VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ADVANCED SCIENCES
DEPARTMENT OF PHYSICS

Integrated
M.Sc Physics
(IMSP)

Curriculum & Syllabi

(2021-2022 Admitted Students)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

- **World class Education**: Excellence in education, grounded in ethics and critical thinking, for improvement of life.
- **Cutting edge Research**: An innovation ecosystem to extend knowledge and solve critical problems.
- **Impactful People**: Happy, accountable, caring and effective workforce and students.
- **Rewarding Co-creations**: Active collaboration with national & international industries & universities for productivity and economic development.
- **Service to Society**: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF SCHOOL OF ADVANCED SCIENCES

To be an internationally renowned science school in research and innovation by imparting futuristic education relevant to the society.

MISSION STATEMENT OF SCHOOL OF ADVANCED SCIENCES

- To nurture students from India and abroad by providing quality education and training to become scientists, technologists, entrepreneurs and global leaders with ethical values for a sustainable future.

- To enrich knowledge through innovative research in niche areas.

- To ignite passion for science and provide solutions for national and global challenges.

Integrated M.Sc. Physics

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be practitioners and leaders in their chosen field.
2. Graduates will function in their profession with social awareness and responsibility.
3. Graduates will interact with their peers in other disciplines in their work place and society and contribute to the economic growth of the country.
4. Graduates will be successful in pursuing higher studies in their chosen field.
5. Graduates will pursue career paths in teaching or research.

Integrated M.Sc. Physics

PROGRAMME OUTCOMES (POs)

PO_01: Having a clear understanding of the subject related concepts and of contemporary issues.

PO_02: Having an ability to design and conduct experiments, as well as to analyze and interpret data.

PO_03: Having an ability to use techniques, skills, and modern tools necessary for solving scientific problems.

PO_04: Having problem solving ability- solving social issues and societal problems having cross cultural competency exhibited by working in teams.

PO_05: Having adaptive thinking and adaptability.

PO_06: Having a clear understanding of professional and ethical responsibility.

PO_07: Having cross cultural competency exhibited by working in teams.

PO_08: Having a good working knowledge of communicating in English.

PO_09: Having a good cognitive load management [discriminate and filter the available data] skills.

PO_10: Having interest in lifelong learning.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of the Integrated M.Sc. Physics (5yr.) Programme, graduates will be able to

PSO_01: Develop a multi-disciplinary approach for solving real life problems through various foundational core courses.

PSO_02: Hone the basic concepts in various areas of Physics through discipline core courses for quantitatively understanding the various phenomena observed in nature.

PSO_03: Perform experiments in foundational and discipline core courses with appropriate analysis for proper interpretation of results.

PSO_04: Independently carry out research/ investigation to solve practical problems/write and present a substantial technical report/document.

CATEGORY-WISE CREDIT DISTRIBUTION

Category	B. Sc.	B. Sc. (Hons)	B. Sc. (Research)	M. Sc.
Foundation Core Courses	47	47	47	50
Discipline Core Courses	36	52	52	68
Discipline Elective Courses	27	36	36	45
Ability Enhancement Compulsory Courses	9	9	9	9
Skill Enhancement Courses	4	4	4	8
Open Elective Courses	0	6	0	6
Project/Capstone Project	0	6	12	14
Total Requirement	**123**	**160**	**160**	**200**

DETAILED CURRICULUM

Foundation Core

S.No.	Course Code	Subject	L	T	P	C
1	TBIT101L	Biological Sciences	3	0	0	3
2	TBIT101P	Biological Sciences Lab	0	0	2	1
3	TCHY102L	Inorganic and Organic Chemistry	3	0	0	3
4	TCHY102P	Inorganic and Organic Chemistry Lab	0	0	2	1
5	TCHY103L	Physical and Analytical Chemistry	3	0	0	3
6	TCHY103P	Physical and Analytical Chemistry	0	0	2	1
7	TCSE103L	Programming in Python	2	0	0	2
8	TCSE103P	Programming in Python Lab	0	0	4	2
9	TCSE104L	Structured and Object Oriented Programming	2	0	0	2
10	TCSE104P	Structured and Object Oriented Programming Lab	0	0	4	2
11	THUM101L	Ethics and Values	2	0	0	2
12	TMAT103L	Calculus and Analytical Geometry	3	0	0	3
13	TMAT103P	Calculus and Analytical Geometry Lab	0	0	2	1
14	TMAT104L	Ordinary and Partial Differential Equations	3	1	0	4
15	TMGT401L	Principles of Management	3	0	0	3
16	TPHY102L	Physics of Waves	3	0	0	3
17	TPHY102P	Physics of Waves Lab	0	0	2	1
18	TPHY103L	Modern Physics	3	0	0	3
19	TPHY103P	Modern Physics Lab	0	0	2	1
20	TRES101L	Research Methodology	3	0	0	3
21	TSSC201L	Critical thinking	2	0	0	2
22	TSSC202L	Intra and Interpersonal Skills	2	0	0	2
23		Foreign Language	2	0	0	2

DETAILED CURRICULUM

Foreign Language Basket

S.No.	Course Code	Subject	L	T	P	C
1	TARB101L	Arabic	2	0	0	2
2	TCHI101L	Chinese I	2	0	0	2
3	TESP101L	Spanish	2	0	0	2
4	TFRE101L	French I	2	0	0	2
5	TGER101L	German I	2	0	0	2
6	TGRE101L	Modern Greek	2	0	0	2
7	TITL101L	Italian	2	0	0	2
8	TJAP101L	Japanese	2	0	0	2
9	TKOR101L	Basic Korean I	2	0	0	2
10	TKOR102L	Basic Korean II	2	0	0	2

DETAILED CURRICULUM

Discipline Core

S.No.	Course Code	Subject	L	T	P	C
1	TCHY407L	Electro and Surface Analytical Techniques	3	0	0	3
2	TPHY201L	Mechanics	3	1	0	4
3	TPHY201P	Mechanics Lab	0	0	4	2
4	TPHY203L	Solid State Physics	3	1	0	4
5	TPHY204P	Materials Science Lab	0	0	4	2
6	TPHY205L	Heat and Thermodynamics	3	0	0	3
7	TPHY301L	Mathematical Physics	3	1	0	4
8	TPHY302L	Electricity and Magnetism	3	1	0	4
9	TPHY303L	Analog & Digital Electronics	3	0	0	3
10	TPHY304P	Electronics Lab	0	0	4	2
11	TPHY305L	Advanced Mathematical Physics	3	1	0	4
12	TPHY306L	Optics & Spectroscopy	3	1	0	4
13	TPHY401L	Classical Mechanics	3	1	0	4
14	TPHY402L	Principles of Quantum Mechanics	3	1	0	4
15	TPHY403L	Statistical Mechanics	3	1	0	4
16	TPHY404L	Laser Physics	3	0	0	3
17	TPHY405P	Advanced Physics Lab	0	0	4	2
18	TPHY406L	Advanced Quantum Mechanics	3	1	0	4
19	TPHY407L	Condensed Matter Physics	3	1	0	4
20	TPHY408L	Electromagnetic Theory	3	1	0	4
21	TPHY409P	Laser and Photonics Lab	0	0	2	1
22	TPHY410P	Computational Physics Lab	0	0	4	2

DETAILED CURRICULUM

Discipline Elective

S.No.	Course Code	Subject	L	T	P	C
1	TPHY206L	Properties of Matter	3	1	0	4
2	TPHY207L	Sound and Acoustics	3	1	0	4
3	TPHY307L	Semiconductor Device Physics	3	0	0	3
4	TPHY308L	Physics of Nanoscale	3	0	0	3
5	TPHY309L	Physics and Technology of Thin Films	3	0	0	3
6	TPHY310L	Physics of Superconductors	3	0	0	3
7	TPHY390J	Study Project	0	0	0	3
8	TPHY392J	Design Project	0	0	0	3
9	TPHY393J	Laboratory Project	0	0	0	3
10	TPHY397J	Special Project	0	0	0	3
11	TPHY411L	Nuclear and Particle Physics	3	1	0	4
12	TPHY412L	Microprocessor and Microcontroller	3	0	0	3
13	TPHY413L	Electronic Instrumentation	3	0	0	3
14	TPHY414L	Quantum Optics	3	0	0	3
15	TPHY415L	Quantum Information Theory	3	0	0	3
16	TPHY416L	Functional Materials	3	0	0	3
17	TPHY417L	Fiber and Nonlinear Optics	3	0	0	3
18	TPHY418L	Characterization of Materials	3	0	0	3
19	TPHY419L	Ferroelectrics and Dielectrics	3	0	0	3
20	TPHY420L	Crystal Growth Techniques	3	0	0	3
21	TPHY421L	Statistical Studies of Complex System	3	0	0	3
22	TPHY422L	Applied Solid State Physics	3	0	0	3
23	TPHY424L	Physics of Renewable Energy Systems	3	0	0	3
24	TPHY425L	Molecular Simulation	3	0	0	3
25	TPHY426L	Fluid Dynamics and Plasma Physics	3	0	0	3

DETAILED CURRICULUM

Ability Enhancement Compulsory Courses

S.No.	Course Code	Subject	L	T	P	C
1	TCHY140L	Environmental Studies	3	0	0	3
2	TENG101L	Effective English Communication	0	0	4	2
3	TENG102L	Technical English Communication	2	0	0	2
4	TENG102P	Technical English Communication Lab	0	0	2	1
5	TENG103P	Technical Report Writing	0	0	2	1

Skill Enhancement Courses

S.No.	Course Code	Subject	L	T	P	C
1	TCSE201E	Programming in Java	3	0	2	4
2	TEEE201P	Electrical workshop	0	0	4	2
3	TPHY202P	Analytical Instrumentation Lab	0	0	4	2

Ability Enhancement Compulsory Courses

S.No.	Course Code	Subject	L	T	P	C
1	TCHY140L	Environmental Studies	3	0	0	3
2	TENG101L	Effective English Communication	0	0	4	2
3	TENG102L	Technical English Communication	2	0	0	2
4	TENG102P	Technical English Communication Lab	0	0	2	1
5	TENG103P	Technical Report Writing	0	0	2	1

Foundation core

TBIT101L	Biological Science	L	T	P	C
		3	0	0	3
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. Recall the understanding of origin and diversity of biological beings
2. Contrast the fundamental concepts of organization and principles of living systems
3. Illustrate the basic concepts of heredity

Course Outcomes

1. Relate the basic concepts of biology including diversity, evolution and ecology
2. Demonstrate the structural and functional organization of the cell
3. Analyze the biological flow of information at the molecular level
4. Outline the metabolic pathways governing cellular function
5. Distinguish the organismal complexities in animals and plants
6. Interpret the genetic basis of hereditary traits and diseases

Module:1	**Origin and Diversity of Living Systems**	**7 hours**

Basis of life – diversification of life including viruses, Chemical basis of life – early origin of life experiments, Concept of evolution and natural selection, Levels of ecological study, Biotic and abiotic factors in ecosystem

Module:2	**The Cellular System**	**6 hours**

Cell as fundamental unit of life, Structure of a prokaryotic cell, Structure of a eukaryotic cell, Cell division – mitosis and meiosis

Module:3	**Molecules of Life**	**6 hours**

Structures and functions of biomolecules – carbohydrates, lipids, nucleic acids, and proteins

Module:4	**Metabolic Systems**	**6 hours**

Redox reactions, ATP energy coupling, Glycolysis, TCA cycle, Electron transport chain and ATP-synthesis

Module:5	**Molecular Information**	**6 hours**

Central dogma of molecular biology, DNA and genetic code, Replication, Transcription, Translation

Module:6	**Overview of Plant and Animal Systems**	**6 hours**

Plant forms and functions, Plant cells and tissue systems, Animal forms and functions, Animal tissues, organs, and systems, Animal homeostasis

Module:7	**Genetics and Heredity**	**6 hours**

Mendel's experiment – monohybrid cross and dihybrid cross, Linkage and crossing over, Mendel's laws of inheritance, Genetics of human diseases

Module:8	**Contemporary issues**	**2 hours**

Lecture by Industry Experts

	Total Lecture hours:	**45 hours**

Text Book

1. Freeman S, Quillin K, Allison L, Black M, Taylor E, Biological Science, 2017, 6th edition Prentice Hall, USA

Reference Books

1. Urry LA, Cain ML, Wasserman SA, Minorsky PV, Orr R, Campbell Biology, 2021, 12th edition,. Pearson Publisher, USA
2. Enger ED, Ross FC, Bailey DB, Concepts in Biology, 2017, 14th edition, Tata McGraw-Hill Publishing Co Ltd, India

Mode of Evaluation: CAT, Assignment, Quiz, and FAT

Recommended by Board of Studies	30-06-2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TBIT101P	Biological Science Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. To develop a basic understanding and practical knowledge of biological beings, their constituents and their functionalities.

Course Outcome

1. Able to interprete the structure-function relationships in biological beings and their constituents.

Indicative Experiments

1.	Principles and handling of microscope and studying the diversity of cells using permanent slides (morphology of bacteria, fungi and algae)	2-4 hours each experiments
2.	Identifying bacteria through Gram's staining	--do--
3.	Study of mitotic stages in onion roots	--do--
4.	Extraction of eukaryotic DNA	--do--
5.	Quantitative estimation of protein	--do--
6	Qualitative assay of salivary amylase	--do--
7	Rate of photosynthesis in plant	--do--
8	Tissue and organ structures in animal and plant from permanent slides	--do--
9	Testing Mendelian ratio by Chi square test	--do--
10	Human genetic variation study in facial feature in the class group	--do--
	Total Laboratory Hours	**30**

Mode of assessment: Continuous assessment, FAT and Oral examination

Recommended by Board of Studies	30-06-2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TCHY102L	Inorganic and Organic Chemistry	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

The course is aimed at

1. Imparting the knowledge on the structure, bonding and reaction mechanisms of inorganic and organic compounds.
2. Making the students to understand stereochemistry and conformational aspects in molecular level with three dimensional perspective which enables to understand reaction mechanism

Course Outcome:

At the end of the course, the students should be able to

1. Understand the basics of atomic structure and the periodic properties.
2. Discuss bonding characteristics of inorganic compounds.
3. Analyse various theories to understand bonding in inorganic compounds.
4. Examine the electronic effects of organic compounds.
5. Relate the concepts of bonding isomerism and stereochemistry.
6. Utilize the concepts of hybridization in different hydrocarbons.

Module:1	**Atomic Structure and periodic properties**	**6 hours**

Electronic configuration - filling of orbitals - stability of filled and semi filled orbitals - shapes and energy of atomic orbitals. Quantum numbers - Bohr's model of atom-Heisenberg uncertainty principle-Pauli's exclusion principle, Hund's rules maximum multiplicity- Aufbau principle. Periodic Properties-Atomic radii, ionic radii, covalent radii-ionisation potential-electronegativity and electron affinity.

Module:2	**Chemical Bonding**	**6 hours**

Types of bonding, Ionic Bond-conditions for bond formation-energetics of NaCl formation-Born-Haber cycle, hydration and lattice energies, Fajan's rule. Covalent bond-Conditions for bond formation-bond polarity-overlap of orbitals-bond length and energies-hybridisation-sigma and pi bond- coordinate – covalent bond.

Module:3	**Bonding in Inorganic Molecules**	**8 hours**

VSEPR theory - $BeCl_2$, BF_3, XeF_4, PCl_5, SF_6 and IF_7. Sidgwick's Theory - EAN rule - Theory of Bonding - Valence Bond Theory, MO theory. Relative order of Energies of molecular orbitals - MO diagram of H_2, He_2, O_2, O^{2+}, O^{2-}, N_2 and CO - Bond Order.

Module:4	**Basic Concepts of Organic Chemistry**	**6 hours**

Electronic Effects: Inductive, Inductomeric and Electromeric effects, resonance, hyperconjugation, steric effect (Hammett and Taft equation). Cleavage of bonds: homolytic and heterolytic C-C bond fission- Reaction Intermediates and their structure, stability and reactivity of intermediates: carbocations, carbanions and free radicals, carbenes and nitrenes.

Module:5	**Bonding and Hybridisation in Organic Molecules**	**6 hours**

Bonding in organic molecules-hybridisation-geometry of molecules-alkanes, alkenes, alkyne and benzene, benzyne; pKa, pKb, pH, polarity of molecules-organic acids and bases: Factors affecting the strength of acids and bases.

Module:6	**Stereochemistry**	**6 hours**

Concept of Isomerism, Classification of Stereoisomers- configurational (cis, trans or E, Z-alkenes, cycloalkanes) Wedge formula, Fischer projection, Newman projection and its interconversion. Application of Newman Projection to understand reaction mechanism.

Optical isomerism, Chirality & elements of symmetry- Chiral, achiral, prochiral, enantiomers, meso form, diastereoisomerism, akamp isomerism and atropisomerism.		
Module:7	**Alkanes, Alkenes and Alkynes**	**5 hours**
Alkanes, Alkenes and Alkynes: Synthesis (any three methods), Physical, Chemical properties and industrially important molecules and its applications.		
Module:8	**Contemporary issues**	**2 hours**
Guest lectures by industry and R & D organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Morrison R. T., Boyd R. N. and Bhattacharjee S. K., Organic Chemistry, Seventh Edition, Pearson Prentice Hall, 2011.
2. J.D. Lee, Concise Inorganic Chemistry, Oxford University Press, 5th Edition, 2014.

Reference Books

1. Peter K., Vollhardt, C., and Schore N. E., Organic Chemistry, W. H. Freeman and Company, 2010.
2. Pine S. H., Organic Chemistry, Tata McGraw Hill, 5th edition, 2008.
3. T. Overton, F. Armstron, J. Rourke and M. Weller. Inorganic Chemistry, 6th Edition, Oxford University Press, 2015.
4. J.E. Huheey, E.A. Keiter, R.L.. Keiter and O.K. Medhi Inorganic Chemistry: Principles of Structure and Reactivity, 4th Edition, Pearson Education, 2006.

Mode of Evaluation: CAT, Quiz , Assignments, FAT

Recommended by Board of Studies	28.06.2021		
Approved by Academic Counc	No. 63	Date	23.09.2021

TCHY102P	Inorganic and Organic Chemistry Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

The course is aimed at
1. Imparting the knowledge on qualitative analysis of inorganic and organic compounds.
2. Understanding the principles of quantitative chemical analysis and synthetic methods of simple organic compounds.

Course Outcome

At the end of the course, the student should be able to
1. Understand the concepts of qualitative and quantitative analyses.
2. Estimate different components in given analytes.
3. Develop synthetic and experimental skills for real time sample analysis

Indicative Experiments	
1	Acid-base titration: Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture
2	Redox titration: Estimation of Fe(II) and oxalic acid using standardized KMnO4 solution.
3	Redox titration: Estimation of ferrous and ferric ions in a mixture
4	Iodometry – Estimation of copper
5	Precipitation Titration: Determination of chloride
6	Acid-Base titrations: Estimation of free alkali present in different soaps/detergents
7	Systematic Qualitative organic analysis -1
8	Systematic Qualitative organic analysis -2
9	Determination of optical rotation for the hydrolysis of sucrose into glucose and fructose using Polari meter
10	Synthesis of *tert.* butyl chloride from *tert.* Butanol
11.	Single step synthesis : Synthesis of benzoic acid from benzaldehyde by oxidation method
	Total Laboratory Hours **30 hours**

Mode of assessment: Lab assessments, Viva-Voce, FAT			
Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TCHY103L	Physical and Analytical Chemistry	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The Course is aimed at

1. To make the student understand the concepts of equilibrium, Thermodynamics, chemical Kinetics and surface chemistry.
2. To impart knowledge on analysis of errors and evaluation of determinate and indeterminate errors which can be applied in volumetric methods of analysis and acid-base, redox systems concepts.

Course Outcomes

1. Apply the concepts in chemical equilibrium reaction calculations.
2. Analyse the thermodynamics of chemical reactions.
3. Evaluate the rate of chemical reactions and factors influencing them.
4. Utilise adsorption isotherms for understanding surface reactions.
5. Introduce concepts of errors and deviations in volumetric analysis.
6. Use electrochemical concepts in study of redox reactions by conductivity and EMF measurements.

Module:1	Chemical and Ionic Equilibria	6 hours

Chemical equilibrium: law of mass action; Kp, Kc and Kx; LeChatelier's principle, solubility product; Concepts of a strong, weak acids and bases; pH scale; Henderson-Hasselbach equations;

Buffer solutions: Acid-base indicators; Ionic equilibrium: monoprotic, diprotic, and triprotic acids; pH, pOH: measurements and significance, solubility products.

Module:2	Thermodynamics	6 hours

Thermodynamic processes – Cyclic, Reversible, Irreversible, Isothermal, Isobaric, Adiabatic; Exact and Inexact Differentials - Heat and Work - Zeroth Law of Thermodynamics. Zeroth law of thermodynamics, First law of Thermodynamics - Cp and Cv Relationship - calculation of w, q, ΔE and ΔH for expansion of Ideal Gases under reversible, Isothermal and adiabatic Conditions.

Module:3	Chemical Kinetics	7 hours

Rate of a chemical reaction. Order and molecularity of chemical reactions, Factors influencing rates of chemical reactions; Rate equations for zero-, first- and second-order reactions - equal and unequal concentrations of reactants. Half-life period; Determination of order of reaction- differential method, method of integration, half-life period method, isolation method.

Module:4	Surface Chemistry	6 hours

Difference between adsorption and absorption. Physical and chemical adsorption--desorption. Adsorption isotherms: Gibbs, Langmuir, BET, other isotherms - measurement of surface area using adsorption isotherms, Freundlich adsorption isotherm and its experimental verification. Adsorption indicators.

Module:5	Errors in Chemical Analysis	7 hours

Classification of analytical methods- classical and instrumental, basis of their classification with examples. Classification - systematic or Determinate errors – additive, proportional; Types – instrumental, operative, errors of method; Random errors – Gaussian distribution; Accuracy-absolute error and relative error; Precision – uncertainty; Propagation of systematic and random errors. Standard deviation, relative standard deviation- related numerical.

Module:6	Acid -Base concept and redox systems	6 hours

Arrhenius concept, Brønsted-Lowry acids and bases, Lewis acids and bases, Acid and base

strength. Theory of electron transfer- redox reactions-electrochemical concepts in the study of redox systems – study of acid base and redox reactions by pH,conductivity and emf measurements		
Module:7	**Volumetric analysis**	**5 hours**
Principles of Volumetric analysis-molarity-molality-normality-mole fraction-calculations-primary and secondary standards-equivalent weight of acid, base, salt, oxidising agent and reducing agents. Theories of Acid-Base, redox, precipitation, complexometric, iodometric and iodimetric titrations-Theories of indicators-acid base, redox.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Skoog and West Fundamentals of Analytical Chemistry by F. James Holler, Donald M. West, Stanley R. Crouch. Cengage Learning EMEA; 9th edition (2013)
2. Atkins Physical Chemistry,11th Edition By Peter Atkins, Julio De Paula, James Keeler, Oxford University press, 2018.

Reference Books

1. Analytical Chemistry, Gary Christian, 6th Edition, John Wiley & Sons, New York, 2004.
2. Chemical Kinetics, Keith James Laidler, J. Keith, Professor Emeritus of Chemistry Keith J Laidler Harper & Row, 1987.
3. Principles Of Physical Chemistry, by B.R. Puri, L.R. Sharma, M.S. Pathania. 47th edition (2016), Vishal Publishing Co, India.
4. Vogel's Text book of Quantitative Chemical Analysis, G. H. Jeffery j. Bassett J. Mendham R C. Denney, 5th Edition, Longman Scientific and Technical and John Wiley & Sons, New York, 1989.

Mode of Evaluation: CAT, Quiz, Assignments, FAT

Recommended by Board of Studies	28-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TCHY103P	Physical and Analytical Chemistry Lab	L	T	P	C
		0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course is aimed at

1. Understand the principles and methods of Conductivity, monitoring redox reactions using electrochemical methods.
2. Impart the concepts of monitoring the kinetics of chemical reactions.

Course Outcomes

1. Apply the concepts of electrochemical measurements in redox titrations.
2. Design experiments for monitoring rates of chemical reactions including surface reactions.
3. Evaluate the dissociation constant and partition coefficient of chemical reactions.

Indicative Experiments	
1.	Estimation of Chloride by Conductometry
2.	Determination of concentration of an acid using pH measurement method
3	Thermodynamics functions from EMF measurements : Zinc – silver chloride system
4	Determination of partition coefficient of iodine in CCl_4 and water
5.	Adsorption of acetic acid on charcoal
6.	Estimation of Ferrous ion by potassium permanganate using potentiometry
7.	Acid catalyzed hydrolysis of an ester- Determination of rate constant
8.	Ionization constant of a weak acid
9.	Kinetics of persulphate and iodide second order reaction
10.	Dissociation constant of methyl red
	Total Laboratory Hours 30 hours

Mode of assessment: Lab assessment, Viva-Voce and FAT			
Recommended by Board of Studies	28-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TCSE103L	Programming in Python	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. To introduce core programming basics required for science using Python language
2. To read and write simple Python programs
3. To develop Python programs with conditionals and loops
4. To use Python data structures – lists, tuples, dictionaries
5. To introduce the important science modules SymPy, NumPy, SciPy, Pandas and Matplotlib
6. To introduce the input/output with files in Python and statistical processing of a data

Course Outcome:

At the end of the course students will be able to:

1. Read, write, execute simple Python programs
2. Decompose a Python program into functions
3. Manipulate with 1-d,2-d and multidimensional data using Python
4. Data Visualization using Python
5. Read and write data from/to files in Python programs
6. Develop algorithmic solutions to science related problems

Module:1	**Algorithmic Problem Solving**	**3 hours**

Algorithms, building blocks of algorithms (statements, state, control flow, functions); algorithmic problem solving; iteration, recursion. Illustrative problems: flow chart, finding minimum in a list, factorial of a number.

Module:2	**Data, Expressions, Statements in Python**	**4 hours**

Python Strengths and Weakness; Installing Python; IDLE - Spyder – Jupyter; Mutable and Immutable Data Types, Naming Conventions; String Values; String Operations; String Slices; String Operators; String functions. Numeric Data Types; Arithmetic Operators and Expressions; Comments in the Program;

Module:3	**Data Collection and Language Component of Python**	**4 hours**

List; Tuples; Sets; Dictionaries; Operations on List, Tuple , Set, Dictionary; Control Flow and Syntax; Indenting; The if statement; Relational Operators; Logical Operators; Bit-wise Operators; The while Loop – break and continue statements; The for Loop; List Comprehension

Module:4	**Functions in Python**	**4 hours**

Functions - Introduction; Defining your own functions; parameters; local and global scope; passing collections to a function; variable number of arguments; passing functions to a function; Lambda function; map; filter.

Module:5	**Modules for Science**	**3 hours**

Modules: Introduction; Standard Modules – sys, math, time, sympy, random.

Module:6	**Handling Scientific Data in Python**	**5 hours**

NumPy arrays – 1-d, multidimensional arrays and matrices; Mathematical operations with arrays; Slicing and addressing arrays; Boolean masks; Difference between lists and arrays SciPy – Scientific Computing library of Python – Introduction, Basic functions, Special functions, scipy.integrate, scipy.optimize, scipy.interpolate

Module:7	**Data Visualization and Analysis of Data in Python**	**5 hours**

Python Plotting: PyPlot – Basic Plotting; Logarithmic Plots; Plots with multiple axes; Matplotlib – interactive functions 3d plotting; Pandas – Introduction, Data Frame, Reading

and writing CSV, XLS files, Working with missing data, categorical data, data visualization with pandas			
Module:8	**Contemporary issues:** (Industry Expert Lecture)		**2 hours**
Research and Development problems related to Scientific Domains			
Total Lecture Hours			**30 hours**
Text Book(s)			
1.	David J. Pine, Introduction to Python for Science and Engineering, CRC Press, 2019.		
2.	Robert Johansson, Numerical Python – Scientific Computing and Data Science Applications with NumPy, SciPy and Matplotlib, Apress, 2019		
Reference Book(s)			
1. Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016 2 Nelli, F., Python Data Analytics: with Pandas, NumPy and Matplotlib, Apress, 2018. 3. Jake vander Plas, Python Data Science Handbook – Essential Tools for Working with Data, O'Really Media, 2017			
Mode of Evaluation: CAT, Quiz, Digital Assignment and FAT			
Recommended by Board of Studies	12-07-2021		
Approved by Academic Council	63	Date	23.09.2021

TCSE103P	Programming in Python Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. To introduce core programming basics required for data science using Python language
2. To read and write simple Python programs
3. To develop Python programs with conditionals and loops
4. To use Python data structures – lists, tuples, dictionaries
5. To introduce the important science modules SymPy, NumPy, SciPy, Pandas and Matplotlib
6. To introduce the input/output with files in Python and statistical processing of a data

Course Outcome:

At the end of the course students will be able to:

1. Read, write, execute simple Python programs
2. Decompose a Python program into functions
3. Manipulate with 1-d,2-d and multidimensional data using Python
4. Read and write data from/to files in Python programs
5. Develop algorithmic solutions to science related problems

List of Challenging Experiments (Indicative)

1. *First Basic Experiment(s):* (i) "Hello World!" Program in IDLE, Jupyter, Spyder Environments. (ii) Program(s) to demonstrate the Python data types
2. Python Operators, Expressions and Flow Controls
3. Python Lists, Tuples, Dictionaries & Sets
4. Python Functions, Modules and Packages
5. Python Symbolic Computation and Random Number generation
6. Array and Matrix Manipulation in Python
7. Data Manipulation – SciPy Module
8. Data Visualization in Python – PyPlot Module
9. Data Manipulation using Pandas
10. Descriptive Statistical Analysis – Evaluation, Plotting and Interpretation
11. Evaluation of Probability using various Distributions Functions
12. Linear and Nonlinear Regression in Python

	Total Laboratory Hours	**60 hours**	
Mode of assessment: CAT / Written Assignment / Quiz / FAT / Project.			
Recommended by Board of Studies	12-07-2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TCSE104L	Structured and Object Oriented Programming	L	T	P	C
		2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To impart the basic constructs in structured programming and object-oriented programming paradigms.
2. To inculcate the insights and benefits in accessing memory locations by implementing real world problems.
3. To help solving real world problems through appropriate programming paradigms.

Course Outcome

At the end of the course, students should be able to:

1. Understand different programming language constructs and decision-making statements; manipulate data as a group.
2. Recognize the application of modular programming approach; create user defined data types and idealize the role of pointers.
3. Comprehend various elements of object-oriented programing paradigm; propose solutions through inheritance and polymorphism; identify the appropriate data structure for the given problem and devise solution using generic programming techniques.

Module:1	C Programming Fundamentals	3 hours

Variables - Reserved words – Data Types – Operators – Operator Precedence - Expressions - Type Conversions - I/O statements - Branching and Looping: if, if-else, nested if, if-else ladder, switch statement, goto statement - Loops: for, while and do…while – break and continue statements.

Module:2	Arrays, Functions	4 hours

Arrays: One Dimensional array - Two-Dimensional Array – Strings and its operations. User Defined Functions: Declaration – Definition – call by value and call by reference - Types of Functions - Recursive functions - Storage Classes - Scope, Visibility and Lifetime of Variables.

Module:3	Pointers	4 hours

Declaration and Access of Pointer Variables, Pointer arithmetic – Dynamic memory allocation – Pointers and arrays - Pointers and functions.

Module:4	Structure and Union	3 hours

Declaration, Initialization, Access of Structure Variables - Arrays of Structure - Arrays within Structure - Structure within Structures - Structures and Functions – Pointers to Structure – Union – Linked list

Module:5	Overview of Object-Oriented Programming	4 hours

Features of OOP - Classes and Objects - "this" pointer - Constructors and Destructors - Static Data Members, Static Member Functions and Objects - Inline Functions – Call by reference - Functions with default Arguments - Functions with Objects as Arguments - Friend Class and Friend Functions

Module:6	Inheritance	4 hours

Inheritance - Types of Inheritance: Single inheritance, Multiple Inheritance, Multi-level Inheritance, Hierarchical Inheritance - Multipath Inheritance - Inheritance and constructors.

Module:7	**Polymorphism and Generic Programming**	**6 hours**
Function Overloading - Operator Overloading – Dynamic Polymorphism - Virtual Functions - Pure virtual Functions - Abstract Classes - Function templates and class templates, Standard Template Library		
Module:8	**Contemporary issues**: (Industry Expert Lecture)	**2 hours**
Research and Development problems related to Scientific Domains		
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Herbert Schildt, C: The Complete Reference, 4th Edition, McGraw Hill Education, 2017
2. Herbert Schildt, C++: The Complete Reference, 4th Edition, McGraw Hill Education, 2017.

Reference Books

1. Yashavant Kanetkar, Let Us C: 17th Edition, BPB Publicaitons, 2020.
2. Stanley Lippman and Josee Lajoie, C++ Primer, 5th Edition, Addison-Wesley publishers, 2012.

Mode of Evaluation: CAT / Written Assignment / Quiz / FAT / Project.

Recommended by Board of Studies	12-07-2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TCSE104P	Structured and Object Oriented Programming Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To impart the basic constructs in structured programming and object-oriented programming paradigms.
2. To inculcate the insights and benefits in accessing memory locations by implementing real world problems.
3. To solve real world problems through appropriate programming paradigms.

Course Outcome

At the end of the course, students should be able to:

1. Understand different programming language constructs and decision-making statements; manipulate data as a group.
2. Recognize the application of modular programming approach; create user defined data types and idealize the role of pointers.
3. Comprehend various elements of object-oriented programing paradigm; propose solutions through inheritance and polymorphism; identify the appropriate data structure for the given problem and devise solution using generic programming techniques.

Indicative Experiments

1.	Programs using basic control structures, branching and looping
2.	Experiment the use of 1-D, 2-D arrays and strings and Functions
3.	Demonstrate the application of pointers
4.	Experiment structures and unions
5.	Programs on basic Object-Oriented Programming constructs.
6.	Demonstrate various categories of inheritance
7.	Program to apply kinds of polymorphism.
8.	Develop generic templates and Standard Template Libraries.
	Total Laboratory Hours **60 hours**

Mode of assessment: CAT / Written Assignment / Quiz / FAT / Project.

Recommended by Board of Studies	12-07-2021		
Approved by Academic Council	No. 63	Date	23.09.2021

THUM101L	Ethics and Values	L	T	P	C
		2	0	0	2
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To understand and appreciate the ethical issues faced by an individual in profession, society and polity.
2. To understand the negative health impacts of certain unhealthy behavior.
3. To appreciate the need and importance of physical, emotional health and social health.

Course Outcomes:

Students will be able to:

1. Follow sound morals and ethical values scrupulously to prove as good citizens.
2. Understand various social problems and learn to act ethically.
3. Understand the concept of addiction and how it will affect the physical and mental health.
4. Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects.
5. Identify the main typologies, characteristics, activities, actors and forms of cybercrime.

Module:1	**Being Good and Responsible**	**5 hours**
Gandhian values such as truth and non-violence – Comparative analysis on leaders of past and present – Society's interests versus self-interests - Personal Social Responsibility: Helping the needy, charity and serving the society.		
Module:2	**Social Issues 1**	**4 hours**
Harassment – Types - Prevention of harassment, Violence and Terrorism		
Module:3	**Social Issues 2**	**4 hours**
Corruption: Ethical values, causes, impact, laws, prevention – Electoral malpractices; White collar crimes - Tax evasions – Unfair trade practices.		
Module:4	**Addiction and Health**	**5 hours**
Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention – Ill effects of smoking - Prevention of Suicides; Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases.		
Module:5	**Drug Abuse**	**3 hours**
Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention.		
Module:6	**Personal and Professional Ethics**	**4 hours**
Dishonesty - Stealing - Malpractices in Examinations – Plagiarism.		
Module:7	**Abuse of Technologies**	**3 hours**
Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social networking websites.		
Module 8	**Contemporary Issues**	**2 hours**
	Total Lecture Hours:	**30 hours**

Text Books :

1.	R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2019, 2nd Revised Edition, Excel Books, New Delhi.

2.	Hartmann, N., "Moral Values" , 2017, United Kingdom: Taylor & Francis.
Reference Books :	
1.	Rachels, James & Stuart Rachels, "The Elements of Moral Philosophy", 9th edition, 2019, New York: McGraw-Hill Education.
2.	Blackburn, S. "Ethics: A Very Short Introduction", 2001, Oxford University Press.
3.	Dhaliwal, K.K , "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts", 2016, Writers Choice, New Delhi, India.
4	Ministry of Social Justice and Empowerment, "Magnitude of Substance Use in India", 2019, Government of India.
5.	Ministry of Home Affairs, "Accidental Deaths and Suicides in India", 2019, Government of India.
6.	Ministry of Home Affairs, "A Handbook for Adolescents/ Students on Cyber Safety", 2018, Government of India.
Mode of Evaluation: Poster making, Quiz, Assignment, CAT and Term End Examination	

Recommended by Board of Studies	27-10-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TMAT103L	Calculus and Analytical Geometry	L	T	P	C
		3	0	0	3
Pre-requisite	**Nil**	**Syllabus version**			
		1. 0			

Course Objectives

1. To reinforces calculus to give a better understanding of the mathematical concepts underlying them and to prepare students for more advanced mathematics.
2. To Learn to analyze and solve problems relating analytical geometry and vector calculus.
3. To consider problems that could be solved by applying appropriate theories, principles and concepts relevant to functions, continuity, derivatives, analytic geometry and vectors.

Course Outcome

At the end of this course the students should be able to

1. To Apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions.
2. Evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints.
3. Apply integrals to find area and volume and to find masses, moments, force, work and energy.
4. Study the equations of lines, planes and spheres and the role of direction cosines and direction ratio.
5. Evaluate the line, surface and volume integral of a scalar and vector fields and apply Green's, Gauss' and Stoke's theorems.

Module:1	**Differential calculus and its geometrical applications**	**7 hours**

Review of continuity and differentiability, Successive differentiation, Leibnitz's rule, Taylor's and Maclaurin's expansions, Indeterminate forms, Tangent and Normal, Curvature, Evolutes and envelopes

Module:2	**Functions of several variables**	**6 hours**

Limit and continuity, Partial Differentiation-Euler's Theorem, Chain rule, Total differentiation, Differentiation of implicit functions, Taylor's series expansion, Jacobians-Change of variables, Maxima and minima, Lagrange multiplier method

Module:3	**Integral calculus**	**6 hours**

Integration-Definite integral, Average value, Length of a plane curve, Areas, Volumes-washer method, disk method, Area of a surface of revolution, Fundamental theorem of Calculus and its consequences, Improper integral, Differentiation under Integral sign-Leibnitz rule

Module:4	**Multiple integrals and their applications**	**5 hours**

Double and triple integrals, Change of order of integration, Change of variables, Areas and volumes, Masses, moments, Force, Work and energy

Module:5	**Analytical solid geometry**	**7 hours**

Coordinate systems and their interrelation, Direction cosines and direction ratios, Projection on a straight line, Angle between straight lines, Equation of plane, Shortest distance between the skew-lines, length of perpendicular from a given point to a given plane, Bisectors of the angles between two planes, Orthogonal projection on a plane, Sphere.

Module:6	**Vector differentiation**	**6 hours**

Scalar, vector fields and level Surfaces, Differentiation-Gradient, Tangent plane and normal, Directional derivative, Divergence and curl

Module:7	**Vector integration**	**6 hours**

Vector Integration, Line integrals, Surface integrals, Green's theorem in plane, Stokes's theorem, volume integrals, Divergence theorem			
Module:8	**Contemporary issues**		**2 hours**
Guest Lecture from industry and R&D organisations			
	Total Lecture hours:		**45 hours**
Text Book(s)			
1. George B. Thomas, Joel Hass, Christopher Heil, Maurice D. Weir, Thomas' Calculus, 2018, 14th edition, Pearson, India 2. Shanti Narayan, P. K. Mittal, Analytical Solid Geometry, 2007, 17th edition, S. Chand & Co., India			
Reference Books:			
1. Karl J. Smith, Monty J. Strauss, Magdalena D. Toda, Calculus, 2017, 7th edition, Kendall Hunt Publishing Company, USA 2. Saturnino L. Salas, Garret J. Etgen, Einar Hille, Calculus One and Several Variables, 2021, 10th edition, Wiley, India			
Mode of Evaluation: CAT, Written assignment , Quiz , FAT			
Recommended by Board of Studies	24.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TMAT103P	Calculus and Analytical Geometry Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. To familiarize with the basic syntax, semantics and library functions of MATLAB which serves as a tool not only in calculus but also many courses in engineering and sciences.
2. To visualize mathematical functions and its related properties.
3. To evaluate single and multiple integrals and understand it graphically.

Course Outcome

At the end of the course the student should be able to:

1. Demonstrate MATLAB code for challenging problems in engineering
2. Using plots/displays, interpret and illustrate elementary mathematical functions and procedures.

Indicative Experiments (Any 10 experiments to be performed)

1.	To plot and visualize curves and surfaces in MATLAB – Symbolic computations using MATLAB
2.	To evaluate limits and Derivatives of functions
3.	To investigate applications of differentiation and study maxima and minima of a function of single variable
4.	To analyze maxima and minima of a function of two variables
5.	To write Taylor's and Maclaurin's series up to finite terms
6.	To evaluate integrals and find area, volume of solid of revolution
7.	To calculate double and triple integrals
8.	To find equation of line and angle between two planes
9.	To study divergence, curl and gradient and visualize vector fields
10.	To evaluate line integral and work done
	Total Laboratory Hours **30 hours**

Text Book(s)

1. Cesar Lopez, MATLAB Differential and Integral Calculus, 2014, 1st Edition, Apress
2. Ronald L. Lipsman, Jonathan M. Rosenberg, Multivariable Calculus with MATLAB: With Applications to Geometry and Physics, 2018, 1st edition Springer

Mode of assessment: Continuous assessments, Oral, FAT

Recommended by Board of Studies	24.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TMAT104L	Ordinary and Partial Differential Equations	L	T	P	C
		3	1	0	4
Pre-requisite	**TMAT103L, TMAT103P**	**Syllabus version**			
		1.0			

Course Objectives

1. To develop mathematical skills so that students can apply mathematical methods & principals in solving problems arising in real life.
2. To understand how real-life problems can give rise to differential equations.
3. To solve the problems choosing the most suitable method.
4. To utilie Laplace and Fourier transform techniques to solve the differential equations.

Course Outcome

1. Recognize the order and degree of differential equations and solve first order differential equations by different methods.
2. Understand the role of complementary functions and particular integrals in finding solution and should be able to apply variation of parameters and method of undetermined coefficients in solving differential equations.
3. Apply Frobenius' method to obtain series solution of second order differential equations.
4. Utilize the method of characteristics in handling partial differential equations of first order and should be able to solve partial differential equations of second and higher order.
5. Apply Laplace and Fourier Transform to solve differential equations.

Module:1	**Differential equations of first order**	**7 hours**
Differential equation of first order-exact and linear differential equations, First order equations of higher degree, Clairaut's form, singular solutions. Orthogonal trajectories, Applications in geometrical and mechanical problems.		
Module:2	**Differential equations of higher order**	**6 hours**
Linear equations, linearity, linear independence and Wronskian, Reduction of order, Homogeneous linear equations with constant coefficients, Nonhomogenous equation-Cauchy-Euler Equation, Solution by method of Undetermined Coefficients and Variation of Parameters.		
Module:3	**Series solution**	**4 hours**
Power Series representation of functions, Power Series method, Method of Frobenius, Series solution of Legendre and Bessel differential equations.		
Module:4	**First order partial differential equations**	**8 hours**
Formation of Partial Differential equations, Solution of first order PDE (Standard forms), Complete integral, General Solution, Singular Solution, Lagrange's Equation, Nonlinear Equation-Charpit's method.		
Module:5	**Higher order partial differential equations**	**6 hours**
Homogeneous linear equation with constant co-efficient, Nonhomogenous linear equations of any order, Non-linear equations of second order-Monge's method.		
Module:6	**Laplace transform**	**6 hours**

Laplace Transform, Sufficient conditions for existence, Translation theorems, Operational properties, Periodic functions, Inverse Laplace Transform, Convolution, Application to the solution of Differential Equations, Heaviside Functions and Pulses, Impulses and Delta Function.		
Module:7	**Fourier transform**	**6 hours**
Fourier Series, Convergence, Fourier Sine and Cosine series, Complex Fourier Series, Fourier Transform and its properties, Fourier Cosine and Sine Transform, Parseval's theorem.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours Lecture** **15 hours Tutorial**

Text Book(s)

1. G. F. Simmons, Differential Equations with Applications and Historical Notes, 2017, 3rd edition, CRC Press, USA
2. B. S. Grewal, Higher Engineering Mathematics, 2018, 44th edition, Khanna Publishers, India

Reference Books

1. Shepley L. Ross, Differential Equations, 2007, 3rd edition, Wiley, India
2. Ian N. Sneddon, Elements of Partial differential equations, 2006, 1st edition, Dover, USA
3. Murray R. Spiegel, Schaum's outline of Theory and Problems of Laplace Transform, McGraw Hill, 1965, USA

Mode of Evaluation: CAT , Written assignment , Quiz , FAT			
Recommended by Board of Studies	24-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

Course Code	Course Title	L	T	P	C
TMGT401L	Principles of Management	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To provide knowledge on management key concepts, evaluation of managementthoughts and theories.
2. To understand the various functions of management and framework.
3. To gain a holistic understanding of multidisciplinary nature of management for effectivefunctioning.

Course Outcomes

At the end of the course, the students will be able to

1. Understand the basic concepts of management.
2. Analyse the environmental factors that affect the organization and its growth.
3. Identify and apply appropriate techniques to manage an organisation.
4. Critically analyse the challenges in each function of the management.
5. Ascertain the role of technologies in management.

Module:1	Management Basics	6 hours

Management - nature and purpose, evolution of management concept, approaches to management process, functions and roles of management, influence of external and internalenvironment on decision making, factors affecting social responsibility and sustainability, andethical business management.

Module:2	Planning	6 hours

Types of plans, steps in planning, strategic planning process, SWOT matrix, portfolio matrix, Porter's industry analysis and generic competitive strategies, decision making - importance of decision making, development of alternatives and evaluation of alternatives, and decision making under certainty, uncertainty and risk.

Module:3	Organizing	7 hours

Formal and informal organization, organizational levels and span of management, organization reengineering, structure and process of organizing, departmentation, matrix organization, strategic business units, virtual organization, line and staff authority, decentralization and delegation of authority, and organization culture.

Module:4	Staffing	6 hours

Overview to staffing functions, factors affecting staffing, position requirements, job design, job description, selection process and techniques, orientating new employees, performance appraisal and career strategy - appraisal criteria, team evaluation, rewards, and formulating career strategy, managerial training and development, conflict management, managing change, and learning organization.

Module:5	Leading	6 hours

Understanding motivation, motivation theories, leadership traits, styles, and types, committees, groups, and team decision making, communication purpose, communication process, and barriers to effective communication.

Module:6	Controlling	6 hours

Basic control process, critical control points, standards and bench marking, real-timeinformation and control, feedforward or preventive control, control of overall performance, profit and loss control, control through ROI, management audits - balanced scorecard,bureaucratic and clan control, and control techniques and information technology.		
Module:7	**Managing Operations and Technology**	**6 hours**
Operations management and corporate strategy, value chain management, role of technology in modern management practices, virtual organization and its structure, online business management, applications of digital technology, e-commerce, m-commerce, socialmedia, and artificial intelligence in business management, and challenges to modern management practices.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Harold Koontz and Heinz Weihrich, Essentials of Management: An International and Leadership Perspective, 2020, 11th edition, McGraw-Hill, India.

Reference Books

1.	Stephen P. Robbins, Mary Coulter and Agna Fernandez, Fundamentals ofManagement, 2019, 14th Edition, Pearson Education, India.
2.	Robert N. Lussier, Management Fundamentals: Concepts, Applications, & SkillDevelopment, 9th Edition, 2020, Sage Publications, USA
3.	Pravin Durai, Principles of Management – Texts and Cases, 2019, 2nd Edition, PearsonEducation, India.

Mode of Evaluation: CAT, Written Assignment, Quiz, and FAT

Recommended by Board of Studies	08-11-2023		
Approved by Academic Council	No. 72	Date:	13-12-2023

TPHY102L	Physics of Waves	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To develop deeper insights to cut through various fields of Physics.
2. To provide expertise for solving the differential equations which arise in simple mathematical models for oscillations and waves.
3. To hone the foundation of various Physics courses such as pre-quantum theory, optics, acoustics etc.

Course Outcome

At the end of the course the student will be able to

1. Comprehend the simple harmonic motion in various physical systems.
2. Explain the damped as well as forced oscillations in realistic physical systems.
3. Recall the theoretical ideas of complex vibrations using Fourier series.
4. Understand the ideas of transverse, longitudinal and standing waves in various physical systems.
5. Apply the knowledge of various types of oscillations and vibrations for designing simple machines.

Module:1	**Simple harmonic motion**	**5 hours**
Oscillations in physical systems, Spring-mass system- Time period and frequency, Harmonic oscillator in one-dimension and its solutions, Superposition of simple harmonic oscillations, Lissajous figures.		
Module:2	**Damped oscillations**	**6 hours**
Damped harmonic oscillator, solution of the differential equation of damped oscillator. Energy considerations, relaxation time, quality factor		
Module:3	**Forced oscillations**	**6 hours**
Differential equation of forced oscillator and its solution, amplitude resonance and velocity resonance.		
Module:4	**Complex vibrations**	**8 hours**
Fourier theorem and evaluation of the Fourier coefficients, analysis of periodic wave functions-square wave, triangular wave, saw tooth wave.		
Module:5	**Transverse waves: Vibrating strings**	**6 hours**
Transverse wave propagation along a stretched string, general solution of wave equation and its significance, modes of vibration of stretched string clamped at ends, overtones, energy transport and transverse impedance. Hertz's experiment.		
Module:6	**Longitudinal waves: Vibration of bars**	**6 hours**
Longitudinal vibrations in bars-wave equation and its general solution. Special cases i) bar fixed at both ends ii) bar fixed at the mid point iii) bar free at both ends iv) bar fixed at one end. Tuning fork.		
Module:7	**Standing waves**	**6 hours**
Standing waves, Reflection and transmission of waves at a boundary, Impedance matching, Wave packet, Phase velocity and group velocity. Tuning fork (revisited).		
Module:8	**Contemporary issues**	**2 hours**
Guest lectures by industry and R & D organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)

1. H. J. Pain, The Physics of Vibrations and Waves, Sixth Edition, 2013, Wiley Publications, USA.

Reference Books	
1. 2. 3. 4	N. Bajaj, The Physics of Waves and Oscillations, 2017, Tata McGraw Hill, India. Walter Fox Smith, Waves and Oscillations, 2010, Oxford University Press, New York, USA. Arnt Inge Vistnes, Physics of Oscillations and Waves-with use of MATLAB and PYTHON, 2016, Springer, Switzerland. Howard Georgi, The Physics of Waves, 2015, Prentice Hall, New Jersey, USA.
	Authors, book title, year of publication, edition number, press, place
Mode of Evaluation: CAT, Written assignment, Quiz and FAT	

Recommended by Board of Studies	26.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TPHY102P	Physics of Waves Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To gain hands on experience with spring-mass system for understanding various types of motions.
2. To learn the basics of waves by doing various types of experiments in different fields of Physics such as quantum theory, optics, acoustics etc.

Course Outcome

At the end of the course the student will be able to

1. Comprehend the various types of motions/oscillations and the behaviour of waves in ideal and real physical systems.
2. Apply the knowledge of various types of oscillations and vibrations for performing experiments in different fields of Physics such as quantum theory, optics, acoustics etc.
3. Analyze the theoretical modelling of harmonic oscillation experiments using software packages.

Indicative List of Experiments	
1.	To demonstrate the simple harmonic motion –spring mass system
2.	To demonstrate the standing waves on a string
3.	To demonstrate the Lissajous figures using CRO
4.	To determine the frequency of the alternating current using a sonometer
5.	To determine the frequency and velocity of ultrasonic wave
6.	To generate electromagnetic wave using Hertz's experiment
7.	To determine the wavelength of sodium light using Newton's ring method
8.	To determine the wavelength of a He-Ne laser source using an optical grating
9.	To determine the refractive index of a given prism
10.	To determine the frequency of the alternating current using a sonometer
	Total Laboratory Hours **30 hours**

Mode of assessment: Continuous assessment, Oral examination and FAT			
Recommended by Board of Studies	26.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TPHY103L	Modern Physics	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the dual nature of matter and radiation.
2. To apply Schrödinger equations to solve finite and infinite potential problems and apply quantum ideas at the nanoscale.
3. To model the atomic and nuclear structure.

Course Outcomes

At the end of the course the student will be able to

1. Compare and contrast the properties of waves and particles.
2. Apply uncertainty principle to estimate position and energy.
3. Model matter waves using tools of quantum mechanics.
4. Apply Schrödinger equation to confined particles and predict tunnelling probability.
5. Demonstrate knowledge on atomic and nuclear structure and appreciate nuclear reactions.

Module:1	**Particle properties of waves**	**7 hours**
Blackbody radiation, Planck's quantum theory of light, idea of quantization (Planck and Einstein), Photoelectric effect, Compton scattering.		
Module:2	**Wave properties of particle**	**7 hours**
Double slit experiment with electrons, de Broglie waves, Davisson Germer experiment, wave function and probability interpretation, construction of wave packets (phase velocity and group velocity).		
Module:3	**Measurement of position and energy**	**6 hours**
Heisenberg uncertainty principle, Heisenberg's microscope (Gedanken experiment), application to virtual particles and range of an interaction.		
Module:4	**Wave mechanics**	**5 hours**
Linear superposition principle, probability and normalization, operators, expectation values: position, momentum, energy, Schrödinger equation for non-relativistic particles.		
Module:5	**Application of wave mechanics**	**6 hours**
Eigenvalues and eigenfunction of particle confined in one- dimensional box - 3 dimensional box (qualitative), quantum confinement and quantum dots.		
Module:6	**Atomic structure**	**6 hours**
Bohr atom model, energy levels and spectra, optical spectra, special terms and notations, selection rule, fine structure of sodium D lines, Zeeman effect- theory and experiment, Stark effect.		
Module:7	**Nuclear structure**	**6 hours**
Nuclear composition, stable nuclei, Liquid drop model (qualitative), Shell model (qualitative), radioactive decay, half-life, alpha, beta, gamma decay, nuclear fission and fusion.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. A. Beiser, S. Mahajan, S. R. Choudhury, Concepts of Modern Physics, 7th edition, 2017, McGraw- Hill., India.
2. H. D. Young and R. A. Freedman, University Physics with Modern Physics, 15th edition, 2019, Pearson, UK.

Reference Books	
1.	K. Krane, Modern Physics, 4th Edition, 2016, Wiley Indian Edition.
2.	D. J. Griffiths, D. F. Schroeter, Introduction to Quantum Mechanics, 3rd Edition, 2019, Cambridge University Press, UK.
3.	B. R. Martin, G. Shaw, Nuclear and Particle Physics: An Introduction, 3rd Edition, 2019, Wiley, USA.

Mode of Evaluation: CAT, Written assignment, Quiz and FAT			
Recommended by Board of Studies	26-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TPHY103P	Modern Physics Lab	L	T	P	C
		0	0	2	1
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To apply theoretical knowledge gained in the theory course and get hands-on experience of the topics.

Course Outcomes

At the end of the course the student will be able to:

1. Comprehend the dual nature of radiation and matter by means of experiments.
2. Get hands-on experience on the topics of quantum mechanical ideas in the laboratory.
3. Apply quantum mechanical ideas to atomic physics experiment.

Indicative Experiments

1.	Determination of Planck's constant using LED.
2.	Determination of work function of a metal using Photoelectric effect.
3.	Demonstration of Black body spectrum of light intensity for a given light source.
4.	Determination of phase velocity and group velocity of EM waves.
5.	Demonstration of wave nature of electrons through electron diffraction.
6.	Demonstration of tunnelling effect in tunnel diode using I-V characteristics.
7	Demonstration of Heisenberg Uncertainty Principle.
8	Determination of wavelength of Sodium D1 and D2 lines.
9	Determination of the ionization potential of mercury.
10	Numerical solutions of Schrödinger equation (e.g., particle in a box problem).

Total Laboratory Hours	**30 hours**

Mode of assessment: Continuous assessment, FAT and Oral examination

Recommended by Board of Studies	26-06-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TRES101L	Research Methodology	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course is aimed at students to
1. Identify the societal lead hypothesis and ability to design the research framework.
2. Understand the value of Research ethics.
3. Scrutinize the raw data and derive to the conclusion.
4. Compose and present the research investigation report.

Course Outcomes:

At the end of the course the students will be able to
1. Understand the basic concepts of research and values of research ethics.
2. Sketch out the research problems and carryout the literature review.
3. Articulate the research design and execute the sampling method.
4. Fetch, Organize, Investigate and Interpret the data.
5. Perform the statistical analysis and identify the significance of research.
6. Use of search engines and various research tools judiciously for research purposes.

Module:1	Introduction to Research	5 hours

Research- Definition, objectives, motivation and its importance. Concepts of theory: empiricism, deductive and inductive theory. Scientific method- definition, characteristics. The language of research- definition-theory, hypothesis, conceptualization, variables- dependent and independent variables, sample, population, validity, reliability, data.

Module:2	Identification and Formulation of Research Problem	5 hours

Research Problem- Need, definition, components, characteristics and formulating the research problem. Literature review- research articles, review articles, case studies and their importance. Hypothesis- null and alternative.

Module:3	Research Ethics and Intellectual Property Rights	7 hours

Introduction to research ethics, moral issues in research. Different types of animal models and human model used in research, basics to animal ethical guidelines. Introduction to Intellectual Property Rights (IPR), basics of patent rights, copy right, trademark. Common authorship issues in publications.

Module:4	Research Design and Sampling	7 hours

Research Design- Importance, features and their concepts. The research process basics. Types of Research Design- Historical, descriptive, exploratory and experimental design. Sampling methods- types, advantages and disadvantages. Criteria to determine the sample method and size.

Module:5	Data Collection and Statistical Analysis	7 hours

Introduction to primary data and secondary data, importance of data collection, open sources reliability. Statistical analysis- basics, univariate, bivariate, and multivariate analysis. Error analysis.

Module:6	Report and Proposal Writing	6 hours

Report Writing- Importance, types of report, precautions. Layout of research report. Interpreting the research results, infographic interpretation and its report writing. Oral presentations. Proposal writing.

Module:7	Use of Encyclopaedias, Tools/Techniques for Research	6 hours

Introduction to research, guides and handbooks. Academic databases for chemistry and biological science discipline. Software for detection of plagiarism. Software used for paper formatting and reference management.

Module:8	Contemporary Issues	2 hours

	Total Lecture hours:	**45 hours**

Text Book(s)

1. C. R. Kothari, 2019. Research methodology- Methods & Techniques, (Second Revision Edition), New Age International Publishers.
2. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, 2017. An Introduction to Statistical Learning with Applications in R, Springer.

Reference Books

1. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
2. Coley, S.M. and Scheinberg, C. A., 1990, “Proposal Writing”, Sage Publications.
3. Catherine Dawson, Introduction to research methods : a practical guide for anyone undertaking a research project, Oxford : How To Books, Reprint 2010

Mode of Evaluation: Quiz/Digital Assignment/CAT/Seminar/Project

Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TSSC201L	Critical Thinking	L	T	P	C
		2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To understand the importance of critical thinking.
2. To diagnose need analysis as well as to identify ways of improving them.
3. To describe and apply the nuances of decision making and problem-solving.

Course Outcomes:

1. Execute the basic tools of critical and lateral thinking in solving real life issues.
2. Develop coherent and critical thinking required for academic and corporate environments.
3. Integrate leadership, decision making and motivational strategies for the professional milieu.
4. Apply informal logical concepts to contemporary scenarios.

Module:1	**Introduction to Critical Thinking in Academic Contexts**	**4 hours**
History of Critical Thinking- - Basic Tools for Critical thinking - Strategies to be adopted for lateral thinking.		
Module:2	**Critical Thinking in Reading and Argumentation**	**4 hours**
Finding and evaluating the line of reasoning in a text - Identifying false premises and flawed reasoning - Recognizing good and bad arguments.		
Module:3	**Skills & Procedure**	**4 hours**
Socratic questioning in a professional environment - Differentiating between different types of statements - Grammar for Critical Thinking.		
Module:4	**Purpose of adopting Critical Thinking**	**4 hours**
Necessity - Professional Excellence - Personality Development - Qualities of a Critical Thinker.		
Module:5	**Decision-Making Skills**	**4 hours**
Cost-Benefit - Narrow Down the Options - Evaluate Significance –Prioritisation.		
Module:6	**Critical Thinking in Corporate Contexts**	**4 hours**
Importance of Critical Thinking in the Workplace - Critical Thinking and Leadership Skills - Critical Thinking for Evaluating Information - Critical thinking skill development & Motivational strategies.		
Module:7	**Informal Fallacies**	**4 hours**
Ad Hominem - Appeal to the Emotions - Bandwagon fallacy - False Dilemma - Appeal to Unqualified Authority - Begging the question - Appeal to tradition - Strawman Fallacy.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Galen A. Foresman, Peter S. Fosl, and Jamie Carlin Watson (2017), *The Critical Thinking Toolkit.* New Sussex: Wiley Blackwell
2. Caroselli, M. (2011). *The Critical Thinking Toolkit: Spark Your Team's Creativity with 35 Problem Solving Activities*. AMACOM

Reference Books

1 Nevid, J. S., &Rathus, S.A. (2009). *Psychology and the challenges of life* (11th edition). New York: John Wiley & Sons.

<table>
<tr><td>2</td><td colspan="4">Hanscomb, S. (2017). Critical thinking: The basics. Taylor & Francis.</td></tr>
<tr><td>3</td><td colspan="4">https://courses.lumenlearning.com/austincc-learningframeworks/chapter/chapter-7-critical-thinking-and-evaluating-information/.</td></tr>
<tr><td>4.</td><td colspan="4">Cottrell, Stella (2017). Critical Thinking Skills: Effective Analysis, Argument and Reflection. London: Palgrave Macmillan.</td></tr>
<tr><td>5.</td><td colspan="4">Manika Ghosh (2013) Positivity – A way of life: Orient Blackswan Private Limited - New Delhi.</td></tr>
<tr><td colspan="5">Mode of Evaluation: CAT / Assignment / Quiz / FAT / Case Study / Seminar</td></tr>
<tr><td colspan="2">Recommended by Board of Studies</td><td colspan="3">28-06-2021</td></tr>
<tr><td colspan="2">Approved by Academic Council</td><td>No. 65</td><td>Date</td><td>17-03-2022</td></tr>
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TSSC202L	Intra and Interpersonal Skills	L	T	P	C
		2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the core concepts of interpersonal and intrapersonal skills.
2. To enrich expertise to evaluate oneself, one's sentiments and to ascertain means of sharing opinions constructively.
3. To classify one's talents and imperfections and improve aptitudes to accomplish constructive relationships.

Course Outcome

1. Exemplify the concepts of interpersonal and intrapersonal skills in all scenarios.
2. Describe the concepts of self, emotions and communication in relationships.
3. Assess features of healthy relationships and develop skills to handle and respond to criticism.
4. Translate what is learned into strategies for use in educational and professional settings.

Module:1	**Introduction to Intrapersonal and Interpersonal Skills**	**4 hours**
Nature and Process - Interpersonal Communication – Models - Perception and communication		
Module:2	**Knowing and valuing Yourself**	**4 hours**
Concept of self, Self-Awareness, Self-Esteem - Attachment styles: Dismissive-Avoidant, Fearful-Avoidant, Anxious Attachment and Secure Attachment - Self-presentation and Self-disclosure		
Module:3	**Understanding yourself throughout your life span**	**4 hours**
Influences on personality - Personality types and development - The Myers Brigg personality test. Genetics and personality: Gender and personality & Culture and Personality		
Module:4	**Exploring values and making wise choices**	**4 hours**
Understanding values and choices - Define wellness and ways of promoting wellness - Exploring and prioritizing - Cultivate skills to make prudent decisions		
Module:5	**Experiencing and expressing emotion**	**4 hours**
Emotional Behaviour - Understanding emotions& adoption of ways to express emotions - Developing effective listening - Positive listening		
Module:6	**Communication in Constructive Criticism**	**4 hours**
Need of criticism - Making constructive criticism - Handling negative comments & Responding to criticism - Giving and receiving criticism		
Module:7	**Building Positive Relationships**	**4 hours**
Ways of achieving happiness and satisfaction - Types of relationships - Define conflict styles and conflict management		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Wood, J. T. (2015). *Interpersonal communication: Everyday encounters*. Cengage Learning. UK
Reference Books	
1.	DeVito, J. A. (2019). The interpersonal communication. *Instructor*, *1*, 18. Pearson Education India; 13th edition
2.	Ury, W. (2007). *Getting past no: Negotiating in difficult situations*. Bantam Books. US
3.	Corey, G., & Corey, M. S. (2017). *I never knew I had a choice: Explorations in personal growth*. Cengage Learning. US.
4.	Pavord, E., & Donnelly, E. (2015). *Communication and interpersonal skills*. Lantern Publishing. UK
5.	Adler, R. B., & Proctor II, R. F. (2016). *Looking out, looking in*. Cengage Learning. US
6.	Goldsmith, D. J. (2008). Politeness theory. *Engaging theories in interpersonal communication: Multiple perspectives*, 255-267. Thousand Oaks. Sage Publishers. CA
7.	Diener, E., Lucas, R. E., &Oishi, S. (2021). Subjective well-being: The science of happiness and life satisfaction. *Handbook of positive psychology*, *2*, 63-73. Oxford University Press. USA
8.	Gibson, T. (2020). *Attachment theory: A guide to strengthening the relationships in your life*. Bottom of Form. Rockridge Press. US

Mode of Evaluation: CAT / written assignment / Quiz / FAT / group discussion/Case Study

Recommended by Board of Studies	28-06-2021		
Approved by Academic Council	No. 65	Date	17-03-2022

Course Code	Course Title	L	T	P	C
TARB101L	Arabic	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Demonstrate proficiency in communicating in Arabic language.
2. Develop the ability to narrate and describe in past, present, and future time by acquiring Arabic grammar knowledge.
3. Develop the knowledge of Arabic literature, culture, and Arabic technical terminologies.

Course Outcomes

The student will be able to:

1. Remember Arabic Alphabets and Vowel signs.
2. Remember simple phrases like days, months, colors with simple conversation in professional and corporate mellow.
3. Understand the parts of speech and conjugations (Past, Present, Futures & Imperative).
4. Remember the Cardinal and Ordinal numbers and different types of members of the family as well as society.

Module:1	حروف الهجاء	**2 hours**
Arabic alphabet. The Pronunciation (Phonetic symbol of Arabic Alphabet). Shapes of Arabic letters.		
Module:2	حروف العلة	**3 hours**
The Vowel. The Vowel Signs & the Cases. The Sun letters & Moon letters.		
Module:3	أقسام الكلمة	**4 hours**
The Noun. The Verb. The Particle. The Definite & the Indefinite.		
Module:4	الجنس, الموصوف والصفة	**5 hours**
The Gender. Singular, Dual & Plural. Adjective and Noun qualified.		
Module:5	الضّمائر	**5 hours**
The Personal Pronoun. The Demonstrative Pronoun. The Relative Pronoun. The Subject & the Predicate. The Demonstrative Phrase.		
Module:6	تصريف الأفعال (الماضي والمضارع والأمر)	**5 hours**
Conjugations. Daily usage vocabularies.		
Module:7	الأعداد والمصطلحات التقنية	**4 hours**
Numerals. Days of the week. Months of the year. Seasons. Colors. Relationship. Technical terminologies (Computer, Civil & Mechanical Engineering)		
Module:8	محاضرات	**2 hours**
	Total Lecture hours:	**30 hours**

Textbook(s)

1. Dr. V. Abdur Rahim, Arabic Course for English Speaking students (Vol-1, 2 & 3), 2019, First Edition, Goodword Books, New Delhi. ISBN: 978-0-9879146-2-0.

Reference Books

1. Dr. W. A. Nadwi, A Practical Approach to the Arabic Language, Islamic studies Research.
2. Academy, New Delhi. Revised edition-2016. ISBN: 9798189202148

	Dr. Aurang zeb Azmi, A New approach to the Arabic Grammar, Al-balagh Publication-New Delhi. 2018. ISBN: 978-93-83313-57-0.		
Mode of Evaluation: CAT, Digital assignment, Quiz, FAT			
Recommended by Board of Studies	30-10-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

Course Code	Course Title	L	T	P	C
TCHI101L	Chinese I	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Develop basic Chinese and do simple conversation.
2. Write Chinese writing system and basic Chinese characters.
3. Understand basic language texts relating to common daily settings and develop translation ability (Chinese to English & vice-versa).

Course Outcomes

The students will be able to:

1. Greeting people in Chinese and use of personal pronouns and interrogative pronouns.
2. Express family names and understand yes – no question and correct use of phonetics.
3. Create expressions related to nationality, place of origin and special questions.
4. Learnoccupations in Chinese, Adverbials of time and place and noun and pronouns and create expressions related to age, numbers, special questions in Chinese.

Module:1	Phonetics语音 YuYin	3 hours

- Phonetics: Syllable initials:/ b/ / p/m /f ;;
- Syllable simple finals:/ a //o// e//i/u// ü;
- Phonetics: Syllable initials:/ d//t/ /n/l;
- Syllable compound finals: an// ie //uo/
- Phonetics: Syllable initials:/ g/k/ h/;
- Syllable compound finals::/ ai // ao//ei//en/
- Phonetics: Syllable initials:/j//q//x/;
- Syllable compound finals: /ang //eng//ong//iang// iong/
- Phonetics: Syllable initials:/z/c//s/;
- Phonetics: Syllable initials:/zh//ch//sh//r;
- Tones: /1// 2 // 3/ /4/

Module:2	Writing System书写系统 shuxiexitong	4 hours

- Chinese Characters
- Radicals
- Stroke order

Module:3	Greetings问候 wenhou	3 hours

- Learn the basic ways to greet people, and tell one's own name and other's name
- The personal pronouns"你，我，他/她，您，您们"
- Question with the interrogative pronoun"谁"

Module:4	Family Names名姓 mingxing	4 hours

• Learn to ask and tell Family names, given names • Special questions with "什么" • The Affirmative-Negative questions		
Module:5	**Nationality国籍 guoji**	**4 hours**
• Learn to ask and tell one's Nationality and origin) • Using "不" to express negation • Special questions with "哪儿"or "什么地方"		
Module:6	**Occupation职业 zhiye**	**5 hours**
• Learn to ask and tell one's occupation • Adverbials of time and place • Noun/pronoun+"的"+noun		
Module:7	**Numbers数字 shuzi**	**5 hours**
• Age (Learn to ask and tell one's age) • The numerals • The special questions with "几" • Time (Learn to tell time in native speakers' style) • Currency (Get idea about the usage of notes and coins in China) • The questions with "多少" and "怎么"		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Textbook(s)	
1.	Jiang Liping (2014) 《HSK Standard Course 1》 Beijing, Beijing Language and Culture University Press, ISBN7-5619-3709-9.
Reference Books	
1.	Kang Yuhua & Lai Siping, (2005) 《Conversational Chinese 301》 Book-1& 2, Beijing, Beijing Language and Culture University Press, ISBN 978-7-5619-1403-8/ H 05014.

Mode of Evaluation: CAT, Digital assignment, Quiz, FAT			
Recommended by Board of Studies	30-10-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

Course Code	Course Title	L	T	P	C
TESP101L	Spanish I	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Demonstrate proficiency in reading, writing, and speaking in basic Spanish.
2. Learn vocabulary related to profession, education centers, day-to-day activities, food, culture, sports and hobby, family set up, workplace, market, and classroom activities.
3. Demonstrate the ability to describe things in simple forms and their details and translate from Spanish to English and vice versa.

Course Outcomes

The students will be able to

1. Remember greetings, give personal details and identify genders by using correct articles.
2. Apply the correct use of SER, ESTAR, and TENER verbs to describe people, place, and things.
3. Discuss time and weather conditions by knowing months, days, and seasons in Spanish.
4. Create opinion about people and places by using regular verbs and reflexive verbs and creating small paragraphs about the daily routine, hometown, best friend, and family.

Module:1	Abecedario; Saludos y Despedidas	4 hours

El Abecedario, Saludos y Datos personales: Origen, Nacionalidad, Números Cardinales (1-100)
Recursos Gramaticales: Vocales y Consonantes, Sílabas. Artículos definidos e indefinidos (Número y Género).
Recursos Comunicativos: Saludar y despedirse: Aprender a Presentarnos, a preguntar cosas en clase.

Module:2	Datos personales; recursos para preguntar sobre las palabras	4 hours

Edad y posesión. Números Cardinales (101-100 000), Profesión, Los días de la semana.
Recursos Gramaticales: Pronombres personales. Adjetivos. Los verbos SER y TENER. Los verbos regulares (-AR, -ER, -IR) en el presente.
Recursos Comunicativos: Escribe sobre mismo/a y los compañeros de la clase.

Module:3	Describir lugares; Expresar existencia y ubicación	4 hours

Hacer un conocimiento del mundo Hispano. Vocabulario de Mi habitación, Países y Ciudades. Colores, Números Ordinales:
Del Primero a Décimo (1 - 10). Descripción de lugares y cosas.
Recursos Gramaticales: Adjetivos posesivos. El uso del verbo SER y ESTAR. Diferencia entre SER y ESTAR. ¿qué, cuál / cuáles, cuántos / cuántas, dónde, cómo, quién, cuándo?
Recursos Comunicativos: Mi habitación, Mi Ciudad.

Module:4	**Mi familia; Direcciones; Expresar la hora y los gustos**	**4 hours**
Mi familia. Direcciones. Expresar la hora. Los meses del año. Expresar y preguntar sobre gustos e intereses. Recursos Gramaticales: Frases preposicionales. Uso del HAY. La diferencia entre MUY y MUCHO. Uso del verbo GUSTAR, JUGAR, Recursos Comunicativos: Mi familia. Dar opiniones sobre tiempo.		
Module:5	**El clima; habilidades y aptitudes; Cualidades y defectos de las personas**	**4 hours**
Expresar fechas, el tiempo y las direcciones. Presentar y Describir a una persona y lugar. Recursos Gramaticales: Los verbos irregulares (E-IE, O-UE, E-I) en el presente. Recursos Comunicativos: Mi mejor amigo/a. Expresar fechas. Traducción Inglés al español y español al inglés.		
Module:6	**Describir el diario; Las actividades cotidianas;**	**4 hours**
Describir el diario. Las actividades cotidianas. Identificar objetos, expresar necesidad. Recursos Gramaticales:Los Verbos y pronombres reflexivos y posesivos. Recursos Comunicativos:El horario. Traducción Inglés a español y español a inglés.		
Module:7	**La Gastronomía: Ir al Restaurante**	**4 hours**
La Gastronomía: ¡A Comer! Dar opiniones sobre alimentos y bebidas. Describir mi ciudad y Ubicar los sitios en la ciudad. Recursos Gramaticales: Los verbos irregulares. Estar + gerundio. Poder + Infinitivo. Recursos Comunicativos:En la cafetería, Conversación en un restaurante. Mi ciudad natal. Mi Universidad.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Textbook(s)

1. Jaime Corpas, Eva Garcia, Agustin Garmendia, AULA INTERNACIONAL 1, Curso de Español, 1 January 2016, GoyalPublishers and DistributorsPvt. Ltd, New Delhi, India

Reference Books

1. Shalu Chopra, VIVA LATINO 1, January 2019, Goyal Publishers and Distributors Pvt.Ltd, New Delhi, India
2. Ramón Díez Galán, NuevoDELE A1: Versión 2020. Preparación para el examen. Modelos de examen
3. DELE A1 (Spanish Edition), July 14, 2020, Independently Published. Spain. Charo Cuadrad, Pilar Melero, Enrique Sacristan, PROTAGONISTAS A1. LIBRO DEL ALUMNO,1 January 2018, GoyalPublishers and DistributorsPvt. Ltd, New Delhi, India

Mode of Evaluation: CAT, Digital Assignment, Quiz, FAT			
Recommended by Board of Studies	30-10-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

Course Code	Course Title	L	T	P	C
TFRE101L	French I	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Develop language competencies for effective communication in French.
2. Provide insights into the French culture and make them understand the nuances through communication activities.
3. Enable the students to communicate effectively in general and in a professional context.

Course Outcomes

The students will be able to:

1. Acquaint with the basics of the French Language.
2. Comprehend the various parts of speech and grammar concepts to frame basic sentences in French.
3. Translate and acquire knowledge on a broad range of printed materials for general, specific, and practical information.
4. Acquire and explain the culture of French people through the language studied in the class.

Module:1	Saluer et se presenter:	6 hours

Les Alphabets, Les Salutations, Les nombres (0-100000), L'heure, Les jours de la semaine, Les mois de l'année, Les Pronoms personnels sujets, La conjugaison des verbes réguliers (Les verbes ER) / irréguliers (avoir / être)

Savoir-faire et savoir-agir :

Saluer, Se présenter, Présenter quelqu'un, Donner des informations, Discuter de la classe / l'université.

Module:2	L'activitéinteractive:	6 hours

La Nationalité du Pays, Les articles définis / indéfinis, Les prépositions de lieu et l'article contracté, L'heure en français, La Couleur, La conjugaison des verbes - habiter / venir/Aller etc.

Savoir-faire et savoir-agir :

Localiser des lieux dans une ville, Exprimer l'heure en français et Échanger des informations sur un hébergement.

Module:3	Les activités quotidiennes:	4 hours

Les adjectifs possessifs, L'accord des adjectifs, Les pronoms toniques, La conjugaison du verbe 'faire' avec du, de la, de l', des. L'interrogation avec combien / comment / où etc. L'adjectif démonstratif, L'adjectif interrogatif,**La traduction simple** (français-anglais/anglais-français)

Savoir-faire et savoir-agir :

Parler de la famille, Décrire une personne, parler de nos goûts, parler de nos activités.

Module:4	S'exprimer:	4 hours

Les parties du corps. Avoir mal à + les parties du corps

La conjugaison des verbes pronominaux, La conjugaison des verbes réguliers (ir) et les autres verbes tels que -lire, écrire, pouvoir, vouloir, devoir, et sortir.

Savoir-faire et savoir-agir : Parler de nos quotidiennes, proposer une sortie, inviter, accepter et refuser une invitation.		
Module:5	**La culturefrançaise:**	**3 hours**
La gastronomie française. Les endroits. Le présent progressif, L'article partitif, Mettez les phrases au pluriel et faites des phrases avec les mots donnés, Trouvez les questions. **Savoir-faire et savoir-agir :** Décrire une journée extraordinaire, Répondre aux questions générales en français, Faire des phrases.		
Module:6	**L'activitédialogique:**	**2 hours**
La traduction avancée (français-anglais/anglais-français) **Savoir-faire et savoir-agir :** Faire des achats, Demander la direction, Réserver une chambre dans un hôtel, La compréhension écrite et orale.		
Module:7	**L'activité de loisir**	**3 hours**
La rédaction / Dialogue:Décrire / parler de: ses goûts et préférences/ une personne / une place/ à la cafeteria / la profession / l'université/ les loisirs.		
Module:8	**Faciliter des échanges académiques**	**2 hours**
	Total Lecture hours:	**30hours**

Textbook(s)	
1.	Nathalie Hirschsprung, Tony Tricot, COSMOPOLITE- 1- Méthode de français, 2017, Hachette Français Langue Étrangère, Paris.
Reference Books	
1.	Celine Braud, EDITO 1, Méthode de français, 2016, Didier,Paris.
2.	Marie-Noelle Cocton, GÉNÉRATION 1, Méthode de français, 2016, Didier,Paris.

Mode of Evaluation:CAT , Digital assignment , Quiz , FAT			
Recommended by Board of Studies	30-10-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

Course Code	Course Title	L	T	P	C
TGER101L	German I	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Demonstrate proficiency in reading, writing, and speaking in basic German.
2. Communicate in German in everyday situations.
3. Understand German culture and adapt in German speaking countries or to work with German speaking people.

Course Outcomes

The students will be able to:

1. Understand basic expressions, words, signs and simple conversations.
2. Understand and translate short texts, simple descriptions, directions and illustrated narratives about daily activities.
3. Write grammatically correct sentences, short paragraphs, informal letters/e-mails, post cards etc… on matters of personal relevance and describe places and people in a simple language.
4. Use German in easy day-to-day conversations and demonstrate understanding of German culture.

Module:1	Die ersteBegegnung	4 hours

Grüßen und Verabschieden; sich und andere vorstellen; Namen, Telefonnummer und E-Mail-Adresse buchstabieren; Zahlen bis 100 und mehr nennen; über Länder, Sprachen und Nationalitäten sprechen.

Wortschatz: Begrüßungen, verabschieden, das Deutsche Alphabet, Zahlen, Länder und Sprachen
Grammatik: ,,W" Fragen, Aussagesätze, Personalpronomen im Singular und Verbkonjugation (sein/kommen/wohnen/lernen/studieren/sprechen/buchstabieren), Bestimmter Artikel
Schreiben: sich und andere vorstellen

Module:2	Hobbys und Berufe	4 hours

Über Hobbys und Freizeitaktivitäten sprechen; Wochentage und Monate nennen; die Uhrzeit nennen; über Arbeit, Berufe und Arbeitszeiten sprechen;

Wortschatz: Hobbys und Berufe, Uhrzeiten
Grammatik: Regel-und-Unregelmäßigen verbkonjugationen, haben konjugatio, Bestimmter und Unbestimmter Artikeln, Ja/Nein Fragen, die entsprechende Präpositionen (um/am/im/von...bis), Negation (nicht vs kein), Verbpositionen und Wortfolge
Schreiben: Was machst du in deiner Freizeit?

Module:3	Familie	4 hours

über Familie sprechen;

Wortschatz: Familie
Grammatik: Possessivpronomen, Nominativ und Akkusativ (Artikel und Personalpronomen)

Schreiben: „Meine Familie“		
Module:4	**Essen und Trinken**	**4 hours**
Über Essen sprechen; Gespräche beim Essen führen; Gespräche beim Einkauf führen; über Vorlieben beim Essen sprechen; Wortschatz: Lebensmittel, Getränke, Mahlzeiten Grammatik: Verben - möchten/mögen, Akkusativ, Verben mit Akkusativ, Präpositionenmit dem Akkusativ (für/ohne)		
Module:5	**ZusammenmitFreunden**	**4 hours**
Etwas gemeinsam planen; eine Speisekarte verstehen; im Restaurant bestellen und bezahlen; sich im Kaufhaus orientieren Wortschatz: Glückwünsche, Redemittel, Stockwerke und Waren im Kaufhaus Grammatik: Imperativ mit du und ihr, Artikel im Dativ, Personalpronomen im Dativ, Dativpräpositionen (mit, nach, ab, von), Modalverben (können, sollen, wollen) Schreiben: Inoffizielle Emails schreiben		
Module:6	**MeineWohnung**	**4 hours**
Wohnungsanzeigen verstehen, Wohnsituationen beschreiben; ein Zimmer beschreiben; Positionen beschreiben, Gefallen und Missfallen ausdrücken; Wortschatz: Wohnung, Zimmer und Räume, Möbel und Geräte, Farben Grammatik: Adjektiv mit sein, zu/sehr+Adj, Wechselpräpositionen Schreiben: „Wohnung"		
Module:7	**Eine Stadtrundfahrt**	**4 hours**
Nach dem Weg fragen; Verkehrsmittel und Verkehrsschilder benennen; Wortschatz: Plätze und Gebäude, Verkehrsmittel, Richtungen, Sehenswürdigkeiten Grammatik: Imperativ mit Sie, Modalverben (müssen/dürfen), Zeitadverbien: zuerst, dann, später…, Schreiben: „Meine Stadt"		
Module:8	**Training vom Sprechen**	**2 hours**
	Total Lecture hours:	**30hours**

Textbook(s)	
1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Ernst Klett Sprachen GmbH, Netzwerk A1, 2017, Stuttgart.
Reference Books	
1.	Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Ernst Klett Sprachen GmbH, Netzwerk A1 Deutsch als Fremdsprache Intensivtrainer,
2.	2019, Stuttgart
3.	Hartmut Aufderstrasse,JuttaMüller, Thomas Storz, Lagune, 2012.
4.	Dallapiazza, Rosa-Maria; Jan, Eduard von; Schönherr, Til, Hueber Verlag, 2008: Tangram aktuell. Hermann Funk, Christina Kuhn, Corneslen Verlag, Studio d A1,2010, Berlin.

Mode of Evaluation: CAT, Digital assignment, Quiz, FAT			
Recommended by Board of Studies	01-11-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

Course Code	Course Title	L	T	P	C
TGRE101L	Modern Greek	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Master the Greek terminology widely used in their subjects of specialization.
2. Communicate in Modern Greek in their day-to-day life.

Course Outcomes

The students will be able to:

1. Make use of the Modern Greek language in everyday conversation.
2. Understand contents from scientific texts that use Greek letters and words, becoming familiar with fundamental linguistic aspects of the International Scientific Vocabulary, and becoming able to formulate hypotheses about unknown compound words derived from Greek.
3. Understand critical socio-economic issues in contemporary Europe, developing their aptitude for critical thinking.
4. Become more aware of linguistic theory and phonetics and correctly pronounce Greek letters and words, be more conscious and confident in using their English vocabulary derived from Greek and compare Modern Greek with a wide number of other languages through a deeper understanding of the International Phonetic Alphabet.

Module:1	**ΤοΕλληνικό αλφάβητο, ηφωνητικήκαιηπροφορά, τομονοτονικόσύστημακαιτασημείαστίξης - IntroductiontotheGreekAlphabet, Phonetics, Accentuation&Punctuation**	10 hours

Correct usage and pronunciation of Greek letters; Greek symbols used in mathematics, science and engineering; Greek suffixes and prefixes used in International Scientific Vocabulary; International Phonetic Alphabet and phonetics of Modern Greek; Greek monotonic system (usage of grave accent and diaeresis); word stress rules; capitalization and punctuation rules.

Module:2	**Η Δομή των Φράσεων και η Πρόταση: Γραμματική - Structureandgrammar**	3 hours

Gender (masculine, feminine, neuter), number (singular/plural) and case (nominative, genitive, accusative and dative); adjectives: explaining agreement (concord); definite and indefinite articles; personal, interrogative, possessive, demonstrative, indefinite pronouns.

Module:3	**Χαιρετισμοί: πληθυντικόςευγενείας -Formal and informal greetings**	3 hours

Communicative functions: using formal and informal greetings; introducing oneself using affirmative form.
Morphology and Syntax: Auxiliary verb είμαι; personal pronouns (nominative form); cardinal numerals from 1 to 20.

Module:4	**Συστήνω τον εαυτό μου- Introductions**	**3 hours**
Communicative functions: asking and providing information about basic personal details (name, age, nationality, studies, profession). Morphology and Syntax:1st conjugation verbs (ending in -ω, simple present tense); masculine nouns in -ας/-ης/-ος (nominative singular); feminine nouns in -α/-η (nominative singular); neuter nouns in -ο/-ι (nominative singular).		
Module:5	**Καταγωγήκαι οικογένεια – Nationality and Family**	**3 hours**
Communicative functions: asking and providing information about nationality and languages known; describing the members of a nuclear or extended family. Morphology and Syntax:2nd conjugation verbs (ending in -αω, simple present tense); accusative case (singular, parisyllabic nouns); accusative case (singular personal pronouns); adjectives of nationality.		
Module:6	**Ηκαθημερινήρουτίνα - Daily Routine and Transportation**	**3 hours**
Communicative functions: asking and providing information about habits and daily routine; telling and asking the time; asking for and giving directions. Morphology and Syntax:verbs πάω, τρώω, λέω, ακούω; simple present tense and adverbs of frequency; simple prepositions.		
Module:7	**Ο καιρός, οι εποχές του χρόνου και η ζωή στην πόλη - Weather, SeasonsandUrbanActivities**	**3 hours**
Communicative functions: talking about the weather; asking the date; asking for prices; making calculations and perform a simple commercial transaction. Morphology and Syntax:accusative case (time); cardinal numerals up to one million; ordinal numbers; indefinite articles; accusative case (plural parisyllabic nouns).		
Module:8	**Διάλεξημε προσκεκλημέν-ο/η ομιλ-ητή/ήτρια: κοινωνίακαιπραγματικότητα της σύγχρονης Ελλάδας – contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Textbook(s)

1.	GeorgantziEvangelia, RaftopoulouEleana, *Greek for you - Ελληνικάγιασας: Textbook A1 Beginners*,March 2018, New Bilingual Edition (ISBN: 978-9607307682), Neohel, Athens, Greece.
2.	GeorgantziEvangelia, RaftopoulouEleana, *Greek for you - Ελληνικάγιασας: Workbook A1 Beginners*, March 2018, New Bilingual Edition (ISBN: 978-9607307736), Neohel, Athens, Greece.

Reference Books

1.	Terpsi Gavala, Konstantinos Oikonomou, *Λυδία. 'Ενα καλοκαίρι στην Ελλάδα!*,2019, firstedition, Omilo, Athens, Greece.
2.	GeorgantziEvangelia, *Greek for you - Ελληνικάγιασας: Textbook A0 Early Beginners + CD mp3*, 2018, Bilingual Bundle Edition (ISBN: 978-9607307668), Neohel, Athens, Greece.

Mode of Evaluation: CAT, Digital Assignment, Quiz, FAT.			
Recommended by Board of Studies	01-11-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

Course Code	Course Title	L	T	P	C
TITL101L	Italian	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Communicate in Italian in their day-to-day life.
2. Describe in simple terms (both in written and oral form) aspects of their background, immediate environment and needs.
3. Learn crucial aspects of Italian culture and civilization, as well as the role of the Italian economy in the global market.

Course Outcomes

The students will be able to:

1. Use Italian language in everyday conversation.
2. Analyze the evolution of Modern European languages, understanding the important connections between English and Neo-Latin languages by using Italian language in written form, thus becoming more conscious of English vocabulary which is derived from Latin and Italian.
3. Understand important cultural aspects and socio-economic issues in contemporary Europe, developing their aptitude for critical thinking and adopting an internationally oriented approach in learning.
4. Understand the concept of Made in Italy, concerning the world-renowned Italian design, fashion, food, manufacturing, craftsmanship, and engineering industries.

Module:1	Primicontatti- Basic interaction	4 hours

Communicative functions:

Salutare (greetings); chiedere il nome (asking someone's name); presentarsi (introducing yourself); chiedere e indicare la provenienza (asking and talking about one's provenance); congedarsi (leaving from a conversation); chiedere il numero di telefono e l'indirizzo e rispondere (sharing personal details such as telephone numbers and addresses); chiedere di ripetereun'informazione (asking someone to repeat a sentence or a piece of information).

Grammar and vocabulary skills:

I pronomi soggetto (subjectpronouns io, tu, Lei); il presente di essere, avere, chiamarsi al singolare (simplepresent tense of the verbs essere, avere, chiamarsi); l'alfabeto (the alphabet); gli articoli determinativi (definite articles il & la); gli aggettivi di nazionalità al singolare (adjectives of nationality - singular); gli interrogativi: come, di dove, quale (interrogatives come, dove, qual); gli aggettivi numerali cardinali da 1 a 20 (numeral cardinal adjectives from one to twenty).

Module:2	Persone e professioni – People and professions	4 hours

Communicative functions:

Chiedere e dire l'età(asking and telling someone's age); indicareoccupazione e luogo di lavoro (share information about one's profession and work place); chiedere

e fornireinformazionipersonali (sharing personal details, such as email, phone number etc.); informarsidelleconoscenzelinguistichealtrui e fornire le proprie (sharing information about one's spoken languages); scusarsi e ringraziare (excusing oneself, thanking someone); chiedere e dire l'età (asking and telling about someone's age). Grammar and vocabulary skills: I verbi regolari in -are (regular verbs - first conjugation); i verbi essere, avere, fare e stare (auxiliaryverbs avere and essere, irreguarverbs fare and stare); i sostantivi al singolare (singularnouns); la negazione (negative clauses); articoli determinativi e indeterminativi (definite and indefinite articles); dimostrativi questo e questa (demonstratives); le preposizioni a e in (prepositions a, in); gli interrogativi che, chi, dove, quanti (interrogatives: what, who, where, howmany); gli aggettivi numerali cardinali fino a 100 (numeral cardinal adjectives up to 100).		
Module:3	**Cibi e bevande – Gastronomic culture in Italy**	**4 hours**
Communicative functions: ordinare al bar e al ristorante (placing an order at a restaurant/café/bar); chiedere e ordinarequalcosa in modo cortese (asking something politely); chiederequalcosachemancasultavolo (making special requests to a waiter); chiedere il conto (requesting the bill); fare una prenotazionetelefonica (making a reservation over phone); compitare (spelling a name/address). Grammar and vocabulary skills: i verbi regolari in -ere (regular verbs - second conjugation); i verbi volere e preferire (irreguarverbs volere and preferire); il plurale dei sostantivi (pluralnouns); articoli determinativi plurali (plural definite articles); bene e buono | (adverb bene and adjective buono); gli interrogativi che cosa, quali, quante (interrogative forms: what, which one, howmany).		
Module:4	**Tempo libero, attivitàabituali - Free time and routine activities**	**4 hours**
Communicative functions: parlare del tempo libero (discussing about free time and leisure); parlaredellafrequenza con cui si fa qualcosa (talking about the frequency of a certain activity). Grammar and vocabulary skills: i verbi regolari in -ire (regular verbs - thirdconjugation); i verbi andare, giocare, leggere e uscire (verbs andare, giocare, leggere and uscire); gli avverbi di frequenza (adverbs of frequency).		
Module:5	**La casa e la stanza d'albergo - Describing a room and everyday objects**	**4 hours**
Communicative functions: Descrivereun'abitazione (describing a home); descrivereiservizi di un albergo (describing a hotel room and the services available); recensire un albergo (writing a simple hotel review); chiedereassistenza (asking for someone's assistance). Grammar and vocabulary skills: iverbiregolari in -ire con -isc (regular verbs - third conjugation in -isc)c'è / ci sono (usage of there is / there are); iverbipotere / venire (to be able to, to come); le preposizioni di tempo da… a (prepositions da… a); le preposizioniarticolate (articulated prepositions); imesidell'anno (months of the year); aggettivinumeraliordinali (ordinal numeral adjectives); l'interrogativoquanto (usage of quanto); i numeri cardinalimaggiori di 100 (cardinal numerals above 100); la data (date and time).		
Module:6	**Spazio e tempo – Space and Time**	**4 hours**

Communicative functions: descriverela propria città(describing one's city); chiedereun'informazione e reagire (asking for directions in an interactive way); descrivere un percorso (describing a route); rammaricarsi/scusarsi (expressing regret/apologizing); indirizzarequalcunoadaltrepersone (giving directions); parlaredegliorari di apertura e chiusura (talking about opening hours); parlare del tempo atmosferico (talking about weather). Grammar and vocabulary skills: ci e il verbo andare (usage of the particle ci in combination with the verb to go); la concordanza degli aggettivi con i sostantivi (adjective-noun agreement); gli aggettivi in -co/-ca (adjectivesending in -co and -ca); il partitivo - l'articolo indeterminativo al plurale (partitives and quantitatives); molto (usage of molto); i verbi dovere e sapere (the verbs dovere and sapere); c'è un…? / dov'è il…? (usage of isthere a…? / whereis the…?); gli interrogativi quando e dove (interrogatives: when&where); l'orario - a che ora…? (usage of a cheora…? - at what time…?).		
Module:7	**Parliamo di me – Habits and Preferences**	**4 hours**
Communicative functions: parlare di gusti e preferenze (talking about preferences and one's tastes); esprimereaccordo e disaccordo (expressing agreement and disagreement); chiedere e dire l'ora (asking and telling the time). Grammar and vocabulary skills: preposizioni in, a, con (prepositions in, a, con); i giorni della settimana (days of the week); mi piace/mi piacciono (usage of mi piace); l'interrogativo perché (the interrogative perché).		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Textbook(s)	
1.	L. Ziglio, G. Rizzo, *Nuovo Espresso 1: Libro dello studente e esercizi*, 2018(under license of ALMA, Italy), ISBN: 978-9386862853,Goyal Publishing House, New Delhi.
Reference Books	
1.	C.M. Naddeo, E. Orlandino, *Dieci lezioni di italiano – Corso di lingua italiana per stranieri A1*, 2020, ALMA edizioni, Florence (Italy).

Mode of Evaluation: CAT, Digital Assignment, Quiz, FAT.			
Recommended by Board of Studies	01-11-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

Course Code	Course Title	L	T	P	C
TJAP101L	Japanese I	2	0	0	2
Pre-requisite	NIL	Syllabus Version			
		1.0			

Course Objectives

The course gives students the necessary background to:

1. Develop interest in Japanese language by teaching them culture and general etiquettes.
2. Develop four basic skills that is reading, writing, listening, and speaking Japanese language.
3. Develop skills to understand and use everyday expressions as well as basic phrases.

Course Outcomes

Students will be able to:

1. Greet in Japanese and remember Japanese alphabets.
2. Introduce themselves as well as can briefly exchange the personal details related to family, home, favorite foods etc., in Japanese.
3. Create simple questions and its answers in Japanese as well as can briefly describe their daily routine in Japanese.
4. Understand the Japanese culture and etiquettes.

Module:1	Introduction, Hiragana, Katakana and Kanji	4 hours

Introduction of Japanese language and alphabets; Hiragana and katakana
Reading and writing Hiragana and Katakana, 20 Nouns in Hiragana and 10 Nouns in Katakana, Numerals
Basic rule of Japanese phonetics.

Module:2	Konnichiwa. Hajimemashite.	4 hours

Daily greetings and basic phrases to introduce yourself
Express about your name, occupation, age, where you live, where you are from and what language you can speak
Body Language such as bowing, pointing to your face, etc.

Module:3	WatashinoKazoku	4 hours

Talk briefly about your family, how many members there are and who they are,
Talk about your family showing a photo. Learn some phrases to give compliments.

Module:4	Sukinatabemono. Hitotsukudasai.	4 hours

Talk briefly about your favorite foods and dishes. Talk about your breakfast and where to go for lunch.
Order food in a fast food restaurant.

Module:5	Watashinoie. Ojamashimasu.	4 hours

Say what kind of home you live in. Say what you have in your room and around your home
Invite your friend to your place / visit your friend's house.

Module:6	Nanjiniokimasuka. Itsugaiidesuka.	4 hours

Say the time and days you do something, Talk about your plans in the week
Talk about your plans and schedule.

Module:7	KonoHitohaDareDesuka.	4 hours

Demonstrative pronoun - Kore, Sore, Are and Dore, (This, That, Over there, which)

Kono, sono, Ano and Dono (this, that, over there, which) Kochira, Sochira, Achira and Dochira. this way....) Koko, Soko, Asoko and Doko (Here, There.... location).Classification of Question words (Dare, Nani, Itsu, Doyatte, dooshite, Ikutsu, Ikura).		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Textbook(s)	
1.	The Japan Foundation (2017), Marugoto Japanese Language and Culture Starter (A1)Course book For Communicative Language Activities, New Delhi: Goyal Publishers (9788183078054).
Reference Books	
1.	The Japan Foundation (2017), Marugoto Japanese Language and Culture Starter A1 Course book For Communicative Language Competences, New Delhi: Goyal Publishers (9788183078047).
2.	Banno, Eri et al (2020), Genki: An Integrated Course in Elementary Japanese I [Third Edition], Japan: The Japan Times.

Mode of Evaluation: CAT, Digital Assignment, Quiz, FAT			
Recommended by Board of Studies	30-10-2021		
Approved by Academic Council	No. 68	Date	19-12-2022

Course Code	Course Title	L	T	P	C
TKOR101L	Basic Korean – Level 1	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To learn the basic Korean alphabet.
2. To enable to read and speak basic Korean necessary for daily life: salutations, self-introduction.
3. To know basic verbs and noun ending and conjugation
4. To read and write the bulletin board writings, invitations, menu card, simple memo noteand sign boards.

Course Outcomes

1. Read and write Korean.
2. Greet with Korean and introduce her/himself in Korean.
3. Grasp basic grammar and writing in Korean.
4. Understand and produce key expressions for everyday activities.

Module 1	Introduction	3 hours

Introduction to Korean Language, Culture, Cross Cultural Communication. After completing the lessons, students will be able to understand Korean Culture.

Module 2	Korean Alphabets – Hangeul – I	6 hours

Philosophy of Korean alphabets, Introducing phonics, the character system. In this module, students will learn the Korean alphabet or Korean writing system called 'Hangeul'. After completing the lessons, the students will be able to understand the principles of how each letter was invented. Also, students will be able to read and write Hangeul.

Module 3	Korean Alphabets – Hangeul – II	6 hours

Philosophy of Korean alphabets, Introducing phonics, the character system. In this module, students will learn the Korean alphabet or Korean writing system called 'Hangeul'. After completing the lessons, the students will be able to understand the principles of how each letter was invented. Also, students will be able to read and write Hangeul.

Module 4	Basic Grammar	4 hours

Noun, Pronoun Basic Verb and Greetings & Introducing, after completing the lessons, students will be able to understand basic grammar, basic greetings and introducing oneself.

Module 5	Self-Introduction & Essential expressions - I	3 hours

In this module, Students will learn how to greet and answer those questions in Korean. After completing the lessons, students will be able to introduce themselves, greet a person and talk about someone's nationalities and occupations.

Module 6	Self-Introduction & Essential expressions - II	3 hours

In this module, Students will learn how to ask someone's nationalities and answer those questions in Korean. After completing the lessons, students will be able to introduce themselves, greet a person and talk about someone's nationalities and occupations.

Module 7	Location and Positions	3 hours

Talking about location, expressing movement, place marker & writing. In this module, students will learn how to explain where a thing is, where I am and where I go to. Students will learn manyvocabularies related with various places.		
Module 8	**Contemporary Issues**	**2 hours**
	Total Lecture Hours	**30 hours**

Reference Books	
Introduction to Sejong Korean	
E-Books	
1.	https://nuri.iksi.or.kr/e-book/ecatalog5.jsp?Dir=303&catimage=&callmode=admin
2.	https://nuri.iksi.or.kr/e-book/ecatalog5.jsp?Dir=611&catimage=&callmode=admin
Mode of Evaluation: CAT / Assignment / Quiz / Seminar/ FAT	

Recommended by Board of Studies	03-03-2023		
Approved by Academic Council	No. 69	Date	16-03-2023

Course Code	Course Title	L	T	P	C
TKOR102L	Basic Korean – Level 2	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To read and write the bulletin board writings, invitations, menu card, simple memo noteand sign boards.
2. To speak an make a note basic requirements and ordering at shop or restaurant
3. To learn the basic grammar
4. To talk about weather and Time
5. To enable to make an appointment and suggestion.

Course Outcomes

1. Shopping and ordering with numbers what they want.
2. Talk about weather, date, and time in various situations.
3. Describe their plan and explain what they did in last weekend and past
4. Make an appointment with friends and suggest what they want to

Module 1	Shopping and Restaurant	4 hours

In this module, students will learn how to order food and make requests at a restaurant in Korean. After completing the lesson, students will be able to inquire about restaurant menus, order a specific portion of food at a restaurant, and order a drink at a café. Students will learn how to make purchases at various types of stores inKorean. After completing the lesson, you will be able to express pricesper item, purchase a product from a store, and make a specific request while shopping.

Module 2	Time & Date and Daily Activities	4 hours

In this module, students will learn various Korean vocabulary regarding your daily lives. After completing the lessons, studentswill be able to utilize informal sentence endings, ask and answer about their everyday life. Students will learn about time and date in Korean.

Module 3	Number and Time	2 hours

In this module, students will learn Two ways of counting numbers and saying time in Korean numbers and Sino numbers. Always use two different names of numbers are commonly used in daily life. Students can count in mathematics and pay Korean currency, Kwon as well.

Module 4	Introduction to Tenses – I	6 hours

In this module, Students will learn how to explain what they did yesterday or last weekend. After completing the lessons, students will be able to speak about their school time story and what happened to them yesterday and last year.

Module 5	Introduction to Tenses – II and Past Tense	4 hours

In this module, Students will learn how to explain what they did yesterday or last weekend. After completing the lessons, students will be able to speak about their school time story and what happened to them yesterday and last year.

Module 6	Making appointment and Suggestions – I	4 hours

Talking about location, expressing movement, place marker and directions.

Students will learn many vocabularies related with various places.		
Module 7	**Making appointment and Suggestions – II**	**4 hours**
Talking about location, expressing movement, place marker & writing about travelling from one place to another. In this module which is an extension of **Module** 6, students will learn how to explain where a thing is, where I am and where I go to. Students will learn many vocabularies related with various places.		
Module 8	**Contemporary Issues**	**2 hours**
	Total Lecture hours	**30 hours**

Reference Books

Introduction to Sejong Korean

E-Books

1. https://nuri.iksi.or.kr/e-book/ecatalog5.jsp?Dir=303&catimage=&callmode=admin
2. https://nuri.iksi.or.kr/e-book/ecatalog5.jsp?Dir=611&catimage=&callmode=admin

Mode of Evaluation: CAT / Assignment / Quiz / Seminar/ FAT

Recommended by Board of Studies	03-03-2023		
Approved by Academic Council	No. 69	Date	16-03-2023

Discipline core

TPHY201L	Mechanics	L	T	P	C
		3	1	0	4
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To lay foundation for understanding physical phenomena in everyday life through concepts such as inertia, momentum and energy.
2. To develop competency in solving these problems via Newtonian mechanics.
3. To prepare for tackling advanced topics such as chaos.

Course Outcomes

At the end of the course the student will be able to

1. Understand the basics of kinematics in various co-ordinate systems.
2. Apply
   laws to most common everyday dynamics of particles
3. Synthesize the concepts of Newtonian Mechanics to a variety of phenomenological forces.
4. Comprehend the generality of conservation principles and their applications.
5. Extend the Newtonian principles to rigid body motion and non-inertial frames.

Module:1	**Vectors and Kinematics**	**5 hours**

Review of vector algebra - Motion in one and several dimensions - Formal solution of kinematic equations - Rotating vectors - Motion in polar coordinates.

Module:2	**Newtonian Mechanics**	**5 hours**

- Fictitious forces - - Dynamics in polar coordinates.

Module:3	**Forces and Equations of Motion**	**6 hours**

Fundamental forces - Gravity - Principle of equivalence - Electrostatic force - Phenomenological forces - Contact forces, tension, normal force and friction - Viscosity -

Hooke's law and simple harmonic motion

Module:4	**Momentum and Energy**	**8 hours**

Dynamics of a system of particles - Centre of mass - Centre of mass coordinates - Conservation of momentum - Impulse - Momentum and flow of mass - Rocket motion - Momentum flow and momentum flux.
Integrating equations of motion in multiple dimensions - Work-energy theorem in multiple dimensions - Power - Conservation of mechanical energy - Potential energy - Energy diagrams - Non-conservative forces.

Module:5	**Dynamics**	**5 hours**

Small oscillations in a bound system - Stability - Normal modes - Collision and conservation laws - Elastic and inelastic collisions - Collision and center of mass coordinates.

Module:6	**Angular momentum and Rigid Body Motion**	**9 hours**

Angular momentum of a particle - Fixed axis rotation - Moment of inertia - Torque - Conservation of angular momentum - Dynamics of fixed axis rotation - The simple and physical pendulums - Motion involving translation and rotation - Torque on a moving body - Work-energy theorem and rotational motion.
The vector nature of angular velocity and angular momentum - The gyroscope - Rigid body motion and tensor of inertia.

Module:7	**Non-inertial Systems and Fictitious Forces**	**5 hours**

Galilean transformation - Uniformly accelerating systems - Physics in a rotating coordinate system - Fictitious forces in a rotating system.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**
	Tutorials **Problems from each module, in the form of problem sets, will be worked out by the students with assistance from the faculty. In addition, problems related to Joint Admission Test for Masters (JAM) will also be addressed.**	**15 hours**

Text Book(s)

1. Kleppner D and Kolenkow R, An Introduction to Mechanics, 2014, 2nd Edition, Cambridge University Press, UK.

Reference Books

1. Mathur D S and Hemne P S, Mechanics, 2012, Revised Edition, S. Chand & Co. Ltd, India.
2. Kittel C, Knight W D, Ruderman M A, Helmholz A C and Moyer B J, Mechanics, Berkeley Physics Course: Volume 1, 2011, 2nd Edition, Tata McGraw Hill, India.
3. Feynman R, Leighton R and Sands M, The Feynman Lectures on Physics, Volume I, 2010, The New Millennium Edition, Basic Books, US.
4. Shankar R, Fundamentals of Physics - Mechanics, Relativity and Thermodynamics, 2014, Yale University Press, New Haven and London.

Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY201P	Mechanics Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. Acquire the appropriate data accurately and keep systematic record of laboratory activities.
2. Interpret findings using the correct physical scientific framework and tools.
3. Prepare professional quality textual and graphical presentations of laboratory data and computational results.
4. Evaluate possible causes of discrepancy in practical experimental observations, results in comparison to theory.

Course Outcome

At the end of the course the student will be able to

1. Understand various experimental and computational tools thereby developing analytical abilities to address real world problems.
2. Formulate, conduct, analyze and interpret experiments.

Indicative Experiments	
1.	Determination of the Moment of Inertia of a Flywheel about its axis of rotation.
2.	Determination of the moment of Inertia of an irregular body, about an axis through its center of gravity and perpendicular to its plane by dynamical method (Inertia table).
3.	Determination of the Precession and nutation of a Gyroscope
4.	Verification of the linear motion under virtually frictionless conditions.
5.	Determination of Spring constant by static & dynamic methods.
6.	Verification of law of parallel and series combination of similar springs(Hooke's law)
7.	Verification of the vector addition of forces.
8.	Determination of the resonance in forced oscillations.
9.	Verification of the static, Kinetic and Rolling Friction
10.	Verification of the Conservation of angular momentum in elastic and inelastic rotational collision
	Total Laboratory Hours: 60 hours

Mode of assessment: Continuous assessment, FAT, and Oral examination

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY203L	Solid State Physics	L	T	P	C
		3	1	0	4
Pre-requisite	TPHY103L, TPHY103P, TMAT104L	Syllabus version			
		1.0			

Course Objectives

1. To give an introduction to the basic concepts of solid state physics.
2. To give an overview of the crystalline solids.
3. To understand the electron transport in metals and semiconductors.

Course Outcomes

At the end of course the student will be able to

1. Differentiate the crystalline and non-crystalline solids.
2. Comprehend the crystalline structure of solids.
3. Analyze the electrical and thermal conductivity of metals.
4. Apply the band theory of solids.
5. Interpret the carrier transport in semiconductors.
6. Evaluate the electron dynamics in solids.

Module:1	**Crystalline Solids**	**7 hours**
Solids- Amorphous and Crystalline solids Interatomic forces Lattice translation vectors- Lattice with a basis- Unit cell - Bravais and Non-Bravais lattice - Crystal systems - Packing fraction- Miller indices - Wigner-Seitz cell.		
Module:2	**Crystal Diffraction**	**6 hours**
Bragg's Scattering from an atom Crystal diffraction Reciprocal lattice - Brillouin zone - Laue condition - Atomic scattering factor.		
Module:3	**Free Electron Theory for Metals**	**7 hours**
Free electron gas Drude model Electrical conductivity Resistivity vs. Temperature for metals Thermal conductivity of metals Wiedemann-Franz law - Sommerfeld quantum corrections - Density of states - Fermi energy and Fermi sphere.		
Module:4	**Electrons in a Periodic Potential**	**6 hours**
Kronig-Penny model Elementary band theory- Band gap Concept of hole Effective mass Carrier mobility Hall effect		
Module:5	**Semiconductors**	**5 hours**
Intrinsic carrier concentration Carrier generation and recombination Fermi level Extrinsic semiconductors Donors and Acceptors		
Module:6	**Carrier Transport in Semiconductors**	**6 hours**
Carrier transport Drift and Diffusion Carrier scattering Temperature dependence of carrier mobility Continuity equation P-N junction Built-in potential Depletion width I-V characteristics		
Module:7	**Elementary Lattice Dynamics**	**6 hours**
Concept of Phonons - Heat Capacity of solids - Classical theory - Quantu Theory - Debye theory- Dynamics of the chain of atoms - 1-dimensional chain of monoatomic atoms - 1-dimensional chain of diatomic atoms - Acoustic and Optical Phonons.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Tutorial	**Tutorial Topics**	**15 hours**
	Assignment Problems/ Problem sets will be discussed GATE & CSIR problems related to the subject will be discussed	

Text Book(s)			
1.	Charles Kittel, Kittel's Introduction to Solid State Physics, 2019, Wiley India Edition, India.		
2.	M.A. Wahab, Solid State Physics, Structure and Properties of Materials, 2015, 3rd Edition, Narosa Publishing House Pvt. Ltd., New Delhi, India.		
Reference Books			
1.	N. Ashcroft and N. Mermin, Solid State Physics, 2021, Brooks/Cole.		
2.	Leonid Azaroff, Introduction to Solids, 2017, McGraw Hill Education, New York, USA.		
Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT			
Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY204P	Materials Science Lab	L	T	P	C
		0	0	4	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To make the students perform experiments related to solid state physics.
2. To apply the theoretical knowledge for developing new materials.
3. To analyze the theory and experimental results for better knowledge.

Course Outcomes

At the end of the course students will be able to

1. Design and develop the materials for advanced applications.
2. Evaluate theoretical calculations using experimental observations.
3. Evaluate various magnetic properties of solids.

Indicative Experiments

1.	Determination of lattice parameter by diffraction method
2.	Measurement of Specific heat capacity of solids
3.	Determination of I-V characteristics using Four Probe set-up
4.	Hall Effect in Metals and Semiconductors
5.	Detection of particles using Geiger Muller counter
6.	Measurement of Susceptibility of Solids by Gouy's Method
7.	Measurement of Hysteresis from B- H Curve
8.	Determination of Dielectric Constant and Curie Temperature of Ferroelectric Ceramics
9.	Determination of Fermi energy of copper
10.	Determination of Charge of electron using Millikan oil drop experiment
	Total Laboratory Hours: 60 hours

Mode of assessment: Continuous assessment, FAT, and Oral examination

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY205L	Heat and Thermodynamics	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. Study the concepts of heat and thermodynamics.
2. Understand the different laws of thermodynamics.
3. Know the function of heat engines.

Course Outcomes

At the end of the course the student will be able to

1. Comprehend the nature of heat and conduction of heat in solids.
2. Understand the effect of temperature in liquifying the gas.
3. Differentiate between the conductor and superconductor.
4. Demonstrate the specific heat capacity of the gas by experiments.
5. Elucidate different laws of thermodynamics.
6. Explain the change in entropy in different processes.

Module:1	Heat, Work and Transmission of heat	7 hours

Nature of heat - work and heat - Transmission of Heat - Conduction in solids: Thermal conduction - Thermal conductivity of good conductor theory and determination - method - Thermal conductivity of poor conductor - theory and determination - method Application of conduction of heat.

Module:2	Kinetic Theory of gases	7 hours

Introduction- Deduction of gas laws on the basis of kinetic theory- ‖'s law of distribution- Boltzmann distribution- Maxwell-Boltzmann distribution formula for speeds- Degrees of freedom- vibratory motion of molecules- Internal energy of gases- Law of equipartition energy.

Module:3	Specific Heat of Gases	7 hours

Specific heat of gases - Specific heat of the gas at constant volume - Specific heat of the gas at constant pressure - Work done during the expansion of a gas at constant pressure - Molar specific heats - Relation between two specific heats - the ratio of two specific heats - Change in internal energy of a gas - Experimental determination of sp. heat at constant volume by - determination of sp. heat at constant pressure

Module:4	Basic concepts and Zeroth Law of Thermodynamics:	4 hours

Extensive and intensive Thermodynamic Variables -Thermodynamic Equilibrium - Zeroth Law of Thermodynamics & Concept of Temperature - Thermodynamic coordinates - extensive and intensive - Equations of state - Various processes - PV indicator diagrams.

Module:5	First Law of Thermodynamics	6 hours

The first law of Thermodynamics - Sign convention for heat and work - Derivation of equation of state - Work done in an isothermal and adiabatic process for an ideal gas - Internal energy as a state function - Application of the first law for Cyclic Process - Adiabatic Process - Isochoric Process - Isobaric Process and Isothermal Process.

Module:6	Second Law of Thermodynamics	6 hours

Reversible and irreversible processes - Carnot Engine - Carnot Cycle and its efficiency (with derivation) -thermodynamics their equivalence) - Practical internal combustion engines - Otto and Diesel Cycles (qualitative treatment) - Carnot theorem (proof) Refrigerator - Coefficient of performance.

Module:7	Entropy	6 hours

The concept of entropy - Entropy of an ideal gas - Entropy - reversible process - Entropy - irreversible process - Entropy and the second law - Clausius inequality - Principle of increase of entropy - Entropy change in adiabatic process - free expansion - cyclic process - isobaric process - TdS diagram of a Carnot cycle - Entropy and disorder.

Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Tutorial	GATE and CSIR problems related to the subject will be solved in the tutorial sessions. Assignment problems will be discussed during the tutorial sessions.	**15 hours**

Text Book(s)	
1.	Mark Zemansky, Richard Dittman, Heat and Thermodynamics, 2017, 8th edition, McGraw Hill Education, India.
2.	Brij Lal ,Subrahmaniyam and P.S. Hemne Heat Thermodynamics and Statistical Mechanics, 2012, Revised Edn. S Chand & Co., India.
Reference Books	
1.	S.J. Blundell and K.M. Blundell, Concepts in Thermal Physics,2012, 2nd Ed., Oxford University Press, UK.
2.	D S Mathur, Heat and thermodynamics, 2014 Sultan Chand & Sons, New Delhi, India.
3.	S.S. Singhal, J.P. Agarwal and Satya Prakash, Heat Thermodynamics and Statistical Mechanics, 1991 First Edn. Pragati Prakashan, India.
4.	A.B.Gupta and H.Roy, Thermal Physics (Heat and Thermodynamics), 2005, Revised
5.	Reprint, Books and Allied (P) Ltd, India. Don S. Lemons, A Student's Guide to Entropy (Student's Guides), 2013, Cambridge University Press, UK.

Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY301L	Mathematical Physics	L	T	P	C
		3	1	0	4
Pre-requisite	TMAT104L	Syllabus version			
		1.0			

Course Objectives

1. To provide a strong background of mathematical tools.
2. To gain insight through examples and applications.
3. To develop competence in solving problems independently.

Course Outcomes

At the end of the course, student will be able to

1. Understand basic concepts of matrix and its application in Physics.
2. Apply vector calculus and evaluate relevant problems in Physics.
3. Explain the origin of Legendre polynomial, Bessel functions and Hermite polynomial and use their properties in relevant problems.
4. Understand the methods of solving partial differential equation with different boundary conditions and apply it in relevant problems in Physics.
5. Analyze periodic functions in the light of its Fourier components.
6. Understand basic concepts in probability theory and apply to simple problems in Physics.

Module:1	Matrices	6 hours

Matrix Algebra: Addition, Multiplication - Transpose and Inverse of a matrix - Special type of matrices: Symmetric, Skew symmetric, Hermitian, Skew-Hermitian - Unitary and Orthogonal matrices - Normal matrices - Trace of a matrix - Solving systems of linear equations - Cramer's Rule

Eigen-values and Eigenvectors (degenerate and non-degenerate cases): Simple matrix and defective matrix - Diagonalization of matrices - Solution of coupled linear ordinary homogeneous differential equations - Caley-Hamilton theorem - Functions of a matrix (operator).

Module:2	Vectors	6 hours

Vector algebra and Identities - Idea of linear independence - Basis vectors - Orthonormalization and completeness of basis vectors - Properties of vectors under rotations.

Vector differentiation: Scalar and Vector fields - Gradient of a scalar field and its geometrical interpretation - Divergence and curl of a vector field and physical interpretation - Laplacian operator.

Vector Integration: Line, Surface and Volume integrals - Flux of a vector field - divergence theorem - and Stokes Theorems and their applications (no rigorous proofs).

Orthogonal curvilinear coordinate system - Gradient, Divergence, Curl and Laplacian in Spherical and Cylindrical Coordinate Systems - Line, Surface and Volume integrals in Spherical and Cylindrical coordinate systems - Jacobian of coordinate transformation.

Module:3	Power Series Solution Method	6 hours

Linear independence of functions - Wronskian - Ordinary point and Singular point - Power series solution method of second order linear homogeneous differential equation with examples - Frobenius method: Series solution around regular singular points - Series solution of Legendre Differential equation and Legendre polynomials - Series Solution of Bessel differential equation and Bessel function - Hermite differential equation and Hermite polynomial - Lauguerre differential equation and polynomials.

Module:4	Properties of Special Functions	6 hours

Properties of Legendre, Hermite and Lauguerre Polynomials: Rodrigues Formula, Generating Function, Orthogonality, Simple recurrence relations - Expansion of function in a series of Legendre Polynomials, Multipole expansion in Electrostatics - Harmonic oscillator

problem in quantum mechanics - Hydrogen atom problem in quantum mechanics - Bessel Functions of the First Kind: Generating Function, simple recurrence relations and Orthogonality. Functions represented as integrals: Gaussian integral, Error function, Gamma function, Beta function and related properties.

Module:5	**Partial Differential Equations in Physics**	**8 hours**
Partial differential equations (PDE) in Physics: preliminaries; classification of second-order quasilinear equations; elliptic, hyperbolic and parabolic type - Characteristics - Boundary conditions (Dirichlet, Neumann, and Cauchy) and types of equations - One-dimensional wave equation - One-dimensional diffusion equation, Solutions to partial differential equations using separation of variables: Solutions of Laplace's equation in problems with cylindrically and spherically symmetric boundary conditions - Examples from Electrostatics. Wave equation and its solution for vibrational modes of a stretched string - rectangular and circular membranes.		
Module:6	**Fourier Series**	**8 hours**
Introduction to travelling wave - Introduction to Fourier series: Time dependent and Space dependent Series - Fourier representation of periodic functions - Calculating coefficients: Average of a function, Orthogonality of Sine and Cosine functions - Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients - Odd function and Even function - Convergence of - Gibbs Phenomenon - Fourier half range series - Fourier Series Using Complex number Parseval's theorem.		
Module:7	**Introduction to Probability**	**3 hours**
Independent random variables - Mean and variance - Multiplicity - Averages, and Distribution functions: Bernoulli, Poisson, Gaussian, Exponential (Boltzmann), Power law, Lorentzian, Flat - Few applications in Physics - Law of large numbers and the central limit theorem.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**
	Tutorial Example problems from each module will be worked out by the student with help of the teacher which will also help them to prepare for CSIR and GATE examinations. Students' doubts will be addressed. Problem set is to be given as home work in each tutorial.	**15 hours**

Text Book(s)

1. V. Balakrishnan, Mathematical Physics with Applications, Problems and Solutions, 2020, Ane Books Pvt. Ltd. India.
2. Mary L. Boas, Mathematical Methods in the Physical Sciences, 3rd Edition, 2005, John Wiley and Sons, New York

Reference Books

1. J.W. Brown and R.V. Churchill, Fourier Series and Boundary Value Problems, 2017, McGraw Hill Education, USA.
2. Brett Borden and James Luscombe, Mathematical Methods in Physics, Engineering, and Chemistry, 2020, John Wiley & Sons, Inc., USA.
3. George B. Arfken, Hans J. Weber and Frank E. Harris, Mathematical Methods for Physicists: A Comprehensive Guide, 2012, 7th Edition, Academic Press, USA.
4. J. F. James, A Students Guide to Fourier Transforms: With Applications in Physics and Engineering, 2011, Cambridge University Press, UK
5. S.Pal and S.C. Bhunia, Engineering Mathematics, 2015, Oxford University Press, UK

TPHY302L	Electricity and Magnetism	L	T	P	C
		3	1	0	4
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. An ability to understand electricity and magnetism.
2. The broad education necessary to understand electrostatic and magnetostatic environment.
3. A knowledge of concepts like polarization, magnetization and electromagnetic induction.

Course Outcomes

At the end of the course the student will be able to

1. Use vector analysis to understand the mathematical physics of electric and magnetic forces, fields, potentials, and their divergence and curls.
2. Explain the concepts about the static behaviour of charges and electric fields inside matter.
3. Explain magnetic fields and vector potentials from stationary currents flowing through straight line segments and loops.
4. Describe magnetism at atomic level and compute magnetic fields within and outside a magnetic material.
5. Calculate energy in electric and magnetic fields in different geometries of current carrying loops.
6. Apply Kirchhoff's laws to analyze AC circuits to describe the graphical relationship of R-C-L.

Module:1	Mathematical preliminary	6 hours

Gradient of a scalar - Divergence or dot product of a vector and Curl or cross product of a vector-Closed Line integrals-Surface integrals and volume integrals - Their (Grad., Div., Curl., and integrals) physical interpretation with examples using Electric filed (E) and Magnetic field (B)-Vector identities- Triple products, Product rules and second derivatives. - Stokes and Divergence theorems.

Module:2	Electric Field and Potential	8 hours

Electric field-Electric field lines - Electric flux-Gauss' Law with applications to charge distributions with spherical-cylindrical and planar symmetry - Conservative nature of Electrostatic Field-Electrostatic Potential-Laplace's and Poisson equations-The Uniqueness Theorem-Potential and Electric Field of a dipole - Force and Torque on a dipole - Electrostatic energy of the system of charges-Electrostatic energy of a charged sphere-Conductors in an electrostatic Field-Surface charge and force on a conductor.

Module:3	Electric Field in matter	9 hours

Polarization (P)-Polarization Charges-Electrical Susceptibility and Dielectric Constant-Capacitor (parallel plate, spherical, cylindrical) filled with dielectric-Displacement vector (D) - Relations between E, P and D-Gauss' Law in dielectrics - Capacitors with dielectric materials.

Module:4	Magnetostatics	5 hours

Magnetic force between current elements and definition of Magnetic Field (B)-Biot-Savart's Law and its simple applications: straight wire and circular loop-Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole) - Ampere's Circuital Law and its application to: Solenoid - Toroid- Properties of B: curl and divergence- Vector Potential. Magnetic Force on: point charge - current carrying wire - between current Elements-Torque on a current loop in a uniform Magnetic Field.

Module:5	Magnetic Properties of Matter	5 hours

Electron spin and magnetic moment-Magnetic Susceptibility and permeability- Magnetic field in matter-Free currents and the field **H**-Ferromagnetism-Magnetic hysteresis.

Module:6	**Electromagnetic Induction**	**5 hours**
Faraday's Law-Lenz's Law-Self-Inductance-Mutual Inductance-Reciprocity Theorem-Energy stored in a Magnetic Field-Concept of eddy current and its applications		
Module:7	**Transient current**	**5 hours**
AC Circuits: Kirchhoff's laws for AC circuits-Complex Reactance and Impedance-Series LCR Circuit: Oscillations, Dissipation, Quality Factor, Driven Oscillations and Resonance – Summary and Introduction to Maxwell's equations.		
Module:8	**Contemporary issues**	**2 hours**
Tutorial	• GATE, CSIR problems related to the subject will be solved in the tutorial session. • Problem sets to improve the understanding of the concepts discussed in the class will be solved.	**15 hours**
	Total Lecture hours:	**60 hours**

Text Book(s) :

1. Edward M. Purcell and David J. Morin, Electricity and Magnetism, 2013, 3rd Edition, Cambridge University Press, UK
2. H. D. Young and R. A. Freedman, Sears and Zemansky's University Physics: Electricity and Magnetism, 2011, 12th Edition, Pearson Education India.

Reference Books

1. D. J. Griffiths, Introduction to Electrodynamics, 2020, 4th Edition, Pearson Education India.
2. Matthew N. O. Sadiku, Elements of Engineering Electromagnetics, 2006, 6th Edition, Oxford University Press, UK

Mode of Evaluation: CAT , Quiz, Digital Assignment, FAT

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY303L	Analog and Digital Electronics	L	T	P	C
		3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To learn the basic methods for the design of digital circuits and provide the fundamental concepts used in the design of digital systems.
2. To explain the importance of operational amplifier and its applications.
3. To introduce basic postulates of Boolean Algebra and show the correlation between Boolean expressions.

Course Outcomes

At the end of the course, the students will be able to

1. Understand the properties of Semiconductor Materials.
2. Know the design and functioning of Semiconductor Devices.
3. Analyze the various applications of operational amplifier.
4. Evaluate the various circuits of combinational and Sequential Circuits.
5. Understand the application of Sequential Circuits.

Module:1	Semiconductor Material Properties	5 hours

Atomic Structure - Atomic Energy level diagram - Electronic configuration of Elements - Energy Band Theory of Crystal - Energy Band Structures and Conduction in Insulator, Semiconductor and Metal - Classification of semiconductor - conduction in semiconductor - Carrier Concentration in Intrinsic Semiconductor - Mass Action Law - Drift Current and Diffusion Currents - Carrier Life Time - Continuity Equation.

Module:2	Semiconductor device	9 hours

PN junction diode V-I Characteristics of diode Rectifiers Half wave full wave and bridge rectifiers Zener diode characteristics Zener diode as voltage regulator. Bipolar junction transistor Basic configurations - Relation between α and β Characteristic curves of transistor CB, CE mode h Parameters. JFET input and output characteristics.

Module:3	Amplifiers and Oscillators	6 hours

Single stage CE amplifier Power amplifiers Efficiency of class B Power amplifier Push pull amplifier - General theory of feedback Negative feedback Criterion for oscillations Hartley oscillator – Colpitt's osc

Module:4	Operational Amplifiers	5 hours

Differential amplifier - Common mode rejection ratio Characteristics of an ideal op-amp Virtual ground Inverting amplifier Non inverting amplifier Applications. Adder Subtractor Integrator Differentiator Unity gain buffer.

Module:5	Digital Logic and Number system	8 hours

Introduction to decimal, binary, octal, hexadecimal number systems Interconversions BCD code, Excess 3 code, Gray code complements Simple binaryarithmetic operations Addition, subtraction, multiplication and division Positive andnegative logic Basic and derived logic gates, symbols and their truth tables AND, OR,NOT, NAND, NOR, XOR, and XNOR - Boolean algebra Basic laws of Boolean algebra De-Morgan's theorems - Reducing Boolean expressions using Boolean laws.

Module:6	Combinational Logic Design	4 hours

Half and full adders Half and full subtractors Multiplexer Demultiplexer Encoders and Decoders.

Module:7	Sequential Circuits	6 hours

Basic Latch circuits S-R Flip-Flop D Flip-Flop J-K Flip-Flop T Flip-Flop Triggering of Flip-Flops Asynchronous Inputs in Flip-Flops Master Slave J-K Flip Flops Racing Condition . Counters: Asynchronous and Synchronous Counters Mod Counters - Registers: 4- bit Shift Register SISO Shift Register SIPO Shift Register PISO Shift Register PIPO Shift Register Ring Counter.

Module:8	Contemporary issues	2 hours

	Total Lecture hours:	**45 hours**

Text Book(s)

1. Albert P Malvino, Donald P Leach and Goutam Saha, Digital Principles and Applications, 2015, 8th edition, McGraw Hill, India.
2. Adel S Sedra and Kenneth C Smith and Arun N Chandorkar, Micro electronic circuits, 2017, 7th edition, Oxford University Press India

Reference Books

1. Jacob Milman, Christos C Halkias and Satyabrata Jit, Electronic devices and circuits, 2015, 4th edition, McGraw Hill, India
2. Ben G. Streetman, Sanjay Kumar Banerjee, Solid State Electronic Devices, 2018, 7th edition, Pearson Education India.
3. Thomas L Floyd, Digital Fundamentals, 2017, 11th edition, Pearson Education India.
4. M.S. Tyagi, Introduction to semiconductor materials and devices, 2008, John Wiley & Sons Inc., India
5. D P Kothari and I J Nagrath, Basic Electronics, 2017, 2nd edition, McGraw Hill, India.

Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY304P	Electronics Lab	L	T	P	C
		0	0	4	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. List out and use the methods to examine electronic circuit problems.
2. Design and construct advanced circuits for demand.
3. Outline semiconductor devices and identify the states and working characteristics of circuits.

Course Outcomes

At the end of course the student will be able to

1. Analyze and interpret the circuits and create new design and instrument.
2. Verify theoretical calculations using experimental observations.

Indicative Experiments	
1.	Measurement of clipping and clamping using PN junction diode
2.	Determination of I-V characteristics of Lock-in-amplifier
3.	Determination of I-V characteristics of CE Transistor
4.	Measurement of I-V characteristics of High, Low, Band pass and Notch Filters
5.	Measurement of Output and Transfer Characteristics of MOSFET
6.	Designing Analog to Digital Converter
7.	Designing a Synchronous Counter
8.	Designing Astable and monostable Multivibrator using IC555 timer
9.	Designing Active High, Low, Band pass and Notch Filters using Op-amp
10.	Solving first order Simultaneous Equation using Op-amp
	Total Laboratory Hours: 60 hours

Mode of assessment: Continuous assessment, FAT, and Oral examination

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course code	Advanced Mathematical Physics	L	T	P	C
TPHY305L		3	1	0	4
Pre-requisite	Mathematical Physics	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To develop mathematical competence prior to undertake advanced courses in Physics
2. To generate interest in the subject and an attitude of independent learning
3. To develop confidence among students to undertake competitive exams like CSIR-NET, GATE

Course Outcome

At the end of the course, students will be able to

1. Understand Dirac Bra-Ket Notation and Matrix representations of operators and related concepts
2. Comprehend and evaluate contour integrals in related problems in physics
3. Understand and apply the Fourier transform and Laplace transform method in related problems in Physics
4. Apply Green's function method to relevant problems in Physics
5. Comprehend the basic concept of Tensor and Apply it to certain examples in Physics; Understand the basic concept of Group Theory and Apply it to certain examples in Physics.

Module:1	**Linear Vector Space**	**5 hours**

Linear vector space definition - Linear dependence and independence - Dimensionality of vector space - Basis, Orthonormality and Completeness - Introduction of Dirac Bra-Ket notation and dual space - Inner product and Outer product - Projection Operator - Gram-Schimdt Orthonormalization procedure - Schwarz Inequality.

Linear Operator and its representation as square matrix in n-dimensional complex vector space - Adjoint or Hermitian Conjugate and rules to take adjoint - Transformation of representation under change of basis and similarity transformation - Eigenvalue problem and Diagonalization - Commuting operators and simultaneous eigenstates for non-degenerate and degenerate eigenvalues - Complete sets of commuting operators.

Module:2	**Complex Variable Theory**	**8 hours**

Recapitulation: Complex numbers, triangle inequalities, Schwarz inequality - Function of complex variable: Single and Multiple-valued function - Differentiation: Cauchy-Riemann equations and their applications - Analytic and harmonic function.

Complex integrals - Cauchy's theorem (elementary proof only) - converse of Cauchy's theorem - Cauchy's Integral Formula and its corollaries - Series: Taylor and Laurent series expansion - Classification of singularities - Branch point and Branch cut - Residue theorem and evaluation of some typical real integrals using this theorem.

Module:3	**Fourier Transform**	**6 hours**

Fourier Transforms: Fourier Integral theorem - Fourier transform of trigonometric - Gaussian, finite wave train & other functions - Representation of Dirac delta function as a Fourier Integral - Fourier transform of derivatives - Inverse Fourier transform - Properties of Fourier transforms - Three dimensional Fourier transforms with examples - Application of Fourier Transforms to differential equations - One dimensional Wave and Diffusion/Heat Flow Equations.

Module:4	**Laplace Transform**	**6 hours**

Laplace transforms and their inverse transforms - Bromwich integral - Transform of derivative and integral of a function - Solution of differential equations using integral transforms.

Module:5	**Green's Function Method**	**5 hours**

Inhomogeneous differential equation - Solution of Inhomogeneous differential equation by variation of parameter technique.

Sturm-Liouville theory - Eigenvalues and Eigenfunctions - The Hermitian nature of the operator L Dirac delta function - Definition of Green's function - Properties of Green's function - Solution of Inhomogeneous differential equation using Green's function technique.

Module:6	**Tensor**	**6 hours**

Tensorial Character of physical quantities - Cartesian tensors in 3-d - Tensors in index notation – Einstein's notation, Inner and Outer products - Kronecker and Levi Civita tensors - Tensor rank - Symmetric and Asymmetric - Contraction - Quotient law - Contravariant and Covariant tensors - Metric tensors and their determinants - Raising and Lowering of Indices - Pseudo tensors - Simple applications: stress tensor and electromagnetic field tensor.

Module:7	**Group theory**	**7 hours**

Definitions and Nomenclature - Discrete groups (symmetry and permutation groups) and continuous

groups (O(n), SO(n), U(n), SU(n)) - Abelian and Non-abelian groups - Rearrangement theorem - Cyclic groups - Subgroups and Cosets - Conjugate elements and Class structure - Factor groups - Isomorphy and Homomorphy - Representation of finite groups - Reducible and Irreducible representations - The Unitarity of Representations - Schurs Lemma - The great orthogonality theorem - Characters of a representation - Character Table - Examples from solid state crystallography: Space and point group.		
Module:8	**Contemporary issues**	**2 hours**
Contemporary research direction ; one/two lectures of experts from renowned national or international institutions.		
	Total Lecture hours:	**45 hours**
Tutorial		
Example problems from each module will be worked out by the student with help of the teacher which will also help them to prepare for CSIR and GATE examinations. Students' doubts will be addressed. Problem set is to be given as home work in each tutorial.		**15 hours**

Text Book(s)

1. V. Balakrishnan, Mathematical Physics with Applications, Problems and Solutions, 2020, Ane Books Pvt. Ltd, Chennai, India.
2. Mary L. Boas, Mathematical Methods in the Physical Sciences, 3rd Edition, 2005, John Wiley and Sons, New York

Reference Books

1. George B. Arfken, Hans J. Weber and Frank E. Harris, Mathematical Methods for Physicists: A Comprehensive Guide, 2012, Academic Press, Seventh Edition.
2. J.W. Brown and R.V. Churchill, Complex Variables and Applications, 2003, Tata McGraw-Hill, Seventh Edition, India.
3. J. Mathews and R.L. Walker, Mathematical Methods of Physics, 2004, Pearson Education, London,
4. UK.
   D. G Zill and P. D Shanahan, Complex analysis, 2015, Jones and Bartlett, Sudbury, Massachusetts,
5. USA.
6. P. Dennery, A. Krzywicki, Mathematics for Physicists, 1996, Dover Publications Inc., New York.
   Michael Tinkham, Group Theory and Quantum Mechanics, 2003, Dover Publications Inc., New York.

Mode of Evaluation: CAT, Quiz, Digital Assignment, FAT

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

TPHY306L	Optics and Spectroscopy	L	T	P	C
		3	1	0	4
Pre-requisite	TPHY102L, TPHY102P	Syllabus version			
		1.0			

Course Objectives

1. To expose to the basic phenomena physical optics.
2. To learn the fundamentals of spectroscopy.
3. To introduce the molecular spectroscopy.

Course Outcomes

At the end of the course the student will be able to

1. Comprehend the phenomenon of interference and its applications as interferometers.
2. Understand the diffraction phenomenon and resolving power of optical instruments.
3. Recall the basics of polarization of light.
4. Understand the essence of spectroscopy.
5. Apply the knowledge of molecular spectroscopy for studying the structure of various molecules.

Module:1	Interference	5 hours

Interference - Coherent sources- interference in thin films - Air wedge- theory - determination of diameter of a thin wire by Air wedge - test for optical flatness - rings - determination of refractive index of a liquid.

Module:2	Interferometers	6 hours

- Measurement of wavelength and thickness of mica sheet, Fabry-Perot interferometer - sharpness of fringes Resolution - Mach-Zehnder interferometer - determination of refractive index - Holography - Construction and reconstruction of a hologram - applications.

Module:3	Diffraction	6 hours

- Diffraction at a circular aperture - Straight edge - narrow wire - Fraunhofer diffraction at a single slit - Double slit - Missing orders in a Double slit, Diffraction pattern - Grating with theory Oblique incidence Overlapping of spectral lines.

Module:4	Resolving power of optical instruments	5 hours

Resolving power - Rayleigh's criterion of resolution - Resolving power of a Prism - Grating - dispersive power of grating - Resolving power of Telescope.

Module:5	Polarization	6 hours

- Nicol Prism - Nicol Prism as polarizer and analyzer - Polaroids and their uses - Quarter wave plates and Half wave plates. Plane, elliptically and circularly polarized light - Production and detection - Optical activity - Fresnel's explanation of optica activity.

Module:6	Fundamentals of Spectroscopy	6 hours

Spectroscopy - Introduction Electromagnetic spectrum -Types of spectra - Emission and absorption spectra Continuous, band and line spectra - Solar spectrum - Fraunhoffer lines.

Module:7	Molecular Spectroscopy	9 hours

Microwave and infrared Spectroscopy - Rotation of molecules - Rotational Spectra - Rigid diatomic molecules, selection rules - Raman Spectroscopy - Classical theory and Quantum theory - Molecular Polarizability - pure rotational Raman spectra of linear molecules - vibrational Raman spectra - Applications.

Module:8	Contemporary issues	2 hours
	Total Lecture hours:	45 hours
Tutorial	Tutorial Topics	15 hours

	GATE, CSIR problems related to the subject will be solved in the tutorial sessions Assignment problems/ problem sets will be discussed during the tutorial sessions	

Text Book(s)

1. F. Jenkins and H. White, Fundamentals of Optics, 2017, 4th Edition, McGraw Hill, India.
2. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 2017, 4th Edition, McGraw Hill, India

Reference Books

1. Ajoy Ghatak, Optics, 2020, 7th Edition, McGraw Hill, India.
2. E. Hecht and A. R. Ganesan, Optics, 2019, 5th Edition, Pearson, India.
3. D. W. Ball, The Basics of Spectroscopy, 2001, SPIE, USA.

Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course code	Classical Mechanics	L	T	P	C
TPHY401L		3	1	0	4
Pre-requisite	Mechanics	**Syllabus version**			
		v.1.0			

Course Objectives

1. To learn the Lagrangian and Hamiltonian formalisms of simple classical systems
2. To learn the methods of solving central force problems and rigid body dynamics

Course Outcome

At the end of the course the student will be able to
1. Understand basic formalism of Lagrangian and Hamiltonian dynamics
2. Apply Lagrangian formalism for solving Kepler's problem
3. Understand rigid body dynamics and small oscillations using Lagrangian approach and to discuss conservation laws in the Hamiltonian dynamics
4. Understand canonical transformations
5. Explain the foundations of relativistic physics
6. Apply Lagrangian and Hamiltonian for solving simple classical dynamics problems

Module:1	**Lagrangian Formalism**	**6 hours**
Generalized coordinates - principle of virtual work - D'Alembert's principle – Lagrange's formulation and simple applications - Variational principle and Lagrange equation		
Module:2	**Hamilton's principle**	**6 hours**
Hamilton's principle - Lagrange equation from Hamilton's principle - Symmetry and conservation laws - conservation of linear momentum, energy and angular momentum.		
Module:3	**Central Force Problem**	**7 hours**
Reduction of two body problem in central force - Equations of motion - effective potential energy - nature of orbits - Virial theorem - Kepler's problem; Scattering in a central force field - center of mass and laboratory frame.		
Module:4	**Rigid Body System - Oscillating System**	**7 hours**
Elements of rigid-body dynamics - Euler angles – symmetric top and applications - Small oscillations - normal mode analysis - normal modes of a linear tri-atomic molecule - forced oscillations.		
Module:5	**Hamiltonian Formulation**	**5 hours**
Legendre transformation - Hamiltonian equations of motion - cyclic coordinates - phase space and Liouville's theorem - Symmetries and conservation laws in Hamiltonian picture.		
Module:6	**Hamiltonian-Jacobi Formalism**	**5 hours**
Canonical transformations- Poisson brackets - Hamilton-Jacobi theory - action-angle variables - Time dependent perturbation - examples of time dependent perturbation.		
Module:7	**Special Theory of Relativity**	**7 hours**
Inertial frames - principle and postulate of relativity - Lorentz transformations - Matrix in Minkowski space-time – Lorentz transformation in real four dimensional space-time - four-vector notation – energy-momentum - four-vector for a particle - Covariant four dimensional formulation.		
Module:8	**Contemporary issues**	**2 hours**
Contemporary research direction; one/two lectures of experts from renowned national or international institutions.		
	Total Lecture hours:	**45 hours**
Tutorial		**15 hours**
GATE, CSIR problems related to the subject will be solved in the tutorial sessions. Assignment problems/ problem sets will be discussed during the tutorial sessions		

Text Book(s)

1. N. C. Rana and P. S. Joag, Classical Mechanics, 2017, 1st edition, McGraw Hill Education, New Delhi, India.
H. Goldstein, C. Poole and J. Safko Classical Mechanics, 2015, 3rd edition, Pearson Education, Delhi,

2.	India.		
Reference Books			
1.	Walecka John Dirk, Introduction To Classical Mechanics, 2021, 1st Edition, World Scientific Publishing Co Pte Ltd, Singapore.		
2.	Gupta, Kumar, Sharma, Classical Mechanics, 2019, 13th Edition, Pragati Prakashan Educational Publishers, India		
Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

TPHY402L	Principles of Quantum Mechanics	L	T	P	C
		3	1	0	4
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To study the formalism, concepts of quantum mechanics and apply to the one-dimensional problems.
2. To understand the world of atomic scale and principles that govern the quantum world.
3. To show complete understanding of hydrogen atom using the laws of quantum mechanics.

Course Outcomes

At the end of the course the student will be able to

1. Comprehend the basic concepts and the laws governing the quantum world.
2. Understand the fundamental ideas of quantum mechanics.
3. Solve the one dimensional problems in atomic scale and extend to 3-dimensions.
4. Understand the consequence of wave-particle duality using the potential problem.
5. Apply the ideas of angular momentum at the atomic scale.
6. Cognize the ideas of quantum mechanics and apply them to understand hydrogen atom.

Module:1	Historical Perspective	6 hours

Double slit experiment - Wave-like properties of particles - hypothesis - de Broglie Wavelength - Phase velocity and group velocity of de Broglie Waves - Wave-particle duality -Davisson-Germer experiment-Uncertainty principle and its implications - deriving uncertainty principles.

Module:2	Fundamental Ideas	6 hours

The concept of measurement in quantum theory - Specification of the state of a system in quantum theory - Representation of observables by Hermitian Operators - Operators associated with position, linear momentum, and kinetic energy - Commutation Relations - Properties of Hermitian Operators - Postulates of quantum theory regarding the results of measurement of an observable.

Module:3	Schrödinger Equation & Basic Formalism	6 hours

Interpretation of the wave function - theorem - The time-independent Schrödinger Equation -Stationary States - Postulates of Quantum Mechanics - Eigenvalues and Eigenfunctions - Generalized Uncertainty principle - Identical particles - Symmetry and antisymmetry of wavefunctions.

Module:4	Exactly solvable problems in One Dimension - I	6 hours

Free particle and Box Normalization - Particle in a box - Particle in a square well potential Bound states eigenvalues - eigenfunctions - nonlocalized states - Energies and wavefunctions of the ground and excited states - Ground state energy from the uncertainty principle - symmetric and antisymmetric solution.

Module:5	Exactly solvable problems in One Dimension - II	7 hours

Potential barrier - Solution of the step potential problem with energy less than or greater than
the step height - Reflection and transmission coefficients - Finite potential barrier - Barrier penetration - Tunnelling, Reflection and Transmission coefficients - quantum mechanical tunnelling - multiple potential well - Periodic potentials & energy bands - Simple harmonic oscillator (differential equation method - Ladder operator methods) - Problems.

Module:6	Angular Momentum	6 hours

Particle in a spherically symmetric potential - Form of the ^{2} operator in spherical polar coordinates -Method of separation of variables - Radial and angular parts of the wave function - Orbital angular momentum(L) - Operators for the components of L - Commutation

relations involving Lx, Ly, Lz and L2 - The forms of Lz and L2 in spherical polar coordinates - Space quantization.		
Module:7	**Three Dimensional Problems**	**6 hours**
Particle in a Central Potential - Spherical Harmonics Parity - Particle in a spherical well - Hydrogen Atom - Energy eigenvalues - Quantum Numbers Degeneracy - Explicit form of the ground state wavefunction -Probability density in the ground state.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Tutorials		
	1. GATE and CSIR examinations related topics, Problems related to the topics discussed in the units 2. Assignment problems will be discussed	**15 hours**
	Total Lecture hours:	**60 hours**

Textbook(s)	
1.	David J. Griffiths & Darrell F. Schroeter, Introduction to Quantum Mechanics, 2018, Cambridge University Press, UK.
Reference Books	
1.	S.L. Kakani SL and H. M. Chandalia, Quantum Mechanics, Theory and Problems, 2004, Sultan Chand & Sons, India.
2.	L. I. Schiff, Quantum Mechanics, 2017, McGraw Hill Education, India.
3.	A. P. French and Edwin Taylor, An Introduction to Quantum Physics, The M.I. T. introductory Physics series, W. W. Norton & Company, New York.
4.	H. C. Verma, Quantum Physics, 2012, 2nd edition, TPS publishers, India.
5.	Mathews & Venkatesan, Tb Of Quantum Mechanics, 2E, 2010, Tata McGraw-Hill Education.
Mode of Evaluation: CAT, Digital Assignments, Quiz and FAT	

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course code	Statistical Mechanics	L	T	P	C
TPHY403L		3	1	0	4
Pre-requisite	Mathematical Physics, Modern Physics	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To understand the properties of macroscopic systems using the knowledge of the properties of individual particles.
2. To differentiate between different ensemble theories to explain the behavior of the systems.
3. To differentiate between classical statistics and quantum statistics.

Course Outcome

At the end of the course the student will be able to
1. Connect statistical Mechanics with thermodynamics.
2. Compare different ensemble theories used to explain the behavior of the systems.
3. Compare classical and quantum statistical Mechanics.
4. Comprehend the statistical behavior of ideal Bose and Fermi systems.
5. Understand various types of phase transitions

Module:1	**Foundations**	**8 hours**
Objective of statistical mechanics - Central Limit Theorem – Macrostates, microstates, phase space and ensembles - Ergodic hypothesis - Postulate of equal a-priori probability and equality of ensemble average and time average - Boltzmann's postulate of entropy - Counting the number of microstates in phase space - Liouville's Theorem, Maxwell-Boltzmann distribution		
Module:2	**Ensembles**	**5 hours**
Micro canonical ensemble - Ideal gas in micro canonical ensemble - Entropy of ideal gas - Sackur-Tetrode equation - Gibb's paradox.		
Module:3	**Canonical Ensemble**	**5 hours**
System in contact with a heat reservoir - Expression of entropy - Canonical partition function - Helmholtz free energy - Fluctuation of internal energy, Ideal gas using canonical ensemble		
Module:4	**Grand Canonical Ensemble**	**5 hours**
System in contact with a particle reservoir - Chemical potential - Grand canonical partition function and grand potential - Fluctuation of particle number - Chemical potential of ideal gas - Chemical equilibrium.		
Module:5	**Quantum statistical mechanics**	**6 hours**
Density matrix - Quantum Liouville theorem - Density matrices for microcanonical - Canonical and grand canonical systems - Identical particles - Bose Einstein and Fermi Dirac statistics.		
Module:6	**Ideal Bose and Fermi gas**	**7 hours**
Equation of state - Black body radiation - Planck's radiation law - Bose Einstein condensation - Equation of state of ideal Fermi gas - Fermi gas at finite T - White dwarf star.		
Module:7	**Phase Transition and Critical Phenomena**	**7 hours**
Ising model - partition function for one dimensional case - Phase transitions - First order and continuous - critical exponents and scaling relations - Calculation of exponents from Mean Field Theory and Landau's theory - Upper critical dimension.		
Module:8	**Contemporary issues**	**2 hours**
Contemporary research direction ; one/two lectures of experts from renowned national or international institutions.		
	Total Lecture hours:	**45 hours**
Tutorial	**Tutorial Topics**	**15 hours**
	• Gate, CSIR-NET problems related to this subject will be solved • Assignment problems / problem sets will be discussed	

Text Book(s)

1.	R. K. Pathria and Paul D. Beale, Statistical mechanics, 2011, 3rd edition, Elsevier, Netherlands
2.	K. Huang, Statistical mechanics, 1987, 2nd edition, John Wiley and Sons, Inc., UK.

Reference Books			
1.	F. Reif, Fundamentals of Statistical and Thermal Physics, 1965 4th Edition, McGraw-Hill, New York, USA		
2.	L.D. Landau, E. M. Lifshitz, Statistical Physics, 1996, 3rd Edition, Butterworth-Heinemann, UK.		
Mode of Evaluation: CAT, Digital assignments, Quiz, FAT			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Laser Physics	L	T	P	C
TPHY404L		3	0	0	3
Pre-requisite	Optics and Spectroscopy	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To expose the students to the physics of lasers.
2. To know the methods of producing pulsed laser output.
3. To get familiarized with operation of a few typical laser systems.

Course Outcome

At the end of the course, the student will be able to

1. Understand the interaction of radiation and matter and eventually the idea of stimulated emission.
2. Comprehend various pumping schemes in laser physics.
3. Derive the rate equations in two, three and four-level systems.
4. Understand the need for resonators and to know about the modes.
5. Understand various techniques for getting pulsed laser output.

Module:1	**Interaction of Radiation with Matter**	**6 hours**
Introduction – spontaneous and stimulated emissions – Einstein's coefficients – line shape function – Line broadening mechanisms – homogeneous and non-homogeneous broadening.		
Module:2	**Amplification of light**	**5 hours**
Rates of stimulated emission and absorption – condition for amplification by stimulated emission- metastable state – laser action.		
Module:3	**Laser rate equations**	**7 hours**
Pumping schemes – two, three and four-level pumping schemes – laser rate equations – two, three and four level systems -condition for population inversion -gain saturation -laser amplifiers		
Module:4	**Optical Resonators and Modes**	**7 hours**
Plane mirror resonators -resonance frequencies – cavity loss – cavity life time and Q-factor -stable and unstable resonators – resonator stability conditions -longitudinal modes – transverse modes.		
Module:5	**Laser and its output characteristics**	**6 hours**
Laser oscillator – Optical feedback – threshold condition – variation of laser power near threshold - characteristics of laser output.		
Module:6	**Some laser systems**	**6 hours**
He-Ne, CO_2, Nd-YAG, Fiber lasers – tunable lasers: Ti sapphire laser – Semiconductor laser		
Module:7	**Methods of pulsing lasers**	**6 hours**
Optimization for pulsed output – methods – Q-switching – Cavity dumping – Mode locking		
Module:8	**Contemporary issues**	**2 hours**
Contemporary research direction; one/two lectures of experts from renowned national or international institutions.		
	Total Lecture hours:	**45 hours**
	Tutorials	**15 hours**
	1. GATE and CSIR examinations related topics, Problems related to the topics discussed in the units 2. Assignment problems will be discussed	

Text Book(s)

1.	William T. Silfvast, Laser Fundamentals, 2009, Cambridge University Press, UK
2.	K. Thyagarajan and Ajoy Ghatak, Lasers: Fundamentals and Applications, 2011, 2nd Edition, Macmillan Publishers India Ltd., India

Reference Books

1.	Richard S.Quimby, Photonics and Lasers, 2006, Wiley Interscience, USA.
2.	Orazio Svelto, Principles of Lasers, 2010, 5th Edition, Springer, USA.
3.	Jeff Hecht, Understanding Lasers, 2008, 3rd Edition, John Wiley, USA.

Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Advanced Physics Lab	L	T	P	C
TPHY405P		0	0	4	2
Pre-requisite		Syllabus version			
		v. 1.0			

Course Objectives

1. To make the students perform advanced experiments
2. To apply theoretical knowledge for developing new science
3. To analyze the theory and experimental results for better understanding

Course Outcome

At the end of the course the student will be able to

1. Design and develop the instruments for advanced studies.
2. Evaluate theoretical calculations using experimental observations.

Indicative Experiments	
1.	Determination of splitting of Spectrum line - Zeeman Effect
2.	Measurement of Kerr coefficient - MOKE
3.	Determination of birefringence with respect to applied voltage – pockel effect
4.	Refractive index of a given material using Mach - Zehnder Interferometer
5.	Determination of refractive index of transparent materials using Michelson Interferometer
6.	Preparation of Thin film preparation using DC sputtering
7.	Preparation of Bulk alloys using Induction Melting furnace
8.	Preparation of Nanomaterial using wet chemical method
9.	Determination of Charge to Mass ratio using Thomson's method
10.	To measure the Lande's g-factor in a free radical using Nuclear Magnetic Resonance (NMR) Simulation
	Total Laboratory Hours: 60 hours

Mode of assessment: Continuous assessment, FAT, and Oral examination			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Advanced Quantum Mechanics	L	T	P	C
TPHY406L		3	1	0	4
Pre-requisite	Principles of Quantum Mechanics	**Syllabus version**			
		v. 1.0			

Course Objectives

1. Understanding of quantum mechanical principles and apply to three dimensions problems
2. Describe the structure of the hydrogen atom and understand quantization of angular momentum
3. Apply techniques such as ladder operators for selected problems in quantum mechanics

Course Outcome

At the end of the course, the student will be able to

1. Understand the basic concepts in quantum Mechanics.
2. Apply Mathematics to understand the physical operations
3. Understand the language of quantum mechanics in 1-dimensional and 3-dimensional problems and the concept of angular momentum
4. Understand the effect of perturbations to the energy values on hydrogen-like problems
5. Understand the interactions between the system under consideration and external forces, Understand the concept of relativity in quantum Mechanics, Understand the complete picture of existence of matter and antimatter

Module:1	**Basics formalism**	**6 hours**
Schrödinger's wave equation – physical interpretation and conditions on wave function – eigenvalues and eigen functions – Continuity equation and probability current density-Expectation values and Ehrenfest's theorem, Quantum Confinement Problems (1D, extension to 3D)		
Module:2	**Operator formalism**	**5 hours**
Linear operators-Hermitian operators and their properties – Commutation relations - Uncertainty relation – Dirac representations - Bra and Ket vectors - Hilbert space – Schrödinger, Heisenberg and interaction pictures.		
Module:3	**Quantum mechanical problems**	**6 hours**
Harmonic oscillator – Operator method – Schrödinger equation for spherically symmetric potentials – Angular momentum operator – Condition on solutions and eigenvalues – spherical harmonics – Rigid rotor – Radial equation of Central potential – Hydrogen atom – Degenerate states.		
Module:4	**Angular Momentum Theory**	**6 hours**
Angular momentum-Commutation relations- Eigenvalues of angular momentum J – Matrix representation of J – Addition of angular momentum – Clebsch-Gordan coefficients – Identical particles with spin – Pauli exclusion principle.		
Module:5	**Perturbation Theory**	**6 hours**
First order perturbation theory for non-degenerate states – Removal of degeneracy – Zeeman effect and Stark effect – Variation method – WKB approximation**.**		
Module:6	**Scattering Theory**	**6 hours**
Theory of scattering- Scattering cross section- Optical theorem- Scattering by attractive square well potential- Scattering Amplitude-Born approximation.		
Module:7	**Relativistic Quantum Mechanics**	**8 hours**
Klein-Gordon equation for a free particle and in an electromagnetic field – Dirac equation for a free particle - Charge and current densities - Dirac matrices – Plane wave solution – Negative energy states		
Module:8	**Contemporary issues**	**2 hours**
Contemporary research direction; one/two lectures of experts from renowned national or international institutions.		
Total Lecture hours:		**45 hours**
Tutorials		
	GATE and CSIR examinations related topics, Problems related to the topics discussed in the units	**15 hours**

	Assignment problems will be discussed	
	Total Lecture hours	**60 hours**

Textbook(s)

1. D. J. Griffiths, Introduction to Quantum Mechanics, 2018, 3rd, Cambridge University Press, United Kingdom**.**
2. E. Merzbacher**,** Quantum Mechanics, 2016, Cambridge India**.**

Reference Books

1. L.D. Landau and E.M. Lifshitz, Quantum Mechanics (Non-relativistic Theory), 2011, 3rd edition, Elsevier, Netherlands.
2. R. Shankar, Principles of Quantum Mechanics, 2014, Springer, Verlag, Berlin, Germany.
3. E. Hecht, Y. Peleg; R. Pnini, E. Zaarur, Quantum Mechanics, 2012, McGraw-Hill
4. R. L. Liboff, Introductory Quantum Mechanics, 2003, Addison-Wesley, Pearson Education,
5. USA**.**
   J. J. Sakurai, Jim Napolitano, Modern Quantum Mechanics, 2020, Cambridge University Press, UK,

Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Condensed Matter Physics	L	T	P	C
TPHY407L		3	1	0	4
Pre-requisite	Solid State Physics, Statistical Mechanics	Syllabus version			
		v. 1.0			

Course Objectives

To study the properties of the condensed phase of matter.
To understand physics of matter and its properties.
To gain the knowledge of the emerging topics like metamaterials and computational analysis of materials

Course Outcome

the end of the course, the student will be able to
1. Knowledge of the various types of materials phenomenon
2. Describe the features and classification of crystal and amorphous
3. Understand the effect of the size on nano properties of solids.
4. Classify the condensed matter upon the properties of materials.
5. Simulate and analyze the structure and other important parameters related to possible applications.
6. Apply the concepts in condensed matter physics to meet the challenges

Module:1	The Nature of Condensed Matter	7 hours

Some basic orders of magnitude - Chemical bonds- The van der Waals bond - Ionic, covalent and metallic bonds - The hydrogen bond - The exchange interaction - magnetic order and energies - Crystalline order and cohesive energies - Solids, liquids, and gases - phase diagram - Colloidal Crystals - Other ordered states - Disordered condensed matter

Module:2	Crystalline Solids	7 hours

Crystal structures - Scattering by crystals - Crystal vibrations - Monatomic basis- Diatomic basis- Scattering from phonons- Elastic (Bragg) scattering: The Debye–Waller factor - Inelastic scattering by single phonons - Reconstruction and surface stress - roughening transition - Equilibrium crystal shapes -liquid crystal - Thermotropic liquid crystals - Nematic phase - Liquid crystal displays - static self assembly - lyotropic liquid crystals

Module:3	Amorphous Materials	7 hours

A statistical structure - Two amorphous structures - Random close packed structure - Continuous random network - scattering by amorphous matter - polymers - Polymerisation mechanism- degree of polymerisation -Classification of polymers-structure, properties and fabrication process of polymers -Conducting polymers - importance of conducting polymers in electric and electronic devices.

Module:4	Liquid dynamics and superfluidity	6 hours

Dynamic structure factor - Hydrodynamic modes in liquids - Glass transition - Structural relaxation - Polymer liquids - Rouse model - Reptation (qualitative) - Tg measurement - Bose–Einstein condensation and superfluidity - ^{3}Helium - Microscopic theory - Ginsburg–Landau model.

Module:5	Fourth state of Matter	5 hours

Plasma - basics beyond the conventional matters - low temperature and high temperature plasma - enthalpy changes - classification of plasma- common forms of plasma - concept of temperature and density, Debye shielding, collision in plasma, plasma oscillations , plasma creation- wave propagation in plasma (qualitative) - Response of plasma to the fields - DC discharge, RF discharge and microwave discharge - Plasma display.

Module:6	Smart Materials	5 hours

Natural and Artificial Materials - Non - linear behaviour of electric, magnetic and optical properties - nanomaterials basics - carbon nanotubes, fullerenes, Graphene - Concept of Metamaterials - negative permittivity and permeability - negative refractive index - Meta structure vs wavelength - applications.

Module:7	Computational Analysis (hands -on training with software)	6 hours
Density Functional Theory - Basics of DFT, Hohenberg-Kohn Theorem; Kohn-Sham Equation;		

Thomas-Fermi approximation and beyond (qualitative); Brief review on empirical and semi-empirical approaches in electronic structure calculation - Practical DFT in a many body calculation and its reliability.		
Module:8	**Contemporary issues**	**2 hours**
Contemporary research direction; one/two lectures of experts from renowned national or international institutions.		
	Total Lecture hours:	**45 hours**
Tutorial	**Tutorial Topics**	**15 hours**
	• GATE, CSIR problems related to the subject will be solved in the tutorial sessions • Assignment problems/ problem sets will be discussed during the tutorial sessions	

Text Book(s)

1.	Fundamentals of Condensed Matter Physics by Marvin L.Cohen and Steven G.Louie, 2019, Cambridge University Press
2.	Advanced Condensed Matter Physics by Leonard M. Sander, 2009, Cambridge University Press

Reference Books

1.	Fundamentals of Condensed Matter and Crystalline Physics by David L. Sidebottom, 2012, Cambridge
2.	superconductivity, Superfluids,and Condensates by James F. Annett, 2004, Oxford
3.	University Press Principles of Plasma Discharges and Materials Processing by Michael A. Lieberman and Alan J. Lichtenberg, 2nd edition (2005) Wiley
4.	Polymer Processing: Principles and Design, 2nd Edition by Donald G. Baird, Dimitris I. Collias, 2014, Wiley-Interscience.
5.	Density Functional Theory - A Practical Introduction, David S. Sholl and Janice A. Steckel, 2009 Published by John Wiley & Sons, Inc.

Mode of Evaluation: Quiz, Written assignment, CAT, FAT

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Electromagnetic Theory	L	T	P	C
TPHY408L		3	1	0	4
Pre-requisite	Mathematical Physics	Syllabus Version			
		v.1.0			

Course Objectives

1. To understand how materials are affected by electric and magnetic fields.
2. To apprehend the relation between the fields under time varying situations and Maxwell equations and principles of propagation of Electromagnetic waves.
3. To appreciate special and general theory of relativity

Course Outcome

At the end of the course, the student will be able to

1. Understand the concepts of electrostatics for different charge distribution systems.
2. Comprehend the basics of magnetostatics and their applications to understand the concepts of magnetism in magnetic materials.
3. Derive the electromagnetic wave equations from Maxwell's equations and calculate the energy carried by electromagnetic waves.
4. Understand the propagation of electromagnetic waves and the phenomena of reflection, refraction, transmission of these waves in different mediums.
5. Realise the concepts of waveguides/transmission lines and modes of electromagnetic waves and correlate the concept of relativity with electrodynamics

Module:1	Electrostatics and special techniques	7 hours

Directional & Normal derivatives – Dirac delta function – Electric field – Gauss's law – Electric potential – Laplace's equation(1-D, 2-D and 3-D) and its solution – Boundary conditions and uniqueness theorems – The method of images – Multipole expansion

Module:2	Electrostatic fields in Matter	4 hours

Dielectric- concepts of polarization, electric susceptibility, dielectric constant, Bound charges – Electric field of a polarized dielectric – Gauss's law for a dielectric

Module:3	Magnetostatics and Magnetic fields in Matter	5 hours

Magnetic field – Magnetic Vector potential –Magnetization –Ampere's law for a magnetized material – Magnetic field due to solenoid and toroid–energy density – Properties of different magnetic materials-linear and nonlinear media

Module:4	Electrodynamics	7 hours

Electromagnetic Induction: Faraday's Law, Electrodynamics before Maxwell – Maxwell's equations– boundary conditions– Scalar and vector potentials – gauge invariance – electromagnetic energy – Poynting's theorem – Newton's third law in electrodynamics – Maxwell's stress tensor – conservation of momentum and angular momentum

Module: 5	EM Waves and their propagation	6 hours

Electromagnetic wave equation –propagation of EM waves in non - conducting media and conducting media – Reflection and refraction at the boundary of non-conducting media –Fresnel's coefficients – Brewster's angle and critical angle – reflection from a conducting plane.

Module:6	Wave Guides and electromagnetic radiation	7 hours

Wave guide; TE, TM and TEM modes – Rectangular wave guide – Dynamics of charged particles in static and uniform electromagnetic fields – Radiation from moving point charges & dipoles and retarded potentials

Module:7	Electrodynamics & Relativity	7 hours

Revisit of Special theory of relativity – Relativistic energy and momentum – relativistic kinematics –

relativistic dynamics – Relativistic electrodynamics(qualitative analysis)			
Module:8	**Contemporary Issues**		**2 hours**
Contemporary research direction ; one/two lectures of experts from renowned national or international Institutions.			
	Total Lecture hours:	**45 hours**	
Tutorials	**Tutorial topics**	**15 hours**	
	• 2 tutorials hours for problems on the topics in each of the 7 modules • Assignment/ Assessments questions and problems		

Text Book(s)

1.	D. J. Griffith, Introduction to Electrodynamics, 2020, 4th edition, Addison-Wesley Professional, Boston, USA.
2.	J. R. Reitz., F.J. Milford and R. W. Christy, Foundations of Electromagnetic Theory, 2010, 4th edition, Pearson, India.

Reference Books

1.	J. D. Jackson, Classical Electrodynamics, An Indian Adaptation, 2020, Wiley-India, Delhi.
2.	W. Greiner, Classical Electrodynamics, 2012, 3rd edition, Springer, New York, USA.

Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Course title	L	T	P	C
TPHY409P	**Laser and Photonics Laboratory**	**0**	**0**	**2**	**1**
Pre-requisite		**Syllabus version**			
		v. 1.0			

Course Objectives

1. To get hands-on experience with the various photonic components, devices and instruments.
2. To measure the various physical parameters related to lasers and optical fibers.

Course Outcome

At the end of the course the student will be able to
1. Comprehend the various laser characteristics.
2. Analyze the important characteristics of photonic components
3. Apply the gained practical knowledge for possible innovations in photonics.

Indicative List of Experiments

1.	To study the Gaussian beam profile by determining the mode field diameter of a laser beam.
2.	To determine the divergence of a laser beam and to study its nature of polarization.
3.	To determine the wavelength of laser light using Michelson interferometer**.**
4.	To study absorption of laser light in various filters.
5.	To explore the P-I characteristics of a laser diode and an LED
6.	To study the characteristics of an opto-coupler.
7.	To study the characteristics of a photodiode and a phototransistor.
8.	To determine the numerical aperture and acceptance angle of an optical fiber.
9.	To estimate the loss due to bending and splicing in optical fibers
10.	To find the mode field diameter of an optical fiber.
	Total Laboratory Hours: 30 hours

Mode of assessment: Continuous assessment, Oral examination and FAT

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Computational Physics Lab	L	T	P	C
TPHY410P		0	0	4	2
Pre-requisite		**Syllabus version**			
		v. 1.0			

Course Objectives

1. To develop numerical, computational and logical skills relevant to theoretical and experimental physics problems
2. To enhance the understanding of the theory courses using computational methods

Course Outcome

At the end of the course, student will be able to

1. Employ computational techniques to solve physics problems
2. Write computer codes for numerical differentiation and integration
3. Learn basic methods, tools, and techniques of computational physics and develop practical computational problem-solving skills

Indicative Experiments	
1.	Finding solutions of first order differential equations using the Runge-Kutta method
2.	Solving the roots of equations by Bisection Method, False position method and Newton Raphson method.
3.	Solving the Linear Interpolation, Lagrange, and Newton Interpolation; Linear and non-linear curve fitting
4.	Differentiation of continuous functions Integration by Trapezoidal and Simpson's rule.
5.	Determination of vacancy formation energy in Silicon lattice using Ab-initio calculation
6.	Material properties from DFT- Electronic structure, Band gap, effective mass
7.	Material properties from DFT- Phonon dispersion, Thermal Properties, Heat capacity
8.	Material properties from DFT- Mechanical properties, Elastic moduli
9.	Monte Carlo simulation: Metropolis algorithm
10.	Molecular Dynamics: Computer simulation of many body systems
	Total Laboratory Hours 60 hours

Mode of assessment: Continuous assessment, Oral examination , FAT

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Discipline Elective

TPHY206L	Properties of Matter	L	T	P	C
		3	1	0	4
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To understand the different kinds of moduli via experimental methods.
2. To understand the physical phenomena like surface tension and viscosity.
3. To explain the applications of diffusion and osmosis.

Course Outcomes

At the end of the course, student will be able to

1. Classify different types of elastic moduli with suitable experimental techniques.
2. Comprehend the fundamental governing principles in hydrostatics and in surface tension.
3. Understand the fundamental governing principles in fluid motion.
4. Explain the significance of diffusion and osmosis.
5. Apply kinetic theory of gases to pressure gauges.

Module:1	**Elasticity**	**6 hours**
Stress- Strain - Hooke's law - Three types of elastic moduli and relation among them - Poisson's ratio and Poisson's ratio for rubber band - Energy stored - Determination of Young's modulus - Searle's method.		
Module:2	**Bending of Beams**	**7 hours**
Bending of beams - Expression for bending moment - Depression of the loaded end of a Cantilever - Uniform and Non-uniform bending - Theory - Experiment pin and microscope method - Work done in uniform bending - Koenig's method - Expression for couple per unit twist - Determination of rigidity modulus - Static torsion method with scale and telescope.		
Module:3	**Hydrostatics**	**5 hours**
Fluids - Hydrostatic pressure - Pascal's law - Centre of Pressure - Principle of Archimedes - Equilibrium of floating bodies - Measurement of atmospheric pressure		
Module:4	**Fluid Motion - Viscosity**	**7 hours**
Viscosity - Coefficient of critical velocity - Poiseulli's formula - Determination of coefficient of viscosity by capillary flow method - Viscosity of a highly viscous liquid - Stoke's method - Viscosity of gases - Mayer's formula - Rankine's method for the determination of viscosity of a gas - Effect of temperature and pressure on viscosity.		
Module:5	**Diffusion and Osmosis**	**5 hours**
Diffusion - Fick's law - Measurement of diffusivity - Diffusion of gases - Graham's law - Effusion - Osmosis - Laws of osmotic pressure - Experimental determination of osmotic pressure - Osmotic and vapour pressure of a solution - Applications.		
Module:6	**Surface tension**	**7 hours**
Surface energy - Angle of contact and its determination - Formation of drops - Variation of Surface tension with temperature - Drop weight method of determining surface tension - Angle of contact of mercury - Quincke's method		
Module:7	**Kinetic Theory of Gases**	**6 hours**
Introduction - Pressure due to perfect gas - Gas laws - Value of gas constant – van der Waal's equation – Production of low pressure - Exhaust pumps - pressure gauges		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Tutorial	GATE and CSIR problems related to the subject will be solved in the tutorial sessions. Assignment problems will be discussed	**15 hours**

	during the tutorial sessions.		
Text Book(s)			
1.	Mathur D. S, Elements of Properties of Matter, 2015, 3rd Edition, S. Chand and Company, New Delhi, India.		
Reference Books			
1.	Brijlal and Subramaniam N., Properties of Matter, 2015, Revised Edition, S. Chand and Company, New Delhi, India.		
2.	Landau L. D., Pitaevskii L P, Kosevich A M and Lifshitz E M, Fluid Mechanics, 2015, Revised Edition, Butterworth-Heinemann, Oxford, UK.		
Mode of Evaluation: CAT, Digital Assignment Quiz, and FAT			
Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY207L	Sound and Acoustics	L	T	P	C
		3	1	0	4
Pre-requisite	TPHY102L, TPHY102P	Syllabus version			
		1.0			

Course Objectives

1. To impart the knowledge on the science of sound.
2. To explain the applications of sound and acoustics.
3. To demonstrate the characteristics and applications of sound.

Course Outcomes

At the end of the course the student will be able to

1. Appreciate the wave motion and their characteristics.
2. Explain the physical parameters deciding the velocity of sound in various media.
3. Comprehend the laws of vibrations.
4. Explain the significance of Doppler effect.
5. Apply the concepts for designing ultrasonics and in architectural acoustics.

Module:1	**Basics of sound**	**6 hours**
Basics of wave motion – simple harmonic motion – origin of sound – need of a medium - characteristics of sound waves.		
Module:2	**Velocity of Sound**	**7 hours**
Newton's formula - Effect of temperature, pressure, density of the medium and humidity. Velocity of sound in air, water and isotropic medium.		
Module:3	**Stationary wave and Interference**	**7 hours**
Stationary wave and its properties – Tuning fork – Conditions for interference of sound waves - Quincke's tube – Basics of beats.		
Module:4	**Vibrations in strings and Air columns**	**7 hours**
Laws of transverse vibration - velocity of transverse wave along a stretched string – frequency determination - Melde's experiment – Sonometer - Longitudinal waves in a rod - Kundt's tube.		
Module:5	**Doppler Effect**	**5 hours**
Definition - Expression for apparent frequency - observer at rest and source in motion, source at rest and observer in motion, both source and observer in motion.		
Module:6	**Ultrasonics**	**5 hours**
Ultrasonics – definition - Production of ultrasonic waves – piezo – electric method - Applications of ultrasonics.		
Module:7	**Architectural Acoustics**	**6 hours**
Architectural Acoustics: Musical sound and noise – Characteristics of musical sound – Reverberation - Sabine's formula – Determination of absorption coefficient - Condition for good acoustics in auditoriums.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**
Tutorial	**Tutorial topics**	**15 hours**
	Problem sheet for each module will be distributed and discussed during the tutorial sessions. Assignment problems will be worked by the students with the help of the course faculty.	

Text Book(s)

1. Robert D Finch, Introduction To Acoustics, 2016, 1st edition, Pearson Publications, New Delhi, India.

Reference Books			
1.	Frank Fahy and David Thompson, Fundamentals of Sound and Vibration, 2015, 2nd Edition, CRC Press, USA.		
2.	N. Subrahmanyam and Brijlal - A Textbook of Sound, 2nd edition, 2018, Vikas Publication House Pvt Ltd., Noida, India.		
Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT			
Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY307L	Semiconductor Device Physics	L	T	P	C
		3	0	0	3
Pre-requisite	TPHY203L	Syllabus version			
		1.0			

Course Objectives

1. Understanding Physics of semiconductor devices and their operation such as Junction devices, bulk devices, real state transfer devices, hetero junction devices and photo devices.
2. This course is suitable for undergraduate seniors and first year post graduate students majoring in engineering or physics. It introduces the fundamentals of semiconductor physics that will enable subsequent study of semiconductor devices.
3. To train them to apply these devices in mostly used and important applications.

Course Outcomes

At the end of the course the student will be able to

1. Explain the basic properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier injection/excitation.
2. Apply the knowledge of basic semiconductor material physics and understand carrier transport phenomena.
3. Synthesize the concepts of Junction theory and metal – semiconductor junctions.
4. Analyze the characteristics of various optoelectronic devices.
5. Classify and describe the semiconductor devices for special Applications.

Module:1	Fundamentals of Semiconductors	5 hours

E-K diagram - Occupation probability - Fermi distribution function - Fermi level and Quasi Fermi level (Variation by Carrier concentration and temperature) – Electron and hole concentrations at equilibrium Bonds in semiconductor - Energy bands - Direct and indirect band gap semiconductors - Elemental and compound semiconductor.

Module:2	Carrier Transport Phenomena	7 hours

Carrier concentrations at equilibrium - excess carriers mechanisms - carrier lifetime - steady state carrier generation - Continuity equation: Solution of diffusion equation for steady state carrier injection-diffusion length - Haynes-Shockley experiment.

Module:3	Junctions theory	8 hours

Homo p-n junctions at equilibrium - forward and reverse biased p-n junction - Carrier injection across p-n junction under forward bias - Derivation of ideal p-n diode current equation - reverse saturation current - real p-n diode V-I characteristics - reverse breakdown - capacitances in p-n diode - Hetero p-n junctions - metal-semiconductor contacts - Bipolar Junction Transistors - Minority carrier distributions and terminal currents - Ebers – Moll equations and charge-control analysis - Heterojunction Bipolar Transistors.

Module:4	Metal-Semiconductor junctions	5 hours

Metal-semiconductor contacts - Flat band diagram and built-in potential - Full depletion analysis -Junction capacitance - Metal-Semiconductor contacts: Ohmic contacts-Schottky contacts.

Module:5	Semiconductor Light Emitting diodes and Lasers	8 hours

Rate equations for carrier density - radiative and non-radiative recombination mechanisms in semiconductors – LED - device structure - materials: characteristics and figures of merit - input & output characteristics of lasers - semiconductor laser: structure, materials, device characteristics, and figures of merit - tunable semiconductor lasers - Semiconductor materials of interest for optoelectronic devices

Module:6	Photodetectors	5 hours

Types of semiconductor photodetectors: p-n junction, pin, and avalanche and their structure - materials - working principle, and characteristics - noise limits on performance - solar cells.

Module:7	**Low dimensional optoelectronic devices**	**5 hours**
Quantum-well, -wire, and -dot based LEDs, lasers, and photodetectors - CCD: introduction to nano devices - fundamentals of tunneling devices - design considerations - physics of tunneling devices.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Streetman, B.G., Banerjee, S. K., Solid State Electronic Devices, 2015, 7th Edition, PHI Learning Private Limited, USA.
2. Singh, J., Semiconductor Devices: An Introduction, 1994, ISE Editions, McGraw-Hill Education, USA.

Reference Books

1. Bhattacharya Pallab, Semiconductor Optoelectronic Devices, 2017, Second Edition, Pearson Education, USA.
2. Sze, S.M., Semiconductor Devices: Physics and Technology, 2008, Second Edition, John Wiley and Sons, India.
3. Tyagi M.S., Introduction to Semiconductor Materials and Devices, 2008, Student Edition, Wiley, Taiwan.
4. Neaman, D., Biswas B., Semiconductor Physics and Devices, 2017, 4th edition, McGraw Hill Education, USA.

Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY308L	Physics of Nanoscale	L	T	P	C
		3	0	0	3
Pre-requisite	TPHY203L	Syllabus version			
		1.0			

Course Objectives

1. To enable students to understand the basic concepts involved in the field of Nanoscience and Nanotechnology.
2. To make the students analyze the concepts of quantum mechanics and its applications in nanomaterials.
3. To introduce students about the possibility of artificially creating novel materials with exotic and tailor made properties, the basic characterization concepts and nanometrology tools.

Course Outcomes

At the end of the course the student will be able to

1. Understand microscopic and nanoscopic physical properties.
2. Classify nanomaterials based on shape and electron motion confinement.
3. Learn various synthesis method for nanomaterials.
4. Learn various characterization tools for nanomaterials.
5. Learn various emerging nanomaterials and its applications in energy, environment, and biomedical fields.

Module:1	**Introduction to Miniature Materials**	**4 hours**
Classification of macroscopic, microscopic, mesoscopic, and nanoscopic materials - Electrical, Optical, Thermal, and Magnetic properties of microscopic materials.		
Module:2	**Properties of Nanoscale materials**	**6 hours**
Historical perspective of nanomaterials - size effect on specific surface area - change of size dominated properties - change of surface dominated properties - Electrical, Electronic, Optical, Magnetic, Chemical, Thermal, and Mechanical properties of nanomaterials- Lotus effect - Gecko adhesion - Moore's law.		
Module:3	**Classification of Nanomaterials**	**6 hours**
Classification of nanomaterial based on shape: Nanoparticles, Nanowires, and Nanofilms - Classification of low dimensional materials: 0D dimensional, 1D dimensional, and 2D dimensional materials.		
Module:4	**Synthesis of Nanomaterials**	**6 hours**
Top-down methods - Bottom-up methods: Physical methods, wet-chemical methods - Self-assembly.		
Module:5	**Characterization of Nanomaterials**	**8 hours**
Nanocrystallite size from X-ray diffraction - Nanostructure dimensions from electron microscopy - Surface chemistry by infrared spectroscopy - Optical properties by UV-Vis spectroscopy - Electrical, Dielectric, Magnetic properties characterization.		
Module:6	**Emerging Nanomaterials**	**7 hours**
0D materials: Fullerences, Nobel metal (Au) nanoparticles, Semiconductor Nanoparticles (CdSe) - 1D materials: CNTs - 2D materials: graphene.		
Module:7	**Applications of Nanomaterials**	**6 hours**
Energy storage – Photocatalysis – Biomedical imaging - Targeted drug delivery.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Narasimha Reddy Katta, Essentials of Nanoscience & Nanotechnology, 2021, 1st edition, Nano Digest, Hyderabad.

2.	Nils O Petersen, Foundations for Nanoscience and Nanotechnology, 2017, 1st Edition, CRC Press, Boca Raton, USA.
Reference Books	
1.	David Andrews, Robert H. Lipson, Thomas Nann, Comprehensive Nanoscience and Nanotechnology, Volume 1: Nanomaterials, 2019, 2nd Edition, Academic Press, Amsterdam.
2.	Narendra Kumar and Sunita Kumbhat, Essentials in Nanoscience and Nanotechnology, 2016, Wiley, New Jersey, USA.
3.	Sabu Thomas, Raju Thomas, Ajesh K Zhachariah, Raghvendra Kumar Mishra, Spectroscopic Methods for Nanomaterials Characterization, Volume 2, 2017, Elsevier, Amsterdam.
4.	Arpan Kumar Nayak, Niroj Kumar Sahu, Nanostructured Materials for Visible Light Photocatalysis, 2021, Elsevier, Amsterdam.

Mode of Evaluation: CAT, Digital assignment, Quiz, and FAT.

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY309L	Physics and Technology of Thin Films	L	T	P	C
		3	0	0	3
Pre-requisite	TPHY203L	Syllabus version			
		1.0			

Course Objectives

1. Provides an introduction to some essential concepts in thin films.
2. To understand different types of thin film deposition methods.
3. To understand multiple technological applications of thin films.

Course Outcomes

At the end of the course the student will be able to

1. Explain the physical concept behind the thin film.
2. Recognize different ways to make vacuum through pumping component.
3. Apply different kinds of physical and chemical techniques to grow a thin film.
4. Describe the growth mechanism of thin film.
5. Apply thin film technology to various real world problems.

Module:1	Review of Solid State Physics and Introduction to thin films	3 hours

Introduction – Structure - Crystalline solids - Bonds and bands in solids - Thermodynamics of Solids – Kinetics – Nucleation - Thin films - exotic properties - difference between thin and thick films – Amorphous –Polycrystalline - Single crystalline thin films – Homo and Heteroepitaxy.

Module:2	Thin Film Growth Mechanism	6 hours

Substrate surface – Adsorption - Thermodynamic aspects of nucleation - Kinetic processes in Nucleation and Growth - Island growth - Adatom mobility - Layer by Layer growth - Stranski-Krastanov Growth - Texture and Microstructure Control in thin films.

Module:2	Vacuum Science and Technology	10 hours

Introduction –Kinetic Theory of Gases - Gas Transport and Pumping - Concept of rough, high and ultrahigh vacuum - Vacuum Pumps – Rotary pump - Diffusion pump - Turbo-molecular pump - Cryogenic pump - Vacuum gauges - Direct and Indirect gauges - Idea and need of clean rooms (different classes).

Module:3	Physical Methods for Thin Film Deposition	8 hours

Evaporation - Physics and Chemistry of evaporation - Evaporation hardware - Thermal evaporation and E-beam evaporation - Sputtering – Plasma - Discharge and Arc - Fundamentals of Plasma Physics - Physics of Sputtering - Magnetron sputtering - DC and RF magnetron sputtering - Pulsed Laser Deposition - Molecular Beam Epitaxy - Hybrid methods - Activated reactive evaporation - Reactive sputtering - Co-sputtering - Atomic Layer Deposition.

Module:4	Chemical Methods for Thin Film Deposition	4 hours

Chemical Vapour Deposition (CVD) - Thermodynamics of CVD - Plasma Enhanced CVD - Sol-gel based Spin and Dip Coating – Electroplating - Spray Pyrolysis.

Module:6	Properties of Thin Films and a few characterization techniques	8 hours

Thin film thickness measurement – Surface profilometer - Mechanical properties - Residual stress measurement- Chemical composition - X-ray photoelectron spectroscopy - Energy dispersive X-ray analysis - Microstructure and morphology - X-ray diffraction - Electron microscopy - Electrical properties - 4 probe method - van der Pauw technique - Hall effect - Optical properties - Band gap determination - Photoluminescence.

Module:7	Technological Applications of Thin Films	4 hours

Thin film industry- Solar Energy Conversion (Photovoltaics) - Gas and Chemical Sensors - Thin Films in Biotechnology and Automobile sector.

Module:8	Contemporary issues	2 hours

	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Hartmut Frey and Hamid R. Khan, Handbook of Thin-Film Technology, 2015, Springer Nature Switzerland AG.
2.	Milton Ohring, The Materials Science of Thin Films, 2003, Academic Press, Elsevier, San Diego, California, USA.
Reference Books	
1.	Sushil Kumar, D. K. Aswal, Recent Advances in Thin Films, 2020, Springer, Germany.
2.	John L. Vossen, Werner Kern, Thin Film Processes, 1991, Academic Press, USA.
3.	K.L. Chopra, Thin Film Phenomena, 1979, McGraw Hill Publications, India.
Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT.	

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY310L	Physics of Superconductors	L	T	P	C
		3	0	0	3
Pre-requisite	TPHY203L	Syllabus version			
		1.0			

Course Objectives

1. To enable students learn the concepts of superconductivity.
2. To enable students learn types of superconductors.
3. To enable students learn applications of superconductors.

Course Outcomes

At the end of the course the student will be able to

1. Explain the basic properties of superconductors.
2. Apply London's equations to superconductors to explain their electromagnetic properties
3. Describe thermodynamic properties of superconductors.
4. Describe different length scales such as the penetration depth and the coherence length with the help of Ginzburg-Landau theory.
5. Explain the basic ideas of the BCS theory, like Cooper-pairs, energy gap and to explain the differences between type-I and type-II superconductors.

Module:1	**Fundamentals of Superconductivity**	**5 hours**
Electrical, thermal and magnetic properties of metals and insulators – Discovery of superconductivity- Zero electrical resistance - Perfect conductors - Electrical and magnetic properties of Superconductors - Thermodynamic critical field - Meissner effect - heat capacity.		
Module:2	**Electrodynamics of Superconductors**	**5 hours**
London equations- penetration depth- Flux quantization- Pippard's non-local electrodynamics - coherence length.		
Module:3	**Thermodynamics of Superconductors**	**6 hours**
Type-I and type-II superconductors - Vortices in type-II superconductors - critical parameters – Ginzburg -Landau theory.		
Module:4	**Microscopic theory of Superconductivity**	**8 hours**
Electron-phonon interaction - cooper pairs - BCS theory - second quantization - BCS wave function and its ground state - BCS energy gap and its temperature dependence.		
Module:5	**Josephson effect**	**7 hours**
Tunneling - Josephson effect - Josephson junction - quantum interferometer - short and long Josephson junction.		
Module:6	**High Tc superconductors**	**7 hours**
Conventional and unconventional superconductors – Structure - d-wave symmetry - phase diagrams - Fe-based superconductors and other materials exhibiting high Tc ($YBa_2Cu_3O_7$, MgB_2).		
Module:7	**Applications of Superconductors**	**5 hours**
Superconducting wires – magnets - Maglev trains – SQUID – tomographs - measurement normal - superconducting electronics.		
Module:8	**Contemporary Topics**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. J Robert Schrieffer, Theory of Superconductivity, 2018, CRC Press, Boca Raton, USA.
2. Werner Buckel and Reinhold Kleiner, Superconductivity: An Introduction, 2016, 3rd Edition, Wiley, Weinheim.

Reference Books			
1.	Charles P Poole Jr, Ruslan Prozorov, Horacio A Farach, Richard J Creswick, Superconductivity, 2014, 3rd Edition, Elsevier, Amsterdam.		
2.	James F Annett, Superconductivity, Superfluids, and Condensates, 2004, Oxford University press, Oxford, UK.		
3.	Michael Tinkham, Introduction to Superconductivity, 2004, 2nd Edition, Dover Publications, New York, USA.		
4.	D R Tilley and J Tilley, Superfluidity and Superconductivity, 2003, 3rd Edition, Taylor & Francis, Boca Raton, USA		
Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT			
Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY390J	Study Project	L	T	P	C
		0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. The student will be able to analyse and interpret published literature for information pertaining to niche areas.
2. Scrutinize technical literature and arrive at conclusions.
3. Use insight and creativity for a better understanding of the domain of interest.

Course Outcome:

1. Retrieve, analyse, and interpret published literature/books providing information related to niche areas/focused domains.
2. Examine technical literature, resolve ambiguity, and develop conclusions.
3. Synthesize knowledge and use insight and creativity to better understand the domain of interest.

Module Content

This is oriented towards reading published literature or books related to niche areas or focussed domains under the guidance of a faculty.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.

Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No.65	Date	17-03-2022

TPHY392J	Design Project	L	T	P	C
		0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. Students will be able to upgrade a prototype to a design prototype.
2. Describe and demonstrate the techniques and skills necessary for the project.
3. Acquire knowledge and better understanding of design systems.

Course Outcome:

1. Develop new skills and demonstrate the ability to upgrade a prototype to a design prototype or working model.
2. Utilize the techniques, skills, and modern tools necessary for the project.
3. Synthesize knowledge and use insight and creativity to better understand and improve design systems.

Module Content

Students are expected to develop new skills and demonstrate the ability to develop prototypes to design prototype or working models related to an engineering product or a process.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.

Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY393J	Laboratory Project	L	T	P	C
		0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. The student will be able to conduct experiments on the concepts already learnt.
2. Analyse experimental data.
3. Present the results with appropriate interpretation.

Course Outcome:

1. Design and conduct experiments in order to gain hands-on experience on the concepts already studied.
2. Analyse and interpret experimental data.
3. Write clear and concise technical reports and research articles

Module Content

Students are expected to perform experiments and gain hands-on experience on the theory courses they have already studied or registered in the ongoing semester. The theory course registered is not expected to have laboratory component and the student is expected to register with the same faculty who handled the theory course. This is mostly applicable to the elective courses. The nature of the laboratory experiments is depended on the course.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – Report to be submitted, presentation and project reviews.

Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY397J	Special Project	L	T	P	C
		0	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. Students will be able to identify and solve problems in a time-bound manner.
2. Describe major approaches and findings in the area of interest.
3. Present the results in a clear and concise manner.

Course Outcome:

1. To identify, formulate, and solve problems using appropriate information and approaches in a time-bound manner.
2. To demonstrate an understanding of major approaches, concepts, and current research findings in the area of interest.
3. Write clear and concise research articles for publication in conference proceedings/peer-reviewed journals.

Module Content

This is an open-ended course in which the student is expected to work on a time bound research project under the supervision of a faculty. The result may be a tangible output in terms of publication of research articles in a conference proceeding or in a peer-reviewed Scopus indexed journal.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews.

Recommended by Board of Studies	18-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY411L	Nuclear and Particle Physics	L	T	P	C
		3	1	0	4
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

1. To know the basic properties of nucleus and visualize the characteristics.
2. To understand the fundamentals of shell model and the necessity of nuclear models.
3. To know the standard particle model and nuclear synthesis of elements in stars.

Course Outcomes

At the end of the course student will be able to

1. Understand the basic properties and parameters of nucleus such as stability, size, shape, spin and electric-magnetic moments and to comprehend the nature of nuclear forces.
2. Apply knowledge of Quantum mechanics to understand the nuclear structure through different models.
3. Apply the different nuclear model to calculate the radioactivity decay process.
4. Apply the theoretical predictions using quantum mechanical reasoning in classification of processes in sub-atomic world to understand the particle physics phenomena.
5. Understand the mechanism of particle accelerators and detector technologies.

Module:1	**Basic Nuclear Properties**	**7 hours**
Nuclear size – shape – density - nuclear masses- mass formula - Segrè chart - classification of nuclei - separation energy - binding energy – spin - parity of nuclear states - electric moments - magnetic dipole moment - quadrupole moment.		
Module:2	**Nuclear Forces**	**6 hours**
The Deuteron - Nuclear stability - nature of nuclear force - meson theory of nuclear force - reaction cross-sections - Q-value equation.		
Module:3	**Nuclear Models**	**6 hours**
Liquid drop model and semi-empirical mass, Single particle shell model - Evidence that led to liquid drop modes - shell model - its validity and limitations - Parabolic and square well.		
Module:4	**Nuclear Radiations**	**6 hours**
Radioactivity (Alpha decay and Beta decay) - Gamow's theory - Nuclear reactions in stars - Continuous β-ray spectrum - Pauli's neutrino hypothesis - detection of neutrino - Nuclear isomerism.		
Module:5	**Introduction to radioactivity**	**6 hours**
Interaction of radiation with matter, attenuation, radiation units, KERMA, Radionuclides-cyclotron and reactor based radionuclides, Biological effects.		
Module:6	**Introduction to Particle Physics**	**6 hours**
Fundamental interactions - classification of elementary particles - Quantum numbers of different particles - Conservation laws - Production of pions and their mass determination - Quark Gluon model.		
Module:7	**Detectors and Accelerators**	**6 hours**
Interaction of charged particles and electromagnetic radiation with matter - Basic principles of particle detectors - Geiger-Muller counter - scintillation detectors - Particle accelerators LINAC – cyclotron – synchrotron - Pelletron.		
Module:8	**Contemporary topics**	**2 hours**
	Total Lecture hours:	**45 hours**
Tutorial	**Tutorial Topic**	**15 hours**
	• GATE, CSIR problem related to	

	subject to be solved in the tutorial sessions. • Assignment problem/ problem sets will be discussed during tutorial session.	

Text Book(s)	
1.	Leonel Ware, Nuclear Physics, 2019, 1st edition, Larsen and Keller Education, USA.
2.	Kris L. G. Heyde, Basic Ideas and Concepts in Nuclear Physics, 2020, 3rd reprint revised edition, Taylor & Francis Group, UK
Reference Books	
1.	Jose Enrique Garcia Ramos, Alonso, Maria Victoria, Francisco, Basic Concepts in Nuclear Physics, 2016, 1st edition, Springer, Germany.
2.	Sergio Petrera, Problems and solutions in Nuclear and Particle Physics, 2019, 1st edition, Springer, Germany.
3.	Vladimir Zevensky, Alexander Volya, Physics of atomic nuclei, 2017, 1st edition, Wiley – VCH, UK.
4.	Kennath S Krane, Introductory Nuclear Physics, 2008, 1st edition, Wiley, India..
5.	Samuel S.M. Wong, Introductory Nuclear Physics, 2008, 1st edition, Wiley, Germany.
Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT	

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TPHY412L	Microprocessor and Microcontroller	L	T	P	C
		3	0	0	3
Pre-requisite	TPHY303L	Syllabus version			
		1.0			

Course Objectives

1. To understand the Architecture of 8086 microprocessor and to interface microprocessors with supporting chips.
2. To learn the design aspects of I/O and Memory Interfacing circuits.
3. To study the Architecture of 8051 microcontroller and design a microcontroller based system.

Course Outcomes

At the end of the course the student will be able to

1. Understand and execute programs based on 8086 microprocessor.
2. Design Memory Interfacing circuits.
3. Design and interface I/O circuits.
4. Design and implement 8051 microcontroller based systems.

Module:1	**Architecture of Microprocessors**	**5 hours**
General definitions of mini computers – microprocessors – microcontrollers and digital signal processors – Internal architecture of 8085 microprocessor Bus organization – Registers – Flags – Overview of 8086 microprocessor.		
Module:2	**8086 Microprocessor**	**8 hours**
Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set and assembler directives – Assembly language programming – Modular Programming - Linking and Relocation - Stacks - Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.		
Module:3	**8086 System Bus Structure**	**8 hours**
8086 signals – Basic configurations – System bus timing –System design using 8086 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor - Closely coupled and loosely Coupled configurations – Introduction to advanced processors.		
Module:4	**I/O Interfacing**	**6 hours**
Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface - Timer – Keyboard /display controller – Interrupt controller – DMA controller.		
Module:5	**Programming and applications**	**5 hours**
Case Studies: Traffic Light control - LED display - LCD display - Keyboard display interface and Alarm Controller.		
Module:6	**Microcontroller**	**5 hours**
Architecture of 8051 – Special Function Registers (SFRs) - I/O Pins, Ports and Circuits – Instruction set - Addressing modes - Assembly language programming.		
Module:7	**Interfacing Microcontroller**	**6 hours**
Programming 8051 Timers - Serial Port Programming - Interrupts Programming – LCD & Keyboard Interfacing - ADC, DAC & Sensor Interfacing - External Memory Interface - Stepper Motor and Waveform generation - Comparison of Microprocessor, Microcontroller, PIC and ARM processors.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

<table>
<tr><td>1.</td><td>Doughlas V.Hall, Microprocessors and Interfacing, Programming and Hardware, 2012, 3rd edition, Tata McGrawHil, India.</td></tr>
<tr><td>2.</td><td>Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, The 8051 Microcontroller and Embedded Systems: Using Assembly and C, 2007, 2nd Edition, Pearson education, India.</td></tr>
<tr><td colspan="2">Reference Books</td></tr>
<tr><td>1.</td><td>Yu-Cheng Liu, Glenn A.Gibson, Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design, 2015, 2nd Edition, Pearson education, India.</td></tr>
<tr><td>2.</td><td>A.K.Ray, K.M.Bhurchandi, Advanced Microprocessors and Peripherals, 2013, 3rd edition, Tata McGrawHill, India.</td></tr>
<tr><td>3.</td><td>Walter A. Triebel, Avtar Singh, The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications, 2007, 4th edition, Pearson, India.</td></tr>
<tr><td>4.</td><td>Ramesh S. Gaonkar, Microprocessor - Architecture, Programming and Applications with the 8085, 2013, 6th edition , Penram International publishing private limited, India.</td></tr>
<tr><td>5.</td><td>A.K. Ray & K. M. Bhurchandi, Advanced Microprocessors and peripherals-Architectures, Programming and Interfacing", 2002, reprint, Tata McGrawHil, India.</td></tr>
<tr><td colspan="2">Mode of Evaluation: CAT, written assignment, Quiz and FAT.</td></tr>
<tr><td colspan="2">Recommended by Board of Studies | 09-02-2022</td></tr>
<tr><td colspan="2">Approved by Academic Council | No. 65 | Date | 17-03-2022</td></tr>
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TPHY413L	Electronic Instrumentation	L	T	P	C
		3	0	0	3
Pre-requisite	TPHY303L	Syllabus version			
		1.0			

Course Objectives

1. Develop skills and capability to measure electrical parameters using various instruments.
2. Obtain basic knowledge of various Instruments, transducers and working of electronic circuits used in electronic test and measuring instruments.
3. Apply the measurement techniques presented in this course for applied physics and device development aspects.

Course Outcomes

At the end of the course the student will be able to

1. Predict the errors in measurement, list the characteristics of instrumentation and use it to solve the problems in instruments.
2. Analyze various types of AC and DC bridges and circuits.
3. Understand the functioning of electronic instruments such as CRO, storage oscilloscopes, and function generators.
4. Understand the working principle of some basic transducers and sensors.
5. Comprehend the functioning of some special measuring instruments.

Module:1	**Measurement principles**	**5 hours**
Measurement of physical parameters - Measurement system block diagram - Measurement Characteristics: Accuracy, Precision, Sensitivity, Linearity, Resolution, Reliability, Repeatability - Errors.		
Module:2	**Analog Instruments**	**6 hours**
DC Ammeter - DC Voltmeter - Voltmeter Sensitivity - AC Voltmeter - Considerations in Analog Voltmeter - Series & Shunt Type Ohmmeter - Calibration of DC Instruments – Study of a Typical Digital Multimeter.		
Module:3	**Bridges**	**6 hours**
Voltage Divider Circuits, Wheatstone Bridge - Balance Equation of General AC Bridges – Capacitance & Inductance Comparison Bridge - Maxwell – Hay - Schering - Wien - Kelvin & Kelvin's Double Bridge.		
Module:4	**Oscilloscope**	**7 hours**
Block diagram - CRT - Vertical Deflection System - Delay line - Horizontal Deflection System - CRT screens & Graticules - Oscilloscope Probes - Measurement of Frequency, Amplitude & Phase - Lissajou's Patterns.		
Module:5	**Signal Generation & Signal Analysis**	**6 hours**
Sample & Hold Circuit - Instrumentation Amplifier - Function Generator - Pulse Generator - Q Meter - Vector Impedance Meter - Wave Analyzer - Harmonic Distortion Analyzer.		
Module:6	**Transducers**	**7 hours**
Resistive Transducers – Inductive Transducers - Capacitive Transducers - Piezo Electric Transducer - Thermo Electric Transducers – Temperature Transducers – Microphones & Loud Speakers.		
Module:7	**Special Measurement Systems**	**6 hours**
Wave Analyzers: Operation of frequency selective wave analyzers and heterodyne wave analyzers and their application - Spectrum analyzer - Digital Thermometer- Illuminometer– Tachometer – Speedometer- pH meter - Humidity meter.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Albert D Helfric and William D Cooper, Modern Electronic Instrumentation and Measurement Techniques, 2015, 1st edition, Pearson Education, India.
2.	H.S. Kalsi, Electronic Instrumentation and Measurement, 2019, 4th edition, Mc Graw Hill, India.
Reference Books	
1.	Jasbir Singh Saini, Text book of Measurement and Instrumentation, 2020, New Age International P. Ltd. Chennai, India
2.	James W Dally, William F Riley, Kenneth G Mcconnel, Instrumentation for Engineering Measurement, 2010, 2nd edition, Willey publishers, USA
3.	S. Salivahanan, R. Rengarajan, G.R. Venkatakrishnan, Measurements and Instrumentation, 2019, 1st edition, Mc Graw Hill, India.
4.	B.C. Nakra and K.K. Chaudhry, Instrumentation measurement and analysis, 2016, 4th edition, Mc Graw Hill, India.
Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT	

Recommended by Board of Studies	09-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

Course code	Quantum Optics	L	T	P	C
TPHY414L		3	0	0	3
Pre-requisite	**Principles of Quantum Mechanics**	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To review the quantum optical description of light
2. To build the foundations for quantum optics
3. To prepare the students for quantum technological applications such as quantum communication using photonic qubits.

Course Outcome

At the end of the course, student will be able to

1. Explain the basics of quantum optics.
2. Understand the quantum nature of light
3. Demonstrate the photon antibunching, coherent states, and squeezed states
4. Design a micro-cavity for a strong light-matter interaction
5. Explain the quantum nature of single-photon measurements

Module: 1	**Review of quantum mechanics**	**6 hours**
Two-level systems – Picture of quantum mechanics- Schrodinger, Heisenberg, and interaction picture- Correlation functions of light waves		
Module: 2	**Field quantization**	**6 hours**
Single-mode field quantization - Multimode field quantization- Single-mode field in thermal equilibrium		
Module: 3	**Coherent states and squeezed states**	**6 hours**
Field quadrature - Vacuum field - Coherent states - squeezed states - a quantum theory of Hanbury Brown and Twiss experiments.		
Module: 4	**Photon statistics**	**6 hours**
Coherent light - Poisson distribution - Classification of light by photon statistics - thermal light - chaotic light - sub-Poissonian light - a quantum theory of photon detection.		
Module: 5	**Photon Antibunching**	**6 hours**
Hanbury Brown and Twiss experiment with photons - The second-order correlation function - Antibunched light (with no classical equivalence) - single-photon sources.		
Module: 6	**Atoms in cavities**	**6 hours**
Optical cavities- atom-cavity coupling- Weak coupling- strong coupling - Purcell effect - Applications of cavity effects		
Module: 7	**Interaction between atoms and quantized fields**	**7 hours**
Dressed states- Rabi-oscillations - the Jaynes-Cummings model - Single-Mode Spontaneous Emission		
Module: 8	**Contemporary issues**	**2 hours**
Contemporary research direction; one/two lectures of experts from renowned national or international institutions.		
	Total Lecture hours:	**45 hours**

Textbook(s)

1. Pierre Meystre and Murray Sargent III, Elements of quantum optics,1998, 3rd edition Springer-Verlag Berlin and Heidelberg GmbH & Co. K, Germany.
2. Mark Fox, Quantum Optics: An Introduction, 2006, Oxford University Press, New Delhi

Reference Books

<table>
<tr><td>1.
2.
3.
4.</td><td colspan="4">Paul R. Berman and Vladimir S. Malinovsky, Principles of laser spectroscopy and quantum optics, 2010, Princeton University Press, USA
M.O. Scully and M.S. Zubairy, Quantum Optics, 2001, Cambridge University Press, UK
C.C. Gerry and P.L. Knight, Introductory Quantum Optics, 2005, Cambridge University Press, UK
Alexey V. Kavokin, Jeremy J. Baumberg, Guillaume Malpuech, and Fabrice P. Laussy, Microcavities, 2010, Oxford university press, New York, USA</td></tr>
<tr><td colspan="5">Mode of Evaluation: CAT, Quiz, Digital Assignment, and FAT</td></tr>
<tr><td colspan="2">Recommended by Board of Studies</td><td colspan="3">20-01-2024</td></tr>
<tr><td colspan="2">Approved by Academic Council</td><td>No. 73</td><td>Date</td><td>14-03-2024</td></tr>
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Course code	Quantum Information Theory	L	T	P	C
TPHY415L		3	0	0	3
Pre-requisite	**Principle of Quantum Mechanics**	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To introduce the foundations of quantum information
2. To expose the applications is quantum algorithms
3. To introduce the applications of quantum cryptography

Course Outcome

At the end of the course, the student will be able to

1. Explain the basics of quantum information
2. Apply different measures of information
3. Appreciate quantum algorithms
4. Apply quantum mechanics in cryptography
5. Perform the fidelity calculations

Module:1	**Basics of quantum information**	**6 hours**
Quantum States – Reduced density matrix, physical realization of qubits - Quantum Operators - Measurements - Quantum gates and circuits - Quantum Entanglement		
Module:2	**Quantum information measures**	**7 hours**
Distance measures - Trace distance - Fidelity. Entropy measures - Shannon entropy and its properties - Von Neumann entropy and its properties		
Module:3	**Quantum algorithms – I**	**7 hours**
Quantum parallelism - Deutsch-Jozsa algorithm - Simon's algorithm - Advantages of quantum algorithm		
Module:4	**Quantum algorithms – II**	**6 hours**
Quantum search algorithm - Grover's algorithm and its implications - Factoring and period finding - Quantum Fourier Transform - Shor's algorithm towards factorization		
Module:5	**Quantum cryptography**	**6 hours**
Basics of Quantum cryptography - No cloning theorem - Quantum key distribution (QKD) - Security analysis		
Module:6	**QKD protocols**	**6 hours**
Analysis of QKD protocols: Bennett-Brassard (BB84) protocol - Bennett (B92) protocol – Bennett-Brassard-Mermin (BBM) protocol		
Module:7	**Noise models**	**5 hours**
Types noise models - Amplitude damping - Phase damping - Collective noise - Pauli noise – Analysis of fidelity		
Module:8	**Contemporary issues**	**2 hours**
Contemporary research direction; one/two lectures of experts from renowned national or international institutions.		
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Bernhardt Chris, Quantum Computing for Everyone, 2020, MIT Press, Massachusetts, USA

Reference Books

1. Anirban Pathak, Elements of Quantum Computation and Quantum Communication, 2015, CRC Press, Boca Raton, USA.
2. Michael A. Nielsen and Issac L. Chuang, Quantum Computation and Information, 2010, 2nd Edition, Cambridge University Press, Cambridge, UK.

Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Functional Materials	L	T	P	C
TPHY416L		3	0	0	3
Pre-requisite	**Solid State Physics**	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To introduce functional materials and the science behind the performance of the functional material.
2. To enable the understanding of the applications of functional materials.
3. To inculcate the knowledge of a wide range of important functional materials.

Course Outcome

At the end of the course the students will be able to

1. Relate properties of functional materials to crystal structure.
2. Understand the relationship between specific material properties and their function in applications using electric, dielectric and/or magnetic materials.
3. Understand the relation between the size and functional properties of materials.
4. Design materials for photovoltaic solar energy harvesting applications and for magnetic and electric coupling phenomenon
5. Have thorough knowledge of material aspects of functional devices and its fabrication.

Module:1	**Functional Properties**	**5 hours**
Characteristics and types of functional materials - Crystal structure and Properties - Effect of size on properties - effect of interfaces on properties - Magnetic materials and storage applications.		
Module:2	**Size effect and electronic properties**	**5 hours**
Size and interface effects on properties - Electronic bands structures - Charge transport in Semiconductor devices. Band structure - Semiconductor devices – Theory, examples and applications.		
Module:3	**Optical properties**	**5 hours**
Optical reflectivity – photoemission - absorption coefficient - free carrier absorption in semiconductors and metals - Direct and indirect inter band transitions - Optical active materials: theory - examples of materials and applications.		
Module:4	**Magnetic properties**	**7 hours**
Microscopic origin of magnetic moments - Magnetic susceptibility- Exchange interaction- Types of Magnetism in materials- Hysteresis in ferromagnetic materials- Response of the functional materials to external parameters- e.g. pressure- temperature. Applications in Giant magneto-resistance effect- Spintronics.		
Module:5	**Dielectric Properties**	**7 hours**
Dielectrics- piezo and ferroelectric materials: Introduction- properties- applications. Recent developments in advanced dielectric- piezoelectric and ferroelectric materials. High strain high performance piezo- and ferroelectric single crystals. Electric field-induced effects and domain engineering.		
Module:6	**Solar Energy and Photovoltaic materials**	**8 hours**
Introduction of energy storage/conversion devices- State-of-the art of portable power sources- Solar/photovoltaic (PV) cells as a source of green energy; Fundamentals- Materials- Design and Implementation aspects of PV energy generation and consumption; Solar cell technologies- Efficiency of solar cells and PV array analysis- Photovoltaic system design (stand alone and grid connected) and applications.		
Module:7	**Smart Materials**	**6 hours**
Material aspects and design rules of functional devices- applications- factors affecting properties of smart materials. Applications in electronic- communication- aerospace- automotive- energy industries- shape memory alloys		
Module:8	**Contemporary issues**	**2 hours**
Contemporary research direction; one/two lectures of experts from renowned national or international institutions.		
	Total Lecture hours:	**45 hours**

Text Book(s)

1. S. Banerjee, A.K.Tyagi, Functional Materials - Preparation, Processing and Applications, 2021, 1st Edition, Elsevier, USA.
2. Ewa Klodzinska, Functional Materials: Properties, Performance and Evaluation, 2015, CRC Press,

	USA.
Reference Books	
1.	Zhengwei Li, Nigel M. Sammes, An Introduction to Electronic Materials for Engineers, 2011, World Scientific Publishing Co. Pte. Ltd., USA
2.	David K. Ferry, Jonathan P Bird, Electronic Materials and Devices, 2001, Wiley, USA.
3.	H. S. Nalwa, Handbook of Advanced Electronic and Photonic Materials and Devices: Ferroelectrics & Dielectrics, 2001, Vol. 10, (ed.), Academic Press, USA.
4.	H. P. Garg and J. Prakash, Solar Energy: Fundamentals & Applications, 1997, Tata McGraw Hill, India.
5.	G. N. Tiwari, S. Dubey & Julian C. R. Hunt, Fundamentals of Photovoltaic Modules and their Applications, 2009, RSC Energy Series, UK.
Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT	

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Fiber and Nonlinear Optics	L	T	P	C
TPHY417L		3	0	0	3
Pre-requisite	**Laser Physics**	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To understand the light guiding mechanism in optical fibers and to study the various linear effects and their mitigations.
2. To expose to the origin of nonlinearity in optics.
3. To learn various nonlinear effects in optical fibers and eventually the realization of optical solitons.

Course Outcome

At the end of the course, the student will be able to

1. Recall the basic structure of an optical fiber and the pulse propagation in optical fibers.
2. Understand the various linear effects in optical fibers and their mitigations.
3. Comprehend the basics of nonlinear optics and multiphoton processes.
4. Analyze the various nonlinear effects in optical fibers.
5. Design a typical soliton based fiber communication system.

Module:1	**Light propagation in optical fibers**	**5 hours**

Optical fibers – basic structure – light propagation in a step index fiber – conditions – total internal reflection-acceptance angle –numerical aperture.

Module:2	**Attenuation and its mitigations**	**6 hours**

Linear effects – attenuation – bending losses- scattering-absorption-transparent windows-measuring attenuation – Mitigations to attenuation- repeaters-optical amplifier-Erbium doped fiber amplifier-fiber Raman amplifier.

Module:3	**Dispersion and its mitigations**	**7 hours**

Dispersion – intermodal and intramodal dispersions– fiber modes – V-parameter – computing intermodal dispersion in a step index fiber- advent of graded index fibers- single mode fiber-mode field diameter- pulse spreading due to chromatic dispersion- mitigations to dispersion-dispersion compensating fibers-fiber Bragg gratings-photonic crystal fibers.

Module:4	**Nonlinear optics**	**6 hours**

Wave propagation in an anisotropic crystal – Polarization response of materials to light – Harmonic generation – Second harmonic generation – Sum and difference -frequency generation – Phase matching – Third harmonic generation.

Module:5	**Multiphoton processes**	**6 hours**

Two photon process –Parametric generation of light – Oscillator – Amplifier –Stimulated Raman scattering – Intensity dependent refractive index optical Kerr effect.

Module:6	**Nonlinear effects in optical fibers**	**6 hours**

Nonlinear effects in optical fibers – Kerr effect – self-phase modulation – cross-phase modulation-stimulated Raman scattering effects- stimulated Brillouin scattering-self-frequency shift.

Module:7	**Optical solitons**	**7 hours**

Modeling pulse propagation in optical fibers – nonlinear Schrödinger equation – optical solitons-soliton based optical fiber communication systems.

Module:8	**Contemporary issues**	**2 hours**

Contemporary research direction; one/two lectures of experts from renowned national or international institutions.

	Total Lecture hours:	**45 hours**

Text Book(s)

1. D. K. Mynbaev, and L. L. Scheiner, Fiber Optics Communications Technology, 2002, Pearson, India.
2. G. P. Agrawal, Nonlinear Fiber Optics, 2019, 6th Edition, Academic Press, USA

Reference Books

1. A. Ghatak, and K. Thyagarajan, Introduction to Fiber Optics, 2017, Cambridge University Press,UK.

2.	P. E. Powers, and J. W. Haus, Fundamentals of Nonlinear Optics, 2017, 1st Edition, CRC Press, Taylor & Francis Group, USA.		
Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Characterization of Materials	L	T	P	C
TPHY418L		3	0	0	3
Pre-requisite	**Solid State Physics, Principles of Quantum Mechanics**	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To empower students with basic physics of the advanced material characterization techniques to understand the materials properties.
2. To provide an introduction to different types of characterization techniques, their importance and uses.
3. To introduce the students to the principles of various spectroscopic techniques for understanding of optical properties.

Course Outcome

At the end of the course the students will be able to
1. determine phase, crystal structure and chemical composition of materials.
2. use appropriate spectroscopic technique to measure the optical properties of materials.
3. optimize material research in selecting the most appropriate morphological and scanning technique, as well as the interpretation of their results.
4. analyze and interpret electrical and magnetic properties of the materials.
5. choose the appropriate characterization technique for suitable analysis.

Module:1	Structural and Chemical Characterization	8 hours

Introduction to materials characterization methods and its importance - Bragg's law - principle of X-ray diffraction and techniques - powder diffraction-particles and polycrystals - phase identification - indexing and lattice parameter determination - structure analysis - crystallite size - examples of X-Ray diffraction and applications - elemental/ compositional analysis by Energy dispersive X-ray analysis (EDAX) - X-ray photoelectron spectroscopy (XPS).

Module:2	Optical Characterization	8 hours

Light interaction with matter - fundamental concepts in spectroscopy and instrumental techniques - principle and applications of Ultraviolet–visible (UV-VIS) spectroscopy - Fourier-transform infrared (FT-IR) spectroscopy - photoluminescence spectroscopy – Raman spectroscopy - examples for each spectroscopy technique.

Module:3	Morphological Characterization	5 hours

Microscopy and the concept of resolution - interaction of electrons with matter, Scattering- elastic scattering, inelastic scattering, and diffraction - electron sources - lenses, apertures - electron detectors - image recording - scanning and transmission electron microscopy.

Module:4	Scanning Probe Microscopy	5 hours

Working principles - scanning elements - sample positioning and precise control of tip - acquisition and processing of scanning probe microscopy images - atomic force microscopy - scanning tunneling microscopy.

Module:5	Electrical and Electronic Measurements	5 hours

Conductivity and resistivity - bulk measurements - surface measurements - Hall effect in semiconductors - data analysis and initial interpretation.

Module:6	Magnetism and Magnetic Measurements	6 hours

Generation and measurement of magnetic fields - magnetic moment and magnetization - soft and Hard magnets - magnetometry - VSM - data analysis and initial interpretation, Weiss Gouy's balance method

Module:7	Magnetotransport and Spintronics	6 hours

Physical mechanism of magnetoresistance - giant and colossal magnetoresistance - skew scattering-anomalous Hall effect - quantum Hall effect - spin Seebeck effect.

Module:8	Contemporary issues	2 hours

Contemporary research direction; one/two lectures of experts from renowned national or international institutions.

	Total Lecture hours:	45 hours

Text Book(s)

1. Kittel, Charles, Introduction to solid state physics, 2005, 8th ed., Wiley, New York.
2. N. W. Ashcroft and N. D. Mermin, Solid State Physics, 1976, Saunders College Publishing, New York.

Reference Books

1.	B.D. Cullity, S.R. Stock, Elements of X-Ray Diffraction, 2013, 3rd Edition, Pearson Education, India
2.	Colin Banwell, Elaine McCash, Fundamentals for Molecular Spectroscopy, 2017, 4th Edition, McGraw Hill, US
3.	David Brandon and Wayne D. Kaplan, Microstructural characterization of Materials, 2008, 2nd Edition, John Wiley & Sons Ltd, England.
4.	Ernst Meyer, Hans Josef Hug, Roland Bennewitz, Scanning Probe Microscopy, 2004, 1st edition, Springer, Berlin, Heidelberg, New York, USA.
5.	Elton N. Kaufmann, Characterization of Materials, 2003, John Wiley & Sons Ltd, USA.

Mode of Evaluation: CAT, Digital assignment, Quiz, FAT			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Ferroelectrics and Dielectrics	L	T	P	C
TPHY419L		3	0	0	3
Pre-requisite	**Solid State Physics**	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To understand the dielectric and ferroelectric phenomena and its importance in new material design.
2. To distinguish between piezoelectric, pyroelectric, ferroelectric and multiferroic materials.
3. To apply the knowledge of the above materials for various types of energy harvesting.

Course Outcome

At the end of the course, the students will be able to:

1. Understand the theoretical concepts of active dielectric materials.
2. Distinguish between and explain the principles of piezoelectric, pyroelectric, ferroelectric and multiferroic materials.
3. Discuss the inherent macroscopic and microscopic phenomenon of these effects.
4. Apply the knowledge of the above materials for various types of energy harvesting.
5. Relate the properties of the dielectric and ferroelectric materials to meet the challenges.

Module:1	Dielectric Polarization	6 hours

The microscopic concept of polarization- Langevin's theory of polarization in polar dielectrics- The static dielectric constant of solids and liquids- Properties of dielectrics in alternating fields- The complex dielectric constant and dielectric loss- dipolar relaxation- Time dependent Electric polarization – Kramers – Kronig relations - Debye equation.

Module:2	Dielectric Relaxation	6 hours

Introduction to Electrostatics – Dielectric Relaxation (Dielectric Retardation) – Linear Response Theory and Fluctuation Dissipation Theorem - Theoretical Considerations (models) – Debye Relaxation Models - Non - Debye Relaxation. Cole - Cole and Cole-Davidson plot – relaxation time with temperature and frequency - The Relation between Dielectric Relaxation and chemical structure.

Module:3	Dielectric measurement Techniques and Applications	7 hours

Broad band measurement techniques – Low frequency – Capacitor method –LCR meter – Microwave wave frequency - Transmission/reflection line method- Free space method- Resonant method. Vector network Analyzer (VNA) - one port – two ports coaxial - Open ended coaxial probe method – wave guide cells – antenna – S-parameters measurement – applications of dielectric materials – electric and electronic devices – communications.

Module:4	Piezoelectricity	5 hours

Introduction to Piezoelectricity – History- origin and principle of piezoelectric effect - spontaneous polarization - non-linear variation of polarization – materials exhibiting piezoelectricity - types of phase transitions - principle of piezoelectric effect for mechanical energy harvesting

Module:5	Pyroelectricity	6 hours

Principle of pyroelectric effect – pyroelectric coefficient and electrocaloric coefficient – primary and secondary pyroelectric coefficients – ternary pyroelectric coefficients and other aspects – materials exhibiting Pyroelectricity - phase transition in pyroelectric materials - pyroelectric materials for thermal energy harvesting applications

Module:6	Ferroelectricity	7 hours

Introduction and properties of ferroelectricity – types of ferroelectric materials – Normal and relaxor ferroelectrics - ferroelectric phase transitions – Landau theory – first and second order transitions – domain structure - coupling to strain – phonons-1D monoatomic and diatomic; phonons in 3D solids – soft modes and microscopic mean field theory - antiferroelectricity – ferroelectric materials exhibiting electrocaloric effect - ferroelectric photovoltaic solar energy harvesting

Module:7	Applications of Ferroelectrics	6 hours

Energy storage devices-memory devices- FERAM - FMRAM - Field Effect transistors - Sensors for naval applications – MEMS, sensor devices including Piezoelectricity, Ferroelectric Tunnel Junctions (FTJ)

Module:8	Contemporary Topics	2 hours

Contemporary research direction; one/two lectures of experts from renowned national or international institutions.

	Total Lecture hours:	**45 hours**

Text Book(s)

1. Qi Li , Advanced Dielectric Materials for Electrostatic Capacitors, 2020, Institution Of Engineering And Technology, UK
2. Ashim Kumar Bain, Prem Chand, Ferroelectrics: Principles and Applications, 2017, 1st edition, Wiley-VCH Verlag GmbH & Co., Germany.

Reference Books

1. E Lines, Principles and Applications of Ferroelectrics and Related Materials, 1977, Oxford University Press, Oxford.
2. es, M.E., Glass AM, Principles and Applications of Ferroelectrics and Related Materials. 2001, Oxford University Press, Oxford.
3. aldo, A., Benedetto, E. D. and Giuseppe Cannazza, Broadband Reflectometry for Enhanced Diagnostics and Monitoring Applications, 2011, Springer, Germany
4. V. Raghavan, Materials Science and Engineering – A First Course 2007, 5th Edition, Prentice Hall India, India.
5. Perembur S Neelakanta, Hand book of Electromagnetic materials – Monolithic and composite versions and their applications, 1995, First edition, CRC press, USA.

Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Course title	L	T	P	C
TPHY420L	Crystal Growth Techniques	3	0	0	3
Pre-requisite	Solid State Physics	Syllabus version			
		v. 1.0			

Course Objectives

1. To provide information on the important aspects of nucleation mechanisms involved in thegrowth of crystals.
2. To evaluate the existing theories of crystal growth.
3. To introduce the development and experimental aspects of crystal growth.
4. To train the students in specific areas of growing techniques in making bulk single crystalsrelated to Lasers, Electronics and Photovoltic activities.

Course Outcome

At the end of the course, the students should be able to:

1. Understand the fundamentals of nucleation and theories of Crystal Growth.
2. Know the various techniques under melt growth.
3. Understand the methods involved in the vapour growth process.
4. Have knowledge on Epitaxial growth techniques and its applications.
5. Experiment the various methods solution and gel growth.

Module:1	Nucelation	7 hours

Supersaturation and supercooling – nucleation concept – Kinds of nucleation - Homogeneous nucleation - Equilibrium stability and metastable state -Classical theory of nucleation - Gibbs- Thomson equation –Kinetic theory of nucleation - Free energy of formation of nucleus considering translation, vibration and rotation energies. Heterogeneous nucleation - Free energy of formation of a critical heterogeneous - cap shaped -disc shaped nucleus.

Module:2	Theories of Crystal Growth	7 hours

Theories of crystal growth - Surface energy theory - Diffusion theory - Adsorption layer theory - Volmer theory -Bravais theory - Kossel theory - Stranski's treatment -Two dimensional nucleation theories of Crystal growth - Crystal growth by mass transfer processes -Bulk diffusion model - Surface diffusion growth theories Physical modeling of BCF theory - PCB theory of crystal growth.

Module:3	Melt Growth	9 hours

Growth of crystal from melt - Bridgman method - Kyropolous method - Czochralski method- Verneuil method - Zone melting method - LEC growth of III - V materials - Growth of oxide materials. Growth of crystal from flux - Slow cooling method - Temperature difference method – High pressure method - Solvent evaporation method - Top seeded solution growth -Growth of superconducting single crystal.

Module:4	Vapour Growth	6 hours

Growth of crystals from vapour phase - Physical vapour deposition - Chemical vapour transport - Open and closed system - Thermodynamics of chemical vapour deposition process - Physical, thermo-chemical factors affecting growth process.

Module:5	Epitaxial Growth	5 hours

Liquid Phase Epitaxy (LPE) – Vapour Phase Epitaxy (VPE)- Metalorganic Vapour Phase Epitaxy - (MOVPE)-Molecular Beam Epitaxy (MBE) - Atomic Layer Epitaxy (ALE) - Electroepitaxy - Chemical Beam Epitaxy (CBE).

Module:6	Solution Growth	5 hours

Growth of crystals from solutions - solvents and solutions - solubility - preparation of a solution - saturation and supersaturation - Measurement of supersaturation - Expression for supersaturation - Low

temperature solution growth - Slow cooling method - Mason-jar method - Evaporation method - Temperature gradient method - Electrocrystallization.		
Module:7	**Other Crystal Growth Techniques**	**6 hours**
Crystal growth in gels - Experimental methods - Chemical reaction method - Reduction method - Complex decomposition method - Solubility reduction method - Growth of biologically important crystals - Crystal growth by hydrothermal method.		
Module:8	**Contemporary Topics**	**2 hours**
Contemporary research direction; one/two lectures of experts from renowned national or international institutions.		
	Total Lecture hours:	**47 hours**

Text Book(s)

1.	Brice J.C, Crystal Growth Processes, John Wiley & sons , New York, 1986
2.	Buckly H.E, Crystal Growth, John Wiley & Sons, New York, 1986.
3.	William Kemp, Oraganic spectroscopy, 3rd Edition, , Palgrave, New York, 2004

Reference Books

1.	A. Laudise, The Growth of single crystals. Prentice Hall, 1970.
2.	B.Pamplin, Crystal Growth. Volume 16, Pergamon Press.1973.
3.	F.F. Abraham, Homogenous nucleation theory, Advances in Theoretical Chemistry,Academic Press, New York, 1974.
4.	R.F. Strickland, Kinetics and Mechanism of Crystallization, Academic Press, New York,1968.
5.	AM Alper, Phase Diagrams: Materials Science and Technology, Vol. I-VI, academicPress, New York, 1970.

Mode of Evaluation: CAT, written assignment, Quiz and FAT

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Statistical Studies of Complex Systems	L	T	P	C
TPHY421L		3	0	0	3
Pre-requisite	**Classical mechanics, Principles of quantum mechanics and Statistical mechanics**	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To apply statistical approach to stochastic systems.
2. To apply nonequilibrium statistical mechanical theories for understanding out of equilibrium disordered systems.
3. To explain how the order parameter is used in describing phase transitions.

Course Outcome

At the end of the course the student will be able to

1. connect classical and quantum statistical mechanics.
2. understand and explain the behavior of stochastic systems.
3. comprehend the nonequilibrium phenomena using statistical mechanics.
4. understand the fundamental principles of the motion of ideal (inviscid) and real (viscous) fluid flows
5. comprehend the application of statistical mechanics in disordered systems
6. understand the phenomena of phase transition.

Module:1	**Review of Statistical mechanics**	**6 hours**
Thermodynamic potentials - Equation of state - Phase transitions - Theory of ensembles - Phase space and ergodicity - Quantum statistics - Density matrix - Maximum entropy principle.		
Module:2	**Brownian Motion**	**6 hours**
Brownian motion as a stochastic process - Central limit theorem - Random events - Poisson distribution - correlation functions - Waiting time - Langevin equation - Gaussian processes - Fluctuation-Dissipation theorem.		
Module:3	**Stochastic Processes**	**6 hours**
Markovian processes - Fokker-Planck equation - Master equation - Principle of detailed balance - Boltzmann equation - Generalized Langevin equation and damping theory.		
Module:4	**Non-equilibrium statistical mechanics**	**6 hours**
Linear response theory - Green-Kubo formula - Onsager regression theory - Causality and the Kramers-Kronig Relations.		
Module:5	**Hydrodynamics**	**6 hours**
Conserved and broken-symmetry variables - Goldstone theorem - Spin dynamics - Navier-Stokes equation and viscous hydrodynamics - Transport Coefficients.		
Module:6	**Disordered systems**	**6 hours**
Spin glasses - Sherrington-Kirkpatrick model - Topological defects – Dislocations - Vortex unbinding and Kosterlitz-Thouless transition.		
Module:7	**Phase transition and Critical Phenomena**	**7 hours**
Ising model - Mean-field theory - Exact solution in 1 dimension - Onsager solution in 2 dimensions - Landau theory of second-order phase transitions - Critical exponents and universality classes - Correlation length, Importance of fluctuations near critical point - Renormalization group theory		
Module:8	**Contemporary issues**	**2 hours**
Guest lectures by industry and R & D organizations		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	R. K. Pathria, Paul D. Beale, Statistical mechanics, 2011, 3rd edition, Elsevier, Netherland
2.	J.M. Yeomans, Statistical Mechanics of Phase Transitions 1992, Oxford Scientific Publications, UK.

Reference Books			
1.	P. M. Chaikin and T. C. Lubensky, Principles of Condensed Matter Physics, 1995, Cambridge University Press, UK		
2.	L.D. Landau, E. M. Lifshitz, Statistical Physics, 1996, 3rd Edition, Butterworth-Heinemann, UK		
Mode of Evaluation: CAT, Digital assignments, Quiz, FAT			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Applied Solid State Physics	L	T	P	C
TPH422L		3	0	0	3
Pre-requisite	**Solid State Physics**	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To apply the topics in solid state physics and visualize their applications.
2. To understand the theory of Hamiltonian of different interaction mechanisms.
3. To know Spin dependent transport and Spin Injection for Spintronic applications.

Course Outcome

An the end of the course the student will be able to

1. Understand the Phase Transitions and critical points in first order and second order.
2. Utilize the critical exponents to model microscopic behavior.
3. Interpret the different models and their implications in solids.
4. Evaluate the spin interaction in reduced dimension
5. Identify the spin transport behavior and their application for electronic industries.

Module:1	**Universality and its application to Critical Phenomena**	**6 hours**

Divergences and Critical exponents- Fluctuations and critical opalescence- the order parameter- Liquid-gas transition- Binary fluids- Ferro-Para transitions- Anti-ferro-para transition- Helium I/helium II transitions-conductor/superconductors transitions-correlation functions-Universality- thermodynamic potentials

Module:2	**Applications of Landau Free Energy**	**6 hours**

Breaking of the Symmetry- Different Models- Landau Theory- Heisenberg Model- Ising Model- 1D & 2D, Consequences- Mean-Field Theory- Critical Exponents- Calculations – Scaling Laws- Excitations-Magnons.

Module:3	**Interactions of Electrons and its consequences**	**6 hours**

Spin dependent atomic Hamiltonian – exchange Interaction – Heisenberg Hamiltonian- Hubbard Hamiltonian – Spin-Orbit Interaction – spin-orbit Hamiltonian & its importance – Hund's rules- Zeeman Interaction – Zeeman versus exchange splitting of electronic states.

Module:4	**Band Model, Stoner Model and their applications**	**6 hours**

Localized versus itinerant electrons – Band model – puzzle of broken Bohr magneton numbers – Stoner Model – Density functional theory – importance of electron correlation – spin alignment in transition metal oxides- Colossal magnetoresistance – RKKY exchange

Module:5	**Magnetism in nanoscale**	**6 hours**

Interaction in single atoms- Influence of the geometrical arrangement and surface symmetry- Clusters at step edges- Nanoscale Materials- Size dependence- Ring structures- Magnetic Vortices- Single Domain particles- single thin films- Influence on the spin dependent transport and Quantum well state.

Module:6	**Giant Magnetoresistance and its applications**	**7 hours**

Diffusion Equations for Spins- Spin Equilibrium processes, Distances and Times- Spin Accumulation voltages in metallic contact- Measurement of Spin Diffusion Lengths in Non magnets- The important roles of interfaces in GMR - Typical Values for the Spin Accumulation Voltage, Boundary Resistance and GMR Effect.

Module:7	**Spintronics**	**6 hours**

Origin and Properties of Spin Injection Torques – Switching of magnetization with spin currents – Excitation and Switching of the magnetization with Spin Currents: Experiments - Spin Currents in Metals and Semiconductors - Spin-Based Transistors and Amplifiers.

Module:8	**Contemporary issues**	**2 hours**

Contemporary research direction ; one/two lectures of experts from renowned national or international Institutions.

	Total Lecture hours:	**45 hours**

Text Book(s)

1. Jurgen M. Honig , Jozef Spalek, A Primer to the Theory of Critical Phenomena, 2018, 1st Edition, Elsevier Science publications, Poland

2. Joachim St¨ohr, Hans Christoph Siegmann, Magnetism: Fundamentals to Nanoscale Dynamics, Springer series in solid state sciences, 2006, 1st Edition, Springer Nature, Switzerland.

Reference Books

1.	J. J. Binney, N. J. Dowrick, A. J. Fisher, M. E. J. Newman, The Theory of Critical Phenomena An Introduction to the Renormalization Group,2002, 1st Edition, Oxford Science Publications, Clarendon Press, Oxford, UK.		
2.	Bekir Aktas, Faik Mikailzade, Nanostructured Materials for Magnetoelectronics: Springer Series in Materials Science, 2016, 1st Edition, Springer Nature, Switzerland.		
3.	R. C. O' Handley, Modern Magnetic Materials: Principles and Applications, 1999, 1st Edition, Wiley, Newyork, USA.		
Mode of Evaluation: CAT , Digital assignments, Quiz and FAT			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Physics of Renewable Energy Systems	L	T	P	C
TPHY424L		3	0	0	3
Pre-requisite	**Solid State Physics**	**Syllabus version**			
		v. 1.0			

Course Objectives

1. To gain a basic overview of some of the renewable energy systems
2. To gain knowledge about science of solar cell, fuel cells, thermoelectric materials
3. To understand the appreciate the need of renewable energy system in present day scenario

Course Outcome

At the end of the course, the student will be able to

1. Understand the importance of renewable energy and utilization.
2. Analyze the performance of different types of solar cell.
3. Remember basics of thermoelectric property and thermoelectric materials.
4. Evaluate the potential of cutting-edge energy storage systems.
5. Understand the working principle of fuel cell and present day applications.

Module:1	**Introduction to Renewable energy**	**6 hours**

What we understand by renewable and what are the various sources (classifications) - Solar energy-solar cells - Wind energy-continuity equation and wind turbines - Hydroenergy- physics of waves - hydroelectric energy and tidal energy - Geothermal energy - Shallow and deep geothermal energy.

Module:2	**Physics of Solar Cell**	**9 hours**

Introduction to p-n junction - Blackbody radiation - Light absorption - p-n heterojunction-formation of depletion layer - Band bending - Metal-semiconductor and metal-insulator-metal junction and related device physics - Photoinduced carrier generation and recombination - Charge carrier transport by drift and diffusion - One dimensional drift-diffusion equation - Characterization of Solar cell (IV, EQE, LBIC) and difference of IV between different types of solar cell - Degradation mechanisms and its characterization.

Module:3	**Different types of solar cell**	**9 hours**

Types of solar cells - First generation Si solar cells - Fabrication of Si solar cells - Second generation thin films solar cells - Bandgap grading in semiconductor - tandum solar cell - thin films deposition methods - Solar Cell Operation - Performance and Design Rules - Third generation-CIGS - Emerging solar cells-Organic, Quantum dot - Pervoskite and dye-sensitized solar cells - Solar cell systems, modules and standards.

Module:4	**Thermoelectrics**	**6 hours**

Revisit to thermodynamic laws - Heat current - coupled electron heat transport - Review of Newton's law of cooling - Seebeck effect - Peltier effect - Thomson effect - Lattice thermal conductivity - Boltzmann transport equation - Classical thermoelectric materials - Oxides, half-Heusler and nanomaterials.

Module:5	**Storage system: Li-ion battery and Supercapacitor**	**5 hours**

Introduction of Energy Storage Systems - Batteries Advanced Lithium Batteries - Nickel Metal Hydride Battery - Lead-acid battery - Supercapacitors - Double layer and Psedocapacitors.

Module:6	**Fuel Cell**	**5 hours**

Introduction to fuel cells - Types of fuel cells - Proton Exchange Membrane Fuel Cells - Alkaline fuel cells - phosphoric acid - Solid oxide - Molten carbonate - Direct methanol fuel cells.

Module:7	**Applications and future prospect**	**3 hours**

Global energy demand and supply - energy economy - solar cell and fuel cells integration in mobility and sustainability - Advances in energy generation, storage - India present energy scenario and policies.

Module:8	**Contemporary issues**	**2 hours**

Contemporary research direction ; one/two lectures of experts from renowned national or international Institutions.

	Total Lecture hours:	**45 hours**

Text Book(s)

1. George C. King, Physics of Energy Sources, 2017, Wiley Publications, New Jersey.
2. E. L. Wolf, Physics and technology of sustainable energy systems, 2018, Oxford Press, Oxford.

Reference Books

1. David JC MacKay, Sustainable Energy - without the hot air, 2009, UIT Cambridge LTD.
2. Peter Wurfel, The Physics of Solar cells, 2009, 2nd Edition,Wiley.
3. David Elliott, Energy Storage Systems, 2017, IOP Publishing, Bristol, UK,

4.	R. O'hayre, S. W. Cha, W. Colella, F. B. Prinz, Fuel cell fundamentals, 2016, John Wiley & Sons.		
Mode of Evaluation: CAT, Digital Assignment, Quiz, FAT			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	20-03-2024

Course code	Molecular Simulation	L	T	P	C
TPHY425L		3	0	0	3
Pre-requisite	**Classical mechanics, Statistical mechanics**	**Syllabus version**			
		v. 1.0			

Course Objectives

1. Apply numerical methods for integration and solving differential equation.
2. Learn Molecular Dynamics and Monte Carlo simulation techniques to study classical systems in different ensembles.
3. Understand stochastic and dissipative systems using statistical mechanics.

Course Outcome

At the end of the course the student will be able to

1. Apply different numerical techniques for integration
2. Apply different numerical techniques for solving ordinary differential equations
3. Comprehend the basics of scientific, numerical simulation and modeling
4. Understand the behavior stochastic systems
5. Understand the behavior dissipative systems

Module:1	**Numerical Integration**	**5 hours**
Generalized quadrature formula - Trapezoidal rule. Simpson's 1/3 rules - Numerical integration by n-point Gaussian quadrature method.		
Module:2	**Solution of Ordinary Differential Equations**	**6 hours**
Initial Value problem- Reduction to 1st order ordinary differential equation-Euler Cauchy Method- Runge-Kutta Method		
Module:3	**Classical Potentials and Force Fields**	**6 hours**
Simple fluids - continuous and discontinuous potentials - Complex molecules and force fields - Multibody effects – Electrostatics – Polarization - Reactive force fields - Bulk systems and periodic boundary conditions.		
Module:4	**Molecular Dynamics**	**8 hours**
Integration of classical equations of motion - Inter and intra molecular forces - Various ensembles (NVE, NVT, NPT, NPH) - Hard Sphere and long-range interactions - Ensemble averaging - Error estimation.		
Module:5	**Energy Minimization**	**4 hours**
Various scheme for minimization - Conjugate gradient - Steepest descent.		
Module:6	***Stochastic Dynamics***	**8 hours**
Brownian motion - The Langevin equation - The Fokker-Planck equation - The fluctuation-dissipation theorem - Dissipative particle dynamics.		
Module:7	***Monte Carlo Simulation***	**6 hours**
Markov processes - Detailed balance - Monte Carlo moves for different ensembles - The Metropolis Method - MC versus MD.		
Module:8	**Contemporary issues**	**2 hours**
Contemporary research direction ; one/two lectures of experts from renowned national or international Institutions.		
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Saman Alavi, Molecular simulation – Fundamentals and Practice, 2020, 1st ed, Wiley, US
2. Paul D. Beale, edited by R. K. Pathria , Statistical mechanics, 2011, 3rd ed, Elsevier.

Reference Books

1. Andrew Leach, Molecular Modelling: principles and applications, 2001, 2nd ed, Prentice Hall, USA.
2. Kun Zhou, Bo Liu, Molecular Dynamics simulation, 2020, 1st ed, Academic Press, USA.

Mode of Evaluation: CAT, Digital assignments, Quiz, FAT

Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Course code	Fluid Dynamics and Plasma Physics	L	T	P	C

TPHY426L	Fluid Dynamics and Plasma Physics	3	0	0	3
Pre-requisite	**Classical mechanics, Electromagnetic theory, Mathematical physics**	**Syllabus version**			
		v.1.0			

Course Objectives

1. To impart knowledge about the basics of fluid dynamics and the plasma state.
2. To understand the fundamental concepts of plasma physics
3. To apply the knowledge of fluid dynamics, electromagnetic theory in elucidating the various properties of plasma.

Course Outcomes

At the end of the course the student will be able to

1. Apply the governing equations to predict the behavior of simple fluids/plasma systems
2. Develop their problem-solving and physical modeling ability for a range of flows including in plasma.
3. Apply the different concepts of fluid dynamics and EM-theory in understanding the plasma state.
4. Describe problems related to plasma physics.
5. Identify different concepts to develop plasma applications and learn about devices based on plasma physics and their applications

Module:1	**Introduction to fluid dynamics**	**6 hours**

Different classes of fluids - continuum hypothesis – kinematics - macroscopic derivation of hydrodynamic equations - conservation laws - continuity equation - Euler and Navier-Stokes equations - Gas dynamics - Thermodynamic properties of an ideal gas

Module:2	**Fluid instabilities and Turbulence**	**6 hours**

Instabilities - Normal mode - the Benard problem - Kelvin-Helmholtz instability - Squids Theorem and Orr-Sommerfeld Equation - Nonlinear Effects – Turbulence - Averaged equations of motion - Kinetic energy of turbulent flow - Turbulence production and cascade - Eddy viscosity and mixing length - Turbulent dispersion.

Module:3	**Basic Concepts of Plasma**	**6 hours**

Definition of a Plasma state - Debye shielding and Plasma frequency - Criteria for plasma state - Discussion on when an ionized gas can be considered as plasma - Plasma production/ Occurrence of plasma in nature - Formation of Van Allen Belt - Cosmic rays - Simple applications of plasma.

Module:4	**Plasma as a Fluid**	**8 hours**

Single charged particle motions in constant and uniform electromagnetic field - Non-uniform magnetic field, grad – B drift and curvature drift - Adiabatic invariants - Introduction to plasma as fluids - Plasma fluid equations - Adiabatic fluid responses - The plasma approximation.

Module:5	**Waves in Plasma**	**7 hours**

Linearization procedure - Plasma oscillations (Electron waves) - Plasma normal modes - Sound wave in a neutral gas - Plasma ion sound waves/acoustic waves - Electromagnetic Plasma waves - Wave properties applications - Upper and lower hybrid waves - Plasma in relation with electromagnetic waves - Electromagnetic wave propagation - Propagation in inhomogeneous plasma - Electrostatic waves in plasma energy flow.

Module:6	**Magnetohydrodynamics in Plasma**	**5 hours**

Induction equation and its consequences - Magneto-hydrostatics - Plasma columns - Hydromagnetic waves - Magneto-convection - Magnetic regions and buoyancy - Parker instability - Magnetic winds - Magneto-hydrodynamics applied to weakly ionized plasmas.

Module:7	**Devices Based on Plasma**	**5 hours**

Relativistic electron beam-plasma interaction - Growth rate - Cerenkov free electron laser - Free electron laser and energy gain - Controlled Fusion - Fusion History - Lawson criteria - Fundamentals of Inertial Magnetic Fusion - Magnetic Confinement method (Magnetic Mirrors) - Tokamak.

Module:8	**Contemporary issues**	**2 hours**

Contemporary research direction ; one/two lectures of experts from renowned national or international Institutions.

	Total Lecture hours:	**45 hours**

Text Book(s)

1. F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, 2016, 3rd Edition, Springer

	International Publishing, Switzerland.
2.	A. R. Choudhuri, The Physics of Fluids and Plasmas: An Introduction for Astrophysicists, 2019, 1st (Latest) Edition, Cambridge University Press, UK.
3.	B. Zohuri, Plasma Physics and Controlled Thermonuclear Reactions Driven Fusion, 1st Edition, 2016, Springer International Publishing, Switzerland.
Reference Books	
1.	P. K. Kundu, I. M. Cohen, and D. Dowling, Fluid Mechanics, 6th Edition, 2015, Elsevier, USA
2.	P. M. Bellan, Fundamental of Plasma Physics, 1st Edition, 2015, Cambridge University Press, UK.
3.	A. Piel, Plasma Physics: An Introduction to Laboratory, Space, and Fusion Plasmas, 2017, 2nd Edition, Springer, Germany.

Mode of Evaluation: CAT, Digital assignments, Quiz, and FAT			
Recommended by Board of Studies	20-01-2024		
Approved by Academic Council	No. 73	Date	14-03-2024

Ability Enhancement Compulsory

TCHY140L	Environmental Studies	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. To make students understand and appreciate the unity of life in all its forms and the implications of life style on the environment.
2. To broaden the understanding of global climate changes and the importance of renewable sources of energy.
3. To give students a basic understanding of the major causes of environmental degradation on the planet, with specific reference to Indian situation
4. To inspire students to find ways in which they can contribute personally and professionally to prevent and rectify environmental problems.

Course Outcome:

Upon Completion of the course, the students will be able to

1. Students will recognize the environmental issues in a problem oriented interdisciplinary perspectives,
2. Students will understand the key environmental issues, the science behind those problems and potential solutions.
3. Students will demonstrate the significance of biodiversity and its preservation.
4. Students will identify various environmental hazards,
5. Students will design various methods for the conservation of resources,
6. Students will formulate action plans for sustainable alternatives that incorporate science, humanity, and social aspects.
7. Students will have foundational knowledge enabling them to make sound life decisions as well as enter a career in an environmental profession or higher education.

Module:1	**Environment and Natural Resources**	**7 hours**

Definition, scope, importance; need for public awareness on natural resources Forest resources – use, exploitation, causes and consequences of deforestation. Water resources – use of surface and subsurface water; dams - effect of drought, water conflicts, Land resources - Land degradation, soil erosion and desertification. Indian Case studies. Food resources – Definition,
world food problems, Traditional and modern agriculture and its impacts and remedies.

Module:2	**Energy Resources**	**7 hours**

Definition for renewable and non-renewable energy resources. Non-renewable energy resources – oil, Natural gas, Coal, Nuclear energy. Renewable energy – Solar energy, Hydroelectric power,
Ocean thermal energy, Wind and geothermal energy. Biomass energy and Bio Gas.

Module:3	**Ecosystem and Biodiversity**	**5 hours**

Concept of ecosystem, Structure and functions of an ecosystem, Food chains, food webs, Energy flow in an ecosystem, ecological pyramids and ecological succession. Case studies: Bio magnification of DDT. Biodiversity–Bio-geographical classification of India, hotspots, values of
biodiversity, Threats to biodiversity - Case study, Conservation of bio-diversity, GM Crops

Module:4	**Environmental changes and Remediation**	**6 hours**

Air, water, soil, Thermal Pollution: Causes, effects and control measures; Nuclear hazard, Solid waste Management– Causes, Effects and control measures. Floods, earthquakes, cyclones,

tsunami and landslides, Case studies.		
Module:5	**Global Climatic Change and Mitigation**	**5 hours**
Global climate change and greenhouse effect – Kyoto Protocol, Carbon sequestration, Acid rain, Ozone depletion problem – Montreal Protocol.		
Module:6	**Social Issues and the Environment**	**6 hours**
Urban problems related to energy and sustainable development, Water conservation, Rain water harvesting, Wasteland Reclamation, Environment Protection Act – Prevention and control of Pollution of Air and Water. Wildlife protection and Forest Conservation Acts.		
Module:7	**Human Population and the Environment**	**7 hours**
Population growth, variation among nations, population explosion, Family Welfare Programme, Environment, Women and Child Welfare, Human rights, HIV/AIDS, Role of information Technology on environment and human health. Discussion on current environmental issues / topics by an Industrial expert or faculty		
Module:8	**Contemporary issues**	**2 hours**
Lecture by Industry Experts		
	Total Lecture hours:	**45 hours**
Lecture by Industry Experts		
Text Book(s)		
1.	Anubha Kaushik and C.P. Kaushik, Environmental Science and Engineering, 2016, 5th Edition, ISBN: 978-81-224-4013-3, New Age International.	
2.	G. Tyler Miller Jrand Scott E. Spoolman, Living in the Environment, 2012. 17th Edition, ISBN-13: 978-0-538-73534-6, Brooks / Cole,	
Reference Books		
1.	Environmental Science and Engineering by Anjali Bagad, 2014, 1st Edition, ISBN-10: 9350997088, Technical Publications,	
2.	Introduction to Environmental Engineering by Masters, 2015, 3rd Edition,	
3.	Basic Environmental Sciences For Undergraduates by Dr.Tanu Allen, Dr.Richa K. Tyagi Dr.Sohini Singh, 2014, 1st Edition, ISBN-10: 938375827, Vayu Education of India.	
Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT		

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TENG101L	Effective English Communication	L	T	P	C
		2	0	0	2
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To enhance the basic communication skills
2. To enable the learners develop proficiency in general and academic writing
3. To expose the learners to the nuances of receptive skills

Course Outcome

1. Use appropriate vocabulary and grammar in writing sentences and paragraphs
2. Write effective letters and E-mails in workplace situations
3. Read and comprehend different texts at the intermediate level
4. Demonstrate effective listening and speaking skills with clear pronunciation

Module:1	**Vocabulary**	**2 hours**
	Synonyms and Antonyms, Prefixes and Suffixes, Word Formation, One Word Substitution, frequently used Idioms and Phrases, Homophones and Homonyms	
Module:2	**Grammar**	**4 hours**
	Parts of Speech, Articles, Tenses, Sentence Structure, Types of Sentences, Subject-Verb Agreement, Connectives and Conjunctions	
Module:3	**Drafting Paragraphs**	**4 hours**
	Elements of Paragraph writing, Keywords Development, Topic Sentence, Writing Paragraphs using Connectives	
Module:4	**Email and Letter Writing**	**4 hours**
	Email writing and etiquettes; Letter writing- process, form and structure, types of formal letters - permission, apology and request	
Module:5	**Reading**	**5 hours**
	Mechanics of Reading, Types of Reading- Skimming and Scanning, Intensive & Extensive, Reading Strategies- Summarizing; Reading short stories and essays for comprehension	
Module:6	**Listening**	**4 hours**
	Process, Types, Barriers, Effective Listening strategies, Comprehension of speech, Listening to short speeches and Note taking	
Module:7	**Speaking**	**5 hours**
	Introduction to phonetics, need and use of it - Word stress and Sentence stress - Intonation- rate of speech, pitch, tone – Clarity of voice- Nuances of delivery; modes of delivery, guidelines for effective delivery	
Module:8	**Contemporary Topics**	**2 hours**
Guest Lectures from Industry and, Research and Development Organizations		
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Rizwi, Ashraf. (2017).*Effective Technical Communication*. New Delhi:McGraw-Hill Education

Reference Books

1. Watkins, P. (2018). *Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers*. India: Cambridge University Press.
2. Koneru Aruna. (2020*). English Language Skills for Engineers.* India: McGraw Hill

	Education.
3.	Wren, P.C. & Martin, H. (2018). *High School English Grammar & Composition* N.D.V. Prasada Rao (Ed.). New Delhi: S. Chand & Company Ltd
4.	Delvin, J. (2017). *How to Speak and Write Correctly*. California, US: Create Space Independent Publishing Platform.

Mode of Evaluation: CAT / written assignment / Quiz / FAT / Seminar / group discussion

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TENG102L	Technical English Communication	L	T	P	C
		2	0	0	2
Pre-requisite	NIL	**Syllabus version**			
		1.0			

Course Objectives:

1. To develop LSRW skills for effective communication in professional situations
   To enhance knowledge of grammar and vocabulary for meaningful communication
3. To understand information from diverse texts for effective technical communication

Course Outcomes:

1. Use grammar and vocabulary appropriately while writing and speaking
   Apply the concepts of communication skills in formal and informal situations
   Demonstrate effective reading and listening skills to synthesize and draw intelligent inferences
4. Write clearly and significantly in academic and general contexts

Module:1	**Introduction to Communication**	**4 hours**
	Nature and Process - Types of communication: Intra-personal, Interpersonal, Group-verbal and non-verbal communication / Cross-cultural Communication - Communication Barriers and Essentials of good communication - Principles of Effective Communications	
Module:2	**Grammatical Aspects**	**4 hours**
	Sentence Pattern - Modal Verbs - Concord (SVA) - Conditionals - Error detection	
Module:3	**Written Correspondence**	**4 hours**
	Job Application Letters - Resume Writing - Statement of Purpose	
Module:4	**Business Correspondence**	**4 hours**
	Business Letters: Calling for Quotation, Complaint & Sales Letter – Memo - Minutes of Meeting - Describing products and processes	
Module:5	**Professional Writing**	**4 hours**
	Paraphrasing & Summarizing - Executive Summary - Structure and Types of Proposal – Recommendations	
Module:6	**Team Building & Leadership Skills**	**4 hours**
	Principles of Leadership - Team Leadership Model - Negotiation Skills - Conflict Management	
Module:7	**Research Writing**	**4 hours**
	Interpreting and Analysing a research article - Approaches to Review Paper Writing - Structure of a research article - Referencing	
Module:8	**Guest Lecture from Industry and R&D organizations**	**2 hours**
	Contemporary Issues	
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Raman, Meenakshi & Sangeeta Sharma. (2015). *Technical Communication: Principles and Practice*, (3rd Edition). India: Oxford University Press.
Reference Books	
1.	Taylor, Shirley & Chandra .V. (2010). *Communication for Business A Practical Approach* 4th Edition. India: Pearson Longman.
2.	Kumar, Sanjay & Pushpalatha. (2018). *English Language and Communication Skills for Engineers.* India: Oxford University Press.
3.	Koneru Aruna. (2020*). English Language Skills for Engineers.* India: McGraw Hill Education.
4.	Rizvi, M. Ashraf. (2018). *Effective Technical Communication* 2nd Edition. Chennai: McGraw Hill Education.
5.	Mishra, Sunitha & Muralikrishna,C. (2014). *Communication Skills for Engineers*. India: Pearson Education.
6.	Watkins, P. (2018). *Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers*. India: Cambridge University Press.

Mode of Evaluation : CAT / Assignment / Quiz / FAT / Group Discussion			
Recommended by Board of Studies		28.06.2021	
Approved by Academic Council	No. 63	Date	23.09.2021

TENG102P	Technical English Communication Lab	L	T	P	C
		0	0	2	1
Pre-requisite	NIL	**Syllabus version**			
		1.0			

Course Objectives:

1. To use appropriate grammatical structures in professional communication
2. To improve English communication skills for better employability
3. To enhance meaningful communication skills in writing and public speaking

Course Outcomes:

1. Demonstrate professional rhetoric and articulate ideas effectively
2. Interpret material on technology and deliver eloquent presentations
3. Apply receptive and productive skills in real life situations and develop workplace communication

Indicative Experiments

1.	**Grammar & Vocabulary** Error Detection **Activity:** -Worksheets
2.	**Listening to Narratives** Interviews of eminent personalities & Ted Talks **Activity:** Listening Comprehension / Summarising
3.	**Video Resume** SWOT Analysis & digital resume techniques **Activity:** Preparing a digital résumé for mock interview
4.	**Product & Process Description** Describing and Sequencing **Activity:** Demonstration of product and process
5.	**Mock Meetings** Types of meetings and meeting etiquette **Activity: Conduct of meetings and drafting minutes of the meeting**
6.	**Reading research article** Scientific and Technical articles **Activity:** Writing Literature review
7.	**Analytical Reading** Case Studies on Communication, Team Building and Leadership **Activity:** Group Discussion
8.	**Presentations** Preparing Conference/Seminar paper **Activity:** Individual/ Group presentations
9.	**Intensive Listening** Scientific documentaries **Activity:** Note taking and Summarising
10.	**Interview Skills** Interview questions and techniques **Activity:** Mock Interviews

Total Laboratory Hours	**30 hours**

Mode of Assessment: Continuous Assessment / FAT / Written Assignments / Quiz/ Oral Presentation and Group Activity.

Recommended by Board of Studies	28,06,2021		
Approved by Academic Council	No. 63	Date	23.09.2021

TENG103P	Technical Report Writing	L	T	P	C
		0	0	2	1
Pre-requisite	Technical English Communication	**Syllabus version**			
		1.0			

Course Objectives:

1. To augment specific writing skills for preparing technical reports
2. To think critically, evaluate, analyse general and complex technical information
3. To acquire proficiency in writing and presenting reports

Course Outcomes:

1. Write error free sentences using appropriate grammar, vocabulary and style
2. Synthesize information and concepts in preparing reports
3. Demonstrate the ability to write and present reports on diverse topics

Indicative Experiments

1.	**Advanced Grammar, Vocabulary and Editing** Usage of Tenses - Adjectives and Adverbs - Jargon vs Technical Vocabulary – Abbreviations - Mechanics of Editing: Punctuation and Proof Reading **Activity:** Worksheets
2.	**Research and Analyses** Synchronise Technical Details from Newspapers - Magazines - Articles and e-content **Activity:** Writing introduction and literature review
3.	**Systematisation of Information** Techniques to Converge Objective-Oriented data in Diverse Technical Reports **Activity:** Preparing Questionnaire
4.	**Data Visualisation** Interpreting Data - Graphs - Tables – Charts - Imagery - Infographics **Activity:** Transcoding
5.	**Introduction to Reports** Meaning - Definition - Purpose - Characteristics and Types of Reports **Activity:** Worksheets on Types of reports
6.	**Structure of Reports** Title – Preface – Acknowledgement - Abstract/Summary – Introduction - Materials and Methods – Results – Discussion - Conclusion - Suggestions/Recommendations **Activity:** Identifying the structure of report
7.	**Report Writing** Data Collection - Draft an Outline and Organize Information **Activity:** Drafting reports
8.	**Supplementary Texts** Appendix – Index – Glossary – References – Bibliography - Notes **Activity:** Organizing supplementary texts
9.	**Review of Final Reports** Structure – Content – Style - Layout and Referencing **Activity:** Examining clarity and coherence in final reports
10.	**Presentation** Presenting Technical Reports **Activity:** Planning, creating and digital presentation of reports
	Total Laboratory Hours **30 hours**

Mode of assessment: Continuous Assessment / FAT / Assignments / Quiz / Presentations / Oral examination

Recommended by Board of Studies	28.06.2021		
Approved by Academic Council	No. 63	Date	23.09.2021

Skill Enhancement Courses

TCSE201E	Programming in Java	L	T	P	C
		3	0	2	4
Pre-requisite	**Nil**	**Syllabus version**			
		1.0			

Course Objectives

1. To apply the core Java fundamentals to learn the advanced concepts in J2SE.
2. To design and develop web application development and database connectivity using Servlets, JSP and JDBC.
3. To apply the advanced Java frameworks for the problems in Scientific Domain.

Course Outcomes

1. Provide a basic understanding of core Java concepts.
2. Comprehend Java's support in parallel programming, GUI creation and network programming.
3. Design and develop server side programming using Servlets.
4. Design and implement Java Applications for real world problems involving Database Connectivity.
5. Design, Develop and Deploy dynamic web applications using Servlets and Java Server Pages.

Module:1	**Java Basics:**	**4 hours**

History of Java, Java buzzwords, JVM architecture, Data types, Variables, Scope and life time of variables, arrays, operators, control statements, type conversion and casting, simple Java program.

Module:2	**Object Oriented Programming:**	**5 hours**

Class Fundamentals, Object & Object reference, Constructor & initialization code block, Modifiers, Nested Methods, Argument Passing Mechanism, Method Overloading, Recursion, Dealing with Static Members, Inheritance, Finalize() Method, Native Method, Use of "this "reference, Use of Modifiers with Classes & Methods.

Module:3	**Exception Handling:**	**5 hours**

The idea behind Exception, Exceptions & Errors ,Types of Exception, Control flow in Exceptions, JVM reaction to Exceptions ,Use of try, catch, finally, throw, throws in Exception Handling ,In-built and User Defined Exceptions, Checked and un-Checked Exceptions.

Module:4	**Array & String:**	**6 hours**

Defining an Array, Initializing & Accessing Array, Multi –Dimensional Array, Operation on String, Mutable & Immutable String, Using Collection Bases Loop for String, Tokenizing a String, Creating Strings using String Buffer,

Module:5	**Thread:**	**6 hours**

Understanding Threads , Needs of Multi-Threaded Programming ,Thread Life-Cycle, Thread Priorities ,Synchronizing Threads, Inter Communication of Threads ,Critical Factor in Thread –Deadlock

Module:6	**Files, Streams, Object serialization and JDBC**	**8 hours**

Java I/O streams Working with files Serialization and deserialization of objects Lambda expressions, Collection framework List, Map, Set Generics Annotations, accessing databases using JDBC connectivity.

Module:7	**Java Server Technologies: Servlet**	**9 hours**

Web Application Basics, Architecture and challenges of Web Application, Introduction to servlet, Servlet life cycle, Developing and Deploying Servlets, Exploring Deployment , Descriptor (web.xml), Handling Request and Response, JSP Tags and Expressions - JSP Expression Language (EL) – Using Custom Tag.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Herbert Schildt, The Complete Reference-Java, Tata Mcgraw-Hill Edition, Eighth Edition, 2014.
2.	Richard M. Reese, Jennifer L. Reese, Alexey Grigorev, Java: Data Science Made Easy, Pocket Publishing, 2017.
Reference Books	
1.	Nicholas S. Williams, Professional Java for Web Applications, Wrox Press, 2014.
2.	Ed Burns, Chris Schalk, Java Server Faces 2.0, The Complete Reference, McGraw-Hill Publishers, 2010.
3.	Christian Bauer, Gavin King, Gary Gregory, Java Persistence with Hibernate, 2015.
4.	Rajat Mehta, Big Data Analytics with Java, Pocket Publishing, 2017.

List of Experiments (Indicative)	
Basic Java Programs	2 hours
Inheritance and Polymorphism	3 hours
Multidimensional arrays and looping constructs.	2 hours
Exception handling, File handling, String handling	4 hours
String handling and Inheritance	4 hours
Multithreaded Programming	4 hours
Problems on Application development	3 hours
Program to register students' data using JDBC with MySQL Database.	2 hours
Creating and configuring servlets, HTTP methods	3 hours
Servlets and JSP	3 hours
Total Laboratory Hours	**30 hours**

Recommended by Board of Studies	12-07-2021		
Approved by Academic Council	No. 64	Date	16-12-2011

TEEE201P	Electrical Workshop	L	T	P	C
		0	0	4	2
Pre-requisite	NIL	Syllabus revision			
		1.0			

Course Objectives

1. Understanding the concept of electrical engineering for development and implementation of electrical systems
2. Impart knowledge and skill in wiring and its standards
3. Facilitate, comprehend and identify appropriate measuring devices for and electric circuit

Course Outcomes

On completion of this course, the student will be able to

1. Design and develop electrical systems for domestic and commercial appliances
2. Acquire skills for interpretation of measurement during experimentation
3. Attain skills to use modern engineering tools for electrical system layout planning

Indicative Experiments

1	Study of conventional symbols for electrical installation, wiring tools & accessories and cable joints
2	Wiring circuit for electrical appliances (eg. a single lamp and a fan with regulator)
3	Staircase wiring circuit layout for multi-storey buildings
4	Hospital wiring with buzzer and lamps
5	Warehouse / tunnel wiring circuit
6	Fluorescent lamp, LED lamp connections
7	Soldering and testing of a rectifier circuit
8	Study of earthing and measurement of earth pit resistance
9	Measurement of single-phase power and energy consumed by a given AC load
10	Types, procedure for operation, maintenance and application of fire extinguishers
11	Earth continuity test
12	Study of fuse, MCBs and ELCB
13	Multi-meter and its testing of different components
14	Electrical appliances: kettle, fan, iron box, refrigerator, grinder, water heater
15	Insulation resistance measurement of motors and cables
	Total Laboratory Hours — **30 hours**

Text Books

1	K. B. Raina and S. K. Bhattacharya, Electrical Design Estimating and Costing, 2010, Wiley Eastern Limited
2	Electricity Rules, 2005 along with allied Rules and Orders, 2021, Reprint

Reference Books			
1	Indian Electricity rules 1956, Law publishers, Allahabad		
2	National Electrical Code 2011-IS-732-1983, Code of practice for electrical wiring installation, Indian standards.		
3	S.L. Uppal, Electrical Wiring Estimating and Costing, Khanna publishers, New Delhi, 2008		
Mode of Assessment: Continuous assessment, FAT			
Recommended by Board of Studies	19-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022

TCHY201P	Analytical Instrumentation	L	T	P	C
		0	0	4	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives

The course is aimed at students to

1. learn on wet chemical analysis and handling of chemical apparatus
2. be able to handle instruments in developing methods for chemical analysis as well as characterize compounds and materials
3. be capable of designing robust protocol for analysis after coupling more instruments together

Course Outcome

At the end of the course the students will be able to

1. understand thoroughly the principles of spectroscopy including NMR and Raman, chromatography, elemental analysis, thermoanalytical and diffraction techniques
2. engineering and designing characterization techniques for new compounds and materials.

Indicative Experiments		Duration
1.	**UV-Vis Diffuse Reflectance Spectroscopy (UV-DRS)** and **Fluorescence Spectroscopy**: Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
2.	**Atomic Absorption Spectroscopy:** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
3.	**Gas Chromatography:** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis..	6 hours
4.	**High Performance Thin Layer and Liquid Chromatography (HPTLC-HPLC):** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
5.	**Thermal Analysis (DSC/TGA/DTA):** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
6.	**CHN Elemental Analyser:** Theory, Instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
7.	**Nuclear Magnetic Resonance Spectroscopy:** Theory, instrumentation, and scope; Hands-on training on Instrument operation and analysis.	6 hours
8.	**GC-MS:** Theory, instrumentation, and scope; Hands-on training on Instrument operation and analysis.	6 hours
9.	**Raman Spectroscopy:** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
10.	**X-ray Diffraction:** Theory, instrumentation, and scope; Hands-on training on instrument operation and analysis.	6 hours
	Total Laboratory Hours	60 hours

Mode of assessment : Quiz, Viva-voce

Recommended by Board of Studies	14-02-2022		
Approved by Academic Council	No. 65	Date	17-03-2022