A three-year Under-Graduate Programme in

B. Sc. (Blended) Physics

Offered By
Centre for International Affairs (CIA), Bharathiar University

in collaboration with The University of Melbourne
(For the students admitted during the academic year 2023 – 24 onwards)

Syllabus for SEM I – VI

(To Be Implemented from Academic Year 2023 – 2024)

Overview of the B. Sc. (Blended) Course

Bharathiar University is offering an innovative Bachelor's Degree known as B.Sc. (Blended) in collaboration with the University of Melbourne (UoM), Australia, to strengthen science education at the undergraduate level.

Bharathiar University is among the top universities in the country and has been at the forefront of initiating innovative programs. The UoM is ranked #1 in Australia and has been among the top 50 universities in the world.

The B.Sc. (Blended) course is a joint initiative of BU-UoM, offering a transparent and internationally recognized bachelor's degree that clearly outlines the teaching objectives and learning outcomes. In the first two years of the degree program, students will study all four basic sciences (Biology, Chemistry, Mathematics, and Physics), and in the third year, they will specialize in either Physics or Chemistry. The UoM will provide support in terms of special lectures, workshops, and quality assurance.

The B.Sc. (Blended) course aims to achieve the following objectives:

- Introduce students to the fundamental concepts of science education.
- Enrich students' knowledge in all basic sciences, including Biology, Chemistry, Mathematics, and Physics.
- Help students develop an interdisciplinary approach to learning that integrates various scientific fields.
- Inculcate a sense of scientific responsibility, social awareness, and environmental consciousness in students.
- Assist students in building a successful and progressive career in academia and industry by providing them with the necessary skills and knowledge.

The B.Sc. (Blended) course will be jointly conducted by Bharathiar University and the University of Melbourne (UoM).

The following features are included in the course:

- Special lectures will be delivered by expert faculty from UoM.
- The course will be quality assured by UoM, ensuring that it meets the highest standards of education.
- Upon completion, the degree will be considered equivalent to a degree from UoM, enabling students to pursue higher studies at UoM or any other Australian university.
- The collaboration with UoM ensures that students receive an internationally recognized education of the highest quality, opening up opportunities for further academic pursuits and careers in various fields. The students will be imparted solid training to enable them to pursue Masters and Integrated Ph. D. degrees in reputed institutes such as IITs, IISERs and Central Universities

Eligibility

Higher Secondary School Certificate (10+2) or its equivalent Examination in Science stream with either PCM group (Physics, Chemistry & Mathematics) or PCMB group (Physics Chemistry, Mathematics & Biology)

Course Structure

- The B.Sc. (Blended) course follows a semester and credit system that spans over six semesters of 14-16 weeks each. The course curriculum is divided into two phases: the first two years and the third year.

- During the first two years, students will receive instruction in the four basic sciences, namely Biology, Chemistry, Mathematics, and Physics. In the third year, students will specialize in either Physics or Chemistry.

- The curriculum is designed to provide students with a well-rounded education in the sciences, preparing them for further academic pursuits or careers in various scientific fields.

Examination and Grading

- The B.Sc. (Blended) course follows a credit-based system, and its examination process comprises two parts: continuous assessment (internal 50%) and end-semester examination (50%).

- The internal assessment will be based on various parameters, including classroom examinations (subjective/objective), fieldwork, viva-voce, assignments, lab work, tutorials, and group discussions. The grading will be carried out in accordance with the university norms applicable to the credit system.

- This examination process ensures that students are regularly assessed and evaluated based on their academic performance, facilitating a more comprehensive understanding of the subjects and enhancing the overall learning experience. The grading will be as per the university norms applicable to credit system.

University Terms

- The commencement and conclusion dates for the odd and even semesters of the B.Sc. (Blended) course will adhere to the university regulations applicable to other departments.

- To be eligible for the term-end examination, students must fulfill the minimum attendance requirement of 75 percent for both theory and practical courses. Additionally, students must demonstrate satisfactory performance during the term.

- Adherence to these guidelines ensures that students attend classes regularly and maintain consistent academic performance throughout the term. This, in turn, promotes a positive and conducive learning environment for all students.

Intake capacity of student: B. Sc. Blended course: 40 (20 for Physics and 20 for Chemistry)

Duration: The duration of **B. Sc. (Blended)** Degree Program shall be of three years.

Medium of Instruction: The medium of instruction for the course shall be English.

Scheme of Examinations (CBCS Pattern)

Number of weeks in a semester: 14-16 (excluding holidays and one week mid semester examination)

Nomenclature: BIO: Biology. CHM: Chemistry. MTH: Mathematics PHY: Physics ENG: English; COMP –Computing; IDC: Interdisciplinary Course; FLX: Flexible timetabling

1 Credit =1 Contact hour per week both for theory and lab courses

Course Code	Title of the Course	Credits	Hours		Maximum Marks		
			Theory	Practical	CIA	ESE	Total
FIRST SEMESTER							
MTH101	**Maths 1: Calculus**	**4**	**4**	**-**	**50**	**50**	**100**
PHY101	**Physics 1: Introductory Classical Physics**	**4**	**4**	**-**	**50**	**50**	**100**
CHM101	**Chemistry 1: Introductory and Organic Chemistry**	**4**	**4**	**-**	**50**	**50**	**100**
BIO101	**Biology 1: The Diversity of Life**	**4**	**4**	**-**	**50**	**50**	**100**
PHY102	**Physics Practical**	**2**	**-**	**2**	**25**	**25**	**50**
CHM102	**Chemistry Practical**	**2**	**-**	**2**	**25**	**25**	**50**
BIO102	**Biology Practical**	**2**	**-**	**2**	**25**	**25**	**50**
11T/11H/11M (FLX101*)	Part I: Language Paper I- Tamil/Malayalam/French/ Hindi	4	4	-	50	50	100
12E (FLX102**)	Part II: English I	4	4	-	50	50	100
1FA#	Foundation Course: Environmental Studies	2	2	-		50	50
	Total	32	26	6	375	425	800
** **and** ** indicates the mandatory language papers for all UG students as per the TN state government. **#** indicates the UGC mandatory course that all students must opt for. This course will be taught either in online mode or offline mode.*							
SECOND SEMESTER							
MTH201	**Maths 2: Algebra**	**4**	**4**	**-**	**50**	**50**	**100**
PHY201	**Physics 2: Modern Physics**	**4**	**4**	**-**	**50**	**50**	**100**
CHM201	**Chemistry 2: Inorganic and Physical Chemistry**	**4**	**4**	**-**	**50**	**50**	**100**
BIO201	**Biology 2: Biology of Cells**	**4**	**4**		**50**	**50**	**100**
PHY202	**Physics Practical**	**2**	**-**	**2**	**25**	**25**	**50**
CHM202	**Chemistry Practical**	**2**	**-**	**2**	**25**	**25**	**50**
BIO202	**Biology Practical**	**2**	**-**	**2**	**25**	**25**	**50**
IDC201	**Scientific Computation and**	**4**	**4**	**-**	**50**	**50**	**100**

	Modeling: Introduction to simple models and programming						
21T/21H/21M (FLX201*)	Part I: Language Paper II- Tamil/Malayalam/French/ Hindi	4	4	-	50	50	100
22E (FLX202**)	Part II: English II	4	4	-	50	50	100
2FB#	Foundation Course: Human Rights	2	2	-		50	50
	Total	36	30	6	425	475	900

** **and** ** indicates the mandatory language papers for all UG students as per the TN state government.*
***#** indicates the UGC mandatory course that all students must opt for. This course will be taught either in online mode or offline mode.*

THIRD SEMESTER							
MTH301	Maths 3: Vector Calculus, and Differential Equations	4	4	-	**50**	**50**	100
PHY301	Physics 3: Quantum mechanics and Thermodynamics	4	4	-	**50**	**50**	100
CHM301	Chemistry 3: Reactions and Synthesis	4	4	-	**50**	**50**	100
BIO301	Biology 3: Functional Biology of Organisms	4	4	-	**50**	**50**	100
PHY302	Physics Practical	2	-	2	25	25	50
CHM302	Chemistry Practical	2	-	2	25	25	50
BIO302	Biology Practical	2	-	2	25	25	50
IDC301	Scientific Computation and Modeling: Projects	2	-	2	25	25	50
31T/31H/ 31M	Part I: Language Paper III- Tamil/Malayalam/French/ Hindi	4	4	-	50	50	100
32E	Part II: English III	4	4	-	50	50	100
3FC#	Value added 3/Foundation Course: Yoga for Human Excellence	2	2	-		50	50
	Total	34	26	8	400	450	850

** **and** ** indicates the mandatory language papers for all UG students as per the TN state government.*
***#** indicates the UGC mandatory course that all students must opt for. This course will be taught either in online mode or offline mode.*

FOURTH SEMESTER							
MTH401	Maths 4: Probability and Statistics	4	4	-	50	50	100
PHY401	Physics 4: Electricity, magnetism, Special Relativity and Optics	4	4	-	50	50	100
CHM401	Chemistry 4: Structure and properties	4	4	-	50	50	100
BIO401	Biology 4: Genetics Evolution and Ecology	4	4	-	50	50	100
PHY402	Physics Practical	2	-	2	25	25	50
CHM 402	Chemistry Practical	2	-	2	25	25	50
BIO402	Biology Practical	2	-	2	25	25	50
41T/41H/ 41M	Part I: Language Paper IV- Tamil/Malayalam/French/ Hindi	4	4	-	50	50	100
42E	Flexible timetabling Part II: English IV	4	4	-	50	50	100
4FC#	Value added 4/Foundation Course: General Awareness	2	2	-	-	50	50
	Total	32	26	6	375	425	800

** **and** ** indicates the mandatory language papers for all UG students as per the TN state government.*

***#** indicates the UGC mandatory course that all students must opt for. This course will be taught either in online mode or offline mode.*

FIFTH SEMESTER							
PHY 501	Classical Mechanics	4	4	-	50	50	100
PHY 502	Quantum Mechanics	4	4	-	50	50	100
PHY 503	Solid State Physics	4	4	-	50	50	100
PHY 504	Electrodynamics	4	4		50	50	100
PHY 505	Elective – 1: Introduction to Astrophysics	2	2	-	25	25	50
PHY 506	Elective – 2: Nanotechnology	2	2	-	25	25	50
PHY 507	Physics Lab I	2	-	2	25	25	50
PHY 508	Physics Lab II(analog and digital)	2	-	2	25	25	50
	Graduate Level Thesis	2	-	2	25	25	50

PHY 509							
Total		26	20	6	325	325	650
SIXTH SEMESTER							
PHY 601	Statistical Mechanics	4	4	-	50	50	100
PHY 602	Subatomic Physics	4	4	-	50	50	100
PHY 603	Atomic and Molecular Spectroscopy and Lasers	4	4	-	50	50	100
PHY 604	Digital and analog electronics	4	4	-	50	50	100
PHY 605	Elective - 3: Renewable Energy and Energy Harvesting	2	2	-	25	25	50
PHY 606	Elective - 4: Introductory Biophysics	2	2	-	25	25	50
PHY 607	Physics Lab I	2	-	2	25	25	50
PHY 608	Physics Lab II (analog and digital)	2	-	2	25	25	50
PHY 609	Graduate Level Thesis	2	-	2	25	25	50
Total		26	20	6	325	325	650
Grand Total		**186**	148	38	2225	2425	**4650**

SEMESTER I

Course code	MTH101	Maths-1	4 Credits	
Core/Elective/SBS		CORE PAPER		
			Syllabus Version	2023-24

Unit-1:Logic and Proof

Basic set theory(review)
Logical connectives (conjunction, disjunction, negation, conditional, bi-conditional)and truth tables
Propositional logic, logical equivalence, logical laws
Quantifiers, predicate calculus
Relations, equivalence relations, ordering
Functions including injective, surjective, bijective, inverse, composition

Unit-2:

Number systems: Natural numbers, integers, rational numbers and their
Properties(eg. closure under addition/multiplication/division; existence of additive/multiplicative identity/inverses)
Real numbers and their properties; completeness property
Proof methods: direct proof, Contrapositive
Proof methods: contradiction, proof by cases
Proof methods: induction
Natural numbers, integers, rational numbers
Real numbers

Unit-3: Sequences and series

Sequences, limits, convergence and divergence
Proving limits using definition
Methods for evaluating limits: standard limits, limit theorems, continuity rule, sandwich theorem
Series, convergence and divergence of series, geometric series, harmoni cp-series
Series convergence tests: divergence test, comparison test
Series convergence tests: ratio test, integral test, alternating series test
Power series, Taylor polynomials
Taylor series
Taylor's theorem, error in Taylor polynomial estimates

Unit-4: Differential calculus& Integral Calculus

Review of differential calculus: limits, derivative, differentiation rules incl. polynomials, trigonometric, exponential, log functions; product, quotient, chain rules
Review of inverse trigonometric functions and their derivatives, implicit differentiation
Integral calculus
Riemann integration
Fundamental Theorem of Calculus; review of standard anti-derivatives
Techniques of integration(review): derivative present substitution, linear substitution

Unit-5

Techniques of integration (review): integration of trigonometric functions
Using identities
Techniques of integration (review): integration of rational functions
Including partial fractions, integration yielding inverse trig functions

Techniques of integration (review): trigono metric substitutions; Integration by parts Improper integrals Applications of integration: areas between curves Applications of integration: volumes of surfaces of revolution Ordinarydifferentialequations:definitionofODE,order,generalsolution,initialconditions;separable ODEs Solving linear ODE using integrating factor Particular solutions of in homogeneous constant coefficient linear ODEs Using method of undetermined coefficients; principle of superposition
Reference Books
Discrete Mathematics and Its Applications with Combinatorics and Graph Theory (SIE) (7th Edition) by Kenneth Rosen. Publisher: McGraw Hill Education; Year: 2017; ISBN-13: 978-0070681880, 998 pp. Mathematical Proofs: A Transition to Advanced Mathematics (Featured Titles for Transition to Advanced Mathematics) by Gary Chartr and, Albert D. Polimeni, Ping Zhang. Publisher: Pearson; Year: 2012; ISBN-13: 978-0321797094; 424 pp. Calculus by James Stewart. Publisher: Cengage Learning; Year: 2015; ISBN-13: 978-1285740621; 1392 pages Calculus: Concepts and Contexts, by James Stewart. Publisher : Brooks/Cole; Year: 2015; ISBN-13 : 978-1337687669; 1152 pages. Calculus: A Complete Course by Robert Adams, Christopher Essex. Publisher : Pearson; 9th edition; Year: 2015; ISBN-13 : 978-0134154367; 1168 pages.

Course code	**PHY101**	**Physics 1: Introductory Physics**	**4 Credits**

Core/Elective/SBS	CORE PAPER		
		Syllabus Version	2023-24

Unit:1	Classical Mechanics	

Straight line motion – Vectors – Two and three dimensional motion – Force and Motion : Newton's Laws – Force and Motion : Drag and Friction – Kinetic energy, work, power – Potential energy, conservation of energy – Collisions and momentum – Rotational motion – Angular momentum-I – Angular momentum-II

Unit:2	Gravitation	

Newton's law of gravity – superposition – Gravity at the earth's surface – far above the earth and within the earth – Work and gravitational potential energy - Kepler's laws : the planets and satellites – Orbital motion and energy – Einstein, the equivalence principle, gravity, gravitational lenses, gravitational waves

Unit:3	Thermal physics	

Zeroth Law of Thermodynamics – Thermal expansion and absorption of heat – Heat transfer, conduction, emission, absorption

Unit:4	Elasticity, fluids and gases	

Equilibrium and elasticity – Density and Pressure, Pascal's and Archimedes' Principles – Continuity and Bernoulli's Equation – Ideal gases (Kinetic theory of gases) – Mean free path, molecular speed distribution – Specific heat, adiabatic expansion – Real world examples – examples: wind power, hydro, blood circulation, water in plants, materials, osmosis, wind and atmosphere

Unit:5	ODEs	

Applications of 2^{nd} order ODEs: Springs – Applications of 2^{nd} order ODEs: LRC series electrical circuits – Real world contextual examples in physics and application of ODEs

TextBook(s)

1	Properties of Matter, Brijlal and N.Subrahmanyam,3rdEdition, S.Chand & Co.(2005).
2	Heat & Thermodynamics, Brijlal & N.Subramaniam, S.Chand & Co(2007)

Reference Books

1	Elements of Properties of Matter, D.S.Mathur, 11thEdition, S.Chand &Co.,(2010).
2	Heat and Thermodynamics–Zemansky and R.H.Dcltanann,TMH (2017)

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.,]

1	https://www.physicstutoronline.co.uk/alevelphysicsnotes/
2	https://latestcontents.com/bsc-physics-mechanics-notes/
3	https://www.askiitians.com/revision-notes/physics/thermodynamics/
4	www.khanacademy.org/science/physics/elasticity/surfacetension

Course Code	CHM101	GENERAL CHEMISTRY – CHEMISTRY OF LIFE	4 Credits	
CORE		Chemistry 1		
			Syllabus Version	2023-2024

UNIT I	General Chemistry	

The Periodic Table - The Basis of the Periodic System, Classifications of Elements and Groups - Molecular Structure and Bonding - Chemical Bonding, Types of Chemical Bonds, Bond Characteristics - Acids and Bases - Theories of Acids and Bases, pH of Acids and Bases, Properties of Acids and Bases - Stoichiometry - Stoichiometric Coefficient, Balanced Reactions and Mole Ratios

UNIT II	Organic Chemistry	

Carbon - The Basis of Life - Structure and Bonding Alkanes - Alkanes Formula and its Condensed Structures, Branched Chain Alkane Formula, sp^3Hybridisation - Structure and Bonding Alkenes - sp^2Hybridisation - Benzene and its derivatives - Structure and Bonding of Alkynes - sp hybridization

UNIT III	Organic Chemistry	

Functional Groups - Nomenclature of Common Functional Groups -Electrophiles and Nucleophiles - Nucleophilic Substitution Reactions - Elimination Reactions - Addition Reactions - Electrophilic Aromatic Substitution Reactions - Nucleophilic Addition Reactions - Organic Redox Reactions

UNIT IV	Physical Chemistry	

First Law of Thermodynamics-Adiabatic processes, Constant Volume Processes, Enthalpy, Cyclical Processes, Free Expansions - Second Law of Thermodynamics - Irreversible Processes, Entropy, Free Energy, Real world Examples - Solar Energy, Geothermal, Wind Power

UNIT V	Applications of ODEs	

Applications of 1st Order ODEs: Ecology Models - Applications of 1st Order ODEs: Chemical Reaction Rates, Newton's Law of Cooling - Second-Order ODEs: Definitions of Homogeneous/Inhomogeneous, Linear/Non-linear ODEs -Solution of Homogeneous Constant-Coefficient Linear ODEs.

Text Book(s)

1	Principles of Physical Chemistry, B.R. Puri, L.R. Sharma, S.Chand& Co.
2	Inorganic Chemistry, P. L. Soni, Sultan Chand & Sons.
3	A Textbook of Organic Chemistry, Arun Bahl, B.S. Bahl, S.Chand& Co.

4	Organic Chemistry, Vol. 1, 2 & 3, S. M. Mughergee, S.P. Singh, R.P. Kapoor, Wiley Eastern.
Reference Books	
1	Advanced Organic Chemistry, B.S. Bahl, Arunbahl, S.Chand & Co.
2	Essentials of Physical Chemistry, B.S. Bahl and G.D. Tuli, S.Chand & Co.
3	Text book of Physical Chemistry, P.L.Soni, D.B. Dharmarke, S.Chand & Co.
4	Ordinary Differential Equations with Applications, Sze-Bi Hsu, World Scientific Publishing Co. Pte. Ltd
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://chem.libretexts.org/
2	https://byjus.com/chemistry/
3	https://openstax.org/details/books/chemistry-2e

Course code	**BIO101**	**Biology 1: Diversity of Biology**	**4 Credits**

Core/Elective/SBS	CORE PAPER		
		Syllabus Version	2023-24

Unit:1	Origin of life	
Theory of Evolution: Understanding Life's diversity – Evolutionary relationships (phylogenies) classifications – Chemical evolution of life – Molecules to cells– Cell theory and the origin of life		
Unit:2	**Prokaryotes and Eukaryotic Origin**	
Prokaryotic Cells: Bacteria and Archaea –Evolution of the eukaryotic cell – Endosymbiosis – Protists 1 – Red and Green algae- Protists 2 – Chromists –Protists 3 – Dinoflagellates and apicomplexans, flagellates, ciliates, amoebae		
Unit:3	**Multicellularity and Kingdom Fungi**	
Evolution of sex, life cycles – Origins of multicellularity –Slime moulds and fungi –Fungi 2		
Unit:4	**Kingdom Plantae**	
Introduction to Land Plants –Bryophytes – Evolution of vascular tissue, Lycophytes, fern allies, early fossil land plants –Seed plants, the seed and secondary growth, Cycads and Ginkgo – Conifer diversity and biology –Angiosperm structure, biology and diversity, the flower, double fertilization –Angiosperm phylogeny and evolution		
Unit:5	**Metazoa**	
Introduction to animals (Metazoa)- Simple animals – Protostomes Flatworms and annelids, - Molluscs, Arthropods, Deuterostomes, Echinoderms-Chordates, Fishes–sharks/rays, teleosts, coelacanth, lungfish–Amphibians, Reptiles, Birds, Mammals, The Primate story		

TextBook(s)

1	Evolution, Strickberger. Fifth Edition, Jones and Bartlett Publishers, Inc (2013).
2	Biology,P.H. Raven, G.B. Johnson, K.A. Mason, L. Jonathan, T. Duncan, Twelfth Edition, McGraw Hill (2019)

ReferenceBooks

1	Campbell Biology, L. Urry, M. Cain, S. Wasserman , P. Minorsky, J. Reece11thEdition,Pearson,(2017).

2	Evolution, Douglas Futuyma, Mark Kirkpatrick, 4th edition, Sinauer, 2017
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.,]	
1	**https://www.easybiologyclass.com/chemical-evolution-theory-biochemical-origin-of-life-short-lecture-notes/**
2	**https://bio.libretexts.org/Introductory_and_General_Biology/ Diversity_of_Microbes_Fungi_and_Protists**
3	**https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/ _Diversity_of_Plants**
4	https://www.khanacademy.org/science/biology-india/ animal-kingdom

Course code	**PHY102**	**PHYSICS PRACTICAL 1**	**2 Credits**	
Core/Elective/SBS		**CORE PRACTICAL**		
			Syllabus Version	**2023-24**

LIST OF EXPERIMENTS

1. 2. Simple Pendulum: To plot a L-T^2 graph using a simple pendulum and find the effective length of the simple pendulum for a given time period using the graph.
3. To calculate the acceleration due to gravity at a place.
4. Torsional Pendulum**:** To find the moment of inertia of the disc and the rigidity modulus of the material of the suspension wire subjected to torsional oscillations.
5. Young's Modulus: To determine the Young's modulus of elasticity of the material of a given wire using Searle's apparatus.
6. Spring: To determine the restoring force per unit extension of a spiral spring by statistical and dynamical methods and also to determine the mass of the spring.
7. Euler's Method: To determine the coefficient of friction by Euler's Method.
8. Viscosity: To determine Coefficient of Viscosity by Stoke's Method.

Reference Books

1	AtextbookofpracticalPhysics,M.N.Srinivasan,S.Balasubramanian,R.Ranganathan,Sultan Chand & Sons (2017)
2	PracticalPhysicsandElectronics,C.C.Ouseph,U.J.Rao,V.Vijayendran,S.Viswanathan Publishers (2007)

Related Online Contents[MOOC, SWAYAM, NPTEL, Websites etc.]

https://nptel.ac.in/course.html/physics/experimentalphysicsI,IIandIII

https://nptel.ac.in/courses/115/105/115105110/

https://www.youtube.com/playlist?list=PLuiPz6iU5SQ8-rZn_LgLofRX7n8z4tHYK

Course Code	CHM102	CHEMISTRY PRACTICAL 1	2 Credits	
Core/Elective/SBS		CORE PRACTICAL		
			Syllabus Version	2023-24

List of Experiments

List of Physical chemistry experiments (Any 2)

1. To determine the rate constant of the hydrolysis of Ethyl acetate using an acid catalyst.
2. Molar mass determination of some base metals, gases.
3. Determination of dissociation constant of a weak acid.
4. Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known substance.
5. Calculation of the enthalpy of ionization of ethanoic acid.

List of Inorganic chemistry experiments (Any 2)

Basic Analytical Terms: Volumetric and Gravimetric analysis, Titration, Types of titration viz. acid base, redox, iodometric, iodometric and complexometric titrations, Types of indicators, Selection of indicator, Aquametry (Karl-Fisher titration)

1. Oxalate Complexes of Aluminum and Chromium.
2. Estimation of Fe (II) with $K_2Cr_2O_7$ using internal external (diphenylamine, anthranilic acid) and external indicator.
3. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
4. Estimation of Fe (II) and oxalic acid using standardized $KMnO_4$ solution.

List of Organic chemistry experiments (Any 3 in Each Group)

1. Techniques:

Crystallization, Sublimation, Distillation, Steam Distillation, Vacuum Distillation, Column Chromatography, Thin Layer Chromatography. Record Melting Point & Boiling Point.

2. Functional group tests following functional groups

Alcohols, Alkenes, Aldehydes and Ketones, Acids, Phenols, Amines, Amides, Esters, Aromatic compounds.

3. Preparations:

Preparation of 4, 4’-Dimethoxy-dibenzylideneacetone
Preparation of 4-tert-Butylphenol

	Reduction of p-nitro benzaldehyde by sodium borohydride Nitration of Salicylic acid by green approach (using ceric ammonium nitrate). Bromination of cinnamic acid.
TextBook(s)	
1	Basic Principles of Practical Chemistry, Kulandaivelu A.R., Veeraswamy R., Venkateswaran, Sultan Chand & Sons, 2017
2	Practical Chemistry for B.Sc Chemistry, A.O. Thomas
3	Practical Chemistry, Pandey D.N., Sultan Chand Publishers, 2018
4	https://www.freebookcentre.net/chemistry-books-download/Chemistry-Laboratory-Manual-by-CSOS.html
Reference	
1	Vogel's Text book of Practical Organic Chemistry, Brian S. Furniss, Antony J.Hannaford, Peter W. G. Smith, Fifth Edition, Bath Press, Great Britan, 1989
2	Vogel's Textbook of Quantitative Chemical Analysis, G H Jeffery, J Bassett, JMendham, R C Denney, Fifth Edition, Bath Press, Great Britan, 1989

Course code	BIO102	BIOLOGY PRACTICAL	2 Credits	
Core/Elective/SBS		CORE PRACTICAL		
			Syllabus Version	2023-24

List of Experiments

1. Basic instrumentation techniques – Principles and Operation
2. Laboratory Sterilization Methods - Principles and Operation
3. Estimation of proteins: Bradford Assay
4. Estimation of DNA: DPA(diphenylamine)method
5. Identification of sugars/carbohydrates.
6. Observation of zooplankton from pond samples under microscope.
7. Determination of dissolved oxygen in water sample.

Text Book(s)

1	Laboratory manual in biochemistry by J. Jayaraman, Wiley Eastern Publishers
2	Biochemical Methods- Sadasivam and Manickam, 3rd Edition, New Age International Publishers
3	Zooplankton Methodology, Collection & Identification – - a field manual, S.C Goswami,

Reference

1	Roy, K. Gupta, S., Nandi, S. K. (2016) Int. J. Res. Biol. Sci. 6 (1):1-6 2.
2	Aneesh E. M., Fathibi, K. and Ambalaparambil, V. S. (2017) Int. J. Recent Sci. Res. 8 (10) : 20999-21015; available athttps://www.researchgate.net/publication/321025466_Indian_Fresh_ Water_Zooplankton_A_Review_Int_J_Recent_Sci_Res_810_pp_209 99-21015

VALUE ADDED 1: ENVIRONMENTAL STUDIES

Course code	**1FA**	**Environmental Studies**	**L**	**T**	**P**	**C**
Value Added		Value Added 1	2	-	-	2
Pre-requisite		Understanding in Environment	**Syllabus Version**		**2023-24**	

Course Objectives:

The main objectives of this course are to:

1. Evolve into ecologically informed and socially responsible citizens who are empowered to protect the natural resources while ensuring sustainable lifestyle and developmental mode

Expected Course Outcomes:

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

1	Gaining in-depth knowledge on natural processes that sustain life	K1, K2
2	Predicting the consequences of human actions on the web of life, global economy, and quality of human life.	K1, K2
3	Develop critical thinking for environmental protection and conservation	K1, K2
4	Acquiring values and attitudes towards understanding environmental-economic-social challenges.	K1, K2
5	Adopting sustainability as a practice in life, society, and industry.	K1, K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyse; **K5** - Evaluate; **K6** - Create

Unit:1	Multidisciplinary nature of environmental studies	**3 Hours**
Unit:2	Natural Resources	**4 Hours**
Unit:3	Ecosystems	**3 Hours**
Unit:4	Biodiversity and its conservation	**3 Hours**
Unit:5	Environmental Pollution	**3 Hours**
Unit:6	**Contemporary Issues**	**2 Hours**

Case Study, Expert Lectures, Online Seminars –Webinars	
Total Lecture Hours	**18 Hours**
Textbook(s)	
1	Erach Barucha, Textbook for Environmental Studies, UGC
2	Dr. Radha (2019), Environmental Studies, Revised Edition Prasanna Publishers
Reference Books	
1	Dharmendra S. Sengar, (2007) 'Environmental law', Prentice hall of India
2	G. Tyler Miller and Scott E. Spoolman, (2014) "Environmental Science", Cengage Learning India
3	Rajagopalan, R, (2005) 'Environmental Studies-From Crisis to Cure', Oxford University Press,
4	Benny Joseph, (2006) 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi,
5	Gilbert M. Masters, (2004) 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education,
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	Environmental Studies - By Dr. Tushar Banerjee | Devi Ahilya Viswavidyalaya, Indore - SWAYAM
Course Designed By: **Bharathiar University**	

SEMESTER II

Course code	MTH201	Maths-2	4 Credits	
Core/Elective/SBS		CORE PAPER		
			Syllabus Version	2023-24

Unit-1: Analysis
Limits of real-valued functions Proving limits using the definition Continuity & differentiability Examples of differentiable and non-differentiable functions; continuity and differentiability of standard functions including polynomials, trigonometric, exponential, log functions and their inverses Techniques for evaluating limits including L'Hopital'srule, sandwich theorem Mean Value Theorem and applications Applications of differential calculus eg. related rates
Unit-2: Complex Numbers
Complex numbers Review of complex numbers including algebra, Arg and plane, cartesian And polar form Complex exponential Fundamental Theorem of Algebra deMoivre's theorem; roots of complex numbers
Unit-3: Vectors
Vector arithmetic, dot product, vector projections (review) Vector cross product; scalar triple product; para metric curves specified by vector equations Lines and planes in R^3 Lines and planes in R^3
Unit-4:LinearAlgebra1
Solving systems of linear equations with Gaussian elimination Solutions of systems of linear equations - consistency, uniqueness Geometric interpretation of solutions Matrices,matrixaddition,multiplication,transposeandproperties(review) Matrix inverse Determinant

R^n as a vector space, linear independence of vectors in R^n Span of a set of vectors, sub spaces of R^n
Unit-5:Linear Algebra 1A
Basis and dimension in R^n Abstract vector space axioms; examples and non-examples of vector spaces Bases, dimension and co-ordinatesin (finite dimensonal) abstract vector spaces Definition of linear transformation and examples/non-examples Linear transformations of the plane Matrix representation of a linear transformation Image and kernel of a linear transformation Rank and nullity
Reference Books
Calculus: Early Transcendentals, Seventh edition by James Stewart. Publisher: Brooks/Cole Year: 2010; ISBN: 9780538497909 (Hardcover), 1170 pp
Complex Variables and Applications by James Brown, Ruel Churchill. Publisher: McGraw Hill Higher Education; Year: 2013; ISBN-13: 978-0073383170, 480 pp.
Vector Calculus by Susan Colley. Publisher: Pearson; Year: 2011; ISBN-13: 978-0321780652, 624 pp.
Linear Algebra And Its Applications by Gilbert Strang. Publisher: Cengage India Private Limited; Year: 2005; ISBN-13:978-8131501726; 544 pp.

Course code	PHY201	Physics 2: Modern Physics	4 Credits
Core/Elective/SBS		CORE PAPER	
			Syllabus Version 2023-24

Unit:1	Electricity
Electric charge, conductors and insulators – Coulomb's Law, superposition principle – Electric field, superposition principle – Electric flux – Gauss's law, applications – Energy and electric field; electric potential – Calculating potential from the field, electric potential, potential energy surfaces – Electric dipoles – Capacitance; parallel plate capacitors – Energy storage in capacitors, dielectrics, series and parallel circuits – Conductors, electric current, electric power, Ohm's law – Kirchoff's rules, resistors in series and parallel circuits.	

Unit:2	Magnetism
Magnetic field, magnetic force, Lorentz force, cyclotrons – ion velocity filter, Hall effect, - Bio-Savart Law, Ampere's Law, solenoids, earth's magnetic field - Magnetic field due to a current, forces on current – carrying wires, Electromagnetic induction, magnetic flux – Lenz' Law, Faraday's law, Maxwell's equations, applications – Magnetic materials.	

Unit:3	Oscillations and Waves
Damped harmonic motion, resonance – electronic circuits, evolution of populations – One dimensional waves, Interference and standing waves, Sound waves and the speed of sound, Intensity, sound level and the physics of music – Doppler effect and supersonic motion, shock waves.	

Unit:4	Optics
Images and mirrors – Thin lenses and optical instruments – Young's experiment, interference – Thin films and the Michaelson interferometer – Diffraction by slits and apertures – Diffraction by grating sand X-ray diffraction – Optical Microscopy – Spectroscopy.	

Unit:5	Modern Physics
Challenges to classical physics; special relativity – Lorentz transformation, transformation of velocities, Doppler effect – Relativistic momentum and energy – Photons and the photoelectric effect – Quantum physics, black body radiator, matter waves – Trapped particles and the tunneling particles – Nuclear physics, nuclear properties, nuclear decay – Quarks, Leptons, The Big Bang.	

Textbook(s)

1	A Text book of Optics, Brijlal & Subramaniam,S. Chand Limited (2001)
2	Modern Physics, R. Murugesan, S. Chand Publishing, 18thEdition (2017)
3	Solid State Physics Gupta and Kumar,K. Nath & Co.(2018)
4	Electricity and Magnetism, R. Murugesan, S.Chand & Co(2017)

Reference Books	
1	Optics and Spectroscopy,RMurugesan,S.ChandPublishing,5th Edition(2013)
2	Heat and Thermodynamics–Zemansky and R.H.Dcltanann,TMH(2017)
3	Modern Physics, Sehgal D.L. ChopraK.L.andSehgalN.K.SultanChand&Sons,9th edition, (2004)
4	Introduction to Solid State Physics Charles Kittel, Wiley(2019)
5	Electricity and Magnetism, D.N.Vasudeva, S.Chand & Co, twelfth edition(2007)
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.,]	
1	**https://www.askiitians.com/revision-notes/physics/current-electricity.html**
2	**https://www.askiitians.com/revision-notes/physics/electromagnetic-induction-and-alternating-current/**
3	**https://www.khanacademy.org/science/physics/light-waves/introduction-to-light-waves/v/polarization-of-light-linear-and-circular**
4	**https://nptel.ac.in/courses/115/105/115105099/**

Course Code	CHM201	PHYSICAL AND INORGANIC CHEMISTRY	4 Credits	
CORE		Chemistry 2		
			Syllabus Version	2023-2024

UNIT I	Chemistry of Life	

The Chemical Basis of Life - Bioenergetics - Examples of Major Bioenergetic Processes - Enzymes and Catalysed Reactions - The Chemistry Behind Enzyme Catalysis - Metabolism: Catabolism and Anabolism - Concatenation and Biopolymers - Stereochemistry and Biomolecular Chirality

UNIT II	Biochemistry & Inorganic Chemistry	

Biochemistry and Biomolecular Structure - Types of Biomolecules, Structure and Functions of Biomolecules - Small Inorganic Molecules of Biological Importance

Ionic Compounds and their Solutions - Formation, Bonding, Structure and Properties - Ionic Solutions - Structures of Solids - Classification of Solids - Types of Crystalline Solids

UNIT III	Inorganic Chemistry & Electrochemistry	

Main Group Chemistry - General Trends in Main Group Chemistry - Chemistry of s- and p-block Elements, Structure, Chemical Reactivity and Bonding Concepts

Redox Reactions and Electrochemistry - the Basics of Redox Reactions - Electrochemical Cell - Electrochemical Series - Electrode and Cell potentials - Nernst equation

UNIT IV	Inorganic Chemistry	

The Transition Metals : A Survey - Coordination Chemistry - Important Terms Involving Coordination Compounds - Bonding in Complex Ions - Types of Coordination Complexes - Transition Metals in Biological Systems - Simple Harmonic Motion, Pendulum, Diatomic Molecules

UNIT V	Quantum Chemistry	

Schrödinger's Equation and Heisenberg's Uncertainty Principle - Bohr and Schrodinger Models of the Hydrogen Atom - Complex Atoms; Pauli Exclusion Principle, Periodic Table of Elements, Selection Rules and Spectra - Nuclear Fission and Fusion

Text Book(s)

1	Textbook of Biochemistry, Seema P. Upadhye, I.K. International Publishing House Pvt. Ltd.
2	Inorganic Chemistry, P. L. Soni, Sultan Chand & Sons.
3	Principles of Physical Chemistry, B.R. Puri, L.R. Sharma, S.Chand& Co.

4	Main Group Chemistry, 2nd Edition, A. G. Massey, Wiley Publication
Reference Books	
1	Bioenergetics: Molecular Biology, Biochemistry, and Pathology, Chong H. Kim, Takayuki Ozawa, Springer Publication
2	Essentials of Physical Chemistry, B.S. Bahl and G.D. Tuli, S.Chand & Co.
3	Principles of Inorganic Chemistry, B.R. Puri L.R. Sharma, S.Chand& Co.
4	Fundamentals of Biochemistry, J L Jain, Nitin Jain, Sunjay Jain, S.Chand & Co.
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]	
1	https://chem.libretexts.org/
2	https://byjus.com/chemistry/
3	https://openstax.org/details/books/chemistry-2e

Course code	BIO201	Biology 2: The Biology of Cells	4 Credits	
Core/Elective/SBS		CORE PAPER		
			Syllabus Version	2023-24

Unit:1	The Cell	
Introduction to Cell Biology – The plasma membrane – Cell walls, extracellular matrix, cellulose synthesis, other cell wall components – Cytoplasm: content, chemistry and properties – Cytoskeleton, actin filaments, microtubules		

Unit:2	Information Flow in the Cell	
Nucleus, chromosomes, DNA – Genes and the genetic code – Control of gene expression		

Unit:3	Endomembrane system and Intracellular Trafficking	
ER and ribosome, proteins and enzymes – Golgi apparatus –Vesicles, transport and secretion, Lysosomes		

Unit:4	Harvesting Energy	
Mitochondria, ATP, energetic reactions, electron transport pathways, cellular respiration – Chloroplasts, photosynthesis, historical experiments, pigments, photo systems		

Unit:5	Multicellularity and the Dividing Cell	
Cell division, cell cycle, mitosis, cytokinesis, division and distribution of organelles – Meiosis, formation of haploid cells – Communication and signaling, recognizing and responding – Cell differentiation and multicellularity.		

Text Book(s)

1	Molecular cell biology, Harvey Lodish, 8th edition, W.H. Freeman, (2016).
2	Cell and Molecular Biology concepts and Experiments, Gerald Karp, Janet Iwasa, Wallace Marshall,9thEdition, Wiley(2019)
3	Molecular Biology of the cell, Bruce Alberts, 6th edition, Garland Science(2014)

Reference Books

1	The Cell : A molecular approach, Geoffrey M. Cooper, Robert E. Hausman, Sixth edition, Sinauer (2013)
2	Essential Cell Biology, Bruce Alberts, 5th edition, Garland Science (2019).
3	Lewin' s Genes XII, 2017, Jocelyn E Krebs, Elliott S. Goldstein, and Stephen T. Kilpatrick Jones, Bartlett Publishers, 12th revised edition

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.,]

1	**https://microbenotes.com/category/cell-biology/**
2	**https://www.larberthigh.com/_documents/%5B1405%5DUnit_1-_Cell_biology_summary_notes.pdf**

3	https://nptel.ac.in/courses/102/103/102103012/
4	https://www.khanacademy.org/science/ap-biology/cell-structure-and-function

Course code	**PHY202**	**PHYSICS PRACTICAL 2**	**2 Credits**	
Core/Elective/SBS		CORE PRACTICAL		
			Syllabus Version	**2023-24**

LIST OF EXPERIMENTS:

1. Young's Modulus – Non-uniform pending methods
2. Determination of the radius of a current carrying coil 2-Determination of magnetic field with the variation of distance along the axis of current carrying coil.
3. To determine the Wavelength of main spectral line of mercury light using plane transmission grating.
4. To determine the Refracting Angle, Refractive Index and Dispersive power of prism using spectrometer.
5. To determine the coefficient of thermal Conductivity of bad conductor by Lee's Disc.
6. Charging and Discharging of Capacitor.
7. Verification of Kirchhoff's law.

Reference Books

1 A text book of practical Physics, M.N.Srinivasan, S.Balasubramanian, R.Ranganathan, Sultan Chand & Sons(2017).

2 Practical Physics and Electronics, C.C. Ouseph, U.J.Rao, V.Vijayendran, S.Viswanathan Publishers(2007)

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

https://nptel.ac.in/course.html/physics/experimentalphysicsI,IIandIII
https://nptel.ac.in/courses/115/105/115105110/
https://www.youtube.com/playlist?list=PLuiPz6iU5SQ8-rZn_LgLofRX7n8z4tHYK

Course Code	CHM202	CHEMISTRY PRACTICAL 2	2 Credits	
Core/Elective/SBS		CORE PRACTICAL		
			Syllabus Version	2023-24

List of Experiments

List of Physical chemistry experiments (Any 2)

1. To determine the rate of chemical reaction by using hydrolysis of tert-Butyl chloride.
2. Effects of catalase enzyme obtained from potato in cleaving H_2O_2 into H_2O and O_2.
3. To measure the vapour pressure of n-Pantane by using high vacuum line.
4. Heat of solution of KNO_3/ NH_4Cl.
5. Glass electrode- Buffer solutions: To titrate a weak base (Na_2CO_3) with a strong acid a) an acid-base indicator,(b) a glass electrode

List of Inorganic chemistry experiments (Any 2)

1. Synthesis of hexamine nickel (II) $[Ni(NH_3)_6]I_2$
2. Cuprous Chloride, Cu_2Cl_2
3. The transition metals: a survey (Transition metals in biological systems and Bonding in complex ions).
4. Estimation of Cu (II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically).
5. Estimation of available chlorine in bleaching powder iodometrically.

List of Organic chemistry experiments (Any 3 in Each Group)

1. Preparation of Derivatives:

Oxime, 2, 4-DNP, Acetyl, Benzoyl, Semicarbazone, Anilide, Amide, Aryloxyacetic acid.

2. Organic single stage preparation:

The preparation of paracetamol.

The synthesis of meso-1,2-Dihydroxy-1,2-Diphenylethane.

Preparation of ⍺-phenyl Cinnamic acid from Benzaldehyde.

Preparation of benzyl alcohol from Benzaldehyde

Preparation glucose pentaacetate from Glucose.

Preparation of 2-iodobenzoic acid from Anthranilic acid.

Use of Computer (Chemistry Software)

Chem Draw-Sketch, ISI – Draw, Draw the structure of simple aliphatic, aromatic, heterocyclic organic compounds with substituents. Get the correct IUPAC name.

Text Book(s)

1	Basic Principles of Practical Chemistry, Kulandaivelu A.R., Veeraswamy R., Venkateswaran, Sultan Chand & Sons, 2017

2	Practical Chemistry for B.Sc Chemistry, A.O. Thomas
3	Practical Chemistry, Pandey D.N., Sultan Chand Publishers, 2018
4	https://www.freebookcentre.net/chemistry-books-download/Chemistry-Laboratory-Manual-by-CSOS.html
Reference	
1	Vogel's Text book of Practical Organic Chemistry, Brian S. Furniss, Antony J.Hannaford, Peter W. G. Smith, Fifth Edition, Bath Press, Great Britan, 1989
2	Vogel's Textbook of Quantitative Chemical Analysis, G H Jeffery, J Bassett, JMendham, R C Denney, Fifth Edition, Bath Press, Great Britan, 1989
3	ChemDraw 17.0 User Guide, PerkinElmer Informatics Inc, 1998-2017

Course code	BIO202	BIOLOGY PRACTICAL 2	2 Credits	
Core/Elective/SBS		CORE PRACTICAL		
			Syllabus Version	2023-24

List of Experiments

1. Microscopy and observation recording of representative organelle readymade specimens.
2. Staining of cell for observations of-Flagella, cell wall, endospores, etc.
   a. Plant cell, bacterial, fungi samples.
   b. Malachite green, safranin, Leifson flagella stain/RYU flagella stain, nitric acid, crystals of potassium chlorate (any suitable stain)
3. Introduction and visualization DNA-Proteins *insilico*.
4. Demonstration of confocal/ fluorescence microscopy at the central instrumentation facility of Bharathiar University.
5. Counting of cells using hemocytometer, observation of dead cells-Trypan blue staining.
6. Isolation of DNA: gel electrophoresis.
7. Mitosis in onion root tips – Microscopic observation

Text Book(s)

1	Cappuccino, James G., and Natalie Sherman. "Microbiology: a laboratory manual." (2005)
2	Wilson, K. and Walker, J. (2010). Principles and techniques of Biochemistry and Molecular Biology. 7th Edition. Cambridge University Press.
3	Tiwari, G. S. Hoondal, (2005). Laboratory Techniques In Microbiology & Biotechnology. Swastik publishers

Reference

1	Sri Jayachama rajendra (2018)/ pdf. Cell Biology and Genetics Lab.
2	K. R. Aneja; Laboratory Manual of Microbiology and Biotechnology, 2018. ED-TECH

Course code	IDC201	Scientific Computation and Modeling: Introduction to simple models and programming	4 Credits			
Core		CORE PAPER				
Pre-requisite			Syllabus Version		2022-23	

Unit 1: Introduction to Scientific Computing

Overview: Definition; Scope; Importance, Mathematical Foundation: Numerical Representation; Basic Linear Algebra, Programming Basics: Introduction; Variable; Data Types; Basic Operations; Control Structures.

Unit 2: Numerical Methods

Root Finding and Optimization: Bisection Method; Newton-Rhapson Method, Linear Systems: Gaussian Elimination; LU decomposition, Interpolation and Approximation: Lagrange interpolation; Polynomial interpolation; Least squares approximation.

Unit 3: Differential Equations

Ordinary Differential Equations (ODEs): Euler's method; Runge-Kutta methods, Partial Differential Equations (PDEs): Classification; Finite difference methods, Applications of ODEs and PDEs: Physical systems modeling; Heat equation, wave equation, and diffusion equation.

Unit 4: Data Analysis and Visualization

Data Manipulation and Analysis: Introduction to data structures; Statistical analysis using computational tools, Visualization Techniques: Plotting and graphing data; 2D and 3D visualization.

Unit 5: Advanced Topics in Scientific Computing

Parallel and High-Performance Computing: Introduction to parallel computing; Parallel algorithms and architectures; High-performance computing clusters, Machine Learning for Scientific Modeling: Basics of machine learning; Applications of machine learning, Advanced Topics in Modeling: Agent-based modeling.

Text Book(s)

Scientific Computing: An Introductory Survey" by Michael T. Heath. This book provides an overview of scientific computing, including numerical methods and algorithms, and discusses their implementation using various programming languages.

"Python for Scientists" by John M. Stewart. This book is specifically designed for scientists and engineers, providing an introduction to Python programming and its application in scientific computing.

VALUE ADDED 2: HUMAN RIGHTS

Course code	2FB	Human Rights	L	T	P	C
Value Added		Value Added 2	2	-	-	2
Pre-requisite		Awareness on Ethics and Values	**Syllabus Version**		**2023-24**	

Course Objectives:

The main objectives of this course are to:

1. Create awareness, conviction and commitment to values for improving the quality of life through education, and for advancing social and human wellbeing

Expected Course Outcomes:

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

1	Understand human values and value education	K1
2	Learn their role in national development	K1
3	Understand global development with ethics and values	K1
4	Learn various therapeutic methods	K1
5	Learn and understand human rights	K1

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyse; **K5** - Evaluate; **K6** - Create

Unit:1	**Concept of Human Values, Value Education Towards Personal Development**	**3 Hours**

Aim of education and value education; Evolution of value-oriented education; Concept of Human values; types of values; Components of value education. Personal Development: Self-analysis and introspection; sensitization towards gender equality, physically challenged, intellectually challenged. Respect to - age, experience, maturity, family members, neighbours, co-workers. Character Formation Towards Positive Personality: Truthfulness, Constructivity, Sacrifice, Sincerity, Self-Control, Altruism, Tolerance, Scientific Vision.

Unit:2	**Value Education Towards National and Global Development**	**4 Hours**

National and International Values: Constitutional or national values - Democracy, socialism, secularism, equality, justice, liberty, freedom, and fraternity. Social Values - Pity and probity, self-control, universal brotherhood. Professional Values - Knowledge thirst, sincerity in profession, regularity, punctuality, and faith. Religious Values - Tolerance, wisdom, character. Aesthetic values - Love and appreciation of literature and fine arts and respect for the same. National Integration and international understanding.

Unit:3	**Impact of Global Development on Ethics and Values**	**3 Hours**

Conflict of cross-cultural influences, mass media, cross-border education, materialistic values, professional challenges, and compromise. Modern Challenges of Adolescent Emotions and behaviour; Sex and spirituality: Comparison and competition; positive and negative thoughts.

Unit:4	**Therapeutic Measures**	**3 Hours**
Control of the mind through a. Simplified physical exercise b. Meditation – Objectives, types, effect on body, mind and soul c. Yoga – Objectives, Types, Asanas d. Activities: (i)Moralisation of Desires (ii)Neutralisation of Anger (iii)Eradication of Worries (iv)Benefits of Blessings		
Unit:5	**Human Rights**	**3 Hours**
Concept of Human Rights – Indian and International Perspectives a. Evolution of Human Rights b. Definitions under Indian and International documents 2. Broad classification of Human Rights and Relevant Constitutional Provisions. a. Right to Life, Liberty and Dignity b. Right to Equality c. Right against Exploitation d. Cultural and Educational Rights e. Economic Rights f. Political Rights g. Social Rights 3.Human Rights of Women and Children a. Social Practice and Constitutional Safeguards (i)Female Foeticide and Infanticide (ii)Physical assault and harassment (iii)Domestic violence (iv)Conditions of Working Women 4.Institutions for Implementation a. Human Rights Commission b. Judiciary 5.Violations and Redressal a. Violation by State b. Violation by Individuals c. Nuclear Weapons and terrorism d. Safeguards.		
Unit:6	**Contemporary Issues**	**2 Hours**
Case Study, Expert Lectures, Online Seminars - Webinars		
	Total Lecture Hours	**18 Hours**
Textbook(s)		
1	Value Education – Human Rights, Bharathiar University	
Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]		
1	Human Rights in India - By Prof. (Dr.) Y.S.R. Murthy | O.P. Jindal Global University - SWAYAM	
Course Designed By: **Bharathiar University**		

Semester III

Course code	MTH301	Maths-3: Vector Calculus and Differential Equations	4 Credits
Core/Elective/SBS		CORE PAPER	
			Syllabus Version: 2023-24

Linear Algebra
Change of basis and linear transformations
Definition of eigenvectors and eigenvalues
Calculating eigen values and eigenvectors
Diagonalisation of matrices; matrix powers
Orthogonal matrices, real symmetric matrices
Characteristic and minimal polynomial, Cayley-Hamilton Theorem
Applications of eigen vectors/diagonalisationeg Markov chains
Inner product axioms; examples/non-examples of inner products
Length, angle, Cauchy-Schwarz inequality in terms of inner product
Orthogonality, projections in terms of inner product
Gram-Schmidt algorithm
Vector Calculus
Functions of several variables; level curves and cross sections of surfaces
Common surfaces including paraboloid, ellipsoid, hyperboloid
Domains and ranges of functions of several variables
Limits and continuity of functions of several variables; Definition of C^N
Partial derivatives, tangent plane
Differentiability of functions of several variables
Directional derivative, gradient
Chain rule and total derivative
Stationary points of surfaces, classification of stationary points using Second derivatives
Optimisation applications
Constrained extreme a using Lagrange multiplier method
Double integrals, changing order of integration
Polar co-ordinates, change of variables for double integrals
Triple integrals
Change of variables for triple integrals; cylindrical co-ordinates
Spherical co-ordinates
Vector fields, div and curl operators

Parameterisation of paths
Line integrals of scalar functions
Line integrals of vector functions
Integrals of scalar functions over surfaces, applications of surface Integrals eg. surface area, mass
Integrals of vector functions over surfaces, flux
Green's Theorem
Gauss Divergence Theorem
Stokes' Theorem
Applications of integral theorems eg. Maxwell's equations
PDEs
Fourier Series
Fourier series: Dirichlet, discontinuities and differentiation
Fourier series: Weak convergence and series summation
Linearity and Superposition
Laplace equation and harmonic functions
Fourier transform
Fourier transform: properties

Course code	**PHY301**	**Physics-3: Quantum Mechanics and Thermodynamics**	**4 Credits**

Core/Elective/SBS	CORE PAPER				
		Syllabus Version		2023-24	
Linear Algebra					
Change of basis and linear transformations					
Definition of eigenvectors and eigen values					
Calculating eigen values and eigenvectors					
Diagonalisation of matrices; matrix powers					
Orthogonal matrices, real symmetric matrices					
Characteristic and minimal polynomial, Cayley-Hamilton Theorem					
Applications of eigen vectors/diagonalisationeg Markov chains					
Inner product axioms; examples/non-examples of inner products					
Length, angle, Cauchy-Schwarz inequality in terms of inner product					
Orthogonality, projections in terms of inner product					
Gram-Schmidt algorithm					
Quantum Mechanics					
The Breakdown of Classical Physics					
Matter Waves and Quantum Interpretation					
Quantum Mechanics in One Dimension					
Expectation Values, Observables and Operators					
Tunneling Phenomena					
Quantum Mechanics in 3-dimensions					
Hydrogen atom, hydrogenic ions, helium atom					
Hydrogen molecule ion, hydrogen molecule					
Thermodynamics					
Temperature and the Zeroth Law of Thermodynamics. Thermal equilibrium.					
Transport, conduction, conductivity, diffusion in gases.					
The two-state paramagnet and the Einstein model of a solid; quantum Deviations from classical equipartition. Partition function, Interacting systems, large systems, Stirling's approximation					
Heatengines, Carnot Cycle, Otto Cycle, Stirling Cycle.					
PDEs					
Fourier Series					
Fourier series: Dirichlet, discontinuities and differentiation					
Fourier series: Weak convergence and series summation					
Linearity and Superposition					
Laplace equation and harmonic functions					

Fourier transform
Fourier transform: properties

Course code	**CHM303**	**Chemistry-3 Reactions and Synthesis**	**4 Credits**
Core/Elective/SBS		**CORE PAPER**	

		Syllabus Version	2023-24

Unit:1	Organic Synthesis	08 L

C-C bond Forming Reactions: Grignard Reagents and Organolithiums. Formation and reaction with Carbonyl compounds.

Organometallic Reagents in Synthesis: Applications of Organocerium and Organocuprate reagents.

Carbonyl Compounds and Reactions: Carbonyl compounds, Tautomerism as a general phenomen, keto-enoltautomerism of carbonyl compounds, mechanism of keto-enoltautomerism - Generating enolate anions, suitable base catalysts for enolising aldehydes, ketones, and ester and β-dicarbonyl compounds, general α- Substitution reaction. Reactions of enols and enolates, α-substitution with H/D^{+}Stereochemical consequences and deuterium incorporation, Halogenation of carbonyl compounds. The haloform reaction, Halogenation of carbonyls, Hell-Volhard-Zelinsky reaction, Synthetic applications of a-halocarbonyl compounds. Alkylation of enolates, LDA, scope and limitations.Aldol reaction, mechanism and retro synthesis, inter-and-intra-Molecular variants, mixed Aldol reaction. Claisen reaction, mechanism and retro synthesis, mixed Claisen and Deickman reaction. MalonateDiester Chemistry, Acetoacetate chemistry, Synthesis of Substituted acetic acid and acetone derivatives, Scope, Mechanism and Retro synthesis. Michael addition Chemistry, reaction of enolates with various Michael electrophiles. Kinetic and Thermo dynamic enolates, Enamines and silylenol ethers

Unit:2	Redox (and important acid-base) Reactions:	08 L

Oxidation of elements by halogens and dioxygen. Metal and main group halides and oxides. Discussion of selected syntheses, chemistry and structures of halides and oxides including amphoteric behaviour and hydroxide/aqua ion formation.

Thermodynamic vs. kinetic control of reactions. Thermodynamic aspects of halide and oxide formation. Thermodynamic parameters, their estimation and uses of tabulations. Born-Haber cycle and construction and uses of Ellingham diagrams for these systems. (Electrides and sodides).

Oxidation of metals by protons etc. and generation of aqua ions. Comparison of TM and main group systems and hydrolysis in TM aqua ions (acid-base chemistry of coordinated water-

hydroxide-oxo ligands).Connection between electrochemical and thermo dynamic parameters. Construction and uses of Latimer and Frost diagrams. Interpretations of Frost diagrams exemplified by the more complex chemistry of main group elements, such as nitrogen.

Thermodynamic content of plots (free energy of formation vs. oxidation state) and predictive power. Nernst equation revisited and construction and uses of Pourbaix diagrams combining redox and acid base reactions. Comparison of chemistry of representative elements as reflected in Pourbaix diagrams.

Unit:3	**Exchange reactions**	**06 L**

Solid/gas phase systems exemplified by transport reactions and preparation of solid-state materials, in volcanology, halogen lamps etc. Solution examples of doubled composition (metathesis).Solubility trends, Common ion effect.

Hard/soft acid/base theory. Thermodynamic basis for HSAB theory. Usefulness in predicting direction of equilibrium and solubility.

Unit:4	**Substitution Reactions**	**06 L**

Typical reactions and synthetic applications and examples. Inert and labile complexes. Stability (K,b) and factors affecting stability (metals, ligands). Irving-Williams series, Chelate effect. Applications of chelate effect. Siderophores. Antioxidants, garden products, chelation therapy in medicine.

Mechanism of substitution reactions. Square planar Pt complexes and applications. Trans effect, Pt chemistry, Applications in synthesis of action of chemotherapeutic agents.

Dissociative, interchange and associative mechanisms in substitution, racemization *etc*in octahedral complexes.

Combination of substitution and redox chemistry in TM systems.

Co(III) syntheses, Cr(II) catalysed substitution. Electron transfer, inner-and outer-sphere reactions.

Metal centered reactions: Template reactions and reactions of coordinated ligands. Atom

transfer reactions (redox reactions). Metal directed ligand syntheses

Unit:5	Thermodynamics	08 L

Ideal gases, the kinetic theory of gases, equipartition theory, Boltzmann distribution, Heat, work, internal energy. First law of thermo dynamics. Heat Capacity and enthalpy. Compression of an ideal gas under various conditions. Latent heats, Multiplicity and ideal gases. Entropy, spontaneous change and the Second Law of Thermodynamics. Interacting ideal gases and the entropy of mixing. Gibbs Free energy and spontaneity, Helmholtz Free energy, standard free energies, free energy as a function of pressure and temperature.

The Fundamental equation, properties of internal energy and Maxwell's relations. Thermodynamics criteria for chemical and phase equilibria, chemical potential and partial molar quantities, the Gibbs Free Energy, minimum and equilibrium, extent of reaction and equilibrium constant, molecular description of equilibrium, response of equilibria to temperature.

Thermodynamics of liquids and liquid mixtures, chemical potentials of liquids, ideal liquid mixtures and Raoult's Law, Henry's Law, vapor pressure diagrams, liquid-liquid phase diagrams, Free energy and entropy of mixing, excess functions and real solutions, solute and Solvent activity, activity coefficient, osmotic pressure

Student Work	09 L
• Assignments, Tutorials • Reviews of various research papers, reports, books • Presentations	

Recommended Books/references

1	OrganicChemistryby J. McMurray, 7th Ed., Thomson, 2008.
2	Carey, F. A. and Sundberg, R. J., "Advanced Organic Chemistry, Part B: Reactions and Synthesis", 5th Ed., Springer.
3	PrinciplesofOrganicSynthesisby R. Norman and J.M. Coxon, 3rd Ed., Chapman and Hall, 1993.
4	Organic Chemistry by Clayden, J., Greeves, N. and Warren, S., "Organic Chemistry", Oxford University Press.

5	Smith, M.B., "Organic Synthesis", 3rd Ed., Academic Press.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1.	https://chem.libretexts.org/
2.	https://byjus.com/chemistry/
3.	https://openstax.org/details/books/chemistry-2e

Course code	**BIO301**	**BIOLOGY-3: Functional Biology of Organisms**	**4 Credits**			
Core/Elective/SBS		**CORE PAPER**				

Pre-requisite		Syllabus Version	2022-23
Functional Biology of Organisms			
Introduction to Functional Biology			
Animal biology (Humans as an example)			
Anatomy and Function 1: Tissues, Organs and Viscera			
Anatomy and Function 2: Skeletal &Muscular system			
Nervous system1: The central nervous system(CNS)and nervous tissues			
Nervous system2: Autonomic nervous system and motor responses			
Endocrine system1: Endocrine and Exocrine glands			
Endocrine system2: HPA axis introduction			
Respiration and Metabolism 1:Breathingin air and water			
RespirationandMetabolism2:Regulationof metabolism			
Cardiovascular and circulatorysystem1: Regulation of the circulatory system			
Cardiovascular and circulatorysystem2: Peripheral circulation			
Digestive system			
Urinary and Excretion systems1: Anatomy and function			
Urinary and Excretion systems 2: Osmoregulation interrestrial& aquatic environments			
Thermal dynamics			
Immunology1: Innate immune system			
Immunology2: Adaptive/Humoral immune system			
ReproductionandDevelopment1:GonadsandtheReproductivetract			
Reproduction and Development2: Gametes, Fertilization and conception			
Plant biology			
Growth and Development			
Photosynthesis			
Water Balance			
Phloem and translocation			
Mineral nutrition and nutrient assimilation			
Respiration and lipid metabolism			
Reproduction			
Signaling; hormones, light responses, control of flowering			
Abiotic stress			
Secondary metabolism and defense			

Microbial physiology

PHY302 - Physics Practical - 2 Credits

1. Michealson's interferometer: To find the wavelength of given laser beam.
2. Specific charge of the electron(e/m): To find the specific charge of the electron from the path of an electron beam in crossed electric and magnetic fields of variable strength.

3. Rydberg's constant: To find Rydberg's constant using diffraction grating.
4. Photoelectric effect: To estimate Planck's constant and work function of the photoelectrons by measuring the variation of stopping potential with the frequency of light. To see the graph of current Vs voltage for different intensity and frequency of light.
5. Electron diffraction: To measure diameter of smallest diffraction rings at different anode voltages.
6. Millikan soil drop experiment: To measure to charge of the electron.

CHM302 - Chemistry Practical - 2 Credits

List of Physical chemistry experiments

1. Thermodynamic data of electrochemical cell by e.m.f. measurements.
2. Determination of the equilibrium constant of tri-iodide ion formation

3. Determination of dipole moment f liquid at various temperatures
4. Dissociation constant of an acid-base indicator by spectrophotometry
5. Flame Photometric determination of Na, K, Li and Ca (Working curve method, standard addition method and Internal standard method)
6. A photometric titration of a mixture of Bi and Cu with EDTA(-745nm)
7. The reaction between potassium per sulphate and potassium iodide by colorimetry.
8. Hydrolysisconstantofanilinehydrochloridebydistributioncoefficient method.
9. Thermodynamic data of electrochemical cell by e.m.f. measurements.
10. Determination of the equilibrium constant of tri-iodide ion formation
11. Determination of dipole moment of liquid at various temperatures
12. Determination of concentration of sulfuric acid, acetic acid and copper sulphate by conduct o metric titration with sodium hydroxide.
13. Determine the formula and stability constant of a metal ion complex (Lead Oxalate) by polarography.

List of Inorganic chemistry experiments

1. **Analysis of ore(Any one)**

   i) Pyrolusite ore –Estimation of silica gravimetrically and Manganese volumetrically.

   ii) Chromite ore–Estimation of Iron gravimetrically and Chromium volumetrically

2. **Analysis of Alloy**

   Solder alloy– Estimation of Tin gravimetrically and Lead volumetrically

3. **Column Chromatography:** Ion exchange capacity of resine by Co and Ni.
4. **Characterization of soil and water.**

List of Organic chemistry experiments

1. **Separation of Binary Mixture (8-10samples)**
2. **Preparations: Single Stage**
   a. Ethyl benzene from acetophenone
   b. P-Nitrobenzylcyanide from Benzyl cyanide.
   c. 2,4dinitroanisolefromanisole
   d. Azo dye from Anthranilic acid
   e. Osazone from Glycose
   f. Cinnamic acid dibromide from Cinnamic acid
   g. Chalcone from P-chloro Benzaldehyde.

h. Hippuric acid from Glycine
i. 4-formyl resorcinol from Resorcinol.
j. Adipic acid from Cyclohexanone
k. 4,6 dimethyl coumarin from p-cresol.
l. Cannizzaro reaction of aromatic aldehyde.

BIO302 - Biology Practical - 2 Credits

Any 5 Experiments

1. Preparation of media, autoclaving and culturing of bacteria

2. Plating techniques

a) Pour plate b) Streaking c) Spread plate technique

3. Dilution and colony counting

4. Bacterial Growth curve

5. Enzyme kinetics (effect of pH, temperature, substrate and enzyme concentration)

6. Estimation of glucose

7. Antibiotic sensitivity test: zone of inhibition

IDC301Scientific Computation and Modeling: Projects* - 2 Credits

Scientific Computing is the collection of tools, techniques, and theories required to solve on a computer mathematical models of problems in Science and Engineering.

VALUEADDED 3: YOGA FOR HUMAN EXCELLENCE (2 CREDITS)

Course code: 3FC **Total Lecture Hours 18 hours**

Yoga and Physical Health

Physical Structure- Three bodies –Five limitations
Simplified physical Exercises-Hand Exercises-LegExercises–BreathingExercises-Eye Exercises – Kapalapathi
Matrarasanas-Massages -Acupuncture- Relaxational
Yogasanas-Padmasana-Vajrasanas–Chakrasanas(Side)-Viruchasanas-Yogamuthra-Patchimothasanas -
Ustrasanas -Vakkarasanasi – Salabasanas

Art of Nurturing the life force and Mind

Maintaining the youthfulness-Postponing the ageing process
Sex and Spirituality-Significance of sexualvital fluid-Married life -Chastity
Ten stages of Mind
Mental frequency-Methods for concentration

Sublimation

Purpose and Philosophy of life
Introspection-Analysis of Thought
Moralization of Desires
Neutralization of Anger

Human Resources development

Eradication of worries
Benefits of Blessings
Greatness of Friendship
Individual Peace and World Peace

Law of Nature

Unified force-Cause and Effect system
Purity of Thought and Deed and Genetic centre
Love and Compassion
Cultural Education- Fivefold Culture

Textbook(s)

1. Manavalakalai Yoga,Vedathiri Publications

2. Simplified Physical Exercises–Vethathiri Maharishi,VethathiriPublication.Yogasanas–Vethathiri Publication
3. Yoga for Modern Age–Vethathiri Maharishi, Vethathiri Publications

4. The World Order of Holistic Unity –Vethathiri Maharishi, Vethathiri -Publications
5. Sound health through yoga–Dr. K. Chandrasekaran.

Related Online Contents[MOOC,SWAYAM,NPTEL,Websites etc.]

1. Yoga Practices 1 -ByDr Vikas|Swami Vivekananda Yoga Anusandhana Samsthan-SWAYAM

Course Designed By: **Bharathiar University**

Semester IV

MTH401: Probability and Statistics – 4 Credits	
Probability	**No. of Lectures**
Review of probability, events, laws of probability	1

Conditional probability, independent events	1
Random variables; discrete random variables and distributions; mean, variance and standard deviation of discrete random variable	1
Bernoulli trials, binomial distribution	1
Poisson distribution and Poisson process	1
Continuous random variables and distributions, probability density functions, cumulative distribution function	1
Mean, variance, standard deviation, median and percentiles of a continuous distribution	1
Normal distribution	1
Uniform and exponential distribution	1
Distributions of functions of a random variable	1
Sums/differences/scalar multiples of random variables, independent random variables, distributions of sums/differences of independent random variables	1
Central Limit Theorem	1
Normal approximation to the binomial distribution, distribution of the sample mean	1
Distribution of sample proportion	1
Stochastic processes, Markov chains	1
Limiting behaviour of Markov chains	1
Statistics	**No. of Lectures**
Study design: bias, confounding, precision, comparison, control	1
Study design: observational studies vs designed experiments	1
Exploratory data analysis: describing and displaying categorical data (tables, frequencies, bar chart)	1
Exploratory data analysis: describing and displaying univariate numeric data (dotplots, boxplots, histograms, mean, median, quartiles/percentiles, standard deviation, variance, IQR)	1
Exploratory data analysis: describing and displaying bivariate numeric data (scatterplot, correlation)	1
Statistical modeling (single mean model, multiple means model, regression model)	1
Sampling distributions: population vs sample, parameter vs statistic; distribution of sample mean, proportion; standard error	1
Estimation: Confidence intervals, confidence interval for mean (using z), confidence interval for mean using t	1
Estimation: confidence interval for difference in mean, confidence intervals for proportion	1

Estimation: required sample size, confidence interval vs prediction interval	1
Theory of estimation: unbiasaed estimators, maximum likelihood estimators	1
Hypothesis testing: concepts and terminology, testing a single mean (z and t)	1
Hypothesis testing: errors, power, 2-sample test, paired test, testing proportion	1
Hypothesis testing: Non-parametric tests for 2 samples	1
Comparing multiple means: one-way ANOVA	1
Theory of ANOVA	1
Regresion: least squares method	1
Partitioning of variability in regression, significance testing in regression	1
Chi-squared test for independence	1
Chi-squared goodness-of-fit	1

PHY401: Electricity, Magnetism, Special Relativity and Optics - 4 Credits	
Electricity and Magnetism	**No. of Lectures**
Coulomb's Law	18
Gauss's Law	
Electric Field, Potential	
Conductors, Insulators	
Laplace equation	
Curl and Stoke's theorem	

Capacitors, capacitance and energy stored in E field	
Current and continuity equation	
Magnetic field and Moving Charges	
Force on Moving charges	
Magnetic Field and vector potential	

relativity and E and B fields	
Induction	
Inductance and energy stored in B field	
RC circuits	
CL and RLC circuits	
Displacement current	
Complete Maxwell's Equations	
Electromagnetic Waves	
Dielectrics and Electric Dipoles	
Dielectrics	
Magnetic Dipoles	
Magnetism in Matter	
Special relativity	**No. of Lectures**
Space-time and simultaneity. Einstein axioms for special relativity. The Lorentz transformation.	2
Relativistic kinematics; length contraction, time dilation. Doppler effect. Twin paradox.	2
Relativistic dynamics. Mass-energy equivalence. Conservation of four-momentum. Centre of momentum frame. De Broglie waves and photons.	2
Einstein, the equivalence principle, gravity, gravitational lenses, gravitational waves (qualitative)	1
Nuclear reactions and thermonuclear power.	1
Optics- Applications and microscopy	**No. of Lectures**
Classical optics: Fermat's Principle	1
Fourier Optics: Huygens-Fresnel Principle	1
Fourier Optics: Fresnel diffraction integral	1
Fourier Optics: Paraxial approximation	1
Fourier Optics: Fraunhofer diffraction	1
Fourier Optics: Apertures and imaging	1
Fourier Optics: phase contrast imaging	1
Microscopy applications	4

Course code	CHM401	Chemistry-4 Structure and Properties	4 Credits	
Core/Elective/SBS		CORE PAPER		
			Syllabus Version	2023-24

Unit:1	Stereochemistry & Group Theory	08 L

Molecular shape and simple electronic structure, Isomerism: Orbitals, hybridization and shapes of molecules, sterochemical consequences of tetrahedral carbon (isomers, enantiomers, R/S, D/L, optical rotation).

Stereochemistry – optical activity: Molecules with more than one chiral centre (diastereomers, meso compounds, separation of racemic mixtures).

Stereochemistry and Reactions: Prochirality, chirality in Nature, Sterochemistry on atoms other than carbon, Retrosynthetic analysis. Stereochemistry and Mechanism (nucleophilic substitution, elimination from non-cyclic compounds).

Alkene addition reactions – Hydrogenation, halogenation, HX addition. Elimination Reactions epoxide ring forming reactions.

Zeeman effect: Effect on the energies of a system by application of a magnetic field; Magneto chemistry, spin and orbital contribution to the magnetic moment.

Symmetry operations and elements, Group theory: Definition of reducible and irreducible representations, Use of group theory to determine the irreducible representation, Assignment of point groups, Leading to definition of components of character tables (irreducible representations, characters – at least the interpretation of the sign of the character)

Simple applications, Label molecular shapes, isomers, Identify chiral molecules, Physical properties – *e.g.* dipole moment, possibleoptical isomers, Orbital symmetry labels (*e.g.* s, p & d orbitals in Td, Oh, D4h).

Unit:2	Magnetic resonance spectroscopies	08 L

EPR spectroscopy, hyperfine coupling application to organic radicals and to transition metal complexes.

Nuclear Magnetic Resonance (NMR), energies of nuclei in magnetic fields. Chemical shift and the δ scale, resonance of different nuclei, shielding, spin-orbit coupling and coupling constants, molecular symmetry. ^{13}C NMR, ^{1}H NMR, integration, multiplicity, chemical shift typical ranges - Introduction to molecular spectroscopy and spectroscopic transitions, absorbance, transmittance, the Beer-Lambert Law, intensities of spectroscopic transitions.

Quantised vibration and simply harmonic oscillator model, wave functions, Molecular vibrational modes, vibrational spectroscopy infrared and Raman spectroscopy 3N-5, 3N-6 vibrational degrees of freedom.

Unit:3	**Vibrational spectroscopy**	**06 L**

Vibrational symmetry and IR/Raman activity: Symmetry properties of the vibrational degrees of freedom and to deduce IR, Raman activity. Use of internal coordinates to get symmetry properties of a subset of bands.

Vibrational spectroscopy: Local mode approximation. Characteristic infrared absorptions (alkyl CH, alcohol, amine RN H2 and R2NH, carboxylic acid, amide, ester, ketone, aldehyde, nitrile RCN, alkyne, alkene, aromatic), fingerprint regions, interpretation of IR spectra.

Molecular orbital theory: Electronic spectroscopy requires understanding of electronic structure leading to Molecular orbital theory – HOMO. LUMO. Diatomic molecules, LCAO-MO, Symmetry of MO's.

Unit:4	**Photoelectron spectroscopy**	**08 L**

Generalisation of the application of MO approaches to polyatomic molecules. Hückel Theory-Aromatic and Heterocyclic Chemistry of compounds with delocalised p orbitals: Benzene and Aromaticity/Antiaromaticity, Reactions of Aromatic Compounds Electrophilic aromatic substitution. Reactions of Polycyclic and Heteroaromatic Compounds. Reactions via Aromatic Transition States Electrophilic aromatic substitution on naphthalene. Electrophilic aromatic substitution on heteroaromatics (*e.g.* pyridine and pyrrol). Non C-based aromatic systems.

Electronic spectroscopy: Chromophores and excited electronic states, electronic transitions, UV-Vis spectroscopy, Franck-Condon Principle, Franck-Condon factors - Fates of electronic excited states – fluorescence and phosphorescence, non- radiative transitions, internal conversion and

intersystem crossing, fluorescence spectra.

Applications – light emitting polymers

Unit:5	Organometallic chemistry	06 L

Types and broad applications of organometallic complexes and catalysts. Ligand types and examples. Group 1 (LiR) and group 2 (Grignard) and p-block chemistries. EPR spectroscopy as a tool to probe electron distribution in carbocyclic and organometallic species. Covalent interactions in coordination compounds – rationalisation of spectrochemical series in terms of bonding interactions Binary metal carbonyl complexes Synergistic bonding and the 18-electron rule. IR and NMR spectroscopy. Substitution at metal carbonyl. Other organometallic ligand types and complexes thereof. Alkyne and alkene complexes *etc*. Redox reaction in organometallic chemistry. Hydrogen complexes and oxidative addition reactions. Reductive elimination reactions. Activation and reactions of organometallic ligands. Insertions, migrations.

Catalysis involving transition metals: Catalytic systems. Water gas shift reaction, hydrogenations, acetic acid process etc. Metallocene complexes and their chemistry leading to advanced polymerization catalysts etc.

Student Work • Assignments, Tutorials • Reviews of various research papers, reports, books • Presentations	**09 L**

Recommended Books/references

1	OrganicChemistrybyJ.McMurray,7thEd.,Thomson,2008.
2	Carey,F.A.andSundberg,R.J.,"AdvancedOrganicChemistry,PartB:ReactionsandSynthesis", 5th Ed.,Springer.
3	PrinciplesofOrganicSynthesisbyR.Normanand J.M. Coxon, 3rd Ed., Chapman and Hall, 1993.
4	Organic Chemistry by Clayden,J.,Greeves,N.andWarren,S.,"OrganicChemistry",OxfordUniversityPress.
5	Smith,M.B.,"OrganicSynthesis",3rdEd.,AcademicPress.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1.	https://chem.libretexts.org/
2.	https://byjus.com/chemistry/
3.	https://openstax.org/details/books/chemistry-2e

BIO401: Genetics, Evolution and Ecology: 4 Credits	
Transmission Genetics	**No. of Lectures**
Genetic variation and behaviour of genes	3
Linkage and recombination; Mapping genes	2
Chromosome maps and genetic markers	1
Sex linkage and sex determination	2
Complementation	2
Chromosomal mutations	2
Non-Mendelian inheritance	1
Extrachromosomal DNA	2
Quantitative genetics	2
Population Genetics	**No. of Lectures**
Genetic variation in populations	2
Mutation and Genetic drift	1
Natural selection	1
Mutation/Selection balance	1
Balanced polymorphism	1

Gene flow & inbreeding	1
Population Biology	**No. of Lectures**
Nature of populations; numbers, mixing (dispersal), structure in age/stage	1
Density independent, density dependent growth (exponential and logistic growth equations)	2
R & K selection, life-histories and links to population growth parameters, (annual vs perennial life-histories, clonality)	1
Demography, Life tables, matrix models (requires simple matrix mathematics) and Epidemiology (simple functions)	1
Communities	**No. of Lectures**
Nature of communities; Community structure: how it is described, measured; what drives it; species composition, diversity (alpha, beta, gamma)	1
Intra-community (interspecific) interactions (bi-partite networks); Symbiosis, Predation, Competition, Host-parasite interactions	1
Dynamics of communities (perturbation and succession)	1
Biomes (communities on a global scale)	1
Ecosystems	**No. of Lectures**
Pond ecosystem (or other integrated example)	1
Food chains and webs	1
Pyramids (numbers, biomass, energy), abstraction, defining trophic levels, the problem of omnivory (stable isotope tracers)	1
Biogeochemical cycles (water, C, N, P) pools and fluxes, mass budget models. Rates of processes: productivity, decomposition, trophic transfer, turnover and Mean Residence Time.	1

PHY402: Physics Practical - 2 Credits

List of experiments

1. Verification of Stefan's Law by Electricalmethod.
2. Study of LR circuit.
3. Study of LCR circuit
4. To determine the self-inductance of the coil using Anderson’s bridge and calculatethe value of inductive reactance (X_L) of the coil at a particular frequency.
5. Measurement of wavelength of Laser by DiffractionGrating.
6. To determine the Wavelength of main spectral line of mercury light usingplanetransmissiongrating.

CHM402: Chemistry Practical - 2 Credits

List of Physical chemistry experiments (Any3)

1. Determination of the stability constant of a complex byspectrophotometry.
2. The reaction between potassium persulphate and potassium iodide bycolorimetry.
3. Determine the formula and stability constant of a metal ion complex (Lead Oxalate) by polarography.
4. Analysis of copper oxide and copper dioxide to determine law of multipleproportions.
5. Behaviour of water at differenttemperatures

List of Inorganic chemistry experiments (Any 3)

1. Photometric Analysis - To study complex formation between Fe (III) and salicylic acid and find the formula and stability constant of the complex.
2. Simultaneous determination of Cr+2 andCu+2
3. To determine the strength of given mixture of carbonate and bicarbonate in thegiven mixture by pH metric method.
4. Determination of chemical oxygen demand(COD)
5. Determination of Biological oxygen demand(COD)

List of Organic chemistry experiments

(Any 3)

1. **Organic Preparations: Double Stage**
    1. Glycine – Hydantoic acid – Hydantoin
    2. Benzoin – Benzil - Benzilicacid
    3. P-cresol – 4,6-Dimethylcoumarin – 3-Bromo-4,6 Dimethyl Coumarin
    4. Benzophenone – Oxime –Benzanilide
    5. Acetanilide – p-Bromoacetanilide –p-Bromoaniline
    6. Hydroquinone – Quinoline – 1,2,4 –Triacetoxybenzene.

BIO402: Biology Practical - 2 Credits

List of Experiments (Any 6)

1. Create an artificial mesocosm (tub/tank of defined area), and inoculate with Lemna./Azolla sp. (brought from nearby habitats). Monitor growth, density and biomass over time.
2. a) Visit different types of water bodies (one river/stream and one quarry/pond/lake) and conduct sampling. Sampling methods (point count/line transect/quadrat) in field. Learn methods
for estimating plant biomass (using GBH). (Field session)
3. Determination of population density in a natural community by quadrate method
4. Solving Genetic problems which obey Mendelian laws
5. Determination of linkage and cross-over analysis – Problem solving
6. Sex linked Inheritance in drosophila – problem solving
7. Analyze the Human karyotype chart for different genetic disorders
8. Use of ABO blood group data to calculate allele frequencies. (Data can be gathered both by interviews and by actual blood group determination)

VALUE ADDED4: GENERAL AWARENESS (2 CREDITS)

Course code - 4FE **Total Lecture Hours** **18 Hours**

Following are the areas which cover the various test items prescribed in the syllabus:

1. Verbal Aptitude
2. Numerical Aptitude
3. Abstract Reasoning
4. Tamil and Other Literature
5. General Science and Technology and Education
6. Computer
7. Economics and Commerce
8. Social Studies
9. Sports
10. Current Affairs

Textbook(s)

1. General Awareness, Bharathiar University

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://www.careerpower.in/gk-general-knowledge.html

Course Designed By: **Bharathiar University**

SEMESTER V

PHY501: Classical Mechanics

This course extends knowledge of fundamental thermal physics principles and introduces the powerful and elegant Lagrangian and Hamiltonian formulations of classical mechanics

PHY501: Classical Mechanics – 4 Credits	
Central force Problem	**No. of Lectures**
Nature of orbits in an attractive inverse square field	3
Kepler's laws of planetary motion. Rutherford scattering as an example of repulsive potential.	3
Mechanics of Ideal Fluids	**No. of Lectures**
Streamlines and flow lines; Equation of continuity; Euler's equation of motion;	3
Streamline motion - Bernoulli's equation and its applications. Definition of Newtonian and non-Newtonian fluids	3
Lagrangian and Hamiltonian formulation of Classical Mechanics	10
Generalized coordinates, constraints and degrees of freedom; D'Alembart's principle;	2
Lagrange's equation for conservative systems (from D'Alembert's principle; variational principle not required) and its application to simple cases	4
Generalized momentum; Idea of cyclic coordinates, its relation with conservation principles;	4
Definition of Hamiltonian, Hamilton's equation (derivation by Legendre transformation) and its application to simple cases.	4

REFERENCE BOOKS:

- Mechanics: C. Kittel, W.D. Knight, M.A. Ruderman, C.A. Helmholz and B.J.Moyer (2008) Berkeley Physics Vol 1, Tata McGraw-HillLtd
- Classical Mechanics: N. Rana and P. Joag (2001) Tata McGraw-HillEducation
- Classical Mechanics: J.R. Taylor (2005) University ScienceBooks
- Feynman Lectures in Physics, Vol I, Addison-Wesley.
- Classical Mechanics: H. Goldstein, C. Poole and J. Safko (2002) 3rd edition, Pearson
- Classical Dynamics of Particles and Systems: Thornton and Marion (2003)Thomson Learning EMEA Ltd

PHY502: Quantum Mechanics

Quantum mechanics plays a central role in our understanding of fundamental phenomena, primarily in the microscopic domain. It lays the foundation for an understanding of atomic, molecular, condensed matter, nuclear and particle physics.

PHY502: Quantum Mechanics – 4 Credits	
Time dependent and time independent Schrodinger equation	**No. of Lectures**
Eigenstates, normalization and orthonormality.	6
Simple applications of Quantum Mechanics	**No. of Lectures**
One dimensional potential well and barrier, boundary conditions, bound and unbound states.	2
Reflection and transmission coefficients for a rectangular barrier in one dimension – explanation of alpha decay.	4
Free particle in one dimensional box, box normalization, momentum eigen functions of a free particle	4
Linear harmonic oscillator, energy eigenvalues from Hermite differential equation, wave function for ground state, parity of wave function.	2
Schrodinger equation in spherical polar coordinates	**No. of Lectures**
Angular momentum operators and their commutation relations;	2
eigenvalues and eigen functions of L2 and Lz; theorem of addition of angular momenta [statement with examples].	6
The hydrogen atom problem – stationary state wave functions as simultaneous eigen functions of H, L2, and Lz;	5
radial Schrodinger equation and energy eigenvalues [Laguerre polynomial solutions to be assumed]; degeneracy of the energy eigenvalues.	5

REFERENCE BOOKS:

- Quantum Physics: S. Gasiorowicz (2003) 3rd edition, Wiley IndiaEdition
- Quantum Physics: E.H. Wichman (2008) Berkeley Physics Course, Vol 4, Tata McGraw-Hill Ltd
- Introduction to Quantum Mechanics, David J. Griffiths, PearsonEducation
- Introductory Quantum Mechanics, Richard Liboff, Addison-Wesley; 4edition
- A Modern Approach to Quantum Mechanics, John Townsend, VivaBooks
- Principles of Quantum Mechanics: R. Shankar (2010) 2nd edition,Springer

PHY503: Solid State Physics

Solid State Physics explains how the macroscopic properties of solids result from atomic scale properties. Solid State Physics forms the theoretical basis of Materials Science

PHY503: Solid State Physics – 4 Credits	
Crystal Structure	**No. of lectures**
Crystalline and amorphous solids, translational symmetry	2
Elementary ideas about crystal structure, lattice and bases, unit cell, reciprocal lattice	3
fundamental types of lattices, Miller indices, lattice planes, simple cubic, f.c.c. and b.c.c. lattices	5
Laue and Bragg equations. Determination of crystal structure with X-rays.	2
Elementary band theory	**No. of lectures**
Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. Effect of concentration and temperature on fermi level.	6
Dielectric properties of materials	**No. of lectures**
Electronic, ionic and dipolar polarizability, local fields, induced and oriented polarization – molecular field in a dielectric; Clausius-Mosotti relation.	4
Magnetic properties of materials	**No. of lectures**
Dia, para and ferro-magnetic properties of solids. Langevin's theory of diamagnetism and paramagnetism. Quantum theory of paramagnetism, Curie's law. Ferromagnetism: spontaneous magnetization and domain structure; temperature dependence of spontaneous magnetisation; Curie-Weiss law, explanation of hysteresis.	8
Superconductivity	**No. of lectures**
Introduction (Kamerlingh-Onnes experiment), effect of magnetic field, Type-I and type-II superconductors, Isotope effect. Meissner effect. Heat capacity. Energy gap. Ideas about High-Tc superconductors	5

REFERENCE BOOKS:

- Solid State Physics: N.W. Ashcroft and N.D. Mermin (1976) College edition, Harcourt College Publishers
- Introduction to Solid State Physics: C. Kittel (2004) 8th edition, John Wiley and Sons
- Atomic and Electronic Structure of Solids, E. Kaxiras; Cambridge University Press.

PHY504: Electrodynamics

Introduction to electrodynamics and a wide range of applications including communications, superconductors, plasmas, novel materials, photonics and astrophysics

PHY504: Electrodynamics – 4 Credits	
Generalization of Ampere's Law	**No. of lectures**
Displacement Current, Maxwell's Field Equations, Wave equation for electromagnetic (EM) field and its solution	4
plane wave and spherical wave solutions, transverse nature of field, relation between E and B; energy density of field, Poynting vector and Poynting's theorem, boundary conditions	4
EM Waves in an isotropic dielectric	**No. of lectures**
Wave equation, reflection and refraction at plane boundary, reflection and transmission coefficients	4
Fresnel's formula, change of phase on reflection, polarization on reflection and Brewster's law, total internal reflection.	4
EM waves in conducting medium	**No. of lectures**
Wave equation in conducting medium, reflection and transmission at metallic surface – skin effect and skin depth,	3
propagation of E-M waves between parallel and conducting plates – wave guides (rectangular only)	5
Dispersion	**No. of lectures**
Equation of motion of an electron in a radiation field : Lorentz theory of dispersion – normal and anomalous	2
Sellmeier's and Cauchy's formulae, absorptive and dispersive mode, half power frequency, band width.	6
Scattering	**No. of lectures**
Scattering of radiation by a bound charge, Rayleigh's scattering (qualitative ideas), blue of the sky, absorption.	4

REFERENCE BOOKS:

- Electricity and Magnetism: E.M. Purcell (2008) Berkeley Physics Course, Vol2, Tata McGraw-Hill Ltd
- Feynman Lectures on Physics: R.P. Feynman, R.B. Leighton and M. Sands (2011) The Millenium edition, Vol 2, Basic Books
- Introduction to Electrodynamics: D.J. Griffths (2012) Pearson Education
- Modern Electrodynamics: A. Zangwill (2013) Cambridge University Press

PHY- 505: ELECTIVE 1-Introduction to Astrophysics

The course defines and analyzes the basic concepts in astronomy. Describes the working principle of the telescope. Identifies important constellations – orient in space. Describes the planets of the solar system and their properties. Interprets the phenomena in the Universe. Describes and understand the physical processes in the Sun and other stars.

PHY505: Introduction to Astrophysics – 2 Credits	
Astronomical Scales	**No. of lectures**
Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature. Astronomical techniques: Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space	4
Telescopes, Detectors and Their Use with Telescopes	**No. of lectures**
(Types of Detectors, detection Limits with Telescopes). The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology). The solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets.	6
Stellar spectra and classification Structure	**No. of lectures**
(Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification)	2
The milky way	**No. of lectures**
Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way(Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the UGC Document on LOCF Physics 189 Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus.	6
Galaxies	**No. of lectures**
Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms	6

REFERENCE BOOKS

- Galaxies in the Universe: An Introduction: L.S. Sparke and J.S. Gallagher III(2000) Cambridge University Press
- Galactic and Extragalactic Radio Astronomy: G.L. Verschuur and K.I. Kellermann (1988) Springer-Verlag
- The Physics of Stars (Manchester Physics Series): A.C. Phillips (1999) John Wiley &Sons

PHY-506: ELECTIVE 2- Nanotechnology

This course will enable students to have the knowledge of syntheses and characterization of nanomaterials. It also highlights the applications and significance of nanotechnology in terms of their properties.

PHY506: Nanotechnology – 2 Credits	
Nanoscale systems	**No. of lectures**
Length scales in physics, Nanostructures: 1D, 2D and 3Dnanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1Dnanostructures and its consequences	4
Synthesis and Characterization of nanostructure materials	**No. of lectures**
Top down and Bottom up approach, Photolithography. Ball milling. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. X-Ray Diffraction. Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunnelling Microscopy.	4
Optical properties	**No. of lectures**
Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi- particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasiparticles and excitons, charging effects. Radiative processes: General formalization- absorption, emission and luminescence. Optical properties of heterostructres and nanostructures.	8
Applications	**No. of lectures**
Applications of nanoparticles. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).	8

REFERENCE BOOKS:

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
- K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
- M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
- Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
- Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

PHY507: Physics Lab I - 2 Credits

1. Verification of Hall Effect.
2. Hysteresis Loop, coercivity, saturation magnetization.
3. Susceptibility of Paramagnetic Materials by Quincke's Tube method.
4. Michelson Interferometer with He-Ne Laser.

PHY508: Physics Lab II (Analog and digital) - 2 Credits

1. Characteristics of p-n Junction diode
2. Characteristics of transistor in forward and reverse bias.
3. Characteristics of Zener diode.

PHY509: Research Project work - - 2 Credits

Combination of experimental and theoretical aspects of a problem. Perform experiment, collect data, analyze with various tools and software. Derive conclusion (positive or negative) from the work and summarize the report in form of dissertation in the VI semester

SEMESTER VI

PHY601: Statistical Physics

Statistical mechanics, the microscopic basis of classical thermodynamics, is developed in this subject. It is one of the core areas of physics, finding wide application in solid state physics, astrophysics, plasma physics and cosmology. Using fundamental ideas from quantum physics, a systematic treatment of statistical mechanics is developed for systems in equilibrium

PHY601: Statistical Physics- 4 Credits	
Microstates and macrostates	**No. of lectures**
Classical description in terms of phase space and quantum description in terms of wave functions.	1
Hypothesis of equal a priori probability for microstates of an isolated system in equilibrium. Interactions between two systems – thermal, mechanical and diffusive.	3
Statistical definition of temperature, pressure, entropy and chemical potential. Partition function of a system in thermal equilibrium with a heat bath	3
Classical statistical mechanics	**No. of lectures**
Maxwell-Boltzmann distribution law. Calculation of thermodynamic quantities for ideal monoatomic gases. Ergodic hypothesis and Liouville theorem and Ideal gases (monoatomic and diatomic): Translational, rotational, vibrational, electronic partition functions, thermodynamic functions	10
Motivations for quantum statistics	**No. of lectures**
Gibbs' paradox. Identical particle and symmetry requirement. Derivation of MB, FD and BE statistics as the most probable distributions (micro-canonical ensemble). Classical limit of quantum statistics.	6
Quantum statistical mechanics	**No. of lectures**
Bose-Einstein statistics: Application to radiation – Planck's law. Rayleigh Jeans and Wien laws as limiting cases, Stefan's law.	8
Fermi-Dirac statistics: Fermi distribution at zero and non-zero temperatures	7

REFERENCE BOOKS:

- Statistical Mechanics: K. Huang (1987) 2nd edition,Wiley
- Fundamental of Statistical and Thermal Physics: F. Reif (2008) Waveland PrInc
- Statistical Physics of Particles: Mehran Kardar (2007) Cambridge UniversityPress
- Statistical Physics- Reif-(2008)) Berkeley Physics Course, Vol 5, Tata McGraw-Hill Ltd

PHY602: Subatomic Physics

This course intends to develop familiarity with the vast areas of nuclear and particle physics as well as develop an interest in these subjects. It also helps students acquire knowledge in the content areas of nuclear and particle physics, focusing on concepts that are commonly used in this area

PHY602: Subatomic Physics -4 Credits	
Bulk properties of nuclei and Nuclear structure	**No. of lectures**
Nuclear mass, charge, size, binding energy, spin and magnetic moment. Isobars, isotopes and isotones; mass spectrometer. Nature of forces between nucleons, nuclear stability and nuclear binding, the liquid drop model (descriptive) and the Bethe-Weizsacker mass formula, application to stability considerations, extreme single particle shell model (qualitative discussion with examples)	2
Unstable nuclei and Nuclear Reactions	**No. of lectures**
Alpha decay : alpha particle spectra – velocity and energy of alpha particles. Geiger-Nuttal law. Beta decay : nature of beta ray spectra, the neutrino, energy levels and decay schemes, positron emission and electron capture, selection rules, beta absorption and range of beta particles, Kurie plot. Gamma decay : gamma ray spectra and nuclear energy levels, isomeric states. Gamma absorption in matter – photoelectric process, Compton scattering, pair production (qualitative)	2
Conservation principles in nuclear reactions. Q-values and thresholds, nuclear reaction cross-sections, examples of different types of reactions and their characteristics. Bohr's postulate of compound nuclear reaction, Ghoshal's experiment.	2
Nuclear fission and fusion	**No. of lectures**
Discovery and characteristics, explanation in terms of liquid drop model, fission products and energy release, spontaneous and induced fission, transuranic elements. Chain reaction and basic principle of nuclear reactors. Nuclear fusion: energetics in terms of liquid drop model.	6
Elementary particles	**No. of lectures**
Four basic interactions in nature and their relative strengths, examples of different types of interactions. Quantum numbers -mass, charge, spin, isotopic spin, intrinsic parity, hypercharge. Charge conjugation. Conservation laws. Classifications of elementary particles – hadrons and leptons, baryons and mesons, elementary ideas about quark structure of hadrons – octet and decuplet families. Particle Accelerator and Detector Cyclotron – basic theory, synchrotron, GM counter	18

REFEENCE BOOKS:

- Nuclear Physics – Cottingham and Greenwood (Cambridge UniversityPress).
- Concepts of Nuclear Physcics – R. Cohen (Tata-Mc GrawHill).
- Paramanu o KendrakGathan Parichay – S. N. Ghoshal(WBSBB).
- Atomic and Nuclear Physics – S. N. Ghoshal (S.Chand).
- Nuclear Physics – S. B. Patel (New Age).
- Nuclei and Particles – E. Segre (Benjamin).
- Nuclear Physics: Principles and applications – J.S. Lilley (Willey Eastern).
- Fundamentals in Nuclear Physics: from Nuclear Structure to Cosmology – J. Basdevant, J. Rich
  and M. Spiro (Springer).
- Particle Physics – Seiden (Persian Education)

PHY603: Atomic and Molecular Spectroscopy and Lasers

This course intends to throw light on the phenomenon of the interaction of light with matter in terms of the relationship with the molecular structure. The course will enable students to select molecular spectroscopy methods suitable for solving given scientific problem.

PHY603: Atomic and Molecular Spectroscopy and Lasers - 4 Credits	
Atomic Spectroscopy	**No. of lectures**
LS and JJ coupling schemes. Terms for equivalent and non-equivalent electron atom. Spectra of one and two electron systems. Electron spin, spin orbit interaction, fine structure, relativistic correction and radiation correction (Lamb Shift). Electric dipole selection rules. Intensity rules. Alkali type spectra. Zeeman effect. Paschen-Back effect. Stark effect. Hyperfine structure and isotopic shifts. Complex Spectra: Vector model for three or more valence electrons. Inverted terms. Compound doublet. Inner-Shell Excitation and Auto ionization, Line intensities, Transition probabilities, oscillator strength. Forbidden transitions.	15
Molecular Spectroscopy	**No. of lectures**
Rotational spectra of diatomic molecules. Vibrational spectra of diatomic molecules. Rotation- Vibration spectra of diatomic molecules. Classification of electronic states. Electronic spectra of diatomic molecules. Franck-Condon principle. Rotational spectra of linear polyatomic molecules: Coriolis interaction and effect of l-type doubling in linear molecules. Nuclear spin statistical weights and their effect on intensities. Rotational spectra of symmetric (prolate and oblate) molecules. Vibration-rotation spectra of polyatomic molecules: Parallel and perpendicular bands of linear molecules and symmetric top (prolate and oblate) molecules.	15
Spectroscopy (elementary and qualitative)	**No. of lectures**
Experimental techniques in spectroscopy: FTIR Raman, Stoke's antiStoke's.	3
Laser Physics Spectroscopy(elementary and qualitative)	3

REFERENCE BOOKS:

- Eisberg, R. and Resnick, R., Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, II Edition, John Wiley,1985
- Banwell, C.N., Fundamentals of Molecular Spectroscopy, III Edition, Tata-McGraw Hill,1972
- Wilson, J. and Hawkes, J. F. B., Optoelectronics- An Introduction, Prentice Hall,1983

PHY604: Digital and Analog Electronics

This course is designed for students to know the operation and the structure of switching circuits, use and working of diodes and transistors as a switching circuits, logic families, TTL, ECL, and MOSFET and amplifiers etc

PHY604: Digital and Analog Electronics -4 Credits	
Digital Circuits	**No. of lectures**
Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and transistors)	4
De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Minterms and	5
Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.	
Binary Addition. Binary Subtraction using 2's Complement Method). Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor.	4
Semiconductor Devices and Amplifiers:	**No. of lectures**
Semiconductor Diodes: P and N type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.	5
Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Active, Cutoff & Saturation regions Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line & Q-point. Voltage Divider Bias Circuit for CE Amplifier. h-parameter Equivalent Circuit. Analysis of single-stage CE amplifier using UGC Document on LOCF Physics 233 hybrid Model. Input & output Impedance. Current, Voltage and Power gains. Class A, B & C Amplifiers	12
Operational Amplifiers (Black Box approach):	**No. of lectures**
Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop and closed-loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Zero crossing detector.	6

Sinusoidal Oscillators: Barkhausen's Criterion for Self-sustained Oscillations. Determination of Frequency of RC Oscillator	

REFERENCEBOOKS:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronic devices & circuits, S. Salivahanan & N.S. Kumar, 2012, Tata Mc-Graw Hill
- Microelectronic Circuits, M.H. Rashid, 2nd Edn., 2011, Cengage Learning.
- Modern Electronic Instrumentation and Measurement Tech., Helfrick and Cooper,1990, PHI Learning
- Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw Hill
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.

PHY605: ELECTIVE 3- Renewable Energy and Energy Harvesting

This course enables the students to outline the principles of energy harvesting systems as well as methods of electro-mechanical conversion, principle of photovoltaic cells and thermoelectric generators. They will be able to describe the physical principles of energy harvesting methods mainly electro-mechanical conversion and simulation modeling of such mechatronic systems.

PHY605: Renewable Energy and Energy Harvesting **- 2 Credits**	
Fossil fuels and Alternate Sources of energy	**No. of lectures**
Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity	3
Solar energy	**No. of lectures**
Its importance, storage of solar energy, solar pond, no convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption	3
Ocean Energy, Hydro Energy and Geothermal Energy	**No. of lectures**
Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. (3 Lectures) Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. (2 Lectures) Geothermal Resources, Geothermal Technologies. Hydropower resources, hydropower technologies, environmental impact of hydro power sources	6
Piezoelectric Energy harvesting	**No. of lectures**
Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric Energy harvesting applications, Human power	4
Electromagnetic Energy Harvesting	**No. of lectures**
Electromagnetic Energy Harvesting	2
Linear generators, physics mathematical models, recent applications	2
Environmental issues and Renewable sources of energy, sustainability.	2

REFERENCE BOOKS:

- Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
- Solar energy - M P Agarwal - S Chand and Co. Ltd.
- Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
- Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004,Oxford University Press, in association with The Open University.
- Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook,2009
- J.Balfour, M.Shaw and S. Jarosek, Photo voltaics, Lawrence J Goodrich (USA).
- http://en.wikipedia.org/wiki/Renewable_energy

PHY606: ELECTIVE 4 -Introductory Biophysics

This course will enable students to define the fundamental concepts of biophysics. The course explains the integration of physical theory into biological processes

PHY606: Introductory Biophysics - **2 Credits**	
Thermodynamics of living systems	**No. of lectures**
Conservation of energy in living systems, Entropy and Life, Gibbs and Standard free energy, Equilibrium constant, Coupled reactions.	2
Dynamics of biomolecules	**No. of lectures**
Diffusion, Laws of diffusion, Active transport, facilitated diffusion, Osmosis, Osmotic pressure, Osmoregulation, Viscosity and biological importance, Surface tension, Factors influencing surface tension, Biological importance.	4
Atomic & Molecular structure	**No. of lectures**
Structure of atom-Models & theories, Periodic table, Concept of bonding; valence of carbon; hybridizations of carbon; hybridizations of nitrogen & oxygen; molecular orbital theories, polar & non polar molecules; inductive effect; Secondary bonding: weak interactions, hydrogen bonding; dipole-dipole & dipole induced dipole interactions; London dispersion forces. Bonds within molecules-Ionic, covalent, Hydrogen, Electrostatic, Disulphide& peptide bonds, Van-der Waals forces Bond lengths & Bond energies, Bond angles, Structural isomerism; optical isomerism & optical activity.	8
Physico-chemical Foundations	**No. of lectures**
Biophysics of Water: Physicochemical properties of water, Molecular structure, Nature of hydrophobic interactions, Water Structure. Small-Molecule Solutes: Hydrophiles, Hydrophobes, Large Hydrophobic Solutes and Surfaces, Aqueous Environment of the Cell, State of water in bio- structures & its significance, Protein Hydration-Nonspecific Effects, The Hydration Shell. Acid	12
& Bases: Acid-Base theories, Mole concept, Molarity, Molality & Normality, Ampholyte, concept of pH, measurements of pH , Henderson–Hasselbatch equation , Titration curve & pK values, Buffers & Stability of their pH , numerical problems. Redox potential : Oxidation –Reduction, examples of redox potential in biological system	

REFERENCES BOOKS:

- Biochemistry by Voet and Voet
- Biological Thermodynamics by Donald T.Haynie
- Introductory Biophysics by J. R. Claycomb and J.Q.P.Tran
- Molecular and Cellular Biophysics by Meyer B.Jackson

PHY607- Physics Lab I - 2 Credits

1. Determine Planck's constant using Photo Vacuum Tube.
2. Refractive index of transparent material.
3. Study of Zeeman Effect.
4. G M counting set up for radioactive experiments.

PHY608- Physics Lab II (Analog and digital) - 2 Credits

1. Verification of Logic Gates.
2. Charging and Discharging of Capacitor.
3. Verification of Kirchhoff's law.
4. Solar Power Lab

PHY609- Research Project work - 2 Credits

Combination of experimental and theoretical aspects of a problem. Perform experiment, collect data, analyze with various tools and software. Derive conclusion (positive or negative) from the work and summarize the report in form of dissertation in the VI semester.