Vivekanand Education Society's

College of Arts, Science and Commerce

(Autonomous)

Sindhi Society, Chembur, Mumbai, Maharashtra – 400 071.

Accredited by NAAC "A Grade" in 3rd Cycle - 2017
Best College Award – Urban Area, University of Mumbai (2012-13)
Recipient of FIST Grant (DST) and STAR College Grant (DBT)

Affiliated to the

University of Mumbai

Syllabus for

Program: B.Sc. (Physics)

(Program code: VESUSPH)

As per Choice Based Credit System (CBCS)
with effect from Academic Year 2023 - 2024

Program Outcomes (PO):

Upon completion of B.Sc Programme, the graduates will have:

PO1	The required analytical skills to apply appropriate scientific principles and methodologies to solve real world problems.
PO2	The ability to design, carry out experiments and analyze results by accounting uncertainties in different quantities measured using various scientific instruments.
PO3	The ability to communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing.
PO4	Understanding of the need for scientific solutions to problems of the environment and society, keeping in mind their sustainable development.
PO5	Imbibed ethical, moral and social values in personal and social life leading to a cultured and civilized personality.

Program Specific Outcomes (PSO)

On completion of B.Sc. Physics program, learners will be enriched with knowledge and be able to

PSO1	Understand applications of physics concepts in different areas.
PSO2	Establish linkages between different areas of physics and other interdisciplinary science subjects.
PSO3	Demonstrate competence in problem solving skills in different areas of Physics namely Classical Mechanics, Quantum Mechanics, Modern Physics, Electrodynamics, Optics, Thermodynamics, Crystallography and Materials Science.
PSO4	Use analytical skills using appropriate physical principles and methodologies to solve a wide range of problems.
PSO5	Design and carry out experiments by using appropriate scientific instruments.

Syllabus S.Y.B.Sc. (PHYSICS)

(SEMESTER III)

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESUSPH301	**Advanced Thermodynamics and Mechanics**	**02**	**03**
	Unit I: Thermodynamics I	**15 Lectures**	
	Unit II: Thermodynamics II	**15 Lectures**	
	Unit III: Mechanics	**15 Lectures**	
VESUSPH302	**Electronics**	**02**	**03**
	Unit I: Transistors	**15 Lectures**	
	Unit II: Oscillators and Operational Amplifiers	**15 Lectures**	
	Unit III: Digital Electronics	**15 Lectures**	
VESUSPH303	**Mathematical & Vector calculus**	**02**	**03**
	Unit I: Differential Equations I	**15 Lectures**	
	Unit II: Differential Equations II & Complex numbers	**15 Lectures**	
	Unit III: Vector Calculus	**15 Lectures**	
VESUSPHP301	**Practical III**	**03**	**09**

Detailed Syllabus: Unit wise / Module wise with number of lectures

Course title: Thermodynamics and Mechanics

Course code:VESUSPH301

Objective: To understand thermodynamics principles and their applications. To understand concepts of Mechanics.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Comprehend the basic concepts of thermodynamics
LO2	Understand Second & third law of thermodynamics and its importance
LO3	Understand applications of thermodynamics in different physical situations.
LO4	Understand low temperature physics
LO5	Understand concepts of compound pendulum, Oscillations
LO6	Understand concepts of system of particles, conservation principles and applications
LO7	Understand concepts of Forced oscillations, resonance
LO8	Demonstrate problem solving skills in all above areas

Unit no.	**Details of topics**	**No of lectures**
1	(Review of zeroth and first law of thermodynamics) Reversible and irreversible process, Heat engines, definition, of efficiency, Carnot's ideal heat engine, Carnot's cycle, effective way to increase efficiency, Carnot's engines and refrigerator, coefficient of performance Steam engine, Rankine cycle, Otto engine, Efficiency of Otto cycle, Diesel cycle, Efficiency of Diesel cycle, Otto and diesel comparison. Second law of thermodynamics, Statements, Equivalence of Kelvin and Planck's statement, Carnot's theorem, Reversible and irreversible process, Absolute scale of temperature. BS: 4.20-4.33, 5.1-5.14	15 Lectures
2	Clausius theorem, Entropy, Entropy of a cyclic process, Reversible process, Entropy change, Reversible heat transfer, Principle of increase in	15 Lectures

	entropy, generalized form of first and second law, entropy change of an ideal gas, entropy of steam, entropy and unavailable energy, entropy and disorder, absolute entropy. Third law of thermodynamics, Nernst heat theorem, Consequences of the third law, Maxwell's thermodynamic relations, Clausius – Clapeyron equation, Thermal Expansion. Low temp Physics: Different methods of liquefaction of gases, methods of freezing, Cooling by evaporation, cooling by adiabatic expansion. Joule - Thompson effect, Liquefaction of Gases, Regenerative cooling, liquefaction of Air, liquefaction of Oxygen, liquefaction of Hydrogen, Liquefaction of helium, properties and uses of liquid Helium BS: 5.15-518, 6.3, 6.4.6, 7.1-7.14	
3	Compound pendulum : Expression for period, maximum and minimum time period, centres of suspension and oscillations, reversible compound pendulum. Kater's reversible pendulum, compound pendulum and simple pendulum – a relative study. HRW: 16.6 HP: (pages 279 to 289) Center of Mass, Motion of the Center of Mass, Linear momentum of a Particle, Linear momentum of a System of Particles, Linear momentum wrt CM coordinate (i.e shift of origin from Lab to CM), Conservation of Linear Momentum. Some Applications of the Momentum Principle, System of Variable Mass. Torque Acting on a Particle, Angular Momentum of a Particle, Angular Momentum of System of Particle, Total angular momentum wrt CM Coordinate, Conservation of Angular Momentum. HRW: 9.1-9.7 Oscillations, The Simple Harmonic Oscillator, Relation between Simple Harmonic Motion and Uniform Circular Motion, Two Body Oscillation, Damped Harmonic Motion, Forced Oscillations and Resonance. HRW: 16.7-16.8	15 Lectures

References:

1. BS : Heat thermodynamics and Statistical Physics, Brijlal, N.Subramanyam, P.S. Hemne, S. Chand, edition 2007.

2.HRW: Fundamental of Physics, Halliday, Resnick and Walker, Wiley, 6th Edition
3. H. P. : Mechanics – H. S. Hans and S. P. Puri, Tata McGraw Hill (2nd Ed.)

Additional reference:

1. H.J. Pain, The Physics of Vibrations and waves by H.J. Pain, John Wiley sons
2. Basic Thermodynamics : Evelyn Guha, Narosa Publications
3. A treatise on heat : Meghanad Saha and BN Srivastava , 1969, India Press.
4. Thermal Physics, AB Gupta and H. Roy, Book and Allied (P) Ltd, Reprint 2008, 2009.
5. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, McGraw-Hill

Course title: Electronics

Course code:VESUSPH302

Objective: To understand working and applications of transistor and operational amplifiers and their applications. To understand digital numbering system and working of flip flops, register and counters. Understand the basic concepts of oscillators and be able to perform calculations using them.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Understand operation of basic electronic components like transistor and biasing of transistor and its applications.
LO2	Understand working of Operational amplifier and its applications
LO3	Understand basic concepts of oscillators and to perform calculations using them.
LO4	Understand the working of flip flops, registers and counters.
LO5	Demonstrate quantitative problem solving skills in all the topics.
LO6	Understand the digital numbering system.
LO7	Understand basic concepts of oscillators and to perform calculations using them.

Unit no.	**Details of topics**	**No of lectures**
1	**Transistors.** I) Types & transistor action, Transistor symbol , Transistor as amplifier: CB, CE, CC modes, definition of gains α, β and g relation between them. CE amplifier: operation, load line analysis, operating point, cut-off and saturation points. Ref: VKM: 8.1 to 8.18, 8.22 II) Transistor biasing methods: base resistor method, emitter bias circuit, circuit analysis of emitter bias, biasing with collector feedback resistor, voltage divider bias method. Ref: VKM: 9.5 to 9.12.	15 Lectures

	III) Practical circuit of CE amplifier: phase reversal, frequency response, decibel gain and bandwidth. Ref: VKM: 10.4, 10.5, 11.3	
2	Oscillators and Operational Amplifiers **.** I) Oscillators: Introduction and qualitative discussions on negative feedback, Effects of positive feedback, Requirements for oscillations, phase shift oscillator, Wien Bridge Oscillator, Colpitts oscillator. Ref.: AM:17.0 to 17.3, 18.0 to 18.3, 18.5, 18.6 II)) Operational Amplifiers: Introduction, Schematic symbol of OPAMP, Output voltage from OPAMP, AC analysis, Bandwidth of an OPAMP, Slew rate, Frequency Response of an OPAMP, OPAMP with Negative feedback, Inverting Amplifier, Non-Inverting Amplifier, Voltage Follower, Summing Amplifier, Applications of Summing amplifier, OPAMP Integrator and Differentiator, Critical frequency of Integrator, Comparator. Ref.:VKM: 25.15,25.16,25.17,25.18,25.19,25.20,25.21,25.22,25.23,25.24,25.25,25.26,25.27,25.33,25.34,25.35,25.37,25.38	15 Lectures
3	**Digital Electronics:** Binary number system, Arithmetic building blocks , Types of registers Digital IC signal levels, Binary to Decimal, Decimal to binary , Hexadecimal number, Hexadecimal to decimal Conversion, Decimal to hexadecimal conversion, Hexadecimal to binary conversion, Binary to hexadecimal conversion, Binary addition, Unsigned binary numbers, Sign magnitude numbers , 1's complement , 2's complement , Converting to and from 2's complement representation , 2's complement arithmetic, The adder-subtractor (ignore IC specific diagrams) RS Flip-Flops (only NOR gate latch, NAND gate latch) , Gated Flip-Flops, Edge-Triggered RS Flip-Flop, Edge- Triggered D Flip-Flop, Edge-Triggered J-K Flip-Flop, JK Master- Slave Flip-Flops, Bounce elimination switch Types of shift registers : SISO , SIPO, PISO , PIPO [in this chapter the teacher should make all IC specific diagrams into general diagrams ie. Ignore pin numbers and IC numbers]	15 Lectures

	Asynchronous counter -3 bit (ignore IC specific diagrams), Synchronous counter only mod 8, Decade Counters Mod5 and Mod10 LMS :5.1-5.5, 6.1-6.8, 8.1-8.5,8.7,8.8, 9.1-9.5,10.1,10.3,10.5	

References:

1. VKM: Principles of Electronics – V. K. Mehta and Rohit Mehta. (S. Chand – Multicoloured 11th revised edition 2008)
2. AM: Electronic devices and circuits – An introduction Allan Mottershead (PHI Pvt. Ltd.– EEE)
3. LMS: Digital Principles and Applications By Leach, Malvino, Saha 6th edn.

Additional references:

1. Digital Fundamentals by Thomas L Floyd 10th edn.
2. Modern Digital Electronics by R P Jain 4th edn.
3. The Art of Electronics: Paul Horowitz and Winfield Hill, Cambridge University Press

Course title: Mathematical Physics & Vector Calculus

Course code: VESUSPH303

Objective: To develop understanding in mathematical techniques required to understand the physical phenomenon at the undergraduate level. To understand functions of complex variables, solve first order homogeneous and nonhomogeneous differential equations, second order homogeneous and nonhomogeneous differential equations and partial differential equations using simple methods.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Understand basic mathematical concepts and techniques required to understand physical phenomena.
LO2	Understand the functions of complex variables
LO3	Solve first order homogeneous and nonhomogeneous differential equations
LO4	Solve homogeneous and nonhomogeneous second order differential equations.
LO5	Solve homogeneous and nonhomogeneous second order differential equations.
LO6	Solve partial differential equations.
LO7	Understand the basic laws of electrodynamics and to be able to perform calculations using them.

Unit no.	**Details of topics**	**No of lectures**
1	Differential equation: Introduction, Ordinary differential quotations, first order homogeneous and non homogeneous equations with variable coefficients, exact differentials, general first order linear differential equations with variable coefficients, linear differential equations, second order homogeneous equations with constant coefficients, problems depicting physical equations like LC,LR,LCR circuits (qualitative discussion), simple harmonic motion (spring mass system) CH:5.1, 5.2,5.2.1, 5.2.3,5.2.4	15 Lectures
2	Second order nonhomogeneous equations with constant coefficients, partial differential equations, some important partial differential equations in physics, method of separation of variables. CH:5.2.4, 5.3.1 to 5.3.4	15 Lectures

	Complex numbers: Functions, exponential and trigonometric functions, hyperbolic functions, logarithmic functions, complex roots and powers, inverse trigonometric and hyperbolic functions, applications of complex numbers MB: 2.11 to 2.16	
3	Introduction to gradient, divergence & curl, Line, Surface and volume integrals, fundamental theorem of gradient, fundamental theorem of divergence, fundamental theorem of curl (statement and geometrical interpretation is included, proof omitted). Curvilinear coordinate systems DG 1.3.1, 1.3.2, 1.3.3, 1.3.4, 1.3.5, 1.4.1, 1.4.2	15 Lectures

References:

1. CH:Charlie Harper :Introduction to Mathematical Physics PHI Pvt. Ltd. EEE
2. MB: Mary Boas: Mathematical Methods in the Physical sciences:3rd edition.
3. DG: David Griffiths (Third edition) : Introduction to Electrodynamics

Additional references:

1. Mathematical Physics: H. K. Das, S. Chand & co.

Lab courses consists of skill experiments, regular experiments and Demonstration experiments: Skills are conducted in the beginning of VESUSPHP301 and Demonstration experiments are conducted at the end of VESUSPHP401.

Course Name : Practical III

Course code: VESUSPHP301

Objective: To get familiar with use of basic instruments in Physics and develop deep understanding of concepts in different concepts studied in theory

Learning Outcomes (LO):

On successful completion of this course students will be able to :

LO1	Understand the use of apparatus and their use without fear & hesitation.
LO2	Correlate the physics theory concepts to practical application.
LO3	Understand the concept of errors and their estimate
LO4	Systematically plan and perform various stages namely, drawing appropriate circuit/ray diagram, recording and tabulating observations, drawing appropriate graphs and compute results
LO5	Understand & practice the skills while performing experiments.
LO6	Express all quantities and results in appropriate units

For practical examination, the learner will be examined in three experiments (one from each group). Each experiment will be of three hours duration, minimum 6 from each group and in all minimum 18 experiments must be reported in journal.

All the skill experiments are required to be completely compulsorily. Students are required to report all these experiments and skill experiments.

A learner will be allowed to appear for the semester and practical examination only if he submits a certified journal of Physics or a certificate that the learner has completed the practical course of Physics Semester III as per the minimum requirements.

Skills Experiments:

1.Soldering Technique
2. Wiring of a simple circuit using breadboard
3.Use of DMM and analogue multimeter
4.Component testing, colour code of resistors, capacitors, etc.
5.Radius of ball bearings (single pan balance)
6. Use of Oscilloscope
7.Travelling microscope (radius of capillary)
8. Spectrometer (optical levelling, schuster's method and least count)
9. Graph plotting of different mathematical functions.

Regular Experiments:

Group A:

1. Helmholtz Resonator
2. Flat Spiral spring (η)
3. Young's Modulus by Koenig's method
4. Coupled oscillations (Resonance pendulum)
5. Bar pendulum
6. Flat Spiral spring (Y)
7. Young's Modulus by Koenig's method
8. Y by bending
9. J by electrical heating

Group B:

1.Transistor characteristics : CE amplifier
2. CE Amplifier: variation of gain with load
3. CE Amplifier: frequency response
4. Op-Amp Inverting amplifier
5.Colpitt's Oscillator Lissajous figure using CRO
6. Op-Amp non Inverting amplifier & voltage follower
7. Wien Bridge Oscillator
8. Op Amp as differentiator
9. Op Amp as integrator

Group C

1. Charging, discharging of a CR circuit.
2. Figure of Merit of a mirror galvanometer.
3. Determination of absolute capacity using BG.
4. Passive low pass filter.
5. Passive high pass filter.
6. Passive band pass filter.
7. LCR parallel resonance.
8. Temperature coefficient of Resistance of conducting material
9. C1/C2 by de Sautys method

References:

1. Advanced course in Practical Physics D. Chattopadhya, PC Rakshit & B Saha. (6th Edition) Book and Allied Pvt.Ltd.
2. B.Sc Practical Physics – Harnam Singh S.Chand & Co. Ld. 2001
3. A test book of advanced practical PHYSICS _ SAMIR Kumar Ghosh, New Central Book Agency (3rd edition)
4. B.Sc. Practical Physics – CL Arora (1st Edition) -2001 S.Chand and Co Ltd.
5. Practical Physics CL Squires (3rd Edition) Cambridge University
6. University Practical Physics – DC Tayal. Himalaya Publication
7. Advanced Practical Physics – Worsnop &Flint.
8. An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements, Taylor, John R , University Science Books

Modality of assessment

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 25% marks in the first part & by conducting the Semester End Examinations with 75% marks in the second part. Practical Examination will consist of End Sem examination.

Student will have to score 40% of marks in Internal assessment as well as End Sem examination to pass the course.

The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:-

Internal Assessment: It is defined as the assessment of the learners on the basis of internal evaluation as envisaged in the Credit & Choice based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

Semester End Assessment : It is defined as the assessment of the learners on the basis of Performance in the semester end Theory/ written/ Practical examination.

A. Theory - Internal assessment 25% **25 marks**

Sr No	Evaluation type	Marks
1.	Class Tests (multiple choice type)/ Assignments/Activity /Project/ Seminar presentation/ case study etc.	20
2.	Active participation in routine class activity Overall conduct as a responsible student, with respect to good behaviour, leadership qualities, interpersonal skills etc.	05

B. Theory - External examination - 75% **75 marks**

Semester End Theory Assessment

Duration - Each paper will be of 75 marks and shall be of 2.5 hours duration

There shall be question of 25 marks questions from each unit. There would be one question from each unit with sub questions with internal choices as given below.

Q	Solve any 5 questions out of eight questions (5 marks each)	25 marks

C. Semester End Practical Assessment **150 marks**

The evaluation of Practical papers will be on the based on performance of three experiments.

A	Three experiments /Lab activities	40+40+40 marks
B	Viva	15 marks
C	Journal	15 marks
	Total marks	**150 Marks**

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Coordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

SEMESTER III

Course	Total Marks
VESUSPH301	**100**
VESUSPH302	**100**
VESUSPH303	**100**
VESUSPHP301	**150**

Vivekanand Education Society's

College of Arts, Science and Commerce

(Autonomous)

Sindhi Society, Chembur, Mumbai, Maharashtra – 400 071.

Accredited by NAAC "A Grade" in 3rd Cycle - 2017

Best College Award – Urban Area, University of Mumbai (2012-13)

Recipient of FIST Grant (DST) and STAR College Grant (DBT)

Affiliated to the

University of Mumbai

Syllabus for

Program: B.Sc. (Physics)

(Program code: VESUSPH)

As per Choice Based Credit System (CBCS)

with effect from Academic Year 2023 - 2024

Program Outcomes (PO):

Upon completion of B.Sc Programme, the graduates will have:

PO1	The required analytical skills to apply appropriate scientific principles and methodologies to solve real world problems.
PO2	The ability to design, carry out experiments and analyze results by accounting uncertainties in different quantities measured using various scientific instruments.
PO3	The ability to communicate scientific concepts, experimental results and analytical arguments clearly and concisely, both verbally and in writing.
PO4	Understanding of the need for scientific solutions to problems of the environment and society, keeping in mind their sustainable development.
PO5	Imbibed ethical, moral and social values in personal and social life leading to a cultured and civilized personality.

Program Specific Outcomes (PSO)

On completion of B.Sc. Physics program, learners will be enriched with knowledge and be able to

PSO1	Understand applications of physics concepts in different areas.
PSO2	Establish linkages between different areas of physics and other interdisciplinary science subjects.
PSO3	Demonstrate competence in problem solving skills in different areas of Physics namely Classical Mechanics, Quantum Mechanics, Modern Physics, Electrodynamics, Optics, Thermodynamics, Crystallography and Materials Science.
PSO4	Use analytical skills using appropriate physical principles and methodologies to solve a wide range of problems.
PSO5	Design and carry out experiments by using appropriate scientific instruments.

S.Y.B.Sc. PHYSICS

(SEMESTER IV)

Course Code	Title	Credits & Lectures per Semester	Lectures per Week
VESUSPH401	**Optics**	**02**	**03**
	Unit I: Interference & Resolving power	**15 Lectures**	
	Unit II: Diffraction : Fresnel and Fraunhofer Diffraction	**15 Lectures**	
	Unit III: Polarisation	**15 Lectures**	
VESUSPH402	**Charged particle dynamics, Microprocessor, and Astrophysics**	**02**	**03**
	Unit I: Charged particle dynamics	**15 Lectures**	
	Unit II: Microprocessor	**15 Lectures**	
	Unit III: Astrophysics	**15 Lectures**	
VESUSPH403	**Introduction to crystallography and Quantum Mechanics**	**02**	**03**
	Unit I: Crystallography	**15 Lectures**	
	Unit II: Quantum Mechanics 1	**15 Lectures**	
	Unit III: Quantum mechanics 2	**15 Lectures**	
VESUSPHP401	**Practicals of VESUSPH401, 402 and 403**	**03**	**09**

Detailed Syllabus: Unit wise / Module wise with number of lecture

Course title: Optics

Course code: VESUSPH401

Objective: To understand the foundation of Optics, like Interference and diffraction. To be able to understand the difference between Fresnel and Fraunhofer diffraction and its applications. To understand the phenomenon of polarisation, production and its applications.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	understand and differentiate different interference origins.
LO2	understand the principle, construction, working and application of Michelson Interferometer.
LO3	understand principle, construction, working and application of Fabry-Perot interferometer and etalon
LO4	find resolving power of telescope, resolving power of a prism, resolving power of a plane transmission grating.
LO5	understand the phenomenon of diffraction and differentiate between diffraction and interference.
LO6	understand rectilinear propagation of light
LO7	understand the phenomenon of Fresnel and Fraunhofer diffraction, and its applications.
LO8	understand the theory of plane transmission grating.
LO9	understand the phenomenon of polarization and its different types, methods to produce polarization of light.
LO10	understand the phenomenon of double refraction, Huygens explanation and the concept of positive and negative crystals.
LO11	understand the superposition of waves linearly polarised at right angles.
L012	understand the simplest device like quarter wave plate, polarised sheets for producing elliptically/ circularly polarized light.

Unit no.	Details of topics	No of lectures
1	**Interference:** Interference in thin films, Fringes in Wedge shaped films, Newton's Rings (Reflective). SBA: 15.1, 15.2.1 to 15.2.5, 15.3, 15.5, 15.6.1, 15.6.2, 15.6.3 **Michelson Interferometer:** principle, construction, working, circular fringes, localised fringes, Visibility of fringes. Applications of Michelson interferometer, a) measurement of wavelength b) Determination of the difference in wavelengths of two waves c) Thickness of thin transparent sheet. d) Standardization of metre. Fabry-Perot interferometer and etalon: Formation of fringes, determination of wavelength, Measurement of difference in wavelength. SBA: 15.7, 15.7.1 to 15.7.7, 15.8, 15.8.1 o 15.8.3, 15.8.5, 15.12, 15.12. to 15.12.3 **Resolving Power**: introduction, resolving power of optical instruments, criterion for resolution according to Lord Rayleigh's, Resolving power of telescope, resolving power of a prism, resolving power of a plane transmission grating. SBA:19.1, 19.2, 19.5, 19.6, 19.7, 19.11, 19.12.	15 Lectures
2	**Diffraction**- Introduction**,** Huygens's- Fresnel theory, Distinction between interference and diffraction, Fresnel's and Fraunhofer diffraction**.** **Fresnel's diffraction**: Fresnel's assumption, Rectilinear propagation (Half period zones) of light, Diffraction pattern due to straight edge, positions of maxima and minima in intensity, intensity at a point inside geometrical shadow (straight edge), Diffraction due to a narrow slit, diffraction due to a narrow wire. **Fraunhofer Diffraction**: Introduction, Fraunhofer diffraction at a single slit, Intensity distribution in diffraction pattern due to a single slit, Fraunhofer diffraction at a double slit, Distinction between single slit and double slit diffraction pattern and missing orders. Plane diffraction grating, width of principal maxima SBA:17.1,17.2,17.6,17.7 SBA:17.3,17.4,17.10,17.10.1,17.10.2,17.11,17.12,18.1,18.2,18.2,1,18.4, 18.4.2,18.4.3,18.7,18.7.1,18.7.2	15 Lectures
3	**Polarization** - Types of Polarisation, Plane polarized light, circularly polarized light, elliptically polarized light, partially polarized light, production of plane polarized light, Brewster's law, polarization by reflection from dielectric surface, polarization by absorption, polarization by double refraction, polarizer and analyzer, Malu's law, anisotropic crystal, calcite crystal, optic axis, double refraction in calcite crystal, Huygen's explanation of double refraction, Ordinary and Extra	15 Lectures

	Ordinary rays, Positive and Negative Crystals, Superposition of waves linearly polarized at right angles, Superposition of e-ray and o-ray, retarders, quarter wave plate, half wave plate, production of linearly polarized light, production of elliptically polarized light, production of circularly polarized light, analysis of polarized light, applications of polarized light. SBA:20.1,20.2,20.3,20.5,20.5.120.5.1.1,20.5.2,20.5.3,20.5.4,20.5.5, 20.6,20.6.3,20.7,20.8,20.8.3,20.9,20.9.1,20.9.2,20.14,20.15,20.17, 20.17,1,20.17.2,20.18,20.18.1,20.19,20.19.1	

References:

SBA: Brijlal, Subramanyam and Avadhanulu A Textbook of Optics, 25th revised ed.(2012) S. Chand

Additional references:

Mathur: N. B. L. Mathur “Optics” Anmol Publications Pvt Ltd

Fundamentals of Optic by F.A Jenkins and H.E White, 1976, McGraw-Hill

Course title: Charged particle dynamics, Microprocessor, and Astrophysics

Course code:VESUSPH402

Objective: To understand motion of charged particle under different combinations of electric and magnetic field. To develop competence in Programming of microprocessor 8085. To understand basic terms, reactions in astrophysics. To understand Stellar Classification and Life Cycle of a Star.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Understand the interaction between charged particles and electric fields
LO2	Understand the interaction between charged particles and magnetic fields
LO3	Understand the principle of cyclotron and mass spectrograph
LO4	Appreciate the developments that lead to atomic and particle physics
LO5	Understand evolution of microprocessor
LO6	Understand and explain internal architecture of microprocessor 8085
LO7	Differentiate between machine language, assembly language and high level language.
LO8	Develop algorithms to solve given tasks, as a first step towards programming.
LO9	Write flowchart of basic programs.
LO10	Find hex code of the instruction and use it while entering the program.
LO11	Write programs at appropriate locations and execute programs in different make kits by using its manual confidently.
LO12	Use different units in cosmology
LO13	Understand Stellar Classification and Life Cycle of a Star
LO14	Understand different thermonuclear reactions

Unit no.	Details of topics	No of lectures
1	Charged particle dynamics: Kinetic energy of charged particle in an electric field. Motion of a charged particle in constant electric field, charged particle in an alternating electric field, force on a charged particle in magnetic field, charged particle in uniform and constant magnetic field. Motion of charged particle in combine electric and magnetic field. Cyclotron. **HP 13.1 to 13.6,13.6.1**	15 Lectures
2	**Microprocessors** 8085 Microprocessor and Basic Assembly Language Programming. Introduction, Historical Perspective, Organization of a Microprocessor Based system, Machine Language, Assembly Language, High Level Languages, Writing and executing an Assembly Language Program. **RG: 1.1 - 1.4** 8085 Bus Organization, 8085 Programming Model, The 8085 Microprocessor, Pin connection diagram and function of each pin, A detailed look at 8085 Microprocessor. **RG: 3.1, 4.1.1, 4.1.4** Basic definitions: Instruction, Opcode, operand. Instruction word Size, instruction Format, data format, Addressing Modes, 8085 Instruction Set (Classification) Data transfer Operations, Arithmetic Operations, Logical Operations, Branch Operations, Introduction to Advanced Instructions Flowchart. Basic Programming: 8-bit Addition/Subtraction, 8-bit multiplication, Transfer of Data block, Even/odd, Positive/Negative Numbers. **RG: 2.1-2.6**	15 Lectures
3	**Cosmology and Astronomy**: Units in cosmology: length, mass, time scale , Magnitude, (solve problems) light year, parsec, structural hierarchy (large scale structure of the universe) Hubble's law and expansion of the universe (problems) **JVN E - 1.1 , 1.2, 1.3** Types of galaxy, Radio Sources, Quasars, pulsar, Radiation background. **JVNI - 1.3, 1.4 , 1.5 ,1.6 , 1.9** Stellar Classification, Hertzsprung-Russell Diagram, Colours of Stars, Star Sizes, Variable Stars, Star Clusters (globular clusters and open clusters)	15 Lectures

	NSO and SWIN The thermonuclear reactions in Stars: P-P chain and CNO cycle. The mass–luminosity relation, The Schönberg–Chandrasekhar limit. **MS- 5.2.1 and 5.2.2, 5.7,5.8** Life Cycle of a Star : Main Sequence, Red Giant, Planetary Nebula, White Dwarf, Brown Dwarf, Type Ia Supernovae, Red Supergiants, Supernovae, Gamma-ray Bursts, Neutron Stars, Pulsar, Black Holes. **NSO**	

References:

1) RG: Microprocessor Architecture, programming and Applications with the 8085 by Ramesh Gaonkar, 5th Edition, Prentice Hall of India.

2) HP: Mechanics by Hans and Puri
3) R: Atomic Physics by Rajam
4) JVNE: Elements of Cosmology – by Jayant V Narlikar 1996 University press
5) JVNI: Introduction to Cosmology(3rd edition 2002) – Jayant Narlikar Cambridge University Press
6) NSO: https://www.schoolsobservatory.org/learn/astro
4) SWIN: https://astronomy.swin.edu.au/cosmos/S/Stellar+Evolution
5) MS : Evolution of Stars and Stellar Populations - by Maurizio Salaris and Santi Cassisi , John Wiley & Sons Ltd

Additional references:

Fundamentals of Physics by Resnick and Halliday
Introduction to Electrodynamics by Griffiths
Microprocessor and Applications by Vibhute and Borole, Technova Publications, Pune.

Microprocessor, Principles & Applications by Gilmore (2nd Ed) TMH

Course title: Introduction to Crystallography and Quantum Mechanics

Course code:VESUSPH403

Objective: To understand symmetry elements, crystal classifications and basics of crystallography. To understand the foundation of Quantum mechanics and learn its use in different basic problems.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Understand symmetry in nature and crystals
LO2	Draw different planes in a crystal system
LO3	Differentiate different crystal plane
LO4	Understand relation between interplanar spacing and miller indices
LO5	Describe two dimensional and three dimensional crystal systems
LO6	Understand differences between different 2d nets in terms of symmetry
LO7	Demonstrate problem solving skills in crystallography
LO8	Differentiate between concepts and use of classical and quantum mechanics
LO9	Understand origin and foundation of Quantum mechanics
LO10	Understand physics phenomenon which can be explained using Quantum mechanics
LO11	Demonstrate use of Schrodinger equation in solving basic problems
LO12	Understand significance of wave function
LO13	Find out different quantities using wave function

Unit no.	**Details of topics**	**No of lectures**
1	**Crystallography:** Lattice points and space lattice, basis and crystal structure, unit cells and lattice parameters, Primitive cells, Crystal systems, Crystal symmetry, basic symmetry elements, Reflection symmetry, centre of inversion, rotation symmetry (proper rotations). Two dimensional nets, Bravais space lattices. qualitative discussion of point groups and space groups. Miller indices.	15 Lectures

	Metallic crystal structures, relation between the density of crystal materials and lattice constants in a cubic structure, separation between lattice planes in a cubic crystal. **SOP: chapter 4 : II, III, IV, V, VI, VII, XIV, XV, XVI, XVIII, XXII** **KK: chapter 3, Article 9**	
2	**Introduction to Quantum Mechanics :** [Review : Evolution of quantum theory, black body radiation, Photoelectric effect and failure of classical theory and success of quantum theory. Bohr model and its limitations] A critique of the old quantum theory. Classical Mechanics and Quantum Mechanics comparison, wave function and its significance, Well behaved wave function. Illustration of well-behaved wave functions using graphs, equations. Plausibility arguments leading to Schrodinger's equation. Construction of Schrodinger's equation -time dependent form and analogy with classical wave equation. Validity of Schrodinger's equation. Linearity and superposition, Eigenvalue equation, Expectation values, Operators, Schrodinger's equation –steady state form **AB - 5.1 to 5.7, ER 4.12, 5.2, 5.6**	15 Lectures
3	**Applications of Quantum Mechanics** Free states, Free particle, potential step, The rectangular potential barrier (Omit derivation of constants from boundary conditions), The tunnel effect, The emission of alpha particle for a radioactive element, Bound states, Square well potential, particle in a one dimensional box, Particle in a rectangular three dimensional box, Degeneracy **AB 5.8, 5.9, 5.10; SPS - 5.1 to 5.5, 6.1 to 6.3**	15 Lectures

References:

SOP: Solid State Physics by S O Pillai , New age international publishers (seventh edition)
KK: Materials Science, S. L. Kakani and Amit Kakani, New age international publishers
AB: Concepts of Modern Physics by Arthur Beiser, Tata McGraw-Hill edition (sixth edition)
ER: Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles by R.Eisberg and R.Resnick, Wiley student edition (second edition)
SPS: Quantum Mechanics by S.P.Singh, M.K.Bagade, K.singh, S.Chand & Company Ltd.

Additional references:

Crystallography and crystal chemistry an introduction by F. D. Bloss
Introduction to Quantum Mechanics by D.Griffiths
The Breakthrough (Quantum revolution 1 by G.Venkatraman, Uni. Press(India) pvt ltd.
Elementary Solid State Physics by M. Ali Omar

Lab courses consists of skill experiments, regular experiments and Demonstration experiments: Skills are conducted in the beginning of VESUSPHP301 and Demonstration experiments are conducted at the end of VESUSPHP401.

Course Name : Practical IV

Course code: VESUSPHP401

Objective: To get familiar with use of basic instruments in Physics and develop deep understanding of concepts in different concepts studied in theory. To understand corelation between theory and practicals.

Learning Outcomes (LO):

On successful completion of this course students will be able to:

LO1	Use instruments such as Vernier calliper, Screw gauge, multimeter, spectrometer confidently.
LO2	Understand the use of different apparatus without fear and hesitation.
LO3	Demonstrate skills of calculating least count of instruments and use it appropriately.
LO4	Demonstrate careful conduct of Lab experiments.
LO5	Demonstrate appropriate use of multimeter in measuring various quantities
LO6	Demonstrate various experiments in Optics, electronics, microprocessors, few experiments in Crystallography, Quantum Physics and Astrophysics

For practical examination, the learner will be examined in three experiments (one from each group). Each experiment will be of three hours duration, minimum 6 from each group and in all minimum 18 experiments must be reported in journal.
All the demo experiments are required to be completely compulsorily. Students are required to report all these experiments and demo experiments.
A learner will be allowed to appear for the semester and practical examination only if he submits a certified journal of Physics or a certificate that the learner has completed the practical course of Physics Semester IV as per the minimum requirements.

Regular Experiments:

SN.	Group 1	Group 2	Group3
	1. Cauchy's constants 2. Optical lever 3. Determination of wavelength of light using grating 4. Fresnel's bi-prism: determination of λ 5. R.P. of telescope/ 6. Cylindrical obstacle: determination of λ 7. Determination of R.I. of liquid by laser 8. Double refraction 9. Newton's Ring 10. Single slit diffraction 11. Brewster's law: determination of μ 12.	1.Determination of Planck's constant using LED 2. Study of MS-JK flip flop 3. Shift registers 4.Half adder and full adder 5.Study of 3:8 Decoder (74LS138) 6.Study of 8:3 Priority Encoder (74LS148). 7.Indexing of XRD data of cubic structure 8.Counters mod 2,3,5,8 9.Op-Amp as Astable multivibrator 10.Luminosity measurement. 11.Square wave oscillator using gates.	1. Study of 8085 microprocessor kit and commands. 2. 8 -bit addition, subtraction, multiplication 3.Two digit Decimal addition, subtraction. 4.Memory block transfer from one location to another. 5.Find largest/smallest number in given block. 6. Find the number of positive/negative in a given block. 7. Find the number of odd/even elements in a given block. 8.Arrange given number in ascending/descending order

Demonstration Practicals:

1. DAD instruction.
2. Concepts of Betas
3. Hysteresis loop of ferromagnetic material
4. Error analysis of an experiment
5. Straight edge Fresnel diffraction
6. First order active filter.
7. Laser beam profile
8. Frank-Hertz experiment
9. e/m measurement
10. Fabry-Perot etalon
11. Michelson interferometer
12. Plotting of data using gnuplot

References:

1. Advanced course in Practical Physics D. Chattopadhyay, PC Rakshit & B Saha. (6^{th} Edition) Book and Allied Pvt.Ltd.
2. B.Sc practical Physics – Harnam Singh S.Chand & Co. Ld. 2001
3. A test book of advanced practical physics Samir Kumar Ghosh, New Central Book Agency (3^{rd} edition)
4. B.Sc. Practical Physics – C.L. Arora, S.Chand and Co Ltd.
5. Practical Physics , C.L. Squires (3^{rd} Edition Cambridge University
6. University Practical Physics – DC Tayal. Himalaya Publication
7. Advanced Practical Physics – Worsnop and Flint.
8. An Introduction to error analysis The studies of Uncertainties in Physical measurements - by John Taylor.

Modality of assessment

The performance of the learners shall be evaluated into two parts. The learner's performance shall be assessed by Internal Assessment with 25% marks in the first part & by conducting the Semester End Examinations with 75% marks in the second part. Practical Examination will consist of End Sem examination.

Students will have to score 40% of marks in Internal assessment as well as End Sem examination to pass the course.

The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below:-

Internal Assessment: It is defined as the assessment of the learners on the basis of internal evaluation as envisaged in the Credit & Choice based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

Semester End Assessment : It is defined as the assessment of the learners on the basis of Performance in the semester end Theory/ written/ Practical examination.

A. Theory - Internal assessment 25% **25 marks**

Sr No	Evaluation type	Marks
1.	Class Tests (multiple choice type)/ Assignments/Activity /Project/ Seminar presentation/ case study etc.	20
2.	Active participation in routine class activity Overall conduct as a responsible student, with respect to good behaviour, leadership qualities, interpersonal skills etc.	05

B. Theory - External examination - 75% **75 marks**

Semester End Theory Assessment

Duration - Each paper will be of 75 marks and shall be of 2.5 hours duration

There shall be question of 25 marks questions from each unit. There would be one question from each unit with sub questions with internal choices as given below.

Q	Solve any 5 questions out of following eight questions (5 marks each)	25 marks

C. Semester End Practical Assessment **150 marks**

The evaluation of Practical papers will be based on the performance of three experiments.

A	Three experiments /Lab activities	40+40+40 marks
B	Viva	15 marks
C	Journal	15 marks
	Total marks	**150 Marks**

PRACTICAL BOOK/JOURNAL

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Coordinator / In-charge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

SEMESTER IV

Course	Total Marks
VESUSPH401	100
VESUSPH402	100
VESUSPH403	100
VESUSPHP401	150