability, 2.2 Target Identification and Drug designing: High-Throughput Screenings, 2.3 Affinity matrix approaches: On-bead affinity matrix, Biotin tags in affinity matrix, Fluorescent tags in affinity matrix, Photo-affinity tags in affinity matrix, 2.4 Drug western approaches, 2.5 Three-hybrid system approaches: mRNA display approaches, Protein micro-array approaches, Drug affinity responsive target stability

## **Module 3.**

**15 hrs**

**Drug delivery basics:** 3.1 Needs and Requirements – 3.2 Nanoparticle Flow: Implications for Drug Delivery – 3.3 Polymeric Nanoparticles as Drug Carriers and Controlled Release Implant Devices – 3.4 Genetic Vaccines 3.5 A Role for Liposomes – 3.6 Polymer Micelles as Drug Carriers 3.7 Recent Advances in Microemulsions as Drug Delivery Vehicles – 3.8 Lipoproteins as Pharmaceutical Carriers – Solid Lipid Nanoparticles as Drug Carriers, 3.9 Multi-targeted drugs – delivery of nucleic acids- barriers to therapeutic applications – 3.10 interaction of organic molecules of the drug with pathological tissue, 3.11 Ligand targeted nanoparticles drug delivery: combining multiple functions - formation of nucleic acid core particle – protective steric coating

## **Module 4.**

**15 hrs**

**Nanocapsules:** 4.1 Nanocapsules – A New Drug Delivery System Nanocapsules preparation, 4.2 Characterization and Therapeutic Applications 4.3 Dendrimers as Nanoparticulate Drug Carriers – Cells and Cell Ghost as Drug Carriers 4.4 Cochleates as Nanoparticulate Drug Carriers – 4.5 Aerosols as Drug Carriers 4.6 Magnetic Nanoparticles as Drug Carriers 4.7 Nanoparticulate Drug Delivery to the Reticuloendothelial System and to Associated Disorders 4.8 Delivery of Nanoparticles to the Cardiovascular System 4.9 Nanocarriers for the Vascular Delivery of Drugs to the Lungs 4.10 Nanoparticulate Carriers for Drug Delivery to the Brain 4.11 Nanoparticles for Targeting Lymphatics 4.12 Polymeric Nanoparticles for Delivery in the Gastro-Intestinal Tract – 4.13 Nanoparticulate Carriers for Ocular Drug



Delivery 4.14 Nanoparticles and Microparticles as Vaccines Adjuvants 4.15 Pharmaceutical NanoCarriers in Treatment and Imaging of Infection

**References**

1. Nanomedicine Technologies and Applications, (2nd Edition) by Thomas Webster, Elsevier.
2. Handbook of modern sensors-Physics, Designs and applications (5th edition) by Jacob Fraden, Springer
3. Nanomedicine in Drug Delivery, A. Kumar, H. M. Mansour, A. Friedman, E. R. Blough, CRC Press.
4. Understanding Nanomedicine- An Introductory Textbook by R. Burgess, CRC Press.
5. Nanoparticulates as Drug Carriers Edited by Vladimir P. Torchilin, Imperial College Press, (2006)
6. Controlled Drug Delivery: Fundamentals and Applications, Second Edition, J. Robinson, V. H. L. Lee, Taylor & Francis.

**Teaching Learning Strategies**

- ... Provide updated Lecture Sessions
- ... Promote Interactive Sessions including discussions and demonstrations.
- ... Provide experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding.
- ... Encourage students to ask questions during or after the lectures

**MODE OF TRANSACTION**

- ... Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

**Sample Questions to test Outcomes**

1. List some examples of implantable materials and devices used in nanomedicine?

2. Summarize the history of nanomedicine
3. Compare the principle and functions of chemical and molecular sensors.
4. Distinguish between pressure sensors and molecular sensors
5. Analyze the role of cells and cell ghosts as drug carriers



## SEMESTER VII

### KU07DSCCHE401-Spectroscopy-I

#### Unit 1: Foundations of Spectroscopic Techniques

15 hrs

Electromagnetic radiation, general nature of electromagnetic waves, wave parameters, regions of the spectrum, quantization of energy, interaction of electromagnetic radiation with matter: absorption, spontaneous emission and simulated emission, Jablonski diagram, factors affecting width of spectral lines, factors affecting intensity of spectral lines, signal to noise ratio, transition moment integral, specific and gross selection rules in spectroscopy.

#### Unit 2: Atomic Spectroscopy

15 hrs

Origin of atomic spectra, classification of atomic spectroscopic methods: absorption spectra, emission spectra and fluorescence spectra, atomic absorption spectroscopy (AAS): principle of AAS, sample atomization techniques, absorption of radiant energy by atoms, measurement of atomic absorption, instrumentation and applications of AAS. Atomic emission spectroscopy (AES): principle of AES, sample atomization techniques, origin of spectra, instrumentation and applications of AES. Principle, instrumentation and application of atomic fluorescence spectra.

#### Unit II: Microwave Spectroscopy

15 hrs

Rotation of molecules, classification of molecules based on principal moments of inertia, rotational spectra of rigid diatomic molecules, gross and specific selection rules in microwave spectroscopy, allowed rotational energy levels of a rigid diatomic molecule, determination of moment of inertia and bond length of molecules, factors affecting the intensity of rotational spectral lines, effect of isotopic substitution, rotational spectra of non-rigid diatomic molecules, chemical analysis by microwave spectroscopy.

#### Unit IV: Electronic Spectroscopy

15 hrs

Introduction to electronic spectroscopy, origin of electronic spectra, singlet and triplet states, selection rules: spin selection rule and Laporte selection rule, electronic transitions in molecules ( $\sigma \rightarrow \sigma^*$ ,  $n \rightarrow \sigma^*$ ,  $\pi \rightarrow \pi^*$  and  $n \rightarrow \pi^*$ ), Beer-Lambert's law, molar extinction coefficient and its importance, chromophores and auxochromes, bathochromic and hypsochromic shifts, effect of conjugation on UV-Visible absorption spectra of molecules, Instrumentation and applications of electronic spectroscopy. Franck-Condon principle: transition, dissociation and predissociation.

#### References

1. Banwell, C. N. & Mc Cash, E. M. Fundamentals of Molecular Spectroscopy, 4th Ed. Tata McGraw-Hill: New Delhi (2006).
2. P. S. Kalsi, Applications of Spectroscopic Techniques in Organic Chemistry, 6th Edn., New Age International (P) Ltd., New Delhi, 2004
3. D. L. Pavia, G. M. Lampman, G. S. Kriz, Introduction to spectroscopy, 3rd edn, Thomson Brooks/Cole, 2001
4. T. Engel, Quantum Chemistry and Spectroscopy, Pearson Education, 2006.
5. K. Veera Reddy, Symmetry and Spectroscopy of molecules, New Age International (P) Ltd, 1999
6. Aruldas, Molecular Structure and Spectroscopy, 2nd Edn., Prentice Hall India, 2007
7. P Gupta, S. S. Das, N. B. Singh, Spectroscopy, Jenny Stanford Publishing, 2023.
8. F. Bernath, Spectra of Atoms and Molecules, 2nd Edn., Oxford University Press, 2005
9. N. Sathyanarayana, Introduction to Magnetic Resonance Spectroscopy ESR, NMR, NQR., IK International, ISBN: 9789380026251
10. Robert L. Carter, Molecular Symmetry and Group Theory, Wiley, 1997, SBN: 978-0-471-14955-2
11. Condon, Edward Uhler, and George Shortley. The Theory of Atomic Spectra. Cambridge University Press, 1935. ISBN: 9780521092098.
12. Sune Svanberg, Atomic and Molecular Spectroscopy: Basic Aspects and Practical Applications, Springer Cham, 2022
13. C. H. Townes, A.L. Schawlow, Microwave Spectroscopy, Courier Corporation, 2013

### **KU07DSCCHE402-Progressive Organic Chemistry**

#### **Module 1**

#### **Basic Organic Spectroscopy**

**18 hrs**

Ultraviolet and visible spectroscopy: sampling, solvent effects, limitations, applications, Woodward-Fieser method of calculations. Infrared spectroscopy: factors influencing vibrational frequencies, sample techniques, solvents, group frequencies, applications, Quantitative infrared analysis, Attenuated Total Reflectance, Photo-Acoustic Spectroscopy, Multiple Internal Reflectance spectroscopy, Proton NMR spectroscopy: Chemical shift, spin-spin splitting and coupling constants, applications to organic compounds, coupling of proton

to other nuclei ( $^{19}\text{F}$ ,  $^{15}\text{N}$ ,  $^{31}\text{P}$ ,  $^{29}\text{Si}$ ). Structural elucidation problems based on UV-Visible, InfraRed and NMR spectroscopies

**Module 2    Advanced Organic Spectroscopy    18 hrs**

Carbon-13 NMR spectroscopy: off-resonance and proton decoupling, Nuclear Overhauser Effect, applications. Advanced NMR techniques: DEPT, HMQC and HSQC techniques, ESR spectroscopy. Structural elucidation of organic compounds based on  $^1\text{H}$ -NMR and  $^{13}\text{C}$ -NMR. Structural elucidation of organic compounds based on IR and  $^1\text{H}$ -NMR spectral data, Mass spectroscopy: Theory and instrumentation, Fragmentations, application studies, McLafferty rearrangement. Combined GC-MS and LC-MS methods. Structural elucidation of organic compounds based on UV, IR, NMRs and MS data

**Module 3    Reagents in Organic synthesis    18 hrs**

Oxidation and reduction reagents. Metal and non-metal based oxidation and reduction reagents. Catalytic hydrogenation and stereochemistry. Reduction using  $\text{LiAlH}_4$ ,  $\text{NaBH}_4$  and  $\text{NaCNBH}_3$ . Synthesis and synthetic applications of crown ethers. Reagents such as NBS, DDQ and DCC. Gilman reagent. Use of sulphur, phosphorous, Silicon, Mercury and cadmium containing reagents. Organometallic reagents in organic synthesis, Platinum and palladium reagents, Application of organo metallic reagents in organic chemistry. Applications of transition metal catalysts in organic synthesis. Olefin metathesis, Grubbs catalysts, enzymes in organic synthesis, Palladium mediated coupling reactions,

**Module 4    Modern Methods of Organic Synthesis    18 hrs**

Retrosynthetic Analysis: Basic principles and terminology of retrosynthesis, synthesis of aromatic compounds, one group and two group C-X disconnections, important strategies of retrosynthesis. One group C-C and two group C-C disconnections, amine and alkene synthesis, Umpolung equivalent. of trimethyl silyl group in organic synthesis. Transition metal catalysts in organic synthesis, introduction to Combinatorial chemistry and Click chemistry, the one pot synthesis. Fundamentals of Supramolecular Chemistry Functional group transposition, important functional group inter-conversions.

**References**

1. Application of Transition Metal Catalysts in Organic Synthesis, H. D. Verkruisje, L. Brandsma, and S.F. Vasilevsky, Springer (2010)
2. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, 2<sup>nd</sup> edn, Oxford University Press (2012).
3. Fundamentals of Fourier Transform Infrared Spectroscopy, Brian C. Smith, CRC Press Organic Spectroscopy William. Kemp, Plagrove publishers (2016)

4. Guide to Organic Spectroscopy, Dipti K. Dodiya, Clever Fox Publishing (2022)
5. Introduction to Organic Mass Spectrometry, Siddiqui Anees A CBS Publishers (2021)
6. Introduction to Organic Spectroscopy, Donald L. Pavia, Gary M. Lampman, George S. Kriz and James A. Vyvyan, Cengage India Private Limited; (2015)
7. Modern Infrared Spectroscopy, Barbara Stuart, Bill George, Peter McIntyre, Wiley India Pvt. Ltd (1995)
8. Modern Organic Chemistry, Jain M.K, Sharma S.C. Vishal Publishing Co., (2018)
9. Modern Techniques of Spectroscopy Basics Instrumentation and Applications, Singh D.K., Springer (2021)
10. Organic Chemistry Reactions & Reagents, Agarwal O.P., 49th ed., Goel Publishing House, (20140.
11. Organic Chemistry, Carey Francis A., 7th ed., New Delhi, Tata McGraw Hill Education Pvt Ltd., (2009).
12. Organic Chemistry, Graham Solomons T.W., 3rd ed., John Wiley & Sons (1984).
13. Organic Chemistry, John E. McMurry, 9th ed., Cengage Learning, (2015).
14. Organic Spectroscopy (NMR, IR, Mass and UV), S.K. Dewan, Atithi Books (2019)
15. Organic Spectroscopy, Jag Mohan , Narosa Publishing House (2009)
16. Organic Spectroscopy, Pradeep Pratap Singh Ambika, Viva Books (2018)
17. Organic structural spectroscopy, J.B. Lambert, H.F. Shurvell, D.A. Lightner and R.G. Cooks, Prentice hall (2010)
18. Organic Structures from Spectra, L D Field, H.L. Li, A.M. Magill, Wiley (2020)
19. Organic Synthesis through Disconnection Approach, P S. Kalsi, Med Tech (2022)
20. Organic Synthesis, The disconnection Approach, Stuart Warren, Paul Wyatt, Wiley (2008)
21. Reagents for High-Throughput Solid-Phase and Solution-Phase Organic Synthesis, Jonathan A. Ellman , John Wiley, (2005)
22. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler, T.C. Morrill, John Wiley (1991)

## KU07DSECHE403-Organic Chemistry Practical II

### Module 1 Analysis of organic binary mixtures

Separation and identification of organic binary mixtures (min 8 numbers) containing two components with at least two substituents in any one of the components. Recrystallization, determination of physical constants and preparation of derivatives

### Module 2 Physical Organic Experiments

Estimation of phenol/ aniline, estimation of glucose, equivalent weight of carboxylic acid, Estimation of lactose in milk, Determination of saponification/ iodine value of an oil

### Module 3 Preparative organic chemistry

Multi stage preparation and identification of organic compounds. (Any 4)

1. Preparation of tribromo benzene from aniline.
2. Preparation of nylon from cyclohexanone via caprolactam.
3. Preparation of phenolphthalein.
4. Preparation of methyl orange.

### Module 4 Bio-Organic Techniques

Soxhlet Extraction :Tulsi, Neem, aloe vera, ginger etc.

### References:

1. A Text Book of Practical Organic Chemistry, A I Vogel, ELBS.
2. Advanced Practical Organic Chemistry, J. Leonard, B, Lygo and G. Procter, Nelson Thornes
3. Lab experiments in organic chemistry, A. Sethi, New Age international
4. Organic synthesis special techniques, V.K.Ahluwalia, Renu Aggarwal
5. Practical Organic Chemistry”, F.G. Mann and B C Saunders, Longman.
6. Systematic identification of organic compounds, Shriner, Hermann, Morrill, Curtin and Fuson, John Wiley
7. Vogel’s Textbook of practical organic chemistry, B.S. Furniss, A.J. Hannaford, Pearson Education 33
8. Laboratory Manual in Organic Chemistry–Dey&Sitaraman(Allied , New Delhi)1992

## **KU07DSECHE404 -Supercapacitors for Electrochemical Energy storage**

### **Module 1**

**15 hrs**

**Fundamentals of Electrochemistry:** EMF, Redox potential, Faraday Law, Nernstlawetc, Electrochemical energy storage systems: Primary and secondary batteries, supercapacitors, calculation of theoretical capacitance, Kinetics and thermodynamics of electrochemical cells, Double layer effects in electrode kinetics

### **Module 2**

**15 hrs**

**Basics of Supercapacitors:** History of supercapacitors, Classification: EDLC, Pseudocapacitors, Hybrid capacitors, Materials and methods: Electrodes (Carbon, Metal Oxides, metal chalcogenides and Conducting polymers), Electrolytes (aqueous, Organic and ionic liquid solvents), Current collectors and separators and their syntheses, parameters that affect the performance of these elements, Electric double layer at the interface: modeling, surface functionalities of carbon, Fabrication of fully functional prototypes: Symmetric and asymmetric, mass balancing, factors to be considered.

### **Module 3**

**15 hrs**

**Characterization of Supercapacitors:** Single electrode and full cell characterization, Cyclic voltammetry, Galvanostatic charge discharge, nominal voltage, rate performance, self discharge, Leakage current, Impedance spectroscopy measurement and analysis, Frequency response of electric double layer capacitors, Electrochemical behavior of specific common anode materials: RuO<sub>2</sub>, NiO, activated carbon, Graphene etc.

### **Module 4**

**15 hrs**

**Innovative technologies and applications:** microsupercapacitors, Flexible SCs, Shape memory SCs, piezoelectric SCs, Transparent SCs, Major application areas: Portable electronics, Smart devices, Biological systems, UPS, Load leveling, Electric and Hybrid electric vehicles, Power harvesting and storage systems, military and defense applications etc, Specifications to be met in terms of the applications, Future perspectives and challenges.

### **References**

1. Conway, Brian E. Electrochemical supercapacitors: scientific fundamentals and technological applications. Springer Science & Business Media, 2013.
2. Khan, A., Asiri, A. M., & Kolosov, A. E. (2022). Handbook of Supercapacitor Materials. R. Boddula (Ed.). Wiley-VCH.
3. Paravannoor, Anjali, and K. V. Baiju, eds. Supercapacitors and Their Applications: Fundamentals, Current Trends, and Future Perspectives. CRC Press, 2023.



4. Stevic, Zoran, ed. Supercapacitor Design and Applications. BoD–Books on Demand, 2016.

### **KU07DSECHE405- Supramolecular Chemistry**

#### **Module 1**

Host-Guest chemistry: The meaning of supramolecular chemistry, classification of host-guest compounds, non-covalent associations, complementarity.

Molecular recognition: Host design, acyclic receptors for neutral and charged guests, macrocycles and crown ethers, macrobicycles and cryptands, clathrates, cyclophanes, cyclodextrins, calixarenes, cucurbiturils.

#### **Module 2**

Supramolecular devices: Sensors and information processing, electro-optic phenomenon, molecular clefts, tweezers, and devices.

#### **Module 3**

Amphibilic molecules and their aggregation: micelle, vesicles, liposomes, microemulsions, H and J-aggregate, aggregation induced emission and quenching, Langmuir Blodgett method, molecular recognition at the air water interface.

#### **Module 4**

Discrete and polymeric metal organic hybrid materials: guest inclusion, catalysis and other applications.

Natural processes: Peptide self-assembly, Protein and DNA aggregation, amyloid and cell membrane.

#### **Text books**

1. Supramolecular chemistry: Concepts and Perspectives, J. –M. Lehn, VCH, Weinheim, 1995.
2. Principles and Methods in Supramolecular Chemistry, H. J. Schneider and A. Yatsimirsky, Wiley, New York, 2000.
3. Supramolecular Chemistry, J. W. Steed and J. L. Atwood, John Wiley & Sons, Chichester, 2009.

### **FOOD CHEMISTRY**

**Course Title** : FOOD CHEMISTRY  
**Course Code** : **KU07DSECHE406**

**Course Type** : DSC  
**Course Credits** : 4  
**Pre-requisites** : Biochemistry, Bioinorganic Chemistry,  
 basic structure protiens, amino acids

**Course Objectives:**

- ... This course aims to teach students about foods as chemical systems.
- ... Outlining the nutrients, or necessary food components, that comprise these systems
- ... The processes that underlie the changes that take place to food as it is processed and stored.
- ... Students will be conversant with food nanotechnology and analytical methods.

Credit			Teaching Hours			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

**Course outcomes:**

After the completion of the course, the learners should be able to

C01	Understanding fundamentals of food chemistry
C02	To acquire knowledge in Food Additives, Preservatives, and Contaminants
C03	To gain concepts on food composition and nutritional aspects
C04	Familiarity with analytical methods and Nanotechnology in food science

**Mapping of Course Outcomes to POs/PSOs:**

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1												
CO2												
CO3												
CO4												

## **Contents:**

### **Module I CHEMISTRY OF FOOD: INGREDIENTS AND FLAVOR ENHANCERS:**

1.1 Introduction, Historical development of food chemistry. 1.2 Food Constituents- Carbohydrates-classification and physical properties, changes of carbohydrates on cooking. 1.3 Lipids-occurrence in food and composition, fats and oils, 1.4 Hydrogenation, Rancidity, reversion, rendering, extraction and refining. 1.5 enzymes- classification and properties, vitamins-fat and water soluble, peptides, amino acids and protein-physical properties.1.6 Protein sources, Protein denaturation.1.7 Determination of proteins in food. Minerals obtained from food. 1.8 Synthetic and natural Aroma compounds, Aroma value and threshold value. 1.9 Sweeteners-Saccharin, Cyclamate, Aspartame. MSG as flavouring enhancer.

### **Module II CHEMISTRY OF FOOD: ADDITIVES, PRESERVATIVES, AND CONTAMINATION**

2.1 Chemical Aspects of Additives, and Preservatives. 2.2 Categories of Food Colours. Water Soluble and fat-soluble Synthetic Colours. 2.3 Classification of Food Colorants-Natural and synthetic colorants. 2.4 Classification of Food Additives. 2.5 Food Spoilage and Preservation: Causes of Spoilage, 2.6 Principle of Food Preservation. Factors Affecting Chemical Preservation, Classification of Chemical Preservatives, Types of Chemical Preservatives, Natural Chemical Preservatives, Methods of Food Preservation. 2.7 Advantages and disadvantages of Food Additives and Preservatives. Effects and safety of Food Additives and Food Preservatives.2.8 History and types of Food Adulteration: Intentional, Incidental and Metallic Adulteration. Food contamination-Toxic trace elements and compounds.

### **Module III: CHEMICAL COMPOSITION OF FOOD AND NUTRITIONAL ASPECTS**

3.1 Chemical Composition of Food and Food Commodities-Beverages and Drinks, 3.2 Cereals and Their Products, 3.3 Eggs and Egg Products, Edible Fats and Oils, Fish and Fishery Products, Meat and Meat Products, Milk and Milk Products. 3.3 Composition of chemicals in vegetables and fruits. 3.4 Compositions of tea and coffee. Composition of Honey and artificial honey.3.5 Raw materials and brewing process of beverages. 3.6 Nutritional and Toxicological Aspects of the Chemical Changes of Food Components and Nutrients During Drying, During Freezing, During Heating and Cooking. 3.7 Nutritional Values of Fermented Foods, Nutritional Quality of Fermented Vegetables and Fruits

### **Module IV: ANALYTICAL METHODS AND NANOTECHNOLOGY IN FOOD**

4.1 Chemical Analysis of Food Components: Classical Wet Chemistry Methods, Sampling

and Sample Preparation, 4.2 Instrumental Food Analysis. Analysis of drinking water. Standards for mineral water. 4.3 An Introduction to Food Nanotechnology, Applications of Nanotechnology in Developing Biosensors for Food Safety, 4.4 Advances of Nanomaterials for Food Processing. Bioactive Ingredients in Functional Foods and Nutraceuticals. 4.5 Bioactive Substances of Plant Origin, Animal Origin, Microbial Origin and Synthetic Bioactive Substances.

### References

1. Mousumi Sen, Food Chemistry: The Role of Additives, Preservatives and Adulteration
2. Peter C. K. Cheung, Bhavbhuti M. Mehta, Handbook of Food Chemistry.
3. Owen R Fennema, Food Chemistry
4. H.D. Belitz, W. Grosch, P. Schieberle, Food Chemistry
5. Lillian Hoagland Meyer, Food Chemistry, CBS Publishers and Distributors
6. HD Belitz, W. Grosch, P Schieberle, Food Chemistry, Springer 4<sup>th</sup> Edn.
7. Matthew Hartings, Chemistry in your Kitchen, Royal Society of Chemistry
8. J. R. Hanson, Chemistry in the Kitchen Garden, RSC Publishing.

## KU07DSECHE407-NUCLEAR CHEMISTRY

### Module 1

Nucleus and its structure, nuclear forces, nuclear stability, binding energy, magic numbers, Odd-Even rule, Semi Empirical Mass equation, Nuclear moments, Nuclear models. Types of nuclear reactions, fission and fusion, Stellar energy.

### Module 2

Radioactive elements, Natural and induced radioactivity, Radioactive decay, Group displacement law, general characteristics of radioactive decay, Radioactive decay and growth, decay kinetics - decay constant, half-life, mean life period, Radioactive equilibrium, Secular and Transient Equilibrium, Units of radioactivity and radiation energy.

### Module 3

Measurement of radioactivity, Geiger-Muller detector, Scintillation detectors, Nuclear reactors: classification of reactors, uranium reactor, breeder reactor. Nuclear reactors in India (Brief Idea).

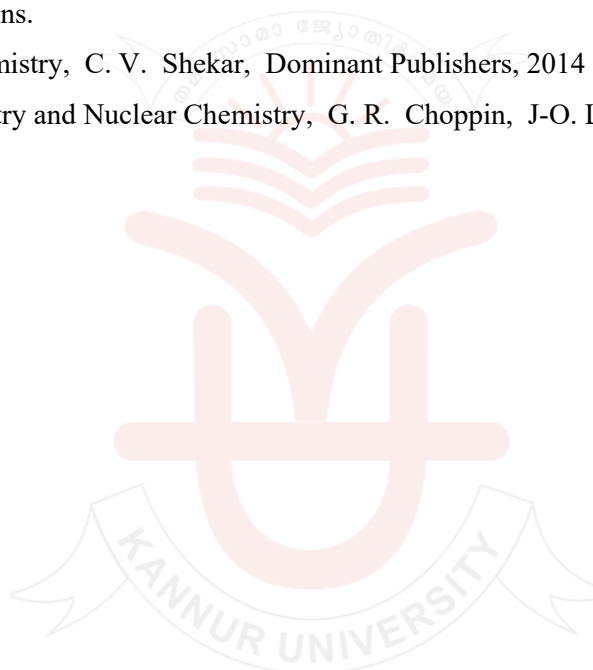
### Module 4

Nuclear pollution and Radiological safety: Interaction of radiation with matter, Radiolysis of water, Radiation dosimetry, Fricke Dosimeter, Radioactive isotopes and their applications,

$^{14}\text{C}$  dating, Rock dating, Isotopes as tracers, Radio diagnosis and radiotherapy, radio-analytical techniques and activation analysis. Isotopic dilution analysis, Neutron activation analysis, Disposal of nuclear waste, nuclear disaster (nuclear accidents– discussion about case studies).

#### References

1. H.J. Arnikar, Essentials of Nuclear Chemistry, Wiley Eastern, 1982.
2. S.N. Goshal, Nuclear Physics, S. Chand and Company, 2006.
3. Elements of Nuclear Chemistry, R. Goplalan, Vikas Publishers, 2000
4. Introduction to Radiochemistry, G. Friedlander and J. W. Kennedy, John Wiley and Sons.
5. Introduction to Radiochemistry, G. Friedlander and J. W. Kennedy, John Wiley and Sons.
6. Nuclear Chemistry, C. V. Shekar, Dominant Publishers, 2014
7. Radiochemistry and Nuclear Chemistry, G. R. Choppin, J-O. Liljenzin and J.



## SEMESTER VIII

### KU08DSCCHE408-GROUP THEORY

#### Unit 1: Symmetry Elements and Point Groups

15 hrs

Importance of symmetry, indistinguishable configurations, symmetry elements and symmetry operations in molecules: identity element, centre of symmetry, plane of symmetry, proper axis and improper axis of rotation, product of symmetry operations, commutative symmetry operations, mathematical rules for the formation of a group, definition and classification of point groups, cyclic point groups, order of a group, similarity transformation, conjugate elements and classes of a group.

#### Unit 2: Group Multiplication Tables and Matrix Representations

15 hrs

Group multiplication tables ( $C_{2v}$  and  $C_{3v}$ ), subgroups, isomorphic groups, abelian groups, applications of point group assignments: prediction of optical activity and dipole moment of molecules, symmetry number, similarity transformations of matrices, addition and multiplication of matrices, adjoint and inverse of a matrix, character of a matrix, block diagonalisation, solutions of linear equations by matrix method, matrix representation of symmetry operations.

#### Unit 3: Reducible and Irreducible Representations

15 hrs

Matrix representation of point groups, construction of matrix representation using vectors and atomic orbital as basis, representation generated by cartesian coordinates positioned on the atoms of a molecule ( $H_2O$  as example), reducible and irreducible representations, construction of irreducible representation by reduction, Great Orthogonality Theorem (GOT), rules derived from the GOT, properties of irreducible representations, construction of irreducible representation using GOT, construction of character tables ( $C_{2v}$ ,  $C_{3v}$ ,  $C_{4v}$ ).

#### Unit 4: Applications of Group Theory

15 hrs

Determination of symmetry of vibrational modes in  $H_2O$  and  $NH_3$  molecules, infrared and Raman activity of molecular vibrations, selection rules for vibrational absorption, complementary character of IR and Raman spectra - mutual exclusion principle, determination of the number of active IR and Raman lines, determination of symmetry of hybrid orbitals for a tetrahedral molecule, construction of hybridization orbitals for  $AB_3$  (triangular planar geometry) and  $AB_5$  (trigonal bipyramidal and square pyramidal geometry) molecules.

#### References

1. F.A. Cotton, Chemical Applications of Group Theory, 3rd Edn., Wiley Eastern, 1990.

2. S. Swarnalakshmi, T. Saroja, R.M. Ezhilarasi, A Simple Approach to Group Theory in Chemistry, Universities Press, 2008.
3. A.S. Kunju, G. Krishnan, Group Theory and its Applications in Chemistry, PHI Learning, 2010
4. P.W. Atkins, R.S. Friedman, Molecular Quantum Mechanics, 4thEdn., Oxford University Press, 2005.
5. K.Veera Reddy, Symmetry and Spectroscopy of molecules, New Age International (P) Ltd,1999.
6. Lowell H. Hall, Group Theory and Symmetry in Chemistry, 1969
7. Alan Vincent, Molecular Symmetry and Group Theory: "A Programmed Introduction to Chemical Applications", 2nd Edition, Wiley
8. Tinkham, Michael. Group Theory and Quantum Mechanics. Dover Publications, 2003. ISBN: 9780486432472.
9. Roy McWeeny, An Introduction to Group Theory and Its Applications, Courier Corporation, 2012
10. A L Gupta, Mukesh Kumar, Group theory and spectroscopy, Pragathi Prakashan,
11. Mark Ladd, Symmetry and Group Theory in Chemistry, ScienceDirect, 1998
12. Richard C Powell, Symmetry, Group Theory, and the Physical Properties of Crystals, Springer, 2010

### Forensic Chemistry & Toxicology

<b>Course Title</b>	:	<b>Forensic Chemistry &amp; Toxicology</b>
<b>Course Code</b>	:	KU08DSECHE409
<b>Course Type</b>	:	DSE
<b>Course Credits</b>	:	4
<b>Pre-requisites</b>	:	Basic concepts of chemical analysis

#### **Course Objectives:**

- ... To learn about the drugs and their abuse with their various identification techniques.
- ... To study various types of poison, their nature, action & symptoms with standard procedure of examination in poisoning cases.
- ... To gain knowledge about ADME of poisons and methods of collection and preservation of evidences.

... To understand the basics of Forensic Chemistry & Toxicology, their scope, role & significance.

Credit			Teaching Hours			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

**Course outcomes:**

C01	Learn about the drugs and their abuse with their various identification techniques.
C02	Learn about various types of poison, their nature, action signs& symptoms with the standard procedure of examination in poisoning cases.
C03	Gain knowledge about ADME of poisons and methods of collection and preservation of evidence.
C04	Apply the basics of Forensic Chemistry & Toxicology, their scope, role & significance.

**Mapping of Course Outcomes to POs/PSOs:**

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	2	2	3	2	2	2	2	1	1
CO2	3	3	2	2	2	3	2	2	2	2	1	1
CO3	3	3	2	2	3	2	2	2	2	3	1	1
CO4	3	3	2	2	3	3	2	2	2	3	1	1

**Contents:**

**Module I:**

**Introduction to Forensic Chemistry:** 1.1 Role of Forensic Chemist, Types of Cases which require Chemical Analysis, Sampling of Evidences, Presumptive Tests (Colour/Spot Tests), Microcrystal Tests, 1.2 Limitations of Forensic Samples, 1.3 Elemental Analysis (Organic and Inorganic), Instrumental Methods and Equipment. Examination of Contact Traces 1.5 Introduction to Cosmetics and Detective Dyes, Collection, Sampling, Analysis and Forensic Importance, 1.4 Analysis of Illicit Liquors including Methyl and Ethyl Alcohol 1.5 Drugs of



Abuse: Introduction, Drug Addiction and its Problems,1.6 Classification of Drugs of Abuse,1.7 Analgesics, Depressants, Stimulants, Hallucinogens, and Narcotics

### **Module II:**

**Instrumentation for Forensic Analysis:**2.1 Instrumental Methods: Sample preparation, calibration of instruments for accuracy and reproducibility of results in forensic analysis, method validation technique and requirements, procurement of standard samples,2.2Forensic applications of TLC, HPTLC, HPLC, GC, FT-IR, AAS, GC-MS, UV-visible spectrophotometer with emphasis over standard operational procedures (SOPs) for test samples,2.3 Physical, Biological and Chemical Methods: Non-destructive testing probes including radiography, X-ray-radiography, Surface penetrations method (SEM and Laser Probes),2.4 Fluoroscopy,2.5 Clinical methods: ELISA, RIA and immune-diffusion , 2. 6 analysis of glucose,bilirubin, total cholesterol, 2.7 creatinine, blood urea nitrogen and barbiturates in biological fluids, DNA-finger printing

### **Module III:**

**Management of Toxicological Cases:**3.1Introduction, Principles of Management of Poisoning Cases, Duties of a Doctor in Poisoning Cases, Signs and Symptoms of Common Poisons, Types of antidotes,3.2Examination and grouping of blood stains and seminal stains, 3.3 Data retrieval and automation techniques for forensic examination with reference to the presence of drugs, glasses, paints, oils and adhesives at crime spot, 3.4Detection of poisoning in the Dead. Selection, Collection and Preservation of Viscera for various Types of Poisons: Choice of Preservatives, Containers and Storage3.5Different Methods of Extraction, Isolation, Identification, Estimation of Poisons from Biological Specimens

### **Module IV:**

**Forensic Toxicology:**4.1 Role of the Toxicologist, Significance of Toxicological findings, Poisons, definition, 4.2 Classification based on their Origin, Physiological Action and Chemical Nature,4.3 Analysis of various types of poisons (corrosive, irritant, analgesic, hypnotic, tranquillizer, narcotic, stimulants, paralytic, anti-histamine, domestic and industrial4.4 Explosive and explosion residue analysis,4.5 Lethal drug analysis, Drug Abuse in Sports: Introduction, Common prohibited substances, Analytical approach, 4.6Importance of physiological tests in forensic toxicology, 4.7 Analysis of Fire Scene Evidences,

Instrumental Methods for Fire Debris Analysis. Analysis of Petroleum Products in Adulterant Cases

### References

1. Curry, A.S. Advances in Forensic Chemical Toxicology. CRC Press:(1972).
2. Curry, A.S. Analytical Methods in Human Toxicology: Part II. Wiley VCH:(1986).
3. Gosselin, R.E.; Hodge, H.; Smith, R.P. and Gleason, M.N. Clinical Toxicology of Commercial Products: Acute Poisoning 4th ed. Williams & Wilkins: Baltimore; (1969).
4. Lundquist, F. and Curry, A.S. Methods of Forensic Science. Inderscience Publisher: California; (1963)
5. Maehly, A. and Stromberg, L. Chemical Criminalistics. Springer: New York; (2011).
6. Matsumura, F. Toxicology of Insecticides. Springer: New York; (1985).

### Teaching Learning Strategies

- ... Provide updated Lecture Sessions
- ... Promote Interactive Sessions including discussions and demonstrations.
- ... Provide experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding.
- ... Encourage students to ask questions during or after the lectures

### MODE OF TRANSACTION

- Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

### Sample Questions to test Outcomes.

1. What is the primary goal of forensic science?
2. What is the difference between circumstantial and direct evidence?

3. Explain the use of instruments in forensic analysis
4. Discuss the effect of toxicology in forensic analysis

### **KU08DSECHE410-Catalysis, Kinetics and Solutions**

#### **Module 1 Fundamentals**

Catalyst - activation energy concept - homogeneous & heterogeneous catalysis, enzyme catalysis, green catalysis, nano catalysis, autocatalysis, phase transfer catalysis, promoters, poisons - examples. Photocatalysis: Porphyrins -phthalocyanines and semiconductor as photo catalysts in photolysis reactions, generation of hydrogen by photo catalysts, photocatalytic break down of water and harnessing solar energy, photocatalytic degradation of dyes, environmental applications.

#### **Module 2 Homogeneous catalysis**

Noyori asymmetric hydrogenation, metal mediated C-C and C-X coupling reactions, Heck, Stille, Suzuki, Negishi and Sonogashira, Nozaki-Hiyama, Buchwald-Hartwig, Ullmann coupling reactions, directed orthometalation - metal (Rh, Ir) catalyzed C-H activation reactions and their synthetic utility. Heterogeneous catalysis: 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, selective catalytic reduction, polymerization.

#### **Module 3 Simultaneous reactions**

Opposing, parallel and consecutive reactions, the steady state approximation - theories of reaction rates-transition state theory and collision theory a comparison - enthalpy, entropy and free energy of activation, potential energy surfaces, reaction coordinates, kinetic isotope effects, factors determining reaction rates in solution, solvent dielectric constant and ionic strength. Chain reactions - linear reactions, branching chains - explosion limits; Rice-Herzfeld scheme; kinetics of free radical polymerization reactions. Enzyme catalysis - rates of enzyme catalysed reactions - effect of substrate concentration, pH and temperature - determination of Michael's parameters. Kinetics in the excited state: Jablonski diagram, Kinetics of Unimolecular and Bimolecular photophysical and photochemical processes, Quantum yield calculation, Excited state lifetime-quenching constant, Resonance energy transfer rates (RET), Rate and efficiency of RET, Dynamics of electron transfer, Solvent re-organization energy, Marcus theory of electron transfer, Free energy and rate relation, Rehm-Weller behaviour, Marcus Inverted Region

#### **Module 4 Solution**

Composition, ways of expressing concentration, molarity, molality, normality, mole fraction, solutions of gases in gases, Henry's law, solutions of liquids in liquids, solubility of completely miscible liquids, solubility of partially miscible liquids, phenol-water system, nicotine-water system, vapour pressures of liquid-liquid mixtures, azeotropes, theory of fractional distillation, steam distillation, solutions of solids in liquids, solubility-equilibrium concept, determination of solubility, solubility of solids in solids.

#### **Reference**

1. P. W. Atkins- Physical Chemistry, Oxford University Press.
2. P. H. Emmet, Catalysis (Vol I and II), Reinhold, 1954.
3. D. K. Chakrabarty and B. Viswanathan, Heterogeneous Catalysis, New Age, 2008.
4. K. J. Laidler, Chemical kinetics, 3rd edn., Pearson education, 2004.

### **KU08DSECHE411-INSTRUMENTATION TECHNIQUES**

#### **UNIT – I Molecular Spectral Analysis**

Introduction to instrumental methods, selection of instrumental methods: precision, sensitivity, selectivity, and detection limit. Sources of noise and S/N ratio. Fundamental law of spectrophotometry, nephelometry and turbidometry and Fluorimetry. UV-visible and IR spectrophotometry – instrumentation, single and double beam instruments, Spectrophotometric titrations. Introduction to NMR spectroscopy: magnets, shim coils, sample spinning, sample probes ( $^1\text{H}$ ,  $^{13}\text{C}$ ,  $^{31}\text{P}$ ).

#### **UNIT – II Atomic and Surface Techniques**

Atomic emission spectrometry – excitation sources (flame, AC and DC arc), spark, inductively coupled plasma, glow discharge, laser microprobes, flame structure, instrumentation, and qualitative and quantitative analysis. Atomic absorption spectrometry: sample atomization techniques, instrumentation, interferences, background correction, and analytical applications. Atomic fluorescence spectrometry – theory, instrumentation and applications. Instrumentation of X-ray methods: X-ray absorption and X-ray diffraction. Photoelectron spectroscopy. XPS, UPS. Auger, ESCA. SEM, TEM, AFM, STM.

#### **Unit-III Thermal and Radiochemical Methods**

Thermogravimetry (TG), Differential Thermal Analysis (DTA), and Differential Scanning Calorimetry (DSC), and their instrumentation. Thermometric Titrations. Measurement of alpha, beta, and gamma radiations, neutron activation analysis and its applications. Principle and applications of isotope dilution methods. Radiation dosimetry – Fricks dosimetry calculation of absorbed dose.

## **UNIT – V Modern Techniques in Analytical Chemistry**

Hyphenated techniques – Gas Chromatography – Mass Spectrometry (GC-MS), Liquid Chromatography – Mass Spectrometry (LC-MS), Gas Chromatography/Liquid Chromatography-Infrared Spectroscopy (GC/LC-IR), Liquid Chromatography-Nuclear Magnetic Resonance Spectroscopy (LC-NMR), Tandem Mass Spectrometry (MS/MS) techniques, Flow injection analysis (FIA).

### **References**

1. D. A. Skoog, D. M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry, 8th Edn., Saunders College Pub., 2007.
2. J.H. Kennedy, Analytical Chemistry: Principles, Saunders College Pub. 1990.
3. G.H. Jeffery, J. Bassett, J. Mendham, R.C. Denney, Vogel's Textbook of Quantitative Chemical Analysis, 5th Edn., John Wiley & sons, 1989.
4. G. D. Christian, Analytical Chemistry, 6th ed., John Wiley & Sons, 2007.
5. R.A. Day, A.L. Underwood, Quantitative Analysis, Prentice Hall, 1967.
6. A.I. Vogel, A Textbook of Practical Organic Chemistry, Longman, 1974.
7. H.A. Laitinen, W.E. Harris, Chemical Analysis, McGraw Hill, 1975.
8. V.K. Ahluwalia, Green Chemistry: Environmentally Benign Reactions, CRC, 2008.
9. F.W. Fifield, D. Kealey, Principles and Practice of Analytical Chemistry, Blackwell Science, 2000.

## **KU08DSECHE412-Introduction to Computational Chemistry**

### **Unit 1 Many electron atoms**

**15 Marks**

Electron correlation, addition of angular momentum, Clebsch-Gordan series, total angular momentum and spin-orbit interaction.

### **Unit II Ab Initio Methods**

**15 Hours**

Review of molecular structure calculations, Hartree-Fock SCF method for molecules, Roothaan-Hartree-Fock method, selection of basis sets.

### **Unit III Electron Correlation and Basis Sets**

**15 Hours**

Configuration Interaction, Multi-Configuration SelfConsistent Field, Multi-Reference Configuration Interaction, Many-Body Perturbation Theory, Coupled Cluster, Basis sets.

### **Unit IV DFT and Force Fields method**

**15 Hours**

Energy as a functional of charge density, Kohn-Sham equations. Molecular mechanics methods, minimization methods, QSAR.

## References

1. Introduction to Computational Chemistry, F. Jensen, 2nd edition, Wiley-Blackwell (2006).
2. Molecular Quantum Mechanics, P. W. Atkins and R. S. Friedman, 3rd edition, Oxford University Press, Oxford (1997).
3. Quantum Chemistry, H. Eyring, J. Walter and G.E. Kimball, (1944) John Wiley, New York.
4. Quantum Chemistry, I.N. Levine, 5th edition (2000), Pearson Educ., Inc., New Delhi.
5. Modern Quantum Chemistry: Introduction to Advanced Electronic Structure, A. Szabo and N. S. Ostlund, (1982), Dover, New York.
6. Cramer, C. J. Essentials of computational Chemistry: Theories and models, 2nd Ed., John Wiley & Sons, 2004.
7. Levine, I. N. Quantum Chemistry, 7th Ed., Pearson, 2013.
8. Wilson, E. B., Decius, J. C. and Cross, P. C. Molecular Vibrations: The Theory of Infrared and Raman Vibrational Spectra, Dover, New York, 1980

## KU08DSECHE413- CERAMICS AND COMPOSITE MATERIALS

### Unit-I Ceramics –I

15 Hours

Introduction, bonding, structure and its effects on physical properties, thermodynamics and kinetic considerations, sintering, defects of ceramics, diffusion Phase equilibria in ceramic systems (one component, binary and ternary systems), chemical reactions at high temperatures and processing of ceramics Thermal properties of ceramics, high temperature materials. Mechanical properties, creep, fatigue, crack growth, electrical conductivity Magnetic properties, Hysteresis curves, magnetic ceramics and their applications, optical properties, scattering, opacity.

### Unit-II Ceramics –II

Crystalline ceramic materials: oxide, carbide, nitride, graphite and clay materials and their structures. Polymorphism, non-crystalline ceramic materials: structure and structural requirements for stability, mode of formation Silicate and nonsilicate glasses, hydrogen bonded structures, applications. Ceramic glasses and their applications, Introduction to bio-ceramic materials and their applications.

### Unit-III Composites

Introduction, classification of composites according to the matrix, classification of composites according to the reinforcement Synthesis techniques, properties and applications

of ceramic matrix composites, polymer matrix composites and metal matrix composites  
Composite Strengths: dispersion and particulate strengthened composites. Fibers as  
reinforcements. Composite Interfaces, Bonding Mechanisms, other Interfacial properties

#### **Unit-IV Inorganic Polymers**

Polyphosphazenes: Introduction, classification, bonding, synthetic routes, characterization,  
and biomedical applications Organosilicon polymers: polysiloxane preparation, structure and  
applications Synthesis and chemical modification of polysilanes, application of polysilanes as  
photoresists and photoinitiators Organometallic polymers: Introduction, structure & bonding,  
synthetic routes, and applications.

#### **References**

1. Elements of Ceramics, F.H. Norton.
2. Introduction to ceramics, W.D. Kingery, H.K. Dowen and R.D. Uhlman, John Wiley.
3. Fundamentals of Ceramics, M.W. Barsoum, McGraw Hill.
4. Introduction to Materials Science and Engineering, William J Callister, John Wiley & Sons Inc.
5. Introduction to Materials Science and Engineering, William J Callister, John Wiley & Sons, Inc.
6. Introduction to the Principles of Ceramic Processing, J. S. Read, Wiley-Interscience  
Fundamentals of Ceramics, M.W. Barsoum, McGraw Hill.
7. Material Science and Engineering, S.K. Hajra Choudhury, Indian Book Dist.
8. Introduction to Materials Science and Engineering, William J Callister, John Wiley & Sons, Inc.
9. Composite Materials: Engineering and Science - F. L. Matthews and R. D. Rawlings, Chapman & Hall.
10. Advanced Composite Manufacturing - Gutowski, Wiley Inorganic and organometallic polymers, Chandrasekhar V .Springer.
11. Introduction to polymers, Young and Lowell, Viva Publications
12. Contemporary polymer chemistry, Allcock, Lampe and Marle, Pearson education
13. Inorganic polymers, Mark JE, Allcock HR, West R. Oxford University Press, New York
14. Inorganic and organometallic polymers, Chandrasekhar V .Springer.

## Analytical Chemistry

Course Title	: Analytical Chemistry
Code	: KU08DSECHE414
Course Type	: DSE
Course Credits	: 4
Pre-requisites	: Solution chemistry, Basic Instrumentation

### Course Objectives:

- ... To develop an understanding of the range and uses of analytical methods in chemistry.
- ... To establish an appreciation of the role of chemistry in quantitative analysis.
- ... To develop an understanding of the broad role of the chemist in measurement and problem solving for analytical tasks.
- ... To provide an understanding of chemical methods employed for elemental and compound analysis.
- ... To provide experience in modern scientific methods and instruments employed in analytical chemistry and material science.

Credit			Teaching Hours			Assessment		
L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
4	0	4	4	0	4	50	50	100

### COURSE OUTCOMES

**Course Learning Outcomes: At the end of the course, the student will be able to –**

<b>C01</b>	The student learns the skill to prepare standard solution, samples and analysis of the samples through using accurate methods. The course makes the student to learn how to prepare solutions quantitatively and analysis the analyte with high accuracy.
<b>C02</b>	Apply the knowledge of chromatography to Separates the constituents from a complex mixture.
<b>C03</b>	Students will learn physical, chemical and biological characterization methods
<b>C04</b>	Students will learn in detail about X-ray diffractometry, Scanning probe microscopy and scanning tunneling microscopy, Optical microscopy– SEM, TEM, AFM, UV-Vis-NIR spectrometry and FTIR



**Mapping of Course Outcomes to POs/PSOs:**

	PS O1	PSO 2	PSO 3	PSO 4	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
<b>C01</b>					2	3	1	2	1	1	1	2
<b>C02</b>					2	3	1	2	1	1	1	2
<b>C03</b>					1	2	1	2	1	1	1	2
<b>C04</b>					1	2	1	2	1	1	1	1

**Module 1: Introduction to analytical methods**

1.1.Introduction to analytical and instrumental methods,1.2.classification of analytical techniques,1.3.Precipitation phenomena, 1.4.organic precipitants in inorganic analysis,1.5.Extraction of metal ions, 1.6.nature and types of extractants and its applications, 1.7.chelometric titration, 1.8.Masking and de masking techniques, 1.9.industrial applications of masking. 1.10.Separation techniques: 1.11.Solvent extraction, 1.12.batch and continuous extractions, extraction of metal ions, 1.13.nature and types of extractants and its applications.

**Module 2: Chromatography and Electroanalytical methods**

2.1.Introduction to chromatography, 2.2.classification of chromatographic methods,theory, 2.3.techniques and applications.  
2.4.Radio analytical methods: Introduction, principle and application of neutron activation analysis (NAA), 2.5.isotope dilution analysis and radiometric titrations. 2.6.Electro analytical methods:Principles and applications of Voltammetry, 2.7.Cyclic voltammetry (CV), 2.8.Polarography, 2.9.Stripping voltammetry, 2.10.Conductometry, 2.11.Amperometry, 2.12.Potentiometry and Electrogravimetry.

**Module 3: Spectroscopy and microscopy methods of analysis**

3.1.Introduction to instrumentation, 3.2.method of samplings, data analysis and applications to chemistry of the followings, 3.3.Attenuated Total Reflection Spectroscopy, 3.4.Electronic Spectroscopy for Chemical Analysis (X-ray Photo Electron Spectroscopy),3.5.UV-Photo Electron Spectroscopy.3.6.Ion Scattering Spectroscopy, 3.7.Secondary Ion Mass Spectroscopy, 3.8.Auger Electron Spectroscopy  
3.9.Principles, general instrumentation and applications of Scanning Electron Microscopy, 3.10.Scanning Tunneling Electron Microscopy, 3.11.Atomic Absorption Spectroscopy and Instrumentations of NMR, 3.12.IR, UV-Visible and Mass spectrometry.

#### **Module 4: Instrumental methods of analysis**

4.1.Principles, instrumentation and applications of thermogravimetry (TGA-DTA),  
4.2.Differential Scanning Calorimetry, 4.3.Dynamic Mechanical Analyzer, Dynamic  
Chemical Analyzer, 4.4.Direct injection enthalpymetry and thermometric titrimetry,  
4.5.Principles, instrumentation and applications of Fluorimetry, 4.6.Phosphorimetry,  
4.7.Flame photometry, 4.8.Nephelometry and Turbidimetry.

#### **Reference Books**

1. Principles of quantitative chemical analysis, de Levine, McGraw Hill.
2. Vogel's Qualiitative Inorganic Analysis, Pearson Education
3. Vogel's Quantitative chemical analysis, Pearson Education
4. Fundamentals of Analytical Chemistry, Skoog, West, Holler, Croach, Thomson Brooks/Cole
5. Instrumental methods of chemical analysis, Willard, Dean and Merrit, Affiliated East West Press
6. Modern analytical chemistry, Harvey, McGraw Hill
7. Principles and practice of Analytical Chemistry, F.W. Fifield and D. Kealeg, Blackwell publications

#### **Teaching Learning Strategies**

- ... Provide updated Lecture Sessions
- ... Promote Interactive Sessions including discussions and demonstrations.
- ... Provide experiments to engage students actively and visual aids like presentations,
- ... Videos, and models to enhance understanding.
- ... Encourage students to ask questions during or after the lectures

#### **Mode of Transaction**

- ... Lectures, seminars, discussions, and demonstrations.

<b>ASSESSMENT RUBRICS</b>			<b>Total</b>
<b>End Semester Evaluation</b>	<b>External Exam</b>	<b>50</b>	<b>50</b>
<b>Continuous Evaluation</b>	<b>Internal Exam</b>	<b>20</b>	<b>50</b>
	<b>Assignment</b>	<b>10</b>	
	<b>Seminar</b>	<b>10</b>	
	<b>Viva</b>	<b>10</b>	

### Sample Questions to test Outcomes

1. Explain the principle of HPLC?
2. Define the terms elution and eluent?
3. How is paper partition chromatography different from paper adsorption chromatography?
4. Explain the significance of R<sub>f</sub> value in chromatographic separation?
5. What is NAA? Give any one use of this technique.

### KU08DSECHE415-ADVANCED ELECTROCHEMISTRY

#### UNIT I – Ionics-I

15 Hours

Characteristics of ionics and electrodictics, properties of materials and surfaces, Ionics: Ionsolvent interaction, structure of water, ion- dipole model and ion -solvent interaction, dielectric effects and dielectric constants of solution, ion- dipole model and ion-solvent interaction, Dielectric effects and dielectric constants of solution, ion -quadrupole model of ion – solvent interaction, Ion – ion interaction, Debye-Huckel ion cloud theory, Linearized Poisson – Boltzmann equation and its solution, Activity coefficient and ion – ion interaction, ion cloud and chemical potential change, activity, activity coefficient and ion -ion interaction, and ion - solvent interaction, merits and demerits of Debye- Huckel theory of activity coefficient, Debye- Huckel Limiting Law.

#### Unit II Ionics-II

15 Hours

Ionic diffusion under chemical potential gradient, Fick's law, diffusion coefficient, random walking model, Einstein- Smoluchowski's equation, ionic drift under electric field, quantitative link between electron flow and ion flow in electrolytes – Faraday's law, electric field and current density,, ionic migration, Einstein relation between absolute mobility and diffusion coefficient,, Nernst- Einstein relation, stoke's - Einstein relation, Interdependence of ionic drift, diffusion potential, Onsagar phenomenological equation, Debye – Huckel - Onsagar equation, Changes to Debye – Huckel – Onsagar equation.

#### Unit III Electrodictics

15 Hours

Overview of reversible electrode processes, electrochemical cells and reactions, Faradaic and non - Faradaic processes, Nature of electrode - solution interface, ideal polarized electrode, capacitance and charge of an electrode, Electrical Double Layer and theories of EDL, thermodynamics of double layer, surface excess and electro capillary equation, Double layer capacitance and charging current, Faradaic process and factors affecting rates of electrode reaction, mass transfer controlled reactions – modes of mass transfer, Kinetics of electrode reaction, relation between reaction rate, current and potential, current - potential diagram,

Butler -Volmer model of electrode kinetics, Polarization phenomena and over potential, Over potentials in electrolysis, Dependence of the Electrochemical Reaction Rate on Overpotential, Butler Volmer Equation & Tafel equation and Tafel plot. Solid state electrochemistry-Ion conducting polymers, electronically conducting polymers and redox polymers.

#### **UNIT – IV Electrochemical Techniques**

**15 Hours**

Electrochemical Techniques: Basic Potential step and potential sweep methods, Potentiometry, Voltammetry : Polarography, Pulse Voltammetry, Cyclic Voltammetry (detailed description), Anode Stripping Voltammetry, Hydrodynamic Voltammetry, Chronopotentiometry, Amperometry, Chrono amperometry , Coulometry, Chrono coulometry, Spectroelectrochemistry. Electrochemical impedance and its application.

#### **References**

1. Bockris and Reddy - Modern Aspects and Electrochemistry vol. I and II, Academic Press. P.W. Atkins - Physical Chemistry, ELBS Oxford University Press.
2. Allen J Bard and Larry R Fajilkner, Electrochemical Methods – Fundamentals & Applications.
3. S. Glasstone - Introduction to Electrochemistry, Van Nonstrand
4. Skoog and West - Fundamentals of Analytical Chemistry.
5. Joseph Wang - Analytical Electrochemistry.
6. J.O.M. Bokris and A.K.N. Reddy, Modern Electrochemistry, Plenum Press, 1973.
7. Modern Electrochemistry, J.O.M. Bockris and A.K.N. Reddy, Plenum
8. Physical Chemistry, Daniels and Alberty, John Wiley.

## SEMESTER IX

### KU09DSCCHE416-SPECTROSCOPY –II

#### Unit I: IR Spectroscopy

15 hrs

Introduction to vibrational spectroscopy, harmonic oscillator: calculation of force constant and energy levels, concept of anharmonicity: Morse potential and dissociation energies. Vibrational energy of diatomic molecules: simple harmonic and anharmonic oscillators, diatomic vibrating rotator, vibration rotational spectrum of carbon monoxide, vibrational spectrum of polyatomic molecules: fundamental vibrational and their symmetry, overtones, hot bands, fermi resonance, influence of rotation on the vibrational spectra of polyatomic linear and polyatomic symmetric top molecules, parallel and perpendicular vibrations, chemical analysis by infrared spectroscopy.

#### Unit II: Raman Spectroscopy

15 hrs

Introduction to Raman spectroscopy, scattering of light, polarizability and classical theory of Raman spectrum, quantum theory of Raman effect, pure rotational Raman spectra of linear and symmetric top molecules, Vibrational Raman spectra: Raman activity of vibrations, Stokes and anti-Stokes lines: their intensity difference, rule of mutual exclusion, overtones and combination vibrations, rotational fine structure, vibrations of spherical top molecules, applications of Raman spectroscopy.

#### Unit III: NMR and ESR Spectroscopy

15 hrs

Magnetic properties of nuclei, theory and measurement techniques, population of energy levels, chemical shift and its measurement, factors affecting chemical shift, relaxation methods, integration of NMR signals, spin-spin coupling, coupling constant 'j' and factors affecting it, shielding and de-shielding, chemical shift assignment of major functional groups, spin decoupling, NMR studies of nuclei other than Proton:  $^{13}\text{C}$ ,  $^{19}\text{F}$  and  $^{31}\text{P}$  NMR. ESR spectroscopy: electron spin in molecules, interaction with magnetic field, 'g' factor, factors affecting 'g' values, fine structure and hyperfine structure, Kramers' degeneracy, applications of ESR spectroscopy.

#### Unit IV: Mossbauer, XPS and Mass Spectroscopy

15 hrs

Mossbauer Spectroscopy: Principle, Doppler effect, recording of spectrum, chemical shift, factors determining chemical shift, application for the analysis of metal complexes. X-ray spectroscopy: origin of X-ray spectra, Moseley's law, X-ray fluorescence, basic principles of energy dispersive X-ray spectrometry (XPS), instrumentation and applications of XPS. Mass spectroscopy: basic principles, ionization methods; gas phase ionization methods, desorption

ionization methods and plasma desorption ionization. separation techniques - time of flight analyser and quadrupole mass analyser, types of peaks involved, fragmentation pathways, applications of mass spectrometry.

### References

1. Banwell, C. N. & Mc Cash, E. M. Fundamentals of Molecular Spectroscopy, 4th Ed. Tata McGraw-Hill: New Delhi (2006).
2. D.L. Pavia, G.M. Lampman, G.S. Kriz, Introduction to Spectroscopy, 3rd Edn., Brooks Cole, 2000
3. A.U. Rahman, M.I. Choudhary, Solving Problems with NMR Spectroscopy, Academic Press, 1996.
4. L. D. Field, S. Sternhell, J. R. Kalman, Organic Structures from Spectra, 4th Edn., John Wiley & sons, 2007.
5. D.F. Taber, Organic Spectroscopic Structure Determination: A Problem Based Learning Approach, Oxford University Press, 2007.
6. H. Gunther, NMR Spectroscopy, 2nd Edn., Wiley, 1995.
7. E.B. Wilson Jr., J.C. Decius, P.C. Cross, Molecular Vibrations: The Theory of Infrared and Raman Vibrational Spectra, Dover Pub., 1980
8. T. Engel, Quantum Chemistry and Spectroscopy, Pearson Education, 2006
9. K.Veera Reddy, Symmetry and Spectroscopy of molecules, New Age International (P) Ltd, 1999.
10. Ewen Smith, Geoffrey Dent, Modern Raman Spectroscopy: A Practical Approach, John Wiley & Sons Ltd., 2019
11. Barbara H. Stuart, Infrared Spectroscopy: Fundamentals and Applications, John Wiley & Sons Ltd., 2004
12. Roger S Macomber, A complete introduction to modern NMR spectroscopy, Wiley, 1997
13. Anders Lund, Masaru Shiotani, Shigetaka Shimada, Principles and Applications of ESR Spectroscopy, Springer, 2011
14. Yutaka Yoshida, Guido Langouche, Mössbauer Spectroscopy, Springer, 2013
15. Jürgen H Gross, Mass Spectrometry, Springer Science & Business Media, 2022
16. Arpana Agrawal, X-Ray Photoelectron Spectroscopy: Principles, Techniques and Applications, Nova Science Publishers, 2023

## KU09DSCCHE417-THEORETICAL CHEMISTRY-II

### **Unit –I Quantum Mechanics of Hydrogen Like atom** **15 hours**

Hamiltonian operator and Schrödinger equation for Hydrogen-like atoms in spherical polar coordinates. Application of the method of separation of variables to separate the Schrödinger equation into the R-,  $\Theta$ - and  $\Phi$ - equations and their solutions. Laguerre and Associated Laguerre polynomials. Wave functions and energies of hydrogen-like atoms, Orbitals. Radial functions and Radial distribution functions and their plots Angular functions (Spherical harmonics) and their plots. Description of Hamiltonians and Schrödinger equation in atomic units (a.u.).

### **Unit-II Approximation methods** **15 hours**

Many electron atoms. Approximate methods in quantum mechanics: The variation theorem, Illustration variation theorem using trial function in particle in box, linear variation principle and perturbation theory for first order correction to energy and wavefunction and second order correction to energy, application of variation method and perturbation theory to the Helium atom, antisymmetry, Pauli exclusion principle, Slater determinantal wave functions. Electron spin.

### **Unit III Self Consistent Field Approximations** **15 hours**

Hartree-Fock Self Consistent Field method, The Coulomb and Exchange Operators, The Fock Operator, Koopmans' theorem, Brillouin's theorem, The Roothaan Equations, Slater's treatment of complex atoms, Slater orbitals. Pauli principle, Slater determinant and wave function.

### **Unit IV Chemical Bonding** **15 hours**

Born-Oppenheimer approximation, essential principles of the MO method, MO treatment of Hydrogen molecule and the  $H_2^+$  ion. Valence bond treatment of ground state of hydrogen molecule, MO treatment of homonuclear diatomic molecules,  $Li_2$ ,  $Be_2$ ,  $N_2$ ,  $O_2$ ,  $O_2^+$ ,  $O_2^-$ ,  $F_2$  and heteronuclear diatomics,  $LiH$ ,  $CO$ ,  $NO$ ,  $HF$ . Correlation diagrams, non-crossing rules, spectroscopic term symbols for diatomic molecules. Theorems in chemical bonding: The Virial theorem, The Hellmann – Feynman theorem.

### **References**

1. Introduction to Quantum Mechanics, L. Pauling and W.B. Wilson, McGraw Hill
2. D. A. McQuarrie, Quantum Chemistry, 3rd ed., Univ. Sci. Books, Mill Valley, California, 1983.
3. I. N. Levine, Quantum Chemistry, 6th ed., Pearson Education, London, 2008.

4. P. W. Atkins, R.S Friedman, Molecular Quantum Mechanics, 5th ed., OUP, Oxford, 2012.
5. J. P. Lowe, Quantum Chemistry 3rd ed., Academic Press, New York, 2008.
6. A. Szabo, N. S. Ostlund, Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory, Dover Book ed., Mc.Graw-Hill, New York, 1982.
7. P.W. Atkins, Physical Chemistry, 8th ed., Wiley, New York, 2006.
8. R. K. Prasad, Quantum Chemistry, 3rd ed., New Age International, 2006.
9. D. J. Griffiths, Introduction to Quantum Mechanics, 2nd ed., 2004.
10. J. J. Sakurai, Modern Quantum Mechanics, 2nd ed., 2010.
11. Fundamentals of Quantum Chemsitry, R Anandaraman, McMillan India, 2000

## **KU09DSCCHE418-STATISTICAL AND NON EQUILIBRIUM THERMODYNAMICS**

### **Module 1 Statistical Mechanics**

Ensemble averaging, postulates of ensemble averaging. Micro canonical, canonical and grand canonical ensembles, corresponding distribution laws (using Lagrange's method of undetermined multipliers). Maxwell-Boltzmann statistics, Boltzmann distribution, derivation of the Boltzmann distribution expression, determination of the Boltzmann constant, Maxwell distribution law of velocities from Boltzmann distribution expression.

### **Module 2 Quantum Statistics**

The Bose-Einstein statistics, statistics of a photon gas, the Fermi-Dirac statistics, Fermi-Dirac systems, extreme gas degeneration, slight gas degeneration, electron gas in metals, thermionic emission and comparison of two statistics, non degenerate and degenerate systems.

### **Module 3 Statistical Thermodynamics – I**

Partition function and thermodynamic properties, partition function and factorization of partition function, translational partition function, translational thermodynamic function, atoms and monoatomic molecules, Sackur-Tetrode equation, diatomic molecules, separation of internal partition function. Rotational and vibrational energies, entropy due to internal degrees of freedom. Rotational partition function, rotational partition function for polyatomic molecules, vibrational partition function.

### **Module 4 Statistical Thermodynamics – II**

Determination and calculation of thermodynamic properties i.e. internal energy, entropy, Helmholtz and Gibbs free energy, ortho and para hydrogen states, free energy



functions. Partition function and equilibrium constant, effect of nuclear spin, isomolecular reaction, isotopic exchange reactions. Einstein theory and Debye theory of heat capacities of monatomic solids. Meaning and scope of irreversible thermodynamics. Thermodynamic criteria for non-equilibrium states, Phenomenological laws-linear laws, Onsager's reciprocal relation, Entropy production-specific laws of entropy production in mass transfer, chemical reaction, heat transfer, Non-equilibrium stationary states, Prigogine's principle of entropy production, Coupled phenomena.

### References

1. A course on statistical thermodynamic, Kistin and Dorfuran- Academic 19
2. Elements of statistical Thermodynamics, L.K. Nash- Addison Wesley Publishing
3. Elements of statistical Thermodynamics, M.C.Gupta- New age international.
4. Principle of Physical Chemistry, Puri Sharma Pathania
5. McQuarrie, Donald A. (1975). Statistical mechanics. New York: Harper & Row.
6. An Introduction to Chemical Thermodynamics, RP Rastogi, R RMisra, Vikas publication
7. Thermodynamics for Chemist, Samuel Glaststone, East West Publishers
8. Introduction to Thermodynamics of Irreversible Processes, I. Prigogine, Cambridge University Press
9. Non-equilibrium Thermodynamics, SybrenRuurds de Groot, Peter Mazur, Dover Publications

## KU09DSCCHE419-ADVANCED ORGANIC CHEMISTRY PRACTICAL.

<b>Module 1</b>	<b>Advanced mixture analysis</b>	<b>15 hrs</b>
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Separation, purification, analysis and derivatization of ternary mixture of organic compounds. Identification, separation and qualitative analysis of the individual compounds. Identification by TLC, purification by column chromatography and characterization by spectral methods. Preparation of suitable derivative for each component. Preparation of solid derivative. TLC and column chromatographic methods of purification and spectral characterization. Fractional crystallization and Fractional distillation

<b>Module 2</b>	<b>Isolation of natural products</b>	<b>15 hrs</b>
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Isolation and characterization of natural products: Caffeine, Ricinoleic acid, Azelic acid, Piperine, Hesperidine, Cysteine, Casein and Lycopene. Extraction of Groundnut oil and Coconut oil. Preparation of soaps and detergents. Isolation of Carotenes. Purification by paper,

TLC and column chromatography. Determination of various components of natural products by polarity based solvent extraction. Identification of individual compounds present in each fraction.

**Module 3** **Quantitative analysis** **15 hrs**

Quantitative determination of sugars, amino acids, carboxylic acids, amides and esters by various methods. Determinations of acid & ester and acid & amide in the mixtures. Determination of functional groups like hydroxyl, vic-hydroxyl, enol, amino, amide, unsaturation and nitro groups by various methods. Determination of Saponification and Iodine values of oils and fats.

**Module 4** **Organic synthesis** **15 hrs**

Laboratory scale preparations of organic named reactions. Monitoring of the reaction by TLC. Purification by column chromatography. Determination of melting point and Spectroscopic identification using UV, IR and NMR. Acyloln condensation, Aldol condensation, Beckmann rearrangement, Cannizzaro reaction, Claisen condensation, Fries rearrangement, Perkin reaction and Sandmeyer reaction.

**References:**

1. Advanced Practical Organic Chemistry, III Edition, J. Leonard, B. Lygo and G. Procter, CRC Press, Routledge, (2013).
2. Advanced practical organic chemistry, J. Mohan, Vol. I and II, Himalaya Publishing House, 1992.
3. An advanced course in practical chemistry, A. Ghoshal, B. Mahapatra and A. Kr. Nad, New central book agency, Calcutta, 2000.
4. Comprehensive practical organic chemistry: Qualitative analysis, V. K. Ahluwalia, S. Dhingra, Universities Press (India), 2000.
5. Elementary Practical Organic Chemistry-Vol. III quantitative Organic Analysis- A.I Vogel
6. Experimental Organic Chemistry- H.D. Durst & G.E. Goke (McGraw-Hill) 1980
7. Experimental Organic Chemistry- Vol. I & II- P.R. Singh, Tata McGraw-Hill, 1981.
8. Laboratory Experiments in Organic Chemistry-Adam, Johnson & Wicon (McMillan, London), 1979.
9. Practical organic chemistry (Quantitative analysis), B.B. Dey, M. V. Sitaraman and T. R. Govindachari, Allied Publishers, New Delhi, 1992.
10. Practical Organic Chemistry- IV Ed- Dey & Sitaraman (Allied)
11. Practical organic chemistry Vinaya Prabha Sharma, Pragati Edition

## KU09DSCCHE420-BIOINORGANIC CHEMISTRY

### Module 1

Introduction to Bioinorganic Chemistry, Distribution of elements in biological systems. Bulk, Essential, Trace and Ultra trace elements, Role of metal ions in biological functions. Biological role of some trace non-metals (B, Si, S, Se, As, Cl, Br, I), Elements of life: Water, sugars, polysaccharides, amino acids, peptides, proteins, nucleosides, nucleotides, nucleic acids, lipids and phosphates. Protein synthesis and DNA replication.

### Module 2

Iron in biological systems, Haemoglobin (Hb) and myoglobin (Mb), transport of oxygen by heme proteins, co-operativity of oxygen binding, reversible oxygen binding, binding of CO to Hb and Mb, Bohr effect, Hemerythrin, Storage and transport of metal ions: ferritin, transferrin, siderophores.

Copper in biological systems: ceruloplasmin, copper in oxidase activity, structure and functions of haemocyanin, azurin, plastocyanin, Type I, II and III copper protein models.

### Module 3

Metalloenzymes and metal activated enzymes, Zn(II) and Mg(II) containing enzymes, Iron enzymes, cytochromes and their roles in biological systems. and the mechanism of its activity. Enzymes containing Zn, Cu, Fe, Mn, Ni, Mo, W. (Carboxy peptidase, Carbonic anhydrase, alcohol dehydrogenase, Catalase, Peroxidase, Cytochrome P450, Urease, Nitrogenase etc.

Transport of ions across membranes: ionophores, active and passive transport, Na<sup>+</sup>/K<sup>+</sup> pump in biological system. Structural role of calcium, transport of calcium, intra and extra cellular calcium binding, role of calcium in blood clotting.

### Module 4

Diseases caused by excess and deficiency of metal ions, metals in medicine, metal ion based drugs (Pt, V and Au), metal ions as diagnostic agents, MRI imaging and contrast agents, toxicity due to non-essential elements and speciation. Chelation theory and chemotherapy, metal detoxification mechanism

Photosynthesis: Chlorophyl: PS I and PS II, Biological nitrogen fixation: nitrogenase, Fe-S clusters, Fe-protein structure, P-cluster and M-centre, nitrogenase model system.

### References

- 1 Inorganic Biochemistry, G.L. Eichhom(Ed), Vol. 1 and 2, Elsevier, 1973.
- 2 Biocoordination Chemistry, D. E. Fenton, (Chemistry Primer 26), Oxford Univ. Press,

- 1995.
- 3 Bioinorganic Chemistry, L. Bertini, H. B. Gray, S. J. Lippard, and J. S. Valentine, Univ. Science Books, 1994.
  - 4 Bioinorganic Chemistry, R.W. Hay, Ellis Harwood, 1984.
  - 5 Metal ions of Biological Systems, H. Siegel and T. G. Spiro, Marcel-Dekker, 1980.
  - 6 Principles of Biochemistry, A. L. Lehninger, D. L. Nelson and M. M. Cox, CBS Publishers and Distributors, 1993.
  - 7 Principles of Bioinorganic Chemistry, S. J. Lippard & J. M. Berg, Univ. Science Books.
  11. Metal in Biochemistry, P.M. Harrison and R.J. Hoare, Chapman and Hall, 1980.
  12. The Inorganic Chemistry of Biological Processes, M.N. Hughes, Wiley, 1981.
  13. Bioinorganic chemistry, Asim K. Das, Books & Allied (P) Ltd. 2013
  14. Bioinorganic and Supramolecular chemistry, P.S Kalsi and J.P Kalsi, Newage International Publishers, 2008.

### LIST OF MULTY DISCIPLINARY COURSES (MDC)

#### Understanding the Nanoworld

<b>Course Title</b>	: Understanding the Nanoworld
<b>Course Code</b>	: KU01MDCCHE101
<b>Course Type</b>	: MDC
<b>Course Credits</b>	: 3
<b>Pre-requisites</b>	: Basic awareness of concepts in physics and chemistry

#### **Course Objectives:**

- To acquire awareness on the importance of Nano-technology, Emergence of Nanoscience and technology and challenges in Nanotechnology.
- To gain understanding of physical chemical and mechanical properties of low dimensional systems.
- To understand the basic science required to know the fundamentals of nanostructures and their types.

Credits	TeachingHours	Assessment
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L/T	P/I	Total	L/T	P/I	Total	CE	ESE	Total
3	0	3	3	0	3	50	50	100

**Course Outcome:**

C 01	Explain the fundamentals and opportunities of Nanoscience and Nanotechnology.
C 02	Classify different types of nanostructures based on quantum confinement.
C 03	Interpret specific properties of nanomaterials in the nano-regime.
C 04	Explain the trends in properties of materials with variation in particle size.

**Mapping of Course Outcomes to POs/PSOs:**

	PSO1	PSO2	PSO3	PSO4	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1												
CO2												
CO3												
CO4												

**Module 1**

**15**

**hrs**

1.1. History of Nanotechnology, 1.2 Feynmann's vision on nanoscience & technology, 1.3 bulk vs nanomaterials. 1.4 Central importance of nanoscale morphology - small things making big differences, 1.5 nanotechnology as nature's technology, 1.6 clusters and magic numbers, 1.7 nanoscale architecture. 1.8 Recent developments, challenges and future prospects of nanomaterials.

**Module 2**

**15 hrs**

2.1 Size and shape dependent chemical properties- Melting points and lattice constants, Surface Tension, Wettability 2.2 density of states, 2.3 Specific Surface Area and Pore 2.4 Composite Structure, 2.5 Mechanical properties, 2.6 Optical properties: Surface plasmon resonance in metal nanoparticles and quantum size effect in in Semiconductors, 2.7 Electrical conductivity: Surface scattering, change of electronic structure, quantum transport, effect of microstructure, 2.8 Magnetic properties: superparamagnetism,

**Module 3**

**15 hrs**

3.1 Classification based on the dimensionality, 3.2 Zero-dimensional nanostructures: metal, semiconductor and oxide nanoparticles. 3.3 One-dimensional nanostructures: nanowires and nanorods, 3.4 Two-dimensional nanostructures: Thin films, 3.5 Three-dimensional nanomaterials, 3.6 Special Nanomaterials: Carbon fullerenes and carbon nanotubes, micro and mesoporous materials, core-shell structures, organic-inorganic hybrids.

**References**

1. G. Cao and Y.Wang, Nanostructures and Nanomaterials, 2nd Ed., Imperial College Press, 2004. 26
2. R. Kelsall , I.Hamley and M. Geoghegan, Nanoscale Science and Technology, Wiley, 2005.
3. K. J Klabunde, R. M. Richards, Nanoscale Materials in Chemistry, 2nd Ed., Wiley, 2009.
4. T. Pradeep, A text book of Nano Science and Technology, Tata McGraw-Hill Education, 2012. 5. G. Schmidt, Nanoparticles: from Theory to applications, Wiley-VCH, 2004

**Teaching Learning Strategies**

- ... Provide updated Lecture Sessions
- ... Promote Interactive Sessions including discussions and demonstrations.
- ... Provide experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding.
- ... Encourage students to ask questions during or after the lectures

**MODE OF TRANSACTION**

- ... Lectures, seminars, discussions, and demonstrations.

Assessment Rubrics			Total
End Semester Evaluation	External Test	50	50
Continuous Evaluation	Internal Exams	20	50
	Assignments	10	
	Seminar	10	
	Viva	10	

**Sample Questions to test Outcomes**

1. Show mathematically that the surface to volume ratio of nanoparticles is much higher than that of the bulk particle of the identical material?
2. Briefly explain the progress of Nanotechnology over years?
3. Give an account on the challenges associated with Nanotechnology as an emerging field?
4. How does the arrangement of nanostructures affect the wettability in leaves?

### **KU02MDCCHE102-Basic Biochemistry and Introduction to Biomolecules**

#### **Unit 1:**

**15 Hrs.**

Introduction to Biochemistry: The foundations and historic prospective of biochemistry Cellular and chemical foundations of life. Carbohydrates: Classification, preparation, properties and structure. Properties, structure and biological functions of mono, di, oligo and polysaccharides. Homopolysaccharides and Heteropolysaccharides.

#### **Unit 2:**

**15Hrs.**

Amino acids: Structure, classification and chemical reactions. peptide bond. Proteins. Biological importance, Forces stabilizing the structure of proteins. classification, general properties, primary structure, Secondary, tertiary and quaternary structures. Denaturation. Nucleic acids - Purine and Pyrimidines - structure and properties. Nucleosides. Nucleotides. DNA and RNA. Composition, structure, their biological importance, Comparison between DNA and RNA.

#### **Unit 3:**

**15Hrs.**

Lipids: Biological significance, classification. Structure, properties and functions- Fatty acids, triglycerides, waxes, terpenes, cholesterol and its derivatives. Compound lipids- Phosphoglycerides, sphingolipids and glycolipids

#### **Text Books:**

1. Biochemistry by N.Arumugam, Saras Publications, 3rd edition (2010)
2. Biochemistry by U.Sathyanarayana, Allied Books Publishers, 4th edition, 2007

#### **Reference Books:**

1. Biochemistry by Lubert Stryer, Free man Publishers Ltd, 5th edition (2002).
2. Biochemistry by Voet & Voet, Wiley Publications, 2nd Edition (2003)

## **KU03MDCCHE201- Basic Biochemistry and Introduction to Biomolecules**

### **Unit 1: 15 Hrs.**

Introduction to Biochemistry: The foundations and historic prospective of biochemistry Cellular and chemical foundations of life. Carbohydrates: Classification, preparation, properties and structure. Properties, structure and biological functions of mono, di, oligo and polysaccharides. Homopolysaccharides and Heteropolysaccharides.

### **Unit 2: 15Hrs.**

Amino acids: Structure, classification and chemical reactions. peptide bond. Proteins. Biological importance, Forces stabilizing the structure of proteins. classification, general properties, primary structure, Secondary, tertiary and quaternary structures. Denaturation. Nucleic acids - Purine and Pyrimidines - structure and properties. Nucleosides. Nucleotides. DNA and RNA. Composition, structure, their biological importance, Comparison between DNA and RNA.

### **Unit 3: 15Hrs.**

Lipids: Biological significance, classification. Structure, properties and functions- Fatty acids, triglycerides, waxes, terpenes, cholesterol and its derivatives. Compound lipids- Phosphoglycerides, sphingolipids and glycolipids

#### **Text Books:**

1. Biochemistry by N.Arumugam, Saras Publications, 3rd edition (2010)
2. Biochemistry by U.Sathyanarayana, Allied Books Publishers, 4th edition, 2007

#### **Reference Books:**

1. Biochemistry by Lubert Stryer, Free man Publishers Ltd, 5th edition (2002).
2. Biochemistry by Voet & Voet, Wiley Publications, 2nd Edition (2003)

## **LIST OF VALUE ADDED COURSE (VAC)**

### **KU03VACCHE202-Water Quality Analysis**

#### **Unit 1: 15 Hrs.**

**Water Quality Fundamentals:** Chemistry of water, Physical and chemical properties, Water resources, water pollution, impurities in water. Important water Quality parameters - Turbidity, colour, taste, pH, acidity, alkalinity, Salinity, chemical constituents-chlorides, nitrates, sulphates, fluoride. Hardness, types of hardness, causes of hardness, total hardness, unit of hardness, Degree of hardness, removal of temporary hardness, dissolved oxygen, BOD, COD. Winkler's method.



**Unit 2:****15Hrs.**

**Practical-I Laboratory tests for water quality monitoring:** Determination of pH, turbidity and conductivity, Test for acidity and alkalinity, Tests for chloride by Argentometric method, Nitrate by colorimetric method, Sulphate by gravimetric method, fluoride by colorimetric method.

**Unit 3:****15Hrs.**

**Practical-II:** Determination of hardness by EDTA method. TDS (Total dissolved solids) determination. Winkler's method for Dissolved oxygen (DO) analysis, Determination of BOD by Winkler's method, Determination of COD.

**References**

1. Droste, Ronald L. (1997). Theory and Practice of Water and Wastewater Treatment. New York, New York: John Wiley & Sons, Inc.
2. Methodology of water analysis; M.S. Kodarkar, IAAB Publication, Hyderabad
3. Engineering Chemistry, Wiley second edition (2013).
4. Principles and Practice of Analytical Chemistry- Fifeild and Kealey, Blackwell publishers (2000).
5. Cowan, P. A.; Porcella, D. B.; Adams, V. D.; and Gardner, L. A., "Water Quality Analysis Laboratory Procedures Syllabus" (1978).

**KU04VACCHE203- Food Adulteration****Module 1: Introduction to Food Chemistry**

Purpose of food, classification of food, Chemical composition of food: Carbohydrates, lipids, proteins, fiber, vitamins, and minerals, Need and methods of food adulteration, prevention of adulteration. Common foods subjected to adulteration, poisonous and non-poisonous Safe levels of additive uses. Preservation of processed foods. Effects of adulterations, Food hygiene, General impact on Human health, Food borne diseases and food poisoning

**Module II: Chemistry of Adulteration**

Adulteration – definition, types, Role of additives in processed foods. Examples of materials used for adulteration. Common methods of detection adulterants in food materials, Oil, grain, sugar, salt, spices and dairy, beverages, Processed food, sweetening agents. Highlights of Food Safety and Standards Act. Rules and procedures of local authorities, Consumer education and Quality control laboratories, Procedures to Complain and Penalties, Food regulation in the Indian and Global context.

### **Module III.Laboratory methods for Determination of Adulteration**

Determination of adulteration in edible oils. Iodine value, saponification value, UV spectroscopy. Refractive index. Adulteration in milk. Determination of density, fat content, total dry-extract, tests for presence of chemicals such as formaldehyde, sugar, etc. Turbidimetry, pH meter, Adulteration in powdered spices. Red lead salts/brick powder in chilli powder, yellow lead salts/ colored saw dust in turmeric powder.

#### **References**

1. A Laboratory Manual of Food Analysis, S. Sehgal, Wiley Publishers.
2. Food Safety and Standards Act, 2006. Bare ACT, November 2020, Commercial law publishers.
3. Food Safety, case studies–Ramesh.V.Bhat,NIN,1992
4. The Food Safety & Standards Act 2006, Virag Gupta, Commercial Law Publishers India Pvt Ltd.
5. Food Microbiology, Frazier and Westhoff, Tata McGraw Hill Publishers, New Delhi
6. Clinical Dietetics and Nutrition, Antia F P, 4th edition, 1997, Oxford university press, New Delhi.

### **LIST OF SKILL ENHANCEMENT COURSES (SEC)**

#### **KU04SECHE204-ANALYTICAL CHEMISTRY**

##### **Module 1 General Awareness On Laboratory Safety 15 Hours**

Handling And Storage Of Chemicals- Safe Laboratory Practice- Safety Symbols-First Aid In Laboratory; Swallowing Of Chemicals, Chemicals In The Eye, Chemical Spills, Inhalation Of Poisonous Gas, Faint And Shock.Errors In Chemical Analysis: Types Of Errors- Methods Of Minimizing Errors- Accuracy And Precision- Mean, Median And Standard Deviation- Significant Figures And Its Applications.

##### **Module 2 Volumetric Analysis 15 Hours**

Fundamental Concepts- Mole, Molarity, Molality, Mole Fraction, PPM And PPB- Primary And Secondary Standards- Different Types Of Indicators Used In Volumetric Analysis. Classification Of Titration Methods- Acid-Base Titration; Principles, Different Types Of Acid-Base Titration Curves And Acid- Base Indicators- Redox Titrations; Principles, Some Oxidizing Agents As Titrant And Redox Indicators-Complexometric Titration; Principle, EDTA Titrations, Titration Curves And Indicator.

**Module 3 Chromatography****15 Hours**

Principle Of Chromatographic Separations- Classification Of Chromatography- Thin Layer Chromatography- Column Chromatography- Paper Chromatography- Gas Chromatography- Ion Exchange Chromatography- Applications Of Chromatography.

**Module 4 Gravimetric Analysis****15 Hours**

Solubility And Solubility Product- Factors Affecting Solubilities Of Precipitates-- Precipitation Methods- Co-Precipitation And Post Precipitation- Washing And Ignition Of Precipitates- Role Of Organic Precipitants In Gravimetric Analysis- -Electrogravimetry.

**REFERENCE**

1. Principles of inorganic Chemistry – B.R Puri , L.R Sharma , Kalia
2. Fundamental of analytical Chemistry – D.A. Skoog, D.M. West and S.R. Crouch.
3. Vogel's Textbook of quantitative analysis.
4. Analytical chemistry – G.D. Christian.

**KU05SECCHE301- Safety Laboratory Practices****Unit 1:****15 hours**

General rule and protocols for lab safety measures, precaution and safety in handling of chemicals, laboratory tools, glass wares and instruments. Awareness of Material Safety Data Sheet (MSDS). Storage and handling of chemicals. Maintenance and cleaning of laboratories. Personal Protective and other safety equipment and their uses: Lab safety signs, various safety goggles, types of gloves, apron, masks, different filters for masks, face shield, full body suit, safety shoes. Eye wash fountains and safety showers.

**Unit 2:****15 Hours**

Simple first aids: Electric shocks, fire, cut by glass and inhalation of poisonous gases – Accidents due to acids and alkalis – Burns due to phenol and bromine. Disposal of sodium and broken mercury thermometer.

Fire extinguishers and their periodic inspection. First aid kit, its contents and need for monitoring. Emergency exit, its location and approach path. Spills, injuries, fires, building evacuations, emergencies. Fire drill and chemical accident drills. Accident recording and investigation for future controls.

**Unit 3:****15 hours**

Safe storage and use of hazardous chemicals. Waste Management: waste classification, hazardous waste, non-hazardous waste, mixed waste. Safe storage and disposal of chemical waste.

Preparation of standard solution and buffers.

Calibration of instruments: pH meter, balances, colorimeter, spectrophotometer, water bath, distillation assembly, burette, pipette etc.

### References

1. Guidelines for good laboratory practices-Indian council of medical research, New Delhi(2008)
2. Chemical Laboratory Safety and Security: A Guide to Prudent Chemical Management, Lisa Moran and Tina Masciangioli, Editors, The National Academies Press Washington,
3. Safety in Academic Chemical Laboratory, Vol. II, ACS Publication, 7th Edition (2003).
4. A Primer for Good Laboratory Practices and Good Manufacturing Practices, L. Huber, Agilent Technologies, 2002.
5. Handbook of Good Laboratory Practices, TDR, WHO, UNICEF, UNDP (2009).

