The Kelkar Education Trust's

Vinayak Ganesh Vaze College of Arts, Science & Commerce

(Autonomous)

Mithaghar Road, Mulund East, Mumbai-400081, India

College with Potential for Excellence

Phones :022-21631421, 221631423, 221631004 Fax : 022-221634262,

email: vazecollege@gmail.com

Syllabus for B.Sc. Third Year Programme

Physics

Syllabus as per Choice Based Credit System (NEP-2020)

(June 2025 Onwards)

Submitted by

Department of Physics

Vinayak Ganesh Vaze College of Arts, Science and Commerce (Autonomous)

Mithagar Road, Mulund (East) Mumbai-400081. Maharashtra, India.

Tel: 022-21631004, Fax: 022-21634262

E-mail: vazecollege@gmail.com Website :www.vazecollege.net

The Kelkar Education Trust's

Vinayak Ganesh Vaze College of Arts, Science & Commerce (Autonomous)

Syllabus as per Choice Based Credit System (NEP 2020)

Syllabus for Approval

Subject: Physics

Sr. No.	Heading	Particulars
1	Title of Programme	**Third Year B.Sc. Physics: Semester V and VI**
2	Eligibility for Admission	The Second Year B.Sc. examination of this university with physics as a Major subject or any other university recognized as equivalent thereto.
3	Passing marks	Minimum D Grade or equivalent minimum marks for passing at the Graduation level.
4	Ordinances/Regulations (if any)	---
5	No. of Years/Semesters	One year/Two semester
6	Level	U.G. Part-III : Level- 5.5
7	Pattern	Semester
8	Status	Revised
9	To be implemented from Academic year	2025-2026

Date: ………… **Signature:**

BOS Chairperson: ……………………

Third Year B. Sc. Program in Physics (Level 5.5)

Semester	Core Course & Credits		NSQF Course & Credits	
	MAJOR	No. of Lectures	**VSC/SEC**	No. of Lectures
	Mandatory Credits 10 (5 x 2)		**VSC Credits 2**	
	Course 1 Cr. 2: Mathematical Methods & Statistical Physics	2L	Course 1 Cr. 2: Practical Introduction to Python Programming	4L
	Course 2 Cr. 2: Solid State Physics	2L		
	Course 3 Cr. 2: Atomic & Molecular Physics	2L		
	Course 4 Cr. 2: Electrodynamics	2L		
	Course 5 Cr. 2: Practical (Practical Based on all Papers)	4L		
Sem - V	**Electives (selected anyone) Credits 4 (2+2)**		**OJT/FP/CEP/CC/RP**	
	Course 1 Cr. 2: 8085 Microprocessor	2L	**FP Credits 2**	
	Course 2 Cr. 2: Practical 8085 Microprocessor	4L	Course 1 Cr. 2: Practical	4L
	Course 1 Cr. 2: Solar Energy	2L		
	Course 2 Cr. 2: Practical Solar Energy	4L		
	MINOR Credits 4 (2+2)			
	Course 1 Cr. 2: Semiconductor Physics – 1	2L		
	Course 2 Cr. 2: Practical Semiconductor Physics – 1	4L		
	MAJOR			
	Mandatory*Credits 10 (5 x 2)		**VSC Credits 2**	
	Course 1 Cr. 2: Classical Mechanics	2L	Course 1 Cr. 2: Practical Data Analysis and Visualization Using Python Practical	4L
	Course 2 Cr. 2: Electronics	2L		
	Course 3 Cr. 2: Nuclear Physics	2L		
	Course 4 Cr. 2: Special theory of Relativity	2L		
Sem - VI	Course 5 Cr. 2: Practical (Practical Based on all Papers)	4L		
	Electives (selected anyone) Credits 4 (2+2)		**OJT/FP/CEP/CC/RP**	
	Course 1 Cr. 2: 8051 Microcontroller	2L	**OJT Credits 4**	
	Course 2 Cr. 2: Practical 8051 Microcontroller	4L	Course 1 Cr. 2: Practical	8L
	Course 1 Cr. 2: Arduino Programming	2L		

	Course 2 Cr. 2: Practical Arduino Programming	4L		
	MINOR Credits 2			
	Course 1 Cr. 2: Semiconductor Physics - 2	2L		
Total Cumulative credits = **20 + 08 + 06 + 04 + 06 = 44 Credits**				
Exit option: *Award of UG Degree in Major and Minor with 132 credits OR continue with Major & Minor*				

B. Sc. Program in Physics: Cumulative Credit Structure

F.Y.B.Sc.

Level	Sem	Mandatory				Minor		Any Faculty	VSC/SEC	Ability Enhancement Course / Indian Knowledge System/Value Education Course			OJT/FP/CEP/CC/RP	Credit	Cumulative Credit
		Major		Elective				OE							
		C-1	Practical	C-1	Practical	C-1	Practical	C-1		AEC	VEC	IKS			
4.5	I	2 [2L]	2 [2P]	-	-	2 [2L]	2 [2P]	4 [3L+1P]	VSC = 4 [2L + 2P]	2	2	2	-	22	44
	II	2 [2L]	2 [2P]	-	-	2 [2L]	2 [2P]	4 [3L+ 1P]	SEC = 4 [2L + 2P]	2	2	-	CC = 2	22	

S.Y.B.Sc

Level	Sem	Mandatory						Minor		Any Faculty	VSC/SEC	Ability Enhancement Course / Indian Knowledge System/Value Education Course			OJT/FP/CEP/CC/RP	Credit	Cumulative Credit
		Major				Elective				OE							
		C-1	C-2	C-3	Practical	C-1	Practical	C-1	Practical	C-1		AEC	VEC	IKS			
5.0	III	2 [2L]	2 [2L]	2 [2L]	2 [2P]	-	-	2 [2L]	2 [2P]	2 [2L]	VSC = 2 [2P]	2	-	-	FP = 2, CC = 2	22	44
	IV	2 [2L]	2 [2L]	2 [2L]	2 [2P]	-	-	2 [2L]	-	2 [2L]	SEC = 2 [2P]	2	-	-	CEP = 4, CC = 2	22	

T.Y.B.Sc.

Level	Sem	Mandatory							Minor		Any Faculty	VSC/SEC	Ability Enhancement Course / Indian Knowledge System/Value Education Course			OJT/FP/CEP/CC/RP	Credit	Cumulative Credit
		Major					Elective				OE							
		C-1	C-2	C-3	C-4	Practical	C-1	Practical	C-1	Practical	C-1		AEC	VEC	IKS			
5.5	V	2 [2L]	2 [2L]	2 [2L]	2 [2L]	2 [2P]	2 [2L]	2 [2P]	2 [2T]	2 [2P]	-	VSC = 2 [2P]	-	-	-	FP = 2	22	44
	VI	2 [2L]	2 [2L]	2 [2L]	2 [2L]	2 [2P]	2 [2L]	2 [2P]	2 [2T]	-	-	VSC = 2 [2P]	-	-	-	OJT = 4	22	

****L = Lecture, P = Practical**

T.Y.B. Sc. Program in Physics: Cumulative Credit Structure

Level	Sem.	MAJOR (Mandatory)		MINOR (Elective – Anyone)	VSC (Vocational & Skill Enhancement)	OJT / FP (Field Project / On-the-Job Training)	Cumulative Credits	Degree Awarded
		Mandatory **Credits 10** **[8T + 2P]**	**Electives** **Credits 4** **[2T + 2P]**	**Credits 4** **[2T + 2P]**	**Credits 4** **[2P]**	**Credits 2** **[2P]**		
5.5	**Sem V**	**Course 1 (Cr.2):** Mathematical Methods & Statistical Mechanics **Course 2 (Cr.2):** Solid State Physics **Course 3 (Cr.2):** Atomic & Molecular Physics **Course 4 (Cr.2):** Electrodynamics **Course 5 (Cr.2):** Practical (Based on all above papers)	**Course 1 (Cr.2):** 8085 Microprocessor **Course 2 (Cr.2):** Practical on 8085 Microprocessor **OR** Course 1 (Cr.2): Solar Energy Course 2 (Cr.2): Practical on Solar Energy	**Course 1 (Cr.2):** Semiconductor Physics – 1 **Course 2 (Cr.2):** Practical on Semiconductor Physics - 1	**Course 2 (Cr.2):** Practical on Introduction to Python Programming	Field Project (FP) – 2 Credits	**22**	**UG Degree after 3 yr**
		Credits 10 **[8T + 2P]**	**Credits 4** **[2T + 2P]**	**Credits 4** **[2T]**	**Credits 4** **[2P]**	**Credits 4** **[4P]**		
	Sem VI	**Course 1 (Cr.2):** Classical Mechanics **Course 2 (Cr.2):** Electronics **Course 3 (Cr.2):** Nuclear Physics **Course 4 (Cr.2):** Special Theory of Relativity **Course 5 (Cr.2):** Practical (Based on all above papers)	**Course 1 (Cr.2):** 8051 Microcontroller **Course 2 (Cr.2):** Practical on 8051 Microcontroller **OR** **Course 1 (Cr.2):** Arduino Programming **Course 2 (Cr.2):** Practical on Arduino Programming	**Course 1 (Cr.2)**: Semiconductor Physics – 2	**Course 2 (Cr.2):** Practical on Data Analysis and Visualization using Python	On-Job Training (OJT) – 4 Credits	**22**	
Total Credit		**20**	**8**	**6**	**4**	**6**	**44**	

Programme Educational Objectives

PEO1	Graduates will have a strong foundation in Physics, allowing them to pursue higher education or careers in academia, industry, and research.
PEO2	Graduates will demonstrate proficiency in problem-solving, analytical thinking, and application of Physics concepts in real-world settings.
PEO3	Graduates will be ethical, socially responsible, and contribute to societal well-being through their professional endeavors.
PEO4	Graduates will demonstrate leadership, communication, and teamwork skills, working effectively in multidisciplinary environments.
PEO5	Graduates will engage in lifelong learning to keep up with advancements in Physics and related fields.
PEO6	Graduates will apply their knowledge of Physics in industries, research institutions, and government agencies, contributing to technological innovation.

Programme Outcomes

Upon successful completion of the B.Sc. (Physics) course from Vaze College affiliated to Mumbai University, graduates can expect the following outcomes:

PO1	**Scientific Knowledge** - Graduates will demonstrate a strong understanding of core principles of Physics and related disciplines, and will apply theoretical knowledge to solve complex problems in scientific contexts.
PO2	**Problem Analysis** - Graduates will be able to identify and analyse complex scientific problems, collect relevant data, and apply appropriate methods to find meaningful solutions.
PO3	**Experimental and Practical Application Skills** - Graduates will be able to apply theoretical knowledge to design and conduct practical experiments, analyse data, and derive conclusions. They will also connect experimental outcomes with theoretical concepts, even in papers that include practical components.
PO4	**Modern Tool Usage** - Graduates will be proficient in using modern computational and experimental tools and software to model, analyse, and solve problems in Physics.
PO5	**Communication** - Graduates will be able to communicate scientific concepts and experimental results effectively, both orally and in writing, to diverse audiences.
PO6	**Lifelong Learning and Societal Contribution** - Graduates will recognize the importance of lifelong learning and contribute to societal and environmental challenges through responsible application of scientific knowledge.

Programme Specific Outcomes

PSO1	Use advanced mathematical and statistical tools to model and interpret complex physical systems.
PSO2	Demonstrate comprehensive knowledge in quantum mechanics, atomic and molecular physics, nuclear physics, and relativity.
PSO3	Analyze properties of materials and electronic systems through theoretical and practical approaches.
PSO4	Integrate theoretical knowledge with practical skills through experiments involving advanced instrumentation and electronics.
PSO5	Apply programming (Python, Arduino), data analysis, and microcontroller skills to real-world scientific problems.
PSO6	Demonstrate readiness for higher studies or professional roles through research-based projects and independent problem-solving.

The Detailed Semester and Course Wise Syllabus as follows:

The total minimum credits required for completing the B.Sc. in Physics is **132**

SEMESTER V					
Code	**Course of Study – Major**	**Cr.**	**L**	**T**	**P**
VSPH300	Course 1: Mathematical Methods & Statistical Physics	2	2	-	-
VSPH301	Course 2: Solid State Physics	2	2	-	-
VSPH302	Course 3: Atomic & Molecular Physics	2	2	-	-
VSPH303	Course 4: Electrodynamics	2	2	-	-
VSPH304	Course 5: Practical (Practical Based on all Papers)	2	-	-	4
	Electives				
VSPH305	Course 1: 8085 Microcontroller	2	2	-	-
VSPH306	Course 2: Practical based on 8085 Microcontroller	2	-	-	4
VSPH307	Course 3: Solar Energy	2	2	-	-
VSPH308	Course 4: Practical based on Solar Energy	2	-	-	4
	VSC				
VSPH309	Course 1: Introduction to Python Programming	2	-	-	4
	MINOR				
VSPH310	Course 1: Semiconductor Devices - 1	2	2	-	-
VSPH311	Course 2: Practical based on Semiconductor Devices - 1	2	-	-	4
	FP				
VSPH312	Course 1: Physics Field Project	2	-	-	4
Total		**22**	**18**	**0**	**22**

***** **Note:** Students are allowed to select one elective out of two electives given in curriculum

SEMESTER VI					
Code	**Course of Study - Major**	**Cr.**	**L**	**T**	**P**
VSPH350	Course 1: Classical Mechanics	2	2	-	-
VSPH351	Course 2: Electronics	2	2	-	-
VSPH352	Course 3: Nuclear Physics	2	2	-	-
VSPH353	Course 4: Special Theory of Relativity	2	2	-	-
VSPH354	Course 5: Practical (Practical Based on all Papers)	2	-	-	4
	Electives				
VSPH355	Course 1: 8051 Microcontroller	2	2	-	-
VSPH356	Course 2: Practical based on 8051 Microcontroller	2	-	-	4
VSPH357	Course 3: Arduino Programming	2	2	-	-
VSPH358	Course 4: Practical Based on Arduino Programming	2	-	-	4
	VSC				
VSPH359	Course 1: Data Analysis and Visualization Using Python	2	-	-	4
	MINOR				
VSPH360	Course 1: Semiconductor Devices - 2	2	2	-	-
	OJT				
VSPH361	Course 1: Physics OJT	4	-	-	8
Total		**22**	**18**	**0**	**22**

***** **Note:** Students are allowed to select one elective out of two electives given in curriculum

L = Lecture hours per week
T = Tutorial hours per week
P = Practical hours per week

Semester – V

Paper I

Course Code: VSPH300

Credits: 2

Mathematical Methods & Statistical Physics

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Develop a mathematical foundation in probability theory, complex numbers, series expansions, and Fourier analysis for applications in statistical physics.
LO 2	Understand the principles of statistical thermodynamics, including ensemble theory, the Boltzmann distribution, and classical limits
LO 3	Apply statistical mechanics concepts to quantum systems, including Bose-Einstein and Fermi-Dirac statistics
LO 4	Analyse qualitative applications of statistical mechanics in condensed matter, astrophysics, and stochastic processes

Course Code VSPH300	Paper I Mathematical Methods & Statistical Physics	Credits 2	Lectures 30
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Use mathematical tools such as probability distributions, Taylor and Laurent series, and Fourier analysis to solve problems		
CO 2	Apply ensemble theory and partition functions to derive thermodynamic quantities and analyse equilibrium properties of systems.		
CO 3	Compare and contrast classical and quantum statistics, including their implications for ideal gases and blackbody radiation.		
CO 4	Explain key applications of Statistical mechanics, statistical distributions		
Unit	**Content**	**No. of Lectures**	
Unit 1	**Mathematical Methods:** **Chapter 1: Probability Theory** 1.1 Basic concepts 1.2 Theorems of Probability 1.3 Probability distributions **Chapter 2: Complex Numbers and Their Algebra** 2.1 Introduction 2.2 Different representations of Complex Numbers 2.3 Euler's formula, Complex functions 2.4 De Moivre’s theorem **Chapter 3: Laurent and Taylor Series** 3.1 Series representation of functions and their applications	**10**	

	Chapter 4: Fourier Series 4.1 Definition of periodic functions 4.2 Odd and Even functions, Applications **Chapter 5: Fourier transform** 5.1 Fourier, Fourier Cosine & Sine Transforms of elementary functions	
Unit 2	**Chapter 7: Statistical Mechanics** 7.1 Microstates and Macrostates 7.2 **Postulates of Statistical Mechanics:** Fundamental assumptions and their implications 7.3 **Ensemble Theory:** Microcanonical, canonical, and grand canonical ensembles. 7.4 Partition function **7.4 Boltzmann Distribution** **7.5 Maxwell - Boltzmann Statistics:** Probability of energy states, classical ideal gas. **7.6 Equipartition Theorem** **Chapter 8: Statistical Thermodynamics** 8.1 Thermodynamic Potentials 8.2 Entropy **Chapter 9: Stochastic processes in statistical mechanics** 9.1 Qualitative discussion on random walks and their application in Brownian motion	**10**
Unit 3	**Chapter 8: Quantum Statistics and applications** **8.1 Bosons and Fermions** **8.2 Bose-Einstein Statistics** 8.2.1 Application 1: Photon gas and Blackbody radiation 8.2.1.1 Planck's distribution as a Bose-Einstein result 8.2.1.2 Stefan–Boltzmann law (outline) **8.2.2 Application 2: Bose-Einstein Condensation** 8.2.2.1 Concept of macroscopic occupation of ground state 8.2.2.2 Ultra-cold atoms and superfluidity (qualitative) 8.3 Fermi-Dirac Statistics **8.3.1 Application 1: Electron gas in metals** 8.3.1.1 Fermi energy, Fermi temperature 8.3.1.2 Density of states (qualitative) **8.3.2 Application 2: Electron degeneracy pressure** 8.3.2.1 White Dwarf stars 8.3.2.2 Chandrashekhar Limit	**10**

Reference Books :

1. Mathematical Methods in the Physical sciences: Mary L. Boas (Wiley India)
2. Introduction to Mathematical Methods: Charlie Harper (PHI Learning)
3. Thermodynamics, Statistical Thermodynamics and Kinetics: T. Engeland P. Reid (Pearson).
4. Perspectives of Modern Physics: Arthur Beiser, (Mc Graw Hill International).
5. Fundamentals of statistical and thermal physics: F. Reif (Berkeley Physics Course, McGraw Hill)

Additional References:

1. Mathematical Physics: A K Ghatak, Chua – 1995 Macmillian India Ltd.
2. Mathematical Method of Physics: Riley, Hobson and Bence, Cambridge (Indian edition).
3. Mathematical Physics: H. K. Das, S. Chand & Co.
4. Mathematical Methods of Physics: Jon Mathews & R. L. Walker, W A Benjamin inc.
5. A Treatise on heat: Saha and Srivastava (Indian press, Allahabad)
6. Introductory Statistical Mechanics: R. Bowley and M. Sanchez (Oxford Science Publications).
7. An Introduction to Thermal Physics: D. V. Schroeder (Pearson).
8. Schaum's Outlines Series: S. Lipschutz and M. L. Lipsonv (Mc Graw Hill International).

Paper II
Course Code: VSPH301
Credits: 2

Solid State Physics

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Analyze the electrical properties of metals using classical and quantum free electron theories.
LO 2	Explain the magnetic behavior of different materials using classical and quantum theories.
LO 3	Apply solid-state concepts to evaluate conduction mechanisms in semiconductors.
LO 4	Understand and compare the properties and applications of Type I and Type II superconductors.

Course Code VSPH301	Paper II Solid State Physics	Credits 2	Lectures 30
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Describe and differentiate magnetic properties such as diamagnetism, paramagnetism, and ferromagnetism using theoretical models.		
CO 2	Analyse the electrical behaviour of metals based on classical and quantum models, including Fermi energy and electron gas theory.		
CO 3	Apply semiconductor theory to calculate carrier concentration, Fermi level, and conductivity in intrinsic and extrinsic semiconductors.		
CO 4	Explain the phenomenon of superconductivity, including the Meissner effect, BCS theory, and technological applications.		
Unit	**Content**	**No. of Lectures**	
Unit 1	**Chapter 1: Magnetic properties of materials** 1.1 Introduction 1.2 Magnetization and magnetic field strength 1.3 Diamagnetism, Classical theory of diamagnetism (Langevin Theory) 1.4 Paramagnetism, Langevin Theory of Paramagnetism 1.5 Quantum theory of Paramagnetism 1.6 Ferromagnetism 1.7 Wies theory of Ferromagnetism 1.8 Antiferromagnetism, Ferrimagnetism **Ref -** D: 18.1 to 18.4	**10**	
	Chapter 2: Electrical properties of metals 2.1 Classical free electron theory of metals	**10**	

Unit 2	2.2 Drawbacks of classical theory 2.3 Relaxation time 2.4 Collision time and mean free path 2.5 Quantum theory of free electrons 2.6 Fermi Dirac statistics and electronic distribution in solids 2.7 Density of energy states and Fermi energy 2.8 The Fermi distribution function 2.9 Heat capacity of the Electron gas 2.10 Mean energy of electron gas at 0K 2.11 Electrical conductivity from quantum mechanical considerations 2.12 Failure of Somerfield's free electron theory **Ref -** SOP: Ch- 6 - II, III, IV, V, XIV, XV, XVI, XVII, XVIII, XX, XXXV	
Unit 3	**Chapter 3: Conduction in Semiconductors** 3.1 Electrons and Holes in an intrinsic Semiconductor, 3.2 Conductivity of a Semiconductor, 3.3 Carrier concentrations in an intrinsic semiconductor, 3.4 Donor and Acceptor impurities, 3.5 Charge densities in a semiconductor, 3.6 Fermi level in extrinsic semiconductors, 3.7 Hall Effect. **Ref -** MH: 4.1 to 4.6, 4.10 **Chapter 4: Superconductivity** 4.1 Experimental Survey, 4.2 Occurrence of Superconductivity, 4.3 Effect of Magnetic field on Superconductivity, 4.4 The Meissner effect, 4.5 BCS theory of superconductivity, 4.6 Type I and Type II Superconductors, 4.7Applications of Superconductivity. **Ref -** K: Ch – 10	**10**

Reference Books :

1. **D -** Solid State Physics: A. J. Dekker, Prentice Hall
2. **SOP -** Solid State Physics: S. O. Pillai, New Age International. 6th Ed.
3. **MH -** Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit. (3rd Ed.) Tata McGraw Hill.
4. **K -** Introduction to Solid State Physics-Charles Kittel, 8th Ed. John Wiley

5. **MW -** Solid State Physics: structure and properties of materials by M.A.Wahab; Narosa Publishing house New Delhi

Paper III

Course Code: VSPH302

Credits: 2

Atomic & Molecular Physics

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Understand the quantum mechanical model of hydrogen atom and its implications for atomic structure.
LO 2	Describe and analyze the role of electron spin, angular momentum coupling, and selection rules in atomic spectra.
LO 3	Explain the interaction of atoms and molecules with external magnetic fields and interpret the Zeeman and Raman effects.
LO 4	Apply quantum mechanical principles to understand molecular spectra and magnetic resonance phenomena like ESR and NMR.

Course Code **VSPH302**	**Paper III** **Atomic & Molecular Physics**	**Credits** **2**	**Lectures** **30**
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Describe the quantum mechanical model of the hydrogen atom and explain quantum numbers and their significance.		
CO 2	Explain vector atom model, spin-orbit coupling, selection rules and Zeeman effects using quantum theory.		
CO 3	Interpret molecular spectra and differentiate between Raman, Infrared, Microwave, and Magnetic Resonance spectra.		
CO 4	Solve numerical problems based on hydrogen atom energy levels, angular momentum, and spectral transitions.		
Unit	**Content**	**No. of Lectures**	
Unit 1	**Chapter 1: Hydrogen Atom – I** 1.1 Schrödinger's equation for Hydrogen atom, 1.2 Separation of variables, 1.3 Quantum Numbers: Total quantum number, Orbital quantum Number, Magnetic quantum number. **Chapter 2: Hydrogen Atom – II** 2.1 Introduction 2.2 Angular momentum of electron in H atom 2.3 Orbital magnetic moment 2.4 Quantization of Lz and space quantization 2.5 Atoms in external magnetic field. **Chapter 3: Electron Spin**	**10**	

	3.1 Introduction, 3.2 Spin of electron 3.3 Space quantization of electron spin 3.4 Spin magnetic moment and Gyromagnetic ratio of electron spin 3.5 The Stern-Gerlach experiment 3.6 Pauli's Exclusion Principle 3.7 Symmetric and Anti-symmetric wave functions 3.8 Hund's rule **Ref - B: 9.1 to 9.9, B: 10.1, 10.3. 2**	
Unit 2	**Chapter 4: Vector Atom Model** 4.1 Introduction 4.2 Spin-orbit coupling 4.3 Total angular momentum & Vector atom model 4.4 L-S and j-j coupling. **Chapter 5: Atomic Spectra and Selection Rules** 5.1 Introduction 5.2 Quantum theory of Radiative transition, 5.3 Selection Rule – Allowed and Forbidden Transitions 5.4 Derivation of selection rule for Magnetic quantum number ml. **Chapter 6: Atoms in Magnetic Field** 6.1 Introduction 6.2 Experimental observation of Zeeman's experiment 6.3 Classical explanation of Normal Zeeman effect 6.4 Quantum Mechanical explanation of Normal Zeeman effect 6.5 The Lande g-factor 6.6 Anomalous Zeeman effect **Ref – B : 10.2, 10.6 -10.9 , 11.1, 11.2**	**10**
Unit 3	**Chapter 7: Spectra of Diatomic Molecule** 7.1 Rotational energy levels, 7.2 Rotational spectra of diatomic molecule, 7.3 Shortcomings of Rigid Rotator 7.4 Model of diatomic molecule and non-rigid rotator, 7.5 Diatomic molecule as Simple Harmonic Oscillator, 7.6 Diatomic molecule as anharmonic Oscillator, 7.7 Vibrational-Rotational spectra, 7.8 Infrared spectrometer & Microwave spectrometer.	**10**

	Chapter 8: Raman Effect 8.1 Quantum Theory of Raman effect, 8.2 Classical Theory of Raman effect, 8.3 Classification of Molecules Based on Rotational Behaviour, 8.4 Pure Rotational Raman spectra, 8.5 Raman activity of vibrations, 8.6 Vibrational Raman spectra, 8.7 Raman Spectrometer. **Chapter 9: Magnetic Resonance (NMR and ESR)** 9.1 Electron Spin Resonance, 9.2 Introduction, Principle of ESR, ESR Spectroscopy, 9.3 Nuclear Magnetic Resonance, Introduction, Nuclear Spin, 9.4 Nuclear magnetic moment, 9.5 Principle of NMR, NMR instrumentation. **Ref – BM : 6.11, 6.1.3.2 4.1.1, 4.1.2, 4.2.2, 4.2.3, 4.3.1,** **GA : 8.6.1, 10.1, 10.2, 10.3, 11.1 – 11.3**	

Reference Books :

1. **B:** Perspectives of Modern Physics: Arthur Beiser Page 8 of 18 McGraw Hill.
2. **BM**: Fundamentals of Molecular Spectroscopy: C. N. Banwell & E. M. McCash (TMH).(4th Ed.)
3. **GA:** Molecular structure and spectroscopy: G Aruldhas (2nd Ed) PHI learning Pvt Ltd.
4. **SG:** Atomic Physics (Modern Physics): S. N. Ghoshal, S. Chand Publication (for problems on atomic Physics).

Paper IV
Course Code: VSPH303
Credits: 2

Electrodynamics

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Understand and Apply Electrostatic Principles.
LO 2	Analyze Magnetic Fields in Static Situations.
LO 3	Investigate the Behavior of Electrostatic and Magnetic Fields in Matter.
LO 4	Apply Maxwell's Equations and Poynting's Theorem. Understand and Analyze Electromagnetic Wave Propagation.

Course Code VSPH303	Paper IV Electrodynamics	Credits 2	Lectures 30
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Apply Fundamental Electrostatic Principles, including Gauss's Law and Electrostatic Potential, to analyse Electric Fields in Free Space and Dielectric Materials.		
CO 2	Analyse Magnetic Fields using Biot-Savart's Law and Ampere's Law, understand Magnetization in materials, and apply Faraday's Law to evaluate Electromagnetic Energy Storage.		
CO 3	Apply Maxwell's modified equations to describe Electromagnetic Wave Propagation, analyse Energy and Momentum in Electromagnetic Waves, and understand Wave Behaviour at Boundaries and Interfaces.		
CO 4	Apply analytical and numerical techniques to solve complex problems involving electric and magnetic fields, electromagnetic wave propagation, and boundary conditions, demonstrating proficiency in interpreting results and validating solutions through theoretical principles.		
Unit	**Content**		**No. of Lectures**
Unit 1	**Chapter 1: Electrostatics** 1.1 Introduction of Electrostatic field lines and Electric flux, Review of Coulomb's Law 1.2 Integral and Differential Form of Gauss Law and Application of Gauss Law 1.3The Divergence of Electrostatic field, The Curl of Electrostatic field 1.4 Introduction to Electrostatic Potential, The potential of a localized charge distribution 1.5 Poisson's and Laplace's Equations		**10**

	Chapter 2: Electrostatics in Matter 2.1 Electric dipoles, Dielectrics-Polar and Non-Polar 2.2 Modification of Gauss Law for Dielectrics 2.3 Susceptibility, Permittivity and Dielectric Constant 2.4 Energy in a linear dielectric system	
Unit 2	**Chapter 3: Magnetostatics** 3.1 Fundamental Concepts (Volume current density, Surface current density, The equation of Continuity) 3.2 Biot - Savart's Law and Ampere's Law (Integral and Differential Form) 3.3 The Divergence of magnetic field and the Curl of magnetic field 3.4 Application of Ampere's Law **Chapter 4: Magnetostatics in Matter** 4.1 Magnetic Vector Potential, Magnetization 4.2 Free and Bound Currents, Physical Interpretation of Bound Currents 4.3 Ampere's Law in Magnetised Materials 4.4 Magnetic Susceptibility and Permeability 4.5 Faraday's Law 4.6 Energy Stored in Magnetic Fields	**10**
Unit 3	**Chapter 5: Maxwell's Modifications and Poynting's Theorem** 5.1 Maxwell's Modification Ampere's Law 5.2 Modification of Maxwell's Equations in Material Media 5.3 Boundary Conditions for Electric Filed and Magnetic Field 5.4 Poynting's Theorem (Conversation of Energy) **Chapter 6: Electromagnetic waves** 6.1 The Wave Equation of Electric and Magnetic Field 6.2 The Velocity of Electromagnetic Waves 6.3 Energy and Momentum in Electromagnetic waves 6.4 Propagation in Linear Media	**10**

	6.5 Reflection and Transmission of EM Waves at Normal Incidence 6.6 Reflection and Transmission of EM Waves at Oblique Incidence	

Reference Books :

1. Classical Mechanics, P. V. Panat (Narosa)

2. Mechanics: Keith R. Symon, (Addision Wesely) 3rd Ed.

3. Classical Mechanics- A Modern Perspective: V. D. Barger and M. G. Olsson. (Mc Graw Hill International 1995 Ed.)

4. Classical Mechanics: Herbert Goldstein (Narosa 2nd Ed.)

5. An Introduction to Mechanics: Daniel Kleppner & Robert Kolenkow Tata Mc Graw Hill (Indian Ed. 2007)

6. Chaotic Dynamics-An Introduction: Baker and Gollub (Cambridge Univ. Press)

7. Classical Mechanics: J. C. Upadhyaya (Himalaya Publishing House)

8. Classical Mechanics: Gupta, Kumar, Sharma (Pragati Prakashan)

Practical
Course Code: VSPH304
Credits: 2 Major Physics Practical

Course Code VSPH304	Major Physics Practical	Credits 2	Lectures 60
Lists of Experiment of GROUP A			
1.	To determine the acceleration due to gravity (‘g’) using Kater’s pendulum		
2.	To study the resolving power [R.P.] of a prism		
3.	To study the working of Searle’s Goniometer		
4.	To study Edser’s ‘A’ interference pattern		
5.	To determine the wavelength of light using a step slit		
6.	To determine the resistivity of a material using the four-probe method		
7.	To study logarithmic decrement in a damped oscillation system		
8.	To determine Rydberg’s constant using hydrogen spectrum		
9.	To determine capacitance using a series bridge method		
10.	To determine capacitance using a parallel bridge method		
11.	To study the temperature dependence of bandgap energy of a Ge diode		
12.	To study the Hall effect in a semiconductor sample		
Lists of Experiment of GROUP B			
1.	To study the logarithmic amplifier using an op-amp		
2.	To design an antilogarithmic amplifier using an op-amp		
3.	To design an inverting summing amplifier using an op-amp		
4.	To design and study a Schmitt trigger in inverting mode using an op-amp		
5.	To design and study a Schmitt trigger in non-inverting mode using an op-amp		
6.	To implement an R-2R ladder binary digital-to-analog (DAC) converter using op-amps		
7.	To implement a binary-weighted ladder DAC using op-amps		
8.	To design and study a Wien bridge oscillator using an operational amplifier		
9.	To design and study an astable multivibrator using an op-amp		
10.	To design a wave generator (sine, square, and triangular waves) using an op-amp		
11.	To design and study an instrumentation amplifier using op-amps		
12.	To study the characteristics of a photodiode and phototransistor		

Note: Minimum **7 from each group** and **total 14 experiments** should be completed in the first semester. All experiments are to be reported in a journal. Certified journal is must to be eligible to appear for the semester end practical.

Elective Paper I
Course Code: VSPH305
Credits: 2

8085 Microprocessor

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Describe the historical development, basic structure, and programming model of the 8085 microprocessor.
LO 2	Write and execute assembly language programs using arithmetic, logical, and branching instructions.
LO 3	Use stack and subroutine instructions along with 8255 interfacing techniques to perform input/output operations.
LO 4	Construct and evaluate time delay routines and counters based on instruction timings and loops.

Course Code VSPH305	Elective Paper I 8085 Microprocessor	Credits 2	Lectures 30
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Explain the architecture, organization, and working of the 8085 microprocessors, including its programming model.		
CO 2	Develop Assembly Language Programs using the 8085-instruction set and addressing modes.		
CO 3	Implement stack operations, subroutines, and peripheral interfacing (8255 PPI) while analysing instruction timings.		
CO 4	Design and implement timing delays and counters using 8085 for real-time applications.		
Unit	**Content**		**No. of Lectures**
Unit 1	**Introduction to Microprocessors and 8085 Architecture** Introduction, Historical Perspective, Organization of a Microprocessor-Based System, How the Microprocessor Works, Machine Language, Assembly Language, High-Level Languages, Writing and Executing an Assembly Language Program, 8085 Bus Organization, 8085 Programming Model, The 8085 Microprocessor Architecture, Pin Connection Diagram and Function of Each Pin. **Ref - RG : Ch - 3, 4**		**10**
Unit 2	**Instruction Set and Addressing Modes of 8085** Basic Definitions: Instruction, Opcode, Operand, Instruction Word Size, Instruction Format, Data Format, Addressing Modes, 8085 Instruction		**10**

	Set Classification, Data Transfer Operations, Arithmetic Operations, Logical Operations, Branch Operations, Introduction to Advanced Instructions, Flowchart Representation of Instructions. **Ref - RG : Ch - 6, 7**	
Unit 3	**Stack, Peripheral Interfacing, and Timing Analysis** Stack and Subroutines: Stack, Subroutine, the 8255 Programmable Peripheral Interface, Block Diagram of the 8255, Mode 0 – Simple Input/Output Mode, Bit Set/Reset (BSR) Mode, Counters, Time Delay Using One Register, Time Delay Using a Pair of Registers, Loop Within Loop for Delay, Instruction Timings of 8085, T-States, Delay Routines, Delay Calculations. **Ref - RG : 9.1 - 9.4, 8.1 - 8.4**	**10**

Reference Books :

1. **RG** : Microprocessor Architecture, Programming, and Applications with the 8085 by Ramesh S. Gaonkar, 5th Edition, Penram International Publishing
2. **B :** 8085 Microprocessor: Architecture and Programming by P.B. Borole, 1st Edition, Technical Publications.

Elective Paper - I

Course Code: VSPH306

Credits: 2

8085 Microprocessor Practical

Course Code VSPH306	Practical based on 8085 Microprocessor	Credits 2	Lectures 60
1.	Write an ALP to perform two 8-bit addition.		
2.	Write an ALP to perform two 8-bit subtraction.		
3.	Write an ALP to find the sum of an array of numbers and store the result in memory.		
4.	Write an ALP to multiply two 8-bit numbers using repeated addition method.		
5.	Write an ALP to divide two 8-bit numbers using Repeated subtraction method.		
6.	Write an ALP to find the largest / smallest number in an array.		
7.	Write an ALP to count the number of positive / Negative numbers in an array.		
8.	Write an ALP to count the number of even / odd numbers in an array.		
9.	Write an ALP to perform the addition of two 16-bit numbers using the DAD instruction.		
10.	Write an ALP to perform the subtraction of two 16-bit numbers.		
11.	Write an ALP to generate a square wave using the 8085 microprocessors.		
12.	Write an ALP to generate a triangular wave using the 8085 microprocessors.		
13.	Write an ALP to generate a trapezoidal wave using the 8085 microprocessors.		
14.	Write an ALP to interface a 7-segment display with the 8085.		
15.	Write an ALP to control a stepper motor using the 8085.		
16.	Perform AND, OR, XOR and NOT Operations on Two 8-bit Numbers.		
17.	Write an ALP to transfer a block of data bytes from one memory location to another.		
18.	Write an ALP to arrange a set of numbers in ascending / descending order.		
19.	Write an ALP to interface an LED with 8085 and blink it at regular intervals.		

Note: A **minimum of 12 experiments** must be completed from the elective paper in Semester V. All experiments should be recorded **neatly in a certified journal**. Submission of the certified journal is **compulsory to be eligible** for the semester-end practical examination.

Elective Paper - II
Course Code: VSPH307
Credits: 2

Solar Energy

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Explain the interaction of solar radiation with the earth and interpret radiation measurements using various instruments.
LO 2	Analyze the working and characteristics of different types of solar cells and evaluate their efficiency using key performance metrics.
LO 3	Apply knowledge of PV and thermal technologies to propose solar-based solutions for heating, cooking, and power generation.
LO 4	Assess recent innovations, smart technologies (AI, IoT), and policy initiatives in solar energy to recommend future directions in the field.

Course Code VSPH307	Elective Paper II Solar Energy		Credits 2	Lectures 30
Course Outcomes : Upon Completion of the course the student will be able to				
CO 1	Describe the basic concepts of solar radiation, sun–earth geometry, and measurement techniques using relevant instrumentation.			
CO 2	Apply knowledge of solar cell technology and performance analysis to evaluate efficiency and power generation			
CO 3	Develop solutions for solar energy utilization through PV systems, storage, and thermal applications.			
CO 4	Design and analyse real-world solar energy applications while considering future technological trends and policies.			
Unit	**Content**	**No. of Lectures**		
Unit 1	**Chapter 1: Solar Radiation and Measurement** **1.1 Introduction to Solar Energy:** Importance of renewable energy, Overview of solar energy potential **1.2 Solar Radiation Basics:** Structure of the Sun and energy production (p–p Chain, CNO Cycle), Solar constant and solar spectrum, Sun-Earth angles (Declination, Zenith, Azimuth, Tilt Factor), Local Solar Time (LST), Standard Time, Solar Noon. Air Mass, Scattering, Absorption, Albedo effect **1.3 Measurement of Solar Radiation:** Pyrheliometers (Angstrom,	**10**		

	Abbot Silver Disc, Eppley), Pyranometers (Eppley, Yellot Solarimeter), Solar radiation on horizontal and tilted surfaces	
Unit 2	**Chapter 2: Solar Photovoltaic (PV) Systems** **2.1 Photovoltaic Effect and Solar Cells -** Working principle of a solar cell, Semiconductor materials used (Si, GaAs, Perovskite) **2.2 Performance Analysis of Solar PV Cells -** Open circuit voltage, short circuit current, Power, efficiency, fill factor, Limitations and challenges of solar cells **2.3 Solar Power Plants -** Autonomous solar power plants (Off-grid), Grid-connected solar power plants, Hybrid solar power systems	**10**
Unit 3	**Chapter 3: Solar Energy Applications and Future Trends** **3.1 Solar Thermal Systems -** Solar water heaters, solar cookers, Solar dryers, solar greenhouses **3.2 Solar Energy Storage and Efficiency Enhancement -** Energy storage methods (Batteries, Thermal Storage), Solar tracking systems for efficiency improvement **3.3 Recent Advances and Future Prospects -** Emerging technologies in solar energy, Role of AI and IoT in solar energy optimization, Policies and initiatives for solar energy development	**10**

Reference Books :

1. Non-Conventional Energy Sources – G. D. Rai, 6th Edition, Khanna Publishers
2. Physics of Solar Energy – C. Julian Chen, 1st Edition, John Wiley & Sons Inc.
3. Solar Energy: Fundamentals and Applications – Saurabh Kumar Rajput, 1st Edition, Nitra Publications
4. Solar Photovoltaics: Fundamentals, Technologies and Applications – Chetan Singh Solanki, 3rd Edition, PHI Learning Pvt. Ltd.

Elective Paper - II
Course Code: VSPH308
Credits: 2 Solar Energy Practical

Course Code VSPH308	Solar Energy Practical	Credits 2	Lectures 60
1.	Calculate solar declination, azimuth angle, and Local Solar Time (LST).		
2.	Measure and compare solar radiation intensity at different times of the day.		
3.	I-V Characteristics of a Solar Cell		
4.	Measure the output power of a solar panel under different light intensities and calculate efficiency.		
5.	Analyze the impact of connecting solar panels in series on voltage and current.		
6.	Analyze the impact of connecting solar panels parallel on voltage and current.		
7.	Observe changes in output voltage and current with varying temperatures.		
8.	Power a small DC load using a solar panel, battery, and charge controller.		
9.	Analyzing the Effect of Shading on Solar Panel Output		
10.	Installation of Solar Panel		
11.	Installation Procedure of Solar Panel on-Grid and Off-Grid		
12.	Making a Solar Toy using DIY Solar Panel		

Note: A **minimum of 12 experiments** must be completed from the elective paper in Semester V. All experiments should be recorded **neatly in a certified journal**. Submission of the certified journal is **compulsory to be eligible** for the semester-end practical examination.

Vocational Skill Course
Course Code: VSPH309
Credits: 2

Introduction to Python Programming

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Identify and apply Python syntax, variables, data types, and operators in simple code snippets.
LO 2	Construct conditional and looping structures to solve logical problems
LO 3	Implement and manipulate data using lists, tuples, sets, dictionaries, and strings in Python
LO 4	Create Python programs using object-oriented concepts such as classes, inheritance, and encapsulation to solve real-world problems.

Course Code VSPH309	VSC – Introduction to Python Programming	Credits 2	Lectures 60
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Recall and understand fundamental programming concepts in Python, including syntax, variables, data types, operators, and debugging techniques.		
CO 2	Analyse and apply control structures, such as conditional statements, loops, and control flow mechanisms, to solve computational problems.		
CO 3	Manipulate, process, and evaluate data using Python's built-in data and functions.		
CO 4	Design, develop, and evaluate object-oriented programs by incorporating concepts such as classes, objects, inheritance, polymorphism, encapsulation, and data hiding.		
Unit	**Content**	**No. of Lectures**	
Unit 1	**Introduction to Python and Basics of Programming** 1. **Introduction to Python:** History, Features, Applications in Science and Engineering , Installing Python, Running Python Programs (Interactive Mode & Script Mode) 2. Variables, Data Types, Type Conversion, Operators, and Expressions, The Difference Between Brackets, Braces, and Parentheses, Order of Operations **3. Conditional Statements:** if, if-else, nested if-else **4. Loops:** for, while, nested loops 5. **Control Statements:** break, continue, pass **6. Debugging:** Syntax Errors, Runtime Errors, Logical Error **RT : Ch – 3, 4**	**10**	

Unit 2	**Functions and Data Structures** 1. **Lists**: Creating, Accessing, Modifying, Traversing, Slicing, List Methods 2. **Tuples**: Creating, Accessing, Traversing, Slicing, Tuple Packing and Unpacking 3. **Dictionaries**: Creating, Accessing, Updating, Dictionary Methods (e.g., keys(), values(), get(), pop(),etc.) 4. **Sets**: Creating, Accessing, Modifying, Set Methods, Membership Testing 5. **Strings**: Creating, Accessing, Modifying, Traversing, Slicing, String Methods 6. **Functions**: Defining and Calling Functions, Arguments, Return Values, Scope & Lifetime of Variables 7. **Built-in Functions**, **User-defined Functions**, **Recursion** **RT : Ch – 8, 6, 5**	**10**
Unit 3	**Advanced Python Concepts and Object-Oriented Programming** 1. **File Handling:** Reading and Writing Files, Working with Text Files and CSV Files, Appending Data to Files, Handling File Paths, 2. **Exception Handling:** Understanding Errors and Exceptions, Using try, except, else, and finally Blocks, Raising Exceptions (raise statement) 3. **Modules and Packages:** Importing and Using Modules, Creating and Exploring Custom Modules, Standard Modules: math, random, time, Introduction to Python Packages 4. **Object-Oriented Programming (OOP) in Python:** Classes and Objects, Attributes and Methods, self-Parameter and Constructor (**init**), Instances as Arguments and Return Values, Built-in Class Attributes, OOP Advanced Concepts: Inheritance and its type, Method Overriding, Polymorphism, Encapsulation and Data Hiding. **RT : Ch – 7, 12, 9, 10, 11**	**10**

Reference Books :

1. **RT :** Python Programming: Using Problem solving approach by Reema Thareja, Oxford University press (2nd Edition)
2. **AG :** Scientific Computing in Python by Abhijit Kar Gupta 2nd edition, Tehno World Publication
3. Think Python: How to Think Like a Computer Scientist by Allen B. Downey, 2nd Edition, Shroff/O'Reilly Publication
4. Core Programming by R. Nageswara Rao, 3rd Ed. Dreamtech Press
5. Python Documentation - https://docs.python.org/3/tutorial/index.html

	Introduction to Python Practical		Lectures 30

1.	Check if a number is Even or Odd.
2.	Find the greatest of three numbers using nested if-else statements.
3.	Find the sum of digits of a number.
4.	Generate the Fibonacci series up to a given number using a loop.
5.	Check whether a given number is a palindrome using loops.
6.	Write a program to print a different pattern using nested loops.
7.	Find the factorial of a number using a loop.
8.	Print all Armstrong numbers in a given range.
9.	Print all Prime numbers in a given range.
10.	Perform basic operations on a list (creation, accessing elements, modifying, slicing, and applying list methods).
11.	Perform tuple operations (creation, accessing, traversing, slicing, and unpacking).
12.	Perform dictionary operations (insertion, deletion, updating, retrieving values using keys, and using dictionary methods).
13.	Perform set operations (creating, adding elements, removing elements, membership testing, and applying set methods).
14.	Perform string operations (accessing, modifying, slicing, concatenation, and using string methods).
15.	Write a function to count the frequency of elements in a given list using a dictionary.
16.	Write a recursive function to find the factorial of a number.
17.	Write a program to count the occurrences of each word in a given string using a dictionary.
18.	Sort a dictionary by keys and values in ascending and descending order.
19.	Write a program to handle multiple exceptions (e.g., IndexError, KeyError, TypeError) while accessing a list and dictionary.
20.	Demonstrate the use of try, except, else, and finally blocks in a program that opens a file.
21.	Import and use built-in modules (math, random, time) to perform various operations.
22.	Develop a package containing multiple modules for scientific calculations (e.g., physics formulas like motion, energy, etc.).
23.	Create a class Student with attributes name, age, and marks, and implement a method to display student details.

24.	Demonstrate polymorphism using method overriding and operator overloading.
25.	Develop a BankAccount class with deposit, withdrawal, balance inquiry.
26.	Implement a Student class with methods to calculate and display percentage from marks.

Note: A **minimum of 16 experiments** must be completed from the VSC paper in Semester V. All experiments should be recorded **neatly in a certified journal**. Submission of the certified journal is **compulsory to be eligible** for the semester-end practical examination.

Minor Theory
Course Code: VSPH310
Credits: 2 Semiconductor Devices – 1

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Identify and apply Python syntax, variables, data types, and operators in simple code snippets.
LO 2	Construct conditional and looping structures to solve logical problems
LO 3	Implement and manipulate data using lists, tuples, sets, dictionaries, and strings in Python
LO 4	Create Python programs using object-oriented concepts such as classes, inheritance, and encapsulation to solve real-world problems.

Course Code VSPH310	Minor – Semiconductor Devices – 1	Credits 2	Lectures 30
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Understand the construction, working, and characteristics of BJTs and UJTs, and their application as switches and oscillators		
CO 2	Analyse the functioning and characteristics of various FETs, including JFETs and MOSFETs in switching applications.		
CO 3	Apply operational amplifiers in basic linear circuit configurations such as amplifiers, adders, and subtractors.		
CO 4	Evaluate different op-amp applications like integrators, differentiators, and comparators in signal processing tasks.		
Unit	**Content**	**No. of Lectures**	
Unit 1	**Chapter 1 : Bipolar Junction Transistor (BJT)** 1.1 Introduction, 1.2 Types of transistors, 1.3 Construction and working of transistor, 1.4 Transistor as amplifier, 1.5 Characteristics of transistor (CB, CE & CC), 1.6 Gain in transistor, 1.7 Transistor as switch. **Chapter 2 : Unijunction Transistor (UJT)** 2.1 Construction & working, 2.2 Characteristics of UJT, 2.3 UJT as a relaxation oscillator. **Ref : VM -** 8.1, 8.2, 8.3, 8.4, 8.6, 8.9, 8.10, 8.12, 8.13, 21.11, 21.13,	**10**	

	21.15	
Unit 2	**Chapter 3 : Field Effect Transistors (FET)** 3.1 Introduction 3.2 Types of FET, Construction and working of JFET 3.3 Characteristics of JFET 3.4 JFET as switch 3.5 Construction and working of depletion type MOSFET (DMOSFET) 3.6 Characteristics of depletion MOSFET 3.7 Construction and working of enhancement MOSFET (EMOSFET) 3.8 Enhancement MOSFET as switch **Ref : VM -** 19.1, 19.2, 19.3, 19.8, 19.27, 19.28, 9.9, 19.30, 19.31,19.36	**10**
Unit 3	**Chapter 4 : Operational Amplifiers** 4.1 Introduction, 4.2 Schematic symbol of operational amplifier, 4.3 Features of Operational Amplifier, 4.4 Op-amp as inverting amplifier, 4.5 Op-amp as non-inverting amplifier, 4.6 Applications of Op-amp, Op-amp as adder, Op-amp as subtractor, Op-amp as integrator, Op-amp as differentiator, Op-amp as comparator **Ref : VM -** 25.16, 25.24, 25.26, 25.27, 25.32, 25.35, 25.37, 25.38	**10**

Reference Books

1. **VM:** Principles of Electronics – V. K. Mehta and Rohit Mehta. (S. Chand –Multicolor revised edition)
2. **MB:** Electronic Principles, Malvino& Bates -7th Edition TMH Publication.
3. **AM:** Electronic Devices and Circuits, Allen Mottershead -PHI Publication.
4. **KVR:** Functional Electronics, K.V. Ramanan-TMH Publication

Minor Practical
Course Code: VSPH311
Credits: 2 Semiconductor Devices – 1 Practical

Course Code VSPH311	Semiconductor Devices – 1 Practical	Credits 2	Lectures 60
1.	To study CE characteristics of Transistor		
2.	To study CB characteristics of Transistor		
3.	To study frequency response of CE amplifier		
4.	To study and design transistor as switch		
5.	To study UJT characteristics		
6.	To study UJT as relaxation oscillators		
7.	To study JFET characteristics		
8.	To study MOSFET characteristics		
9.	To study and design MOSFET as switch		
10.	To study Op-amp as Inverting amplifier		
11.	To study Op-amp as non-inverting amplifier		
12.	To study Op-amp as voltage follower		
13.	To study Op-amp as summing amplifier		
14.	To study Op-amp as difference amplifier		
15.	To study Op-amp as astable/Square wave generator		
16.	To study Op-amp as integrator		
17.	To study Op-amp as differentiator		
18.	Op-Amp as Wave generator (Sine, Square and Triangular)		

Note: A **minimum of 12 experiments** must be completed from the Minor paper in Semester V. All experiments should be recorded **neatly in a certified journal**. Submission of the certified journal is **compulsory to be eligible** for the semester-end practical examination.

Field Project

Course Code: VSPH312

Credits: 2

Guidelines for Field Project (FP)

General Instructions

1. Each student is expected to dedicate 60 hours to complete the Field Project.
2. The actual fieldwork must be conducted outside regular college hours — during holidays, weekends, or vacations.
3. Successful completion and submission of the Field Project is mandatory for the award of the degree.
4. The Field Project carries 2 credits, and evaluation will be done for 50 marks.
5. Students must pass this course to be eligible for the B.Sc. degree.

Project Implementation Instructions

1. Students should engage in hands-on field learning/projects under the supervision of a faculty guide.
2. A minimum of 30 hours per credit is required per semester.
3. Students may work individually or in groups (2–3 students per group).
4. Each group will be assigned a faculty guide for mentorship.
5. Prepare a questionnaire of 20–30 questions (or more) in English or Marathi, depending on the topic.
6. For non-survey-based projects (e.g., sample/data collection), the questionnaire may be replaced by another appropriate method.
7. Faculty guides or coordinators must review and finalize the questionnaire.
8. Avoid questions that may create unnecessary complications.
9. Ensure the questionnaire includes both qualitative and quantitative questions.
10. Conduct field visits and collect at least 50 responses or samples.
11. Record all field data and observations clearly and systematically.
12. Analyze the collected data using appropriate tools, tables, graphs, or software.
13. Prepare a project report with the structure: Index, Chapters (1, 2, 3...), Conclusion, References.
14. The report must be typed in Times New Roman, font size 12, 1.5 spacing, and have a minimum of 25 pages, excluding title and prelims.

15. Submit two hard copies of the project report signed by the faculty guide to the departmental FP coordinator.
16. All students must give an oral presentation of their project in front of an internal departmental panel.
17. Two examiners will be appointed by the HoD for evaluation.
18. The evaluation will be done as per the guidelines provided by the Examination Cell.
19. The certified project report and oral presentation are mandatory for appearing in the practical examination.
20. Projects will be assessed on topic selection, study design, fieldwork, analysis, reporting, and presentation.

Typical Time and marks allocation for the different stages of the field project is:

Step of Project	**Individual students work in hours**	**Marks**
Topic Selection	5	3
Study Design and Survey preparation	15	10
Fieldwork	20	12
Analysis	10	5
Report writing	10	10
Oral Presentation	-	10
Total	**60**	**50**

Semester – VI

Paper I

Course Code: VSPH350

Credits: 2

Classical Mechanics

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Analyze motion in non-inertial reference frames by applying the concepts of translational and rotational coordinate transformations, including the effects of Earth's rotation. Solve problems in central force motion using the inverse-square law, orbital mechanics, and Kepler's laws.
LO 2	Formulate equations of motion for constrained systems using D'Alembert's principle and Lagrangian mechanics.
LO 3	Understand rigid body dynamics by applying Euler's equations, moments of inertia, and torque in rotational motion.
LO 4	Interpret fluid motion mathematically through the continuity equation, Euler's equations for ideal fluids, and fundamental conservation laws.

Course Code **VSPH350**	**Paper I** **Classical Mechanics**	**Credits** **2**	**Lectures** **30**
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Develop the ability to apply coordinate transformations and central force principles to study the motion of particles in rotating frames and gravitational fields.		
CO 2	Formulate and analyse the equations of motion for constrained systems using D'Alembert's principle and Lagrangian mechanics.		
CO 3	Understand and apply the principles of rigid body rotation and fluid kinematics to analyse motion using inertia, Euler's equations, and conservation laws.		
CO 4	Apply numerical techniques to solve complex problems in particle dynamics, rigid body motion, and fluid mechanics.		
Unit	**Content**		**No. of Lectures**
Unit 1	**Chapter 1: Moving Coordinate Systems** 1.1 Coordinate frames with relative translational motion 1.2 Coordinate frames with relative rotational motion 1.3 Laws of Motion on the rotating earth 1.4 Foucault Pendulum 1.5 Larmor's Theorem **Chapter 2: Motion Under a Central Force**		**10**

	2.1 Motion of a particle under the influence of a central force 2.2 Inverse square law of Force 2.3 Elliptical orbits 2.4 The Kepler problem	
Unit 2	**Chapter 3: Constraints and D'Alembert's Principle** 3.1 Degree of Freedom 3.2 Constraints and different types of constraints 3.3 Virtual displacement, Virtual work, D' Alembert's principle **Chapter 4: Lagrangian Mechanics** 4.1 Generalized Coordinates 4.2 Lagrange's equation with one degree of freedom 4.3 Applications of Lagrange's equation 4.4 Canonical momentum 4.5 Cyclic coordinates	**10**
Unit 3	**Chapter 5: Rotation of a Rigid Body** 5.1Moments and Products of Inertia 5.2 Principal axes and principal moments 5.3 Euler's equation of motion for a rigid body 5.4 Torque and Kinetic Energy 5.5 Euler Angles **Chapter 6: kinematics of Moving Fluids** 6.1Equation of Continuity 6.2 Euler's equation of motion for an Ideal Fluid 6.3 Conservation laws for fluid motion	**10**

Reference Books :

1. Classical Mechanics, P. V. Panat (Narosa)
2. Mechanics: Keith R. Symon, (Addision Wesely) 3rd Ed.
3. Classical Mechanics- A Modern Perspective: V. D. Barger and M. G. Olsson. (Mc Graw Hill International 1995 Ed.)
4. Classical Mechanics: Herbert Goldstein (Narosa 2nd Ed.)
5. An Introduction to Mechanics: Daniel Kleppner & Robert Kolenkow Tata Mc Graw Hill

(Indian Ed. 2007)

6. Classical Mechanics: J. C. Upadhyaya (Himalaya Publishing House)
7. Classical Mechanics: Gupta, Kumar, Sharma (Pragati Prakashan)

Paper II

Course Code: VSPH351

Credits: 2

Electronics

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Explain the working principles and characteristics of JFET, MOSFET (depletion and enhancement), and UJT.
LO 2	Construct and simulate JFET/MOSFET circuits used as amplifiers and switches in practical applications like multiplexers and VCRs.
LO 3	Identify and analyze op-amp configurations and calculate parameters such as gain, CMRR, and output voltage for different op-amp applications.
LO 4	Design and evaluate multivibrators and waveform generators using transistors and 555 timers, including applications like PWM and PPM.

Course Code VSPH351	Paper II Electronics		Credits 2	Lectures 30
Course Outcomes : Upon Completion of the course the student will be able to				
CO 1	Describe the construction, working, and characteristics of JFET, MOSFET, and UJT and evaluate their use in amplifier and switching circuits.			
CO 2	Analyse and apply differential amplifiers and operational amplifier circuits for various linear and nonlinear applications.			
CO 3	Design and implement multivibrator circuits using transistors and IC 555 timer for waveform generation and signal processing.			
CO 4	Compare the performance of various electronic components and circuits based on applications in oscillation, modulation, and signal shaping.			
Unit	**Content**			**No. of Lectures**
Unit 1	**Chapter 1: JFET** 1.1 Introduction 1.2 Construction and working, Characteristics 1.2 Biasing of JFET 1.3 JFET as common source amplifier, JFET as switch 1.3 Application of JFET (multiplexer, voltage-controlled resistor, current sourcing) **Chapter 2: MOSFET** 2.1 Introduction, Types of MOSFET (Depletion and Enhancement mode) 2.2 Depletion MOSFET: construction, operation, Characteristics 2.3 Enhancement MOSFET: construction, operation, Characteristics			**10**

	2.4 MOSFET as switch. **Chapter 3: Unijunction Transistor (UJT)** 3.1 Construction, working, Characteristics 3.2 UJT as a relaxation oscillator. **Ref : VM -** 19.1, 19.2, 19.3, 19.8, 19.27, 19.28, 9.9, 19.30, 19.31,19.36, 21.11, 21.13, 21.15	
Unit 2	**Chapter 4: Operational Amplifiers** 4.1 Block diagram of Operational Amplifier 4.2 Basic circuit of differential amplifier using transistor, Operation of differential amplifier, Common mode and Differential mode signals, Voltage gain of differential amplifier, Common–mode Rejection Ratio, DC of differential amplifier**.** **Chapter 5: Applications of Op-Amp** 5.1 Log amplifier 5.2 Instrumentation amplifiers 5.3 first order Active filters 5.4 Astable multivibrator using OP AMP 5.5 Square wave and triangular wave generator using OP AMP 5.6 Wein-bridge oscillator using OP AMP 5.7 Comparators with Hysteresis, Window Comparator, Schmitt trigger. **Ref: MB:** 17.1 to 17.5 2. 2., 20.5, 21.4, 22.2, 22.3,22.4, 22.7, 22.8, 23.2	**10**
Unit 3	**Chapter 6: Transistor Multivibrators** 6.1 Astable Multivibrator 6.2 Monostable Multivibrator 6.3 Bistable Multivibrator 6.4 Schmitt trigger 6.5 Problems. **Chapter 7: 555 Timer** 7.1 Block diagram of 555 timer 7.2 555 timer as Monostable multivibrator 7.3 555 timer as Astable multivibrator 7.4 555 timer as Voltage Controlled Oscillator 7.5 555 timer as Pulse width modulation and Pulse Position Modulation 7.6 555 timer as Triggered linear ramp generator**.** **Ref: KVR:** 14.5.2.1, 14.5.2.5, 14.5.2.6, 14.5.4.1	**10**

Reference Books :

1. **VM:** Principles of Electronics – V. K. Mehta and Rohit Mehta. (S. Chand –Multicolor revised edition)
2. **MB:** Electronic Principles, Malvino& Bates -7th Edition TMH Publication.
3. **AM:** Electronic Devices and Circuits, Allen Mottershead -PHI Publication.
4. **KVR:** Functional Electronics, K.V. Ramanan-TMH Publication

Paper III
Course Code: VSPH352
Credits: 2

Nuclear Physics

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Describe the energy, velocity, and range of alpha and beta particles and explain the fine structure and decay mechanisms using barrier penetration and Pauli's neutrino hypothesis.
LO 2	Apply nuclear models like the Weizsäcker formula and mass parabolas to predict beta decay and assess nuclear stability.
LO 3	Compare the construction and working of ionization chambers, proportional counters, and GM counters used in nuclear detection.
LO 4	Classify elementary particles and apply conservation laws to understand nuclear reactions and the role of mesons in nuclear forces.

Course Code VSPH352	Paper III Nuclear Physics	Credits 2	Lectures 30
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Explain the fundamental concepts and processes involved in alpha and beta decay, including particle interactions, spectra, and detection techniques.		
CO 2	Describe and analyse gamma decay, nuclear models, and stability using theoretical frameworks such as selection rules, the shell model, and the semi-empirical mass formula.		
CO 3	Illustrate the working principles of particle accelerators and discuss the properties and interactions of elementary particles and nuclear forces.		
CO 4	Apply relevant physical laws and mathematical techniques to solve numerical problems related to nuclear decay, particle detection, nuclear models, and accelerator-based physics.		
Unit	**Content**		**No. of Lectures**
Unit 1	**Chapter 1: Alpha Decay** 1.1 Introduction 1.2 Velocity, energy, and Absorption of alpha particles 1.3 Range, Ionization and stopping power, nuclear energy levels 1.4 Range of alpha particles 1.5 Alpha particle spectrum 1.6 Fine structure, long range alpha particles, Alpha decay paradox: Barrier penetration (Gamow's theory of alpha decay and Geiger-Nuttal law) 1.7 G.M. Counter **Chapter 2: Beta Decay**		**10**

	2.1 Introduction 2.2 Velocity and energy of beta particles 2.3 Energy levels and decay schemes 2.4 Continuous beta ray spectrum 2.5 Difficulties encountered to understand it 2.6 Pauli's neutrino hypothesis 2.7 Detection of neutrino 2.8 Energies of beta decay 2.9 Ionization Chamber 2.10 Proportional Counter **Reference:** **1. IK: 13. 1, 13.2, 13.5, SBP: 4. II. 1, 4. II. 2, 4. II. 3, 1.II.3** **2. IK: 14.1, 14.7, SBP: 4. III. 1, 4. III. 2, 4. III. 3, 4. III. 5, SNG : 5.5.**	
Unit 2	**Chapter 3: Gamma Decay** 3.1 Introduction 3.2 Selection rules 3.3 Internal conversion 3.4 Nuclear isomerism 3.5 Mossbauer effect **Chapter 4: Nuclear Models** 4.1 Liquid drop model 4.2 Weizsacker's semi-empirical mass formula 4.3 Mass parabolas - Prediction of stability against beta decay for members of an isobaric family 4.4 Stability limits against spontaneous fission 4.5 Shell model (Qualitative) 4.6 Magic numbers in the nucleus. **Reference:** **1. SBP: 4. IV. 1, 4. IV.2, 4. IV. 3, 4. IV. 4, 9.4** **2. SBP: 5.1, 5.3, 5.4, 5.5. AB: 11.6-pages (460,461).**	**10**
Unit 3	**Chapter 5: Particle Accelerators** 5.1 Cyclotron 5.2 Synchrotron 5.3 Betatron and Idea of Large Hadron Collider **Chapter 6: Nuclear Force** 6.1 Introduction,	**10**

	6.2 Deuteron problem, 6.3 Meson theory of Nuclear Force - A qualitative discussion **Chapter 7: Elementary Particle** 7.1 Introduction 7.2 Classification of elementary particles 7.3 Particle interactions 7.4 Conservation laws (linear & angular momentum, energy, charge, baryon number & lepton number) **Reference:** **1. SBP: 6.1, 6.3 to 6.9, 9.6, 9.7, 8.1,8.2,8.3** **2. SBP: 1.I.4 (i), 1.I.4 (ii), 1.I.4 (iii), 1.I.4 (iv), 6.9, AB: 13.3**	

Reference Books :

1. **AB:** Concepts of Modern Physics: Arthur Beiser, Shobhit Mahajan, S Rai Choudhury (6th Ed.) (TMH).
2. **SBP:** Nuclear Physics, S.B. Patel (Wiley Eastern Ltd.).
3. **IK:** Nuclear Physics, Irving Kaplan (2nd Ed.) (Addison Wesley).
4. **SNG:** Nuclear Physics, S. N. Ghoshal (S. Chand & Co.)
5. **DCT:** Nuclear Physics, D. C. Tayal (Himalayan Publishing House) 5th ed

Additional References

1. Modern Physics: Kenneth Krane (2nd Ed.), John Wiley & Sons.
2. Atomic & Nuclear Physics: N Subrahmanyam, Brij Lal. (Revised by Jivan Seshan.) S. Chand.
3. Atomic & Nuclear Physics: A B Gupta & Dipak Ghosh Books & Allied (P) Ltd
4. Introduction to Elementary Particles: David Griffith, Second Revised Edition, Wiley-

Paper IV

Course Code: VSPH353

Credits: 2 Special Theory of Relativity

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Understand the need for Special Relativity and the limitations of classical mechanics at high velocities
LO 2	Explain and apply Einstein's postulates, leading to key concepts such as time dilation, length contraction, and simultaneity
LO 3	Use Lorentz transformations to analyze events and solve problems in different inertial frames.
LO 4	Derive and interpret relativistic energy and momentum relations, including mass-energy equivalence ($E=mc^2$)

Course Code VSPH353	Paper IV Special Theory of Relativity		Credits 2	Lectures 30
Course Outcomes : Upon Completion of the course the student will be able to				
CO 1	Explain the fundamental principles of Special Relativity and their implications.			
CO 2	Solve numerical problems involving relativistic kinematics and transformations.			
CO 3	Analyse energy and momentum relations in relativistic systems.			
CO 4	Interpret spacetime geometry using Minkowski diagrams.			
CO 5	Apply relativistic concepts to practical situations in physics and technology.			
Unit	**Content**			**No. of Lectures**
Unit 1	**Chapter 1: Limitations of Classical Mechanics** 1.1 Galilean Transformation and its limitations 1.2 Michelson-Morley Experiment: Evidence for Special Relativity **Chapter 2: Foundations of Special Relativity** 2.1 Postulates of Special Relativity 2.2 Lorentz Transformations: Derivation and Consequences **Chapter 3: Consequences of Lorentz transformation** 3.1 Length Contraction and Time Dilation 3.2 Simultaneity and the Relativity of Time 3.3 Velocity Addition Theorem and Its Applications **Chapter 4: Geometrical representation of Space-Time** 4.1 Introduction to Four-Dimensional Spacetime			**10**

	4.2 Calibration of Spacetime axes 4.3 Minkowski Spacetime diagrams for time dilation and length contraction	
Unit 2	**Chapter 5: Relativistic Kinematics and Dynamics** 5.1 Lorentz Transformation of Velocities **5.2** Relativistic Energy and Momentum **5.3** Equivalence of Mass-Energy and its application **5.4** Relativistic Form of Newton's Second Law **5.5** Lorentz Transformation of force in Relativity **5.6** Collisions in Special Relativity **5.7** Stellar Aberration and Relativistic Doppler Effect	**10**
Unit 3	**Chapter 6: Relativistic Electrodynamics** 6.1 Transformation of Electric and Magnetic Fields **6.2** Relativistic Dynamics of Charged Particles in Electromagnetic Fields **6.3** Relativity and Maxwell's Equations **Chapter 7: Introduction to General Relativity** 7.1 Principle of Equivalence 7.2 Gravitational Red Shift **Chapter 8: Applications of Relativity** **8.1** GPS Systems 8.2 High-Energy Collisions in particle accelerators	**10**

Reference Books :

1. **Introduction to Special relativity:** Robert Resnick (Wiley Student Edition)
2. **Concepts of Modern Physics:** Arthur Beiser
3. **Introduction to Electrodynamics:** David J. Griffiths
4. **Spacetime Physics:** Edwin F. Taylor and John Archibald Wheeler
5. **Special Relativity:** A. P. French (MIT Introductory Physics Series)

Additional References:

1. **Special Relativity:** N. M. J. Woodhouse (Springer Undergraduate Mathematics Series)
2. **Special Relativity and Classical Field Theory:** Art Friedman and Leonard Susskind (Penguin publications)
3. **Mechanics: K. R. Symon** (Pearson)
4. **Einstein's Theory of Relativity:** Max Born (Dover Books on Physics)

Practical
Course Code: VSPH354
Credits: 2

Major Physics Practical

Course Code VSPH354	Major Physics Practical	Credits 2	Lectures 60
Lists of Experiment of GROUP A			
1.	To determine the surface tension of mercury using Quincke's method		
2.	To determine the thermal conductivity of a material using Lee's disc method		
3.	To determine Young's modulus using Koenig's method		
4.	To determine the wavelength of monochromatic light using Fresnel's bi-prism		
5.	To determine the wavelength of light using Lloyd's single mirror		
6.	To study the phenomenon of double refraction		
7.	To calculate interplanar spacing of glycodium powder using a LASER		
8.	To study the dielectric constant of a given material		
9.	To study the characteristics of a diode as a temperature sensor		
10.	To study the carrier lifetime using the pulsed reverse recovery method		
11.	To design and test LM317 as a variable voltage source		
12.	To design and test LM317 as a constant current source		
Lists of Experiment of GROUP B			
1.	To design and study a transistorized astable multivibrator using a breadboard		
2.	To design and study a transistorized monostable multivibrator using a breadboard		
3.	To design and study a transistorized bistable multivibrator using a breadboard		
4.	To design and study an astable multivibrator using IC 555		
5.	To design and study a ramp generator using IC 555		
6.	To study the application of IC 555 as a voltage-to-frequency converter using a breadboard		
7.	To study the characteristics of a JFET as a switch (series and shunt configurations)		
8.	To study the characteristics of a JFET as a common-source amplifier		
9.	To study the characteristics of a UJT and design a relaxation oscillator		
10.	To study Pulse Width Modulation (PWM) or Pulse Position Modulation (PPM) using a breadboard		
11.	To design and study a second-order active high-pass filter using a breadboard		
12.	To design and study a second-order active low-pass filter using a breadboard		

Note: Minimum **7 from each group** and **total 14 experiments** should be completed in the first semester. All experiments are to be reported in a journal. Certified journal is must to be eligible to appear for the semester end practical.

Elective I
Course Code: VSPH355
Credits: 2

8051 Microcontroller

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Identify the key components and internal architecture of the 8051 microcontroller, including I/O ports and memory structure.
LO 2	Write and trace 8051 assembly language programs using different addressing modes and control flow instructions.
LO 3	Implement 8051 programs for hardware tasks such as timing delays, serial communication, and interrupt handling.
LO 4	Interface peripherals like LEDs, switches, and sensors to 8051 and develop real-time applications using embedded programming techniques.

Course Code VSPH355	Elective I 8051 Microcontroller	Credits 2	Lectures 30
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Describe the evolution, architecture, and memory organization of 8051 microcontrollers.		
CO 2	Develop simple programs using 8051 instruction sets, addressing modes, and stack operations in assembly language.		
CO 3	Write and debug programs using timers, counters, serial communication, and interrupts in the 8051 microcontroller.		
CO 4	Design embedded applications by interfacing external devices with the 8051 microcontroller.		
Unit	**Content**		**No. of Lectures**
Unit 1	**Chapter 1: Introduction to 8051 Microcontrollers** 1.1 Introduction to Microcontrollers & Microprocessors, 1.2 History & Classification (8-bit, 16-bit, CISC, RISC, Harvard & Von Neumann) 1.3 Block Diagram & Architecture of 8051 1.4 Registers & Memory Organization 1.5 8051 Pin Description, I/O Ports & Connections. **Ref : AVD:** Ch -1, 2, 3		**10**
Unit 2	**Chapter 2: 8051 Instruction Set and Programming** 2.1 8051 Addressing Modes 2.2 Instruction Set Overview 2.3 Data Transfer, Arithmetic, and Logical Instructions		**10**

	2.4 Branching and Stack Pointer Usage 2.5 Simple Assembly Language Programs. **Ref : AVD:** Ch-4	
Unit 3	**Chapter 3: Timers, Serial Communication, and Interrupts** 3.1 Programming 8051 Timers, 3.2 Counter Programming 3.3 Basics of Serial Communication, 3.4 8051 Connection to RS232 3.5 8051 Serial Port Programming in assembly, 3.6 8051 Interrupts, Programming Timer Interrupts, Programming External Hardware Interrupts **Ref : AVD:** Ch -	**10**

Reference Books :

1. **AVD :** Microcontrollers Theory and Applications by Ajay Deshmukh, The Tata McGraw Hill Companies.
2. **Microcontroller 8051 by D.** Karuna Sagar, Narosa Publishing House pvt. ltd.
3. **MMM :** The 8051 Microcontroller & Embedded Systems by M. A. Mazdi, J. G. Mazdi and R. D. McKinlay, 2nd Edition, Pearson.
4. **A :** The 8051 Microcontroller and Embedded Systems using Assembly and C by Kenneth J. Ayala, Cengage Learning.

Elective I
Course Code: VSPH356
Credits: 2
8051 Microcontroller Practical

Course Code VSPH356	8051 Microcontroller Practical's	Credits 2	Lectures 60
1.	Write an ALP to perform two 8-bit addition.		
2.	Write an ALP to perform two 8-bit subtraction.		
3.	Write an ALP to multiply two 8-bit numbers.		
4.	Write an ALP to divide two 8-bit numbers.		
5.	Write an ALP to transfer a block of data bytes from one memory location to another.		
6.	Write an ALP to compute the cube of numbers.		
7.	Write an ALP to perform a 32-bit data rotation.		
8.	Write an ALP to find the greatest/smallest number from a block of data.		
9.	Write an ALP for a decimal/hexadecimal counter.		
10.	Write an ALP to display a bit pattern on LEDs.		
11.	Generate a Square Wave of 2 kHz using Timer 0 in Mode 1.		
12.	Generate a Square Wave of 50 Hz using Timer 1 in Mode 1.		
13.	Generate a Square Wave of 5 kHz using Timer 0 in Mode 2.		
14.	Implement Serial Communication using 8051.		
15.	Write an ALP to trigger interrupt INT1 on Port 1.		

Note: A **minimum of 12 experiments** must be completed from the elective paper in Semester VI. All experiments should be recorded **neatly in a certified journal**. Submission of the certified journal is **compulsory to be eligible** for the semester-end practical examination.

Elective II

Course Code: VSPH357

Credits: 2 Arduino Programming Practical

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Identify and describe the architecture, pin configuration, and development environment of Arduino boards and use Tinkercad for circuit simulation.
LO 2	Interface basic sensors (LDR, temperature, ultrasonic) and actuators (motors, relays) with Arduino and display data using LCDs or 7-segment displays.
LO 3	Apply the concepts of timers, interrupts, and real-time clock modules to create time-based automation and real-time applications using Arduino.
LO 4	Design and simulate embedded projects using Arduino and Tinkercad, applying IoT principles and wireless communication modules like ESP8266.

Course Code **VSPH357**	**Elective II** **Arduino Programming**		**Credits** **2**	**Lectures** **30**
Course Outcomes : Upon Completion of the course the student will be able to				
CO 1	Describe the architecture, pin configuration, and working principles of the Arduino platform.			
CO 2	Develop and execute Arduino programs to interface with sensors, actuators, and displays			
CO 3	Implement real-time applications using timers, interrupts, and communication modules.			
CO 4	Design and develop embedded systems projects using Arduino and Tinkercad simulation.			
Unit	**Content**		**No. of Lectures**	
Unit 1	**Chapter 1: Introduction to Arduino** **1.1** Basics of microcontrollers, differences from microprocessors 1.2 Overview of Arduino boards (Uno, Mega, Nano, etc.) 1.3 Architecture and pin configuration of Arduino Uno **Chapter 2: Introduction to Tinkercad for Circuit Simulation** **2.1** Setting up a free account on Tinkercad 2.2 Creating and simulating circuits online, Writing and testing Arduino code in Tinkercad **Chapter 3: Arduino IDE and Basic Programming** **3.1** Installing and using Arduino IDE, Writing, compiling, and uploading programs 3.2 Basics of C/C++ programming for Arduino 3.3 Serial communication (Serial Monitor & Serial Plotter).		**10**	

	Chapter 4: Basic Input/Output (I/O) Operations in Arduino & Tinkercad **4.1** Digital input and output (using LEDs and push buttons) 4.2 Analog input and output (using potentiometers and PWM) 4.3 Simulating basic circuits in Tinkercad.	
Unit 2	**Chapter 5: Sensors, Actuators, and Communication** **5.1 Interfacing Sensors with Arduino :** Light-dependent resistor (LDR) for light sensing, Temperature sensor (DHT11, LM35), Ultrasonic sensor (HC-SR04) for distance measurement, IR sensor for object detection. **5.2 Controlling Actuators :** Interfacing with DC motors and servo motors, Motor driver circuits (L293D, L298N), Relay control for automation. **5.3 Display Modules and Communication:** LCD (16x2) and OLED displays, 7-segment displays for numeric output, Bluetooth communication (HC-05), Basics of IoT: Sending data to cloud platforms, Simulating these interfaces in Tinkercad.	**10**
Unit 3	**Chapter 6: Advanced Applications** **6.1 Timers, Interrupts, and Real-Time Applications:** Understanding Arduino timers, Internal and external interrupts, Real-time clock module (RTC) for time-based automation, Simulating timers and interrupts in Tinkercad. **6.2 Wireless Communication and IoT Applications:** Introduction to WiFi module (ESP8266, ESP32), IoT-based data logging using Arduino, Virtual IoT experiments using Tinkercad. **6.3 Mini Project Development :** Home automation using Arduino and relays, Smart irrigation system using soil moisture sensors, Weather monitoring system using sensors, Line-following robot using IR sensors	**10**

Reference Books :

1. Arduino-Based Embedded Systems : By Rajesh Singh, Anita Gehlot, Bhupendra Singh, and Sushabhan Choudhury.
2. https ://www.arduino.cc/en/Tutorial/HomePage
3. Arduino Made Simple by Ashwin Pajankar
4. 4. Embedded C, Pont, Michael J

Elective II
Course Code: VSPH358
Credits: 2 Arduino Programming Practical

Course Code VSPH358	Arduino Programming Practical	Credits 2	Lectures 60
1.	LED Blinking using Arduino and Tinkercad		
2.	Controlling an LED with a Push Button		
3.	PWM-based LED Brightness Control using a Potentiometer		
4.	Light Intensity Measurement using LDR Sensor		
5.	Temperature Measurement using DHT11 / LM35 Sensor		
6.	Distance Measurement using Ultrasonic Sensor (HC-SR04)		
7.	Object Detection using IR Sensor		
8.	Motion Detection using PIR Sensor		
9.	DC Motor Speed Control using L293D Motor Driver		
10.	Servo Motor Angle Control using PWM		
11.	Relay Module Control for Home Automation		
12.	Displaying Sensor Readings on a 16x2 LCD Display		
13.	Real-Time Clock (RTC) Module Interfacing		
14.	Precise Delay Generation using Arduino Timers		

Note: A **minimum of 12 experiments** must be completed from the elective paper in Semester VI. All experiments should be recorded **neatly in a certified journal**. Submission of the certified journal is **compulsory to be eligible** for the semester-end practical examination.

Vocational Skill Course

Course Code: VSPH359

Credits: 2

Data Analysis and Visualization Using Python

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Integrate MySQL with Python to manage databases and perform CRUD operations relevant to physics data.
LO 2	Generate 2D and 3D plots using Matplotlib to visualize scientific data including error bars, subplots, and CSV-based input.
LO 3	Use NumPy for efficient numerical array operations, mathematical computation, and linear algebra applications.
LO 4	Use SciPy for analyzing experimental data through curve fitting and solving simple differential equations.

Course Code **VSPH359**	**VSC** **Data Analysis and Visualization Using Python**	**Credits** **2**	**Lectures** **60**
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Apply MySQL with Python for database management and CURD operations in physics.		
CO 2	Analyse scientific data using Matplotlib for effective visualization.		
CO 3	Implement NumPy for numerical computations and matrix operations.		
CO 4	Evaluate experimental data using SciPy for curve fitting and analysis.		
Unit	**Content**		**No. of Lectures**
Unit 1	**Chapter 1- Numerical Computing with NumPy and SciPy** 1.1 **Introduction to NumPy –** Overview, Installing NumPy, Advantages over lists 1.2 **NumPy Arrays –** Creating 1D, 2D, and 3D arrays, Array attributes and properties 1.3 **Array Operations** – Indexing, Slicing, Reshaping, Stacking, Splitting 1.4 **Mathematical Functions –** Basic arithmetic, Trigonometric functions, Exponential and logarithmic functions 1.5 **Linear Algebra with NumPy –** Matrix operations, Determinants, Eigenvalues and Eigenvectors 1.6 **Curve Fitting with SciPy** – Introduction to SciPy, fitting experimental data to curves, solve simple differential equation **AG : Ch- 7 , 8.1, 8.4, 8.7, 12.6**		**10**
Unit 2	**Chapter 2 - Data Visualization with Matplotlib** 2.1 **Introduction to Matplotlib –** Overview, Installing Matplotlib,		**10**

	Basic Plot Structure 2.2 **Basic 2D Plots –** Line plots, Scatter plots, Bar charts, Histograms, Pie charts 2.3 **Advanced 2D Plots –** Semilog and Log-log plots, Error bars, Annotating graphs 2.4 **Multiple Plots –** Subplots, Multiple plots in one figure, Customizing axes and legends 2.5 **3D Visualization –** Surface plots, Contour plots 2.6 **Plotting Data from Files –** Reading and visualizing CSV and text file data 2.7 **Customization and Styling –** Colors, Markers, Line styles, Labels, Titles, Grids **AG : Ch- 9**	
Unit 3	**Chapter 3 : MySQL with Python for Physics Applications** 3.1 **Introduction to MySQL and Python Integration** – Overview of MySQL, setting up MySQL Connector in Python, Understanding Database Management, Cursor object 3.2 **Database and Table Management** – Creating databases, Defining tables with data types and constraints 3.3 **CRUD Operations (Create, Retrieve, Update, Delete)** – Inserting, Updating, deleting records in MySQL using Python 3.4 **Retrieving Data** – SELECT queries, Filtering data with WHERE, LIKE, BETWEEN 3.5 **Sorting and Grouping Data** – ORDER BY, GROUP BY, HAVING 3.6 **Aggregation Functions** – COUNT(), SUM(), AVG(), MIN(), MAX() 3.7 **Fetching Query Results in Python** – Using execute(), executemany(), fetchone(), fetchall() 3.8 **Applications in Physics** – Storing and analyzing experimental data, Managing large datasets for computational physics	**10**

	Data Analysis and Visualization Using Python	**Lectures 30**
1.	Create a MySQL database and define tables with appropriate data types and constraints.	
2.	Perform Create, Read, Update, and Delete (CRUD) operations on an experimental dataset using Python.	
3.	Execute SELECT queries with WHERE, LIKE, and BETWEEN to filter data.	
4.	Apply aggregation functions (COUNT(), SUM(), AVG(), MIN(), MAX()) to analyze experimental data.	
5.	Use ORDER BY, GROUP BY, and HAVING to organize and analyze physics data; visualize MySQL query results using Matplotlib.	

6.	Plot a line graph for simple harmonic motion (sine wave) with labeled axes and a grid.
7.	Create a scatter plot for temperature variations over 24 hours with customized markers.
8.	Plot histograms and statistical analysis (mean, median, standard deviation) of random experimental errors with a normal distribution curve.
9.	Create semilog and log-log plots for radioactive decay to determine half-life.
10.	Use subplots to visualize displacement-time, velocity-time, and acceleration-time graphs for free fall.
11.	Create a 3D surface plot and contour plot to visualize gravitational potential around a planet.
12.	Read data from a CSV file and plot an appropriate graph to analyse trends.
13.	Generate Lissajous figures for different frequency ratios and phase differences.
14.	Generate 1D, 2D, and 3D arrays, perform reshaping, slicing, and indexing operations.
15.	Perform element-wise operations – Add, subtract, multiply, and divide arrays; apply mathematical functions (sin, cos, log, exp) to arrays.
16.	Compute transpose, determinant, inverse, and eigenvalues/eigenvectors of matrices using NumPy.
17.	Use numpy.linalg.solve() to find the solution of Ax = B for a given coefficient matrix A and vector B.
18.	Fit experimental data to a polynomial or exponential curve and find best-fit parameters.
19.	Calculate and plot the trajectory of a projectile under gravity.
20.	Use NumPy's random module to generate uniform, normal, and Poisson-distributed numbers and analyse their properties.
21.	Perform Fourier Transform and Inverse Fourier Transform (IFFT) on single and multiple frequency signals; analyse their frequency spectra using FFT.
22.	Solve differential equations (e.g., damped harmonic motion, RC circuits) using SciPy.

Note: A **minimum of 16 experiments** must be completed from the VSC paper in Semester VI. All experiments should be recorded **neatly in a certified journal**. Submission of the certified journal is **compulsory to be eligible** for the semester-end practical examination.

Reference Books :

1. **RT :** Python Programming: Using Problem solving approach by Reema Thareja, Oxford University press (2nd Edition)
2. **AG :** Scientific Computing in Python by Abhijit Kar Gupta 2nd edition, Tehno World Publication
3. Think Python: How to Think Like a Computer Scientist by Allen B. Downey, 2nd Edition, Shroff/O'Reilly Publication
4. NumPy Array Documentation - https://numpy.org/doc/stable/reference/generated/numpy.array.html
5. NumPy Matrix Documentation - https://numpy.org/doc/stable/reference/generated/numpy.matrix.html

6. Scipy Documentation - https://docs.scipy.org/doc/scipy/reference/index.html
7. Matplotlib Documentation - https://matplotlib.org/stable/tutorials/pyplot.html

Minor Theory
Course Code: VSPH360
Credits: 2

Semiconductor Devices - 2

Course Learning Objective

Upon Completion of the course the student will be able to

LO 1	Understand the types and principles of feedback in amplifier circuits.
LO 2	Analyze the working of various transistor oscillators using the Barkhausen criterion.
LO 3	Describe the characteristics and applications of SCR, Diac, and Triac in AC control systems.
LO 4	Solve numerical problems related to amplifier gain, oscillator frequency, and power control using feedback and semiconductor devices.

Course Code VSPH360	Minor Semiconductor Devices - 2	Credits 2	Lectures 30
Course Outcomes : Upon Completion of the course the student will be able to			
CO 1	Explain the concept of negative feedback in amplifiers and evaluate its effects on voltage and current gain.		
CO 2	Illustrate the working principles and types of sinusoidal oscillators and analyze oscillator circuits		
CO 3	Interpret the working and characteristics of Silicon Controlled Rectifier (SCR), Diac, and Triac for power control applications.		
CO 4	Apply the knowledge of feedback, oscillators, and thyristor family devices to solve basic electronics problems and design circuits.		
Unit	**Content**	**No. of Lectures**	
Unit 1	**Chapter 1: Amplifiers With Negative Feedback** 1.1 Feedback and its types 1.2 Principles of Negative Voltage Feedback in Amplifier, Gain of Negative Voltage Feedback Amplifier, Advantages of Negative Voltage Feedback 1.3 Principles of Negative Current Feedback, Current Gain with Negative Current Feedback, Effect of Negative Current Feedback, 1.4 Emitter Follower, Application of Emitter Follower, Problems Based on Negative Feedback **Ref : VM -** 13.1, 13.2, 13.3, 13.4, 13.6, 13.7, 13.8, 13.9	**10**	
Unit 2	**Chapter 2: Sinusoidal Oscillators** 2.1 Sinusoidal Oscillator and its Types 2.2 Oscillatory Circuit 2.3 Undamped Oscillations from Tank Circuits	**10**	

	2.4 Positive Feedback Amplifier 2.5 Essentials of Transistor Oscillator 2.6 Explanation of Barkhausen Criterion 2.7 Different Types of Transistor Oscillators Colpitts Oscillator, Hartley Oscillator, Phase Shift Oscillator, Wien Bridge Oscillator, Problems on Oscillator Circuit **Ref : VM -** 14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 14.7, 14.8, 14.10, 14.11, 14.13, 14.14	
Unit 3	**Chapter 3: Silicon Control Rectifier** 4.1 Silicon Control Rectifier, Working of Silicon Control Rectifier, Equivalent Circuit of Silicon Control Rectifier, V-I characteristics of Silicon Control Rectifier 4.2 Silicon Control Rectifier as Half Wave Rectifier, Silicon Control Rectifier as Full Wave Rectifier 3.2 Construction and Working of Triac, V-I Characteristic of Triac 3.3 Construction and Working of Diac, V-I Characteristic of Diac **Ref : VM -** 20.1, 20.2, 20.3, 20.5 , 20.9 , 20.10, 21.2.21.3,21.5,21.6, 21.9	**10**

Reference Books :

5. **VM:** Principles of Electronics – V. K. Mehta and Rohit Mehta. (S. Chand –Multicolor revised edition)
6. **MB:** Electronic Principles, Malvino& Bates -7th Edition TMH Publication.
7. **AM:** Electronic Devices and Circuits, Allen Mottershead -PHI Publication.
8. **KVR:** Functional Electronics, K.V. Ramanan-TMH Publication

OJT
Course Code: VSPH361
Credits: 4
On - Job Training

General instructions:

- On-the-job training (OJT) will carry a weightage of Four Credits.
- Each student is required to complete one hundred and twenty clock hours of On-the-Job Training (OJT).
- The OJT program is to be completed during Semester VI.
- Semester Integrated Internship is an integral part of the academic curricula. Satisfactory completion of an internship is a mandatory requirement for the degree to be awarded by the University.
- Furthermore, considering the curriculum structure approved by the Academic Council of the college and respective department's Board of Studies. Multiple modes of internships are possible and are assigned academic credits within the curricula. The general idea is to enable students to undertake immersive assignments within the organisations for a limited period.
- It must be noted that **1 credit is equivalent to minimum 30 hours of work**. An intern is expected to spend 30 hours per week on Internship and related activities. Furthermore, Internships must be done offline.
- During the internship registration, the **students are to notify their preference on whether they are seeking academic or industrial internships**

Objectives of the OJT Programme:

An OJT programme in general sets out to achieve objectives such as:

1. Align classroom learnings with workplace outcomes.
2. Provide students with real-world work experience and align their expectations with job demands.
3. To enhance employability skills such as critical thinking, problem-solving, communication, and teamwork.
4. Combine physical and digital learning modes in industry settings, blended with mentorship.
5. Foster research skills, including knowledge discovery, analytical tools, methodologies, and ethical conduct.

6. To prepare students for future job roles by exposing them to the latest tools, techniques, and technologies.
7. Strengthen students' entrepreneurial skills and encourage job creation.
8. Facilitate problem-solving, decision-making, teamwork, and collaboration.
9. Foster social awareness and philanthropic values among students.
10. Encourage collaboration between Higher Education Institutes (HEIs), industry, and academia for internships and research opportunities.
11. Instil professional principles, ethics, values, and integrity to meet employment market demands and social needs.

Course Outcomes

After the completion of the OJT programme, the student will be able to;

1. Apply concepts learned in classrooms to real-world work environments, enhancing their understanding and skills.
2. Demonstrate insights into the challenges, opportunities, and culture of different workplaces, preparing them for future employment.
3. Effectively navigate through various learning modalities effectively through exposure to hybrid learning models.
4. Show evidence of research aptitude and skills of critical thinking, analytical skills, and ethical research conduct in the conduct, and communication of their work.
5. Use and appreciate the use of emerging technologies and their applications, enhancing their technological literacy and adaptability.
6. Display problem-solving abilities in making informed decisions in complex scenarios through practical situations.
7. Work in teams and collaborate to achieve common goals in diverse work environments through collaborative projects.
8. Give examples and cite ways of contributing to the field of work in a manner that displays social responsibility and sustainability.
9. Display integrity in their dealings with their work and the people that they interact with by upholding professional; principles and ethical standards.

Duration and Scheduling

Duration: A minimum of 8–12 weeks, aligning with NEP 2020 recommendations for practical and skill-based learning.

Flexibility: OJT will be integrated into the academic calendar as part of the curriculum.

Blended Mode: Incorporate both in-person and online training opportunities.

Training Modules
1. Skill Development: Industry-relevant technical and soft skills training. 2. Project-Based Learning: Students will work on live projects, contributing to organizational goals. 3. Mentorship: Mentors or supervisors from the organization will guide students. 4. Periodic Evaluation: Regular performance assessments and feedback mechanisms.

The process of evaluation of On-Job Training Program is structured as below.

The student will prepare a plan for proposed On-Job Training Program. The plan may contain following aspects:

Sr. No.	Particulars
1	Name of the organization where the On-Job Training is proposed to be carried out.
2	Details of the organization.
3	The area in which he/she is planning to undergo On-Job Training.
4	Details of the various subject specific concepts learnt by the student before joining the On-Job Training.
5	Allocation of 120 hours of On-Job Training Program.
6	List of the skills that he/she is planning to acquire during On-Job Training.
7	A brief note on how the On-Job Training program may benefit him/her to develop better skills in his/her subject.
8	Details of the primary discussion that the student had with any officer / authority of the On-Job Training Program providing organization about proposed work.
9	Proposed outcomes of the On-Job Training Program.

Evaluation Scheme

Particulars	Marks
Duration of Training	30
Practical skills	20
Professional Conduct	10
Report based on Training	20
Knowledge assessments through oral presentation	20
TOTAL	100

Theory / Practical Examination Pattern for Semester V / VI

(Major / Minor and VSC / SEC)

➢ **Internal Assessment – Theory Paper (Total: 40 Marks)**

Sr. No.	Component	Nature of Assessment	Marks
1.	**CIA-1** **Class Test** (Short Answers/ MCQs/ Objective Questions)	Written test conducted in class	15
2.	**CIA-2** **Assignment / Project / Presentation / Book Review / Research Review**	Individual or group work submitted as report or presented orally	15
3.	**CIA-3** **Participation, Performance & Attendance**	Based on engagement, attentiveness, regularity	10
	Total		**40**

➢ **External Assessment – Semester End Theory Paper (Total: 60 Marks)**

Paper Name		
Duration : 2 Hours		**Marks : 60**
Q. 1 A)	**Attempt any ONE.**	**7 Marks**
i.	Questions Based on Unit 1	
ii.	Questions Based on Unit 1	
B)	**Attempt any TWO.**	
i.	Questions Based on Unit 1	**8 Marks**
ii.	Questions Based on Unit 1	
iii.	Questions Based on Unit 1	
Q. 2 A)	**Attempt any ONE.**	**7 Marks**
i.	Questions Based on Unit 2	
ii.	Questions Based on Unit 2	
B)	**Attempt any TWO.**	
i.	Questions Based on Unit 2	**8 Marks**
ii.	Questions Based on Unit 2	
iii.	Questions Based on Unit 2	
Q. 3 A)	**Attempt any ONE.**	**7 Marks**
i.	Questions Based on Unit 3	
ii.	Questions Based on Unit 3	
B)	**Attempt any TWO.**	**8 Marks**
i.	Questions Based on Unit 3	
ii.	Questions Based on Unit 3	
iii.	Questions Based on Unit 3	
Q. 4	**Solve the following.**	**15 Marks**
i.	Questions Based on Unit 1	
ii.	Questions Based on Unit 2	
iii.	Questions Based on Unit 3	

- **External Assessment – Semester End Practical Examination (Total: 100 Marks)**
  - Every student must maintain and complete a practical journal as per the prescribed syllabus.
  - The journal must be duly checked and certified by the subject teacher and Head of the Department (HOD).
  - Students without a completed and certified journal will not be permitted to appear for the practical examination.

MAJOR / MINOR	
Component	**Marks**
Experiment from group - A	40
Experiment from group - B	40
Viva Voce	10
Journal Evaluation	10
Total Marks	**100**

VSC / SEC	
Component	**Marks**
Experiment - I	40
Experiment - II	40
Viva Voce	10
Journal Evaluation	10
Total Marks	**100**