## SEMESTER-I
## COURSE 2: ADVANCES IN MATHEMATICAL, PHYSICALAND CHEMICAL SCIENCES

Theory Credits: 4 5 hrs/week

**Course Objective:**

The objective of this course is to provide students with an in-depth understanding of the recent advances and cutting-edge research in mathematical, physical, and chemical sciences. The course aims to broaden students' knowledge beyond the foundational concepts and expose them to the latest developments in these disciplines, fostering critical thinking, research skills, and the ability to contribute to scientific advancements.

**Learning outcomes:**

1. Explore the applications of mathematics in various fields of physics and chemistry, to understand how mathematical concepts are used to model and solve real-world problems.

2. To Explain the basic principles and concepts underlying a broad range of fundamental areas of physics and to Connect their knowledge of physics to everyday situations.

3. Understand the different sources of renewable energy and their generation processes and advances in nanomaterials and their properties, with a focus on quantum dots. To study the emerging field of quantum communication and its potential applications. To gain an understanding of the principles of biophysics in studying biological systems. Explore the properties and applications of shape memory materials.

3. Understand the principles and techniques used in computer-aided drug design and drug delivery systems, to understand the fabrication techniques and working principles of nanosensors. Explore the effects of chemical pollutants on ecosystems and human health.

4. Understand the interplay and connections between mathematics, physics, and chemistry in various advanced applications. Recognize how mathematical models and physical and chemical principles can be used to explain and predict phenomena in different contexts.

5 Understand and convert between different number systems, such as binary, octal, decimal, and hexadecimal. Differentiate between analog and digital signals and understand their characteristics. Gain knowledge of different types of transmission media, such as wired (e.g., copper cables, fiber optics) and wireless (e.g., radio waves, microwave, satellite).

### UNIT I: ADVANCES IN BASICS MATHEMATICS

**Straight Lines:** Different forms – Reduction of general equation into various forms – Point of intersection of two straight lines

**Limits and Differentiation:** Standard limits – Derivative of a function –Problems on product rule and quotient rule

**Integration:** Integration as a reverse process of differentiation – Basic methods of integration

**Matrices:** Types of matrices – Scalar multiple of a matrix – Multiplication of matrices – Transpose of a matrix and determinants

**UNIT II: ADVANCES IN PHYSICS:**

**Renewable energy**: Generation, energy storage, and energy-efficient materials and devices. **Recent advances in the field of nanotechnology**: Quantum dots, Quantum Communication- recent advances in biophysics- recent advances in medical physics- Shape Memory Materials.

**UNIT III: ADVANCES IN CHEMISTRY:**

Computer aided drug design and delivery, nano sensors, Chemical Biology, impact of chemical pollutants on ecosystems and human health, Dye removal - Catalysis method

**UNIT IV: ADVANCED APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY**

**Mathematical Modelling applications in physics and chemistry**

**Application of Renewable energy**: Grid Integration and Smart Grids,

**Application of nanotechnology**: Nanomedicine,

**Application of biophysics**: Biophysical Imaging, Biomechanics, Neurophysics,

**Application of medical physics**: Radiation Therapy, Nuclear medicine

Solid waste management, Environmental remediation- Green Technology, Water treatment.

**UNIT V: Advanced Applications of computer Science**

Number System-Binary, Octal, decimal, and Hexadecimal, Signals-Analog, Digital, Modem, Codec, Multiplexing, Transmission media, error detection and correction- Parity check and CRC, Networking devices- Repeater, hub, bridge, switch, router, gateway.

**Recommended books:**

1. Coordinate Geometry by S.L.Lony, Arihant Publications
2. Calculus by Thomas and Finny, Pearson Publications
3. Matrices by A.R.Vasishtha and A.K.Vasishtha, Krishna Prakashan Media(P)Ltd.
4. "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle
5. "Energy Storage: A Nontechnical Guide" by Richard Baxter
6. "Nanotechnology: Principles and Applications" by Sulabha K. Kulkarni and Raghvendra A. Bohara
7. "Biophysics: An Introduction" by Rodney Cotterill
8. "Medical Physics: Imaging" by James G. Webster
9. "Shape Memory Alloys: Properties and Applications" by Dimitris C. Lagoudas
10. Nano materials and applications by M.N.Borah
11. Environmental Chemistry by Anil.K.D.E.
12. Digital Logic Design by Morris Mano
13. Data Communication & Networking by Bahrouz Forouzan.

# STUDENT ACTIVITIES

## UNIT I: ADVANCES IN BASIC MATHEMATICS

1: Straight Lines Exploration

Provide students with a set of equations representing straight lines in different forms, such as slope-intercept form, point-slope form, or general form.

Students will explore the properties and characteristics of straight lines, including their slopes, intercepts, and point of intersection.

2: Limits and Differentiation Problem Solving

Students will apply the concept of limits to solve various problems using standard limits.

Encourage students to interpret the results and make connections to real-world applications, such as analyzing rates of change or optimizing functions.

3: Integration Exploration

Students will explore the concept of integration as a reverse process of differentiation and apply basic methods of integration, such as the product rule, substitution method, or integration by parts.

Students can discuss the significance of integration in various fields, such as physics and chemistry

4: Matrices Manipulation

Students will perform operations on matrices, including scalar multiplication, matrix multiplication, and matrix transpose.

Students can apply their knowledge of matrices to real-world applications, such as solving systems of equations or representing transformations in geometry.

## UNIT II: ADVANCES IN PHYSICS:

1: Case Studies

Provide students with real-world case studies related to renewable energy, nanotechnology, biophysics, medical physics, or shape memory materials.

Students will analyze the case studies, identify the challenges or problems presented, and propose innovative solutions based on the recent advances in the respective field. They will consider factors such as energy generation, energy storage, efficiency, sustainability, materials design, biomedical applications, or technological advancements.

2: Experimental Design

Assign students to design and conduct experiments related to one of the topics: renewable energy, nanotechnology, biophysics, medical physics, or shape memorymaterials.

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They will identify a specific research question or problem to investigate and design an experiment accordingly.

Students will collect and analyze data, interpret the results, and draw conclusions based on their findings.

They will discuss the implications of their experimental results in the context of recent advances in the field.

3: Group Discussion and Debate

Organize a group discussion or debate session where students will discuss the ethical, social, and environmental implications of the recent advances in renewable energy, nanotechnology, biophysics, medical physics, and shape memory materials.

Assign students specific roles, such as proponent, opponent, or moderator, and provide them with key points and arguments to support their positions.

**UNIT III: ADVANCES IN CHEMISTRY:**

1. Experimental Design and Simulation

In small groups, students will design experiments or simulations related to the assigned topic.

For example, in the context of computer-aided drug design, students could design a virtual screening experiment to identify potential drug candidates for a specific disease target.

For nano sensors, students could design an experiment to demonstrate the sensitivity and selectivity of nano sensors in detecting specific analytes.
Chemical biology-related activities could involve designing experiments to study enzyme-substrate interactions or molecular interactions in biological systems.
Students will perform their experiments or simulations, collect data, analyze the results,and draw conclusions based on their findings.

2. Case Studies and Discussion

Provide students with real-world case studies related to the impact of chemical pollutants oneco systems and human health.
Students will analyze the case studies, identify the sources and effects of chemical pollutants, and propose mitigation strategies to minimize their impact.

Encourage discussions on the ethical and environmental considerations when dealing with chemical pollutants.
For the dye removal using the catalysis method, students can explore case studies where catalytic processes are used to degrade or remove dyes from wastewater.

Students will discuss the principles of catalysis, the advantages and limitations of the catalysis method, and its applications in environmental remediation.
3: Group Project

Assign students to work in groups to develop a project related to one of the topics.

The project could involve designing a computer-aided drug delivery system, developing a nano sensor for a specific application, or proposing strategies to mitigate the impact of

chemical pollutants on ecosystems.
Students will develop a detailed project plan, conduct experiments or simulations,analyze data, and present their findings and recommendations.
Encourage creativity, critical thinking, and collaboration throughout the project.

**UNIT IV: ADVANCED APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY**

1: Mathematical Modelling Experiment

Provide students with a mathematical modelling experiment related to one of the topics. For example, in the context of renewable energy, students can develop a mathematical model to optimize the placement and configuration of solar panels in a solar farm.
Students will work in teams to design and conduct the experiment, collect data, and analyze the results using mathematical models and statistical techniques.
They will discuss the accuracy and limitations of their model, propose improvements, and interpret the implications of their findings in the context of renewable energy or the specific application area.

2: Case Studies and Group Discussions

Assign students to analyze case studies related to the applications of mathematical modelling in nanotechnology, biophysics, medical physics, solid waste management, environmental remediation, or water treatment.
Students will discuss the mathematical models and computational methods used in the case studies, analyze the outcomes, and evaluate the effectiveness of the modelling approach.
Encourage group discussions on the challenges, ethical considerations, and potential advancements in the field.

Students will present their findings and engage in critical discussions on the advantages and limitations of mathematical modelling in solving complex problems in these areas.

3. Group Project

Assign students to work in groups to develop a group project that integrates mathematical modelling with one of the application areas: renewable energy, nanotechnology, biophysics,medical physics, solid waste management, environmental remediation, or water treatment.

The project could involve developing a mathematical model to optimize the delivery of radiation therapy in medical physics or designing a mathematical model to optimize waste management practices.
Students will plan and execute their project, apply mathematical modelling techniques, analyze the results, and present their findings and recommendations.Encourage creativity, critical thinking, and collaboration throughout the project.

**UNIT V: Advanced Applications of computer Science**

Students must be able to convert numbers from other number system to binary number systems

1. Identify the networking media used for your college network
2. Identify all the networking devices used in your college premises.

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**Single Major B.Sc Computer Science (w.e.f:2023-24A.B)**

***Course – I & II Model Paper  Time: 3Hrs  (70 Marks)***

***SECTION A (Multiple Choice Questions)*** ***30 x 1 = 30 M***

***30 Multiple Choice Questions (Each Unit 6 Questions)***

***SECTION B (Fill in the blanks)*** ***10 x 1 = 10 M***

***10 Fill in the Blanks (Each Unit 2 Questions)***

***SECTION C (Very short answer questions)*** ***10 x 1 = 10 M***

***10 Very short answer questions (Each Unit 2 Questions)***

***SECTION D (Matching) (From 5 Units)*** ***2 x 5 = 10 M***

***1 A***
***B***
***C***
***D***
***E***

***2 A***
***B***
***C***
***D***
***E***

***SECTION E (True or False)*** ***10 x 1 = 10 M***

***10 True or False (Each Unit 2 Questions)***

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**Single Major (w.e.f. AY 2023-24)**
**SEMESTER-I**
**Model Paper**
***COURSE -2 ADVANCES OF MATHEMATICAL, PHYSICAL & CHEMICAL SCIENCES***
***Time: 3Hrs*** ***MAX MARKS: 70 M***

**I Multiple Choice Questions** **3x10=30M**

**SECTION – A**

1. The equation of the line passing through the point (1, 2) and perpendicular to the line x+y+1=0 is [ ]
   a) y-x+1=0 b) y-x-1=0 c) y-x+2=0 d) y-x-2=0
2. $\lim_{x \to 0} \frac{1-\cos 2x}{x^2}$ is equal to [ ]
   a) 0 b) 1 c) 2 d) 4
3. The derivative of $\cos^{-1}(2x^2-1)$ w.r.to $\cos^{-1}(x)$ is [ ]
   a) 2 b) $\frac{-1}{2\sqrt{1-x^2}}$ c) $\frac{2}{x}$ d) 1- $x^2$
4. $\int e^{\tan x} \sec^2 x \, dx$ = [ ]
   a) $e^{\tan x}$ b) $e^{\sin x}$ c) $\tan x$ d) sin x
5. If $2x+y=\begin{bmatrix} 1 & 0 \\ -3 & 2 \end{bmatrix}$ and $2x-y=\begin{bmatrix} 3 & 4 \\ -1 & 2 \end{bmatrix}$ then X is equal to [ ]
   a) $\begin{bmatrix} 4 & 4 \\ -4 & 4 \end{bmatrix}$ b) $\begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$ c) $\begin{bmatrix} -1 & -2 \\ -1 & 0 \end{bmatrix}$ d) None of these
6. If $A=[aij]_{mxn}$ such that aij = 0 for $i \neq j$ then A is [ ]
   a) a row matrix b) a column matrix
   c) a diagonal matrix d) a scalar matrix
7. Which of the following is an renewable energy source [ ]
   a) Coal b) Natural gas c) Solar d) Nuclear
8. What is the main purpose of Photovoltaic cells in solar panels [ ]
   a) Heat generation b) Electricity generation c) Water purification d) Carbon captune
9. Which renewable energy source is harnessed from the earth's Internal heat? [ ]
   a) Solar b) Wind c) Geothermal d) Hydro
10. What is the fundamental principle behind quantum mechanics [ ]
    a) Classical Mechanics b) Quantum Superposition c) Newton law of motion d) Maxwell's equation
11. What is the primary application of proton therapy in medical physics? [ ]
    a) Diagnostic Imaging b) Radiation therapy c) Magnetic resonance Imaging
    d) Computed Tomography (C.T)
12. What is the primary advantage of using quantum dob in solar cells? [ ]
    a) Low cost b) High efficiency
    c) Fast charging d) Large size
13. The Binding capacity between the drug and target is known as [ ]
    a) Virtual Screening b) Docking Score c) ADMET d) None
14. The Increased sensitivity of Nanosensors is due to [ ]
    a) High Surface-to-volume ratio b) Low surface-to-volume ratio
15. The green pigment chlorophyll is affected by [ ]
    a) $Co_2$ b) $No_2$ c) $So_2$ d) $CH_4$

16. What is the Photo catalyst used in the dye renoval catalysis method [ ]

a) Oxygen b) Hydrogen c) Titanium Oxide d) Zinc

17. Which phase of Shape memory alloy occurs at higher temperature & has a needle – like structure [ ]

a) Martensite b) Austenite c) Hysterisis d) None

18. The Pollutant causing Global warming [ ]

a) $Co_2$ b) $So_2$ c) $No_2$ d) $O_3$

19. In Quantum mechanics, the Schrodinger Equation is a fundamental Equation, used to model the behavior of particles. What does the Schrodinger Equation describe [ ]

a) Stability b) Wave-Particle duality
c) Degidity d) Massive

20. What is the term used to describe the process of using nano particles to enhance imaging techniques for medical diagnostics [ ]

a) Nano Scopy b) Nano Therapy c) Nano Diagnose d) None of these

21. How can nano medicine contribute to personalized medicine? [ ]

a) By increasing the cost of medical treatment.
b) By using a one-size –fits all approach.
c) By tailoring based on an individual's genetic make-up.
d) By avoiding the use of advanced technologies.

22. In radiation therapy, What does the term "brancy therapy" refer to [ ]

a) External beam radiation therapy
b) Radiation therapy using photons
c) Internal radiation therapy involving the placement of radio active sources directly within or close to the tumor.
d) Radiation therapy without the use of imaging.

23. What is the purpose of coagulation in the water treatment process? [ ]

a) Removing dissolved minerals
b) Disinteching water
c) Settling suspended particals
d) Adjusting PH levels

24. What is the purpose of green building design and construction? [ ]

a) maximizing energy consumption
b) minimizing the use of sustainable materials
c) Reducing the environmental impact of buildings
d) Ignoring energy – efficient technologies

25. Hybrid system combine which two types of signals? [ ]

a) Analog and Analog b) Digital and Digital c) Analog and Digital d) Continuous and Finite

26. Which error detection technique can detect a wide range of errors including burst errors and most multiple bits.

a) Hamming code b) Read- Solomon code c) Parity check d) CRC

27. Which layer of the OSI model does a router operate at [ ]

a) Transport layer b) Network layer c) Transport layer d) Data link layer

28. What technology allows DSL modems to separate voice and data signals.

a) Dail-up modem b) DSL modem c) Wireless modem d) Cable modem

Ans b) DSL modem

29. What protocol do bridges use to prevent network loops? [ ]

a) Internet Protocol b) Transmission Control Protocol (TCP)
c) Simple Network Management Protocol (SNMP) d) Spanning Tree Protocol (STP)

30. The……. between two words is the number of difference between corresponding bits

a) Hamming code b) Hamming distance [ ]
c) Hamming rule d) Hamming data

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## SECTION – B

**III Fill in the Blanks** **10x1=10M**

1. Tidal energy is an Example for_____energy.
2. _____are the particles used in quantum dots.
3. Expand CADD _____
4. First step in the purification of water _____
5. _____is an application for Medical Physics.
6. MRI stands for _____
7. $\int e^x \sin x \cos x dx =$_____.
8. Equation of the lines through the point (3, 2) and making an angle of 45° with the line x-2y = 3 are _____.
9. A computer understands only .....code
10. converts audio and video into digital information

## SECTION – C

**III Answer the following Questions** **10x1=10M**

1. Give some Examples for renewable sources?
2. Information stored in quantum computer in the form of?
3. What is the difference between MRI and C.T. Scan?
4. Name two applications of Nanotechnology?
5. Solid waste Management? (SWM)
6. Expand ADMET
7. $\lim_{x \to 0} \frac{ax + x\cos x}{b\sin x}$; Evaluate
8. Evaluate $\int x(\log x)^2 dx$
9. What are the key design issues of the computer networks?
10. What is multiplexing?

## SECTION – D

**III Match the following** **10x1=10M**

1. A. Wind energy ( ) a) Orthodontic applications
   B. Solar energy ( ) b) Non invasile imaging
   C. Minamata ( ) c) Harness the kinetic energy of wind to produce electricity
   D. Ni-Ti wire ( ) d) Convert sunlight into electricity
   E. Magnetic Resonance Imaging ( ) e) Mercury
2. A. Fluoroscene microscopy ( ) a) 3
   B. $\begin{bmatrix} 3 & -4 \\ m & 5 \end{bmatrix} = 3$ then m value is ( ) b) Moniterity cellular
   C. $\frac{d}{dx}[\log(\sec x + \tan x)]$ ( ) c) F1
   D. 1111000l ( ) d) Guided media
   E. Ethernet cable ( ) e) (secx)

## SECTION – E

**IV True (or) False** **10x1=10M**

1. Quantum dots are the nano particles, are primarily used for structural Reintor cement in medical implants?
2. Quantum mechanics is a branch of physics Extensively used mathematical Models, to describe the behavior of particles at atomic and subatomic level.
3. The Mass of a body is equivalent to the ratio of the force action on it to the acceleration it generates.
4. The region of the atmosphere above troposphere is known as Lithosphere.
5. Essential Amino acids can be synthesized by the human body
6. Electrons fill the lowest energy levels first
7. The equation of a line with slope m and making an intercept c on y axis is y=mx
8. Intercept form of a line which cuts a and b respectively on the x and y axis

   Then $\frac{x}{a}+\frac{y}{b}=1$
9. A university would use a CAN to converts its composes in two cities.
10. Gateway device is operate at transport layer.