## VIKRAM UNIVERSITY, UJJAIN



## **Faculty of Science**

M. Sc. (Physics) I Semester (As per Common Ordinance No. 14) Scheme of Examination and Courses of Studies Including Recommended Books for the Examination of year 2018-19 and onwards

Based on Choice Based Credit System (CBCS) and Ordinance 14

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## Scheme of M. Sc. (Physics) I-Semester Examination (from July to December) Choice Based Credit System

Course Code	Course Title	Credits	Equivalent Marks Alloted (End Semester Examination+CCE)	Passing Marks ( As per Item No. 10.4 0f ordinance 14)
PHY-101	Mathematical Physics	4	100 (60+40)	35
Core		roefficients	aldainey drive stiphture la terrable	offic
PHY-102 Core	Statistical Mechanics	4	100 (60+40)	35
PHY-103 Core	Quantum Mechanics-I	4	100 (60+40)	35
PHY-104 Core	Electrodynamics and Plasma Physics	4	100 (60+40)	35
PHY-105 Elective Generic	Entrepreneurship Development	4	100(60+40)	35
PHY-106	Laboratory Course I (Electrical)	6	100	35
PHY-107	Comprehensive Viva voce	4	Examp 100 - CE)	35
Gillion (anniaic) Gillion	Total Credits/Marks	30	700	Automatica
Con	Conparent in the story of the s	g Militerna The Macin	Gerszig Advanced Engineeri D. Rainville: Special Functions (	3.8 3.4
PHY-102 Contributivity	Statistical Mechanics In rol aborbate inclusion	ver Publici Bonce: W	Constraint laised in the	
PHN-103 Core	-solnanooM murrauQ wiley & Sona)	ss) 4 sicists (Joi		nigall 3.5 a.d. 7
PHN=104 Core	Electrodynamics and Plasma Physics	- 4	100 (60+40)	
PHY-105 Elective Generic	Entrepreneurship Development		109(50+40)	
PHY-106	Laboratory Course I (Electrical)		1170~	35
PHY-107	Comprehensive Viva voce	2		35
	Total Credits/Marks		765	

## M. Sc. I Semester PHY – 101 [Mathematical Physics]

#### Unit-I

Vector Spaces and Matrices: Vector Spaces; Base, Dimension, Inner product space, Linear transformations, Matrices; Inverse, Orthogonal and Unitary matrices, Independent elements of a matrix, Eigen values and eigenvectors, Diagonalisation of a matrix, Complete Orthogonal set of functions.

#### Unit-II

Differential Equations and Special Functions: Second order linear Ordinary Differential Equations with variable coefficients; Solution by series expansion; Legendre, Bessel, Hermite and Lagurre equations; Generating functions; Recurrence relations. Physical Applications: Solving one dimensional harmonic oscillator; Schrödinger equation and Hydrogen atom, Schrödinger equation with Lagurre equation.

#### Unit-III

Integral Transforms: Integral transform; Laplace transform; Inverse LT by partial fractions; Solution of initial value problems by LT.

#### **Unit-IV**

Fourier Series and Fourier Transform: Fourier series; FS of arbitrary period; Halfwave expansions; Partial sums; Fourier integral and transforms; FT of delta function; Solution of time dependent problems by FT.

#### Text and Reference Books

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1. G. Arfken: Mathematical Methods for Physics (Academic Press, INC. (London) Ltd.)

2. A. W. Joshi: Matrices and Tensors in Physics (Wiley Eastern Ltd, New Delhi)

3. E. Kreyszig: Advanced Engineering Mathematics (Wiley Eastern Ltd, New Delhi)

4. E. D. Rainville: Special Functions (The Macmillan Company, NewYork)

5. W. W. Bell: Special Functions (Dover Publication Inc.)

4 E. D. Rainville, Sylveint Constiants (11), Association (11)

6. K.F. Reily, M.P. Hobson and S.J. Bence: Mathematical Methods for Physicists and Engineers (Cambridge University Press)

7. Mary L Boas: Mathematics for Physicists (John Wiley & Sons)

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## M. Sc. I Semester PHY – 102 [Statistical Mechanics]

#### Unit-I

Foundations of Statistical Mechanics; Specification of states of a system, Statistical interpretation of the basic thermodynamic variables, Classical ideal gas, Entropy of mixing and Gibb's paradox.

#### Unit-II

Microcanonical ensembles, Phase space, Trajectories and density of states, Liouville's theorem, Canonical and Grand canonical ensembles, Partition function, Calculation of statistical quantities: Energy and Density fluctuations.

#### Unit-III

Density matrix, Statistics of ensembles, Statistics of indistinguishable particles; Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics, Properties of ideal Bose and Fermi gases, Bose-Einstein condensation.

#### **Unit-IV**

Correlation of space-time dependent fluctuations, Fluctuations and transport phenomena; Brownian motion; Langevin theory, Fluctuation dissipation theorem, The Fokker-Planck equation.

### Text and Reference Books

1. F. Reif: Fundamentals of Statistical and Thermal Physics (Mcgraw-Hill Series)

2. K. Huang: Statistical Mechanics (Wiley eastern Ltd.)

3. R. K. Patharia: Statistical Mechanics (Pergamon Press)

4. R. Kubo: Statistical Mechanics (North-Holland Publishing Company, Amsterdam Landon)

5. Landau and Lifshitz: Statistical Physics (Pergamon Press, Oxford)

6. B.B. Laud: Fundamentals of Statistical Mechanics (New Age International Publisher)

#### Unit-[1]

Density matrix, Statistics of ensembles, Statistics of mais Polizingun, Fermi-Diric and Sose-Einstein statistics, Pre gases, Bose-Einstein condensation.



#### Unit-IV

Correlation of space-time dependent fluctuations. Fluctuations and transport phenomenal Brownian motion: Langevin theory. Fluctuation dissipation theorem, The Pocker-Planck equation.

#### Text and Reference Books'

L. P. Reif: Fundamentals of Statistical and Thermal Physics (Megarasized) Scries

2. K. Hummer Statistical Mechanics, Wiley 64 (ern Ltd.)

3 R. K. Patharia: Statistical Mechanics (Perganoon Press)

4. R. Kubo Statistical Mechanics (North-Holland Fublishing Company, Amsterdam Landon)

5. Landau and Lifshitz: Statistical Physics (Constant) Print, Constant

6: R. R. Lands Fundamentals of Statistical Mechanics (Mex-Age hitche Domat Putchaland).

## M. Sc. I Semester PHY – 103 [Quantum Mechanics-I]

#### Unit-I

Inadequacy of classical mechanics, Schrödinger equation, Continuity equation, Ehrenfest theorem, Admissible wave function, Stationary states.One-dimensional problems, Wells and barriers, Harmonic oscillator by Schrödinger and by operator method.

#### Unit-II

Uncertainty relation of x and p, States with uncertainty product, General formalism of wave mechanics, Commutation relations, Representation of states and dynamical variables, Completeness of eigen functions, Dirac-delta function, Bra and Ket notation, Matrix representation of an operator, Unitary transformation.

#### **Unit-III**

Angular momentum in QM, Central force problem, solution of Schrödinger equation for spherically symmetric potentials, Hydrogen atom.

#### Unit-IV

Time independent or stationary perturbation theory; Non-degenerate case; Application such as Stark effect.

#### Text and reference books

1. L I Schiff: Quantum Mechanics (Mcgaw-Hill Book Company)

2. S Gasiorowicz: Quantum Physics (Wiley, New York)

3. J D Powell and B Craseman: Quantum Mechanics (Addison Wesley Publishing Company)

4. A P Messiah: Quantum Mechanics (North - Holland)

S vasiorewiew Ottomatin President 105.

5. J J Sakurai: Modern Quantum Mechanics (Pearson Education, INC.)

6. Mathews and Venkatesan: A text book of Quantum Mechanics (Tata McGraw-Hill Publishing Company Ltd.)

7. A Ghatak & S Loknathan: Quantum Mechanics; Theory and Applications (Macmillan IndiaLtd.)

## M. Sc. I Semester PHY – 104 [Electrodynamics and Plasma Physics]

#### Unit-I

(i) Review of four-vector and Lorentz transformations in four-dimensional space; Covariance form and transformation equations for Lorentz condition, electromagnetic potentials, Lorentz force law, Continuity equation, electric and magnetic field equations and Maxwell's field equations.

(ii) Wave equation for vector and scalar potential and solution, Retarded potential and Leinard- Wiechert Potential, Electric and magnetic fields due to a uniformly moving charge.

#### Unit-II

(i) Reaction force of radiation; Abraham-Lorentz equation of motion.

(ii) Motion of charged particles in electromagnetic field: Uniform E and B fields, Time varying E and B fields.

#### Unit-III

(i) Elementary concept: Plasma oscillations, Debye shielding, Plasma parameters.
(ii)Hydrodynamical description of plasma: Fundamental equations, Hydromagnetic waves: Magneto sonic and Alfven waves.

#### **Unit-IV**

(i) Wave phenomena in magneto plasma: Polarization, Phase velocity, Group velocity, Cut-offs and Resonance for electromagnetic waves propagating parallel and perpendicular to the magnetic field.

(ii) Propagation through ionosphere and magnetosphere.

#### Text and reference books

1. Panofsky and Philips: Classical electricity and magnetism (Addison – Wesley Publishing Company).

2. J.D. Jackson: Classical electrodynamics (Berkley, California, 1974)

3. J.A. Bittencourt: Fundamentals of Plasma Physics (Springer, III Edition)

4. F.F. Chen: Introduction to Plasma Physics (Plenum Press, III Print)

#### Unit-III

(i) Elementary concept: Plasma oscillation. Debye as Appendix memory as a generative of the second se

#### Unit-IV

(i) Wave phenomena in magneto plasma Polarization, Phase velocity. Group velocity, Cut-offs and Resonance for electromagnetic waves propagating parallel and perpendicular to the magnetic field.

(ii) Propagation through ionosphere and magnetosphere.

#### Text and reference books

[ Panolsky and Philips: Classical electricity and magnetism (Academic Vesley Publishing Company).

## M. Sc. I Semester PHY – 105 [Entrepreneurship]

#### **Unit I: Introduction**

Entrepreneurship - meaning, nature, importance, specific traits of Entrepreneurs, , Role of entrepreneurs in Indian Economy.

#### Unit II: Analysis of Entrepreneur opportunities

Defining, objectives, identification, process of sensing, accessing the impact of opportunities and threats.

#### Unit III: Search of Business Idea

Preparing for business plan, legal requirements for establishing of a new unit-procedure for registering business, starting of new venture, product designing / branding, research and development, selection of forms of business organization.

#### **Unit IV: Role of Supportive Organizations**

D.I.C and various government policies for the development of entrepreneurship, Government schemes and business assistance; subsidies, Role of Banks.

#### **Unit V: Market Assessment**

Meaning of market assessment, components and dimensions of market assessment, Questionnaire preparations, survey of local market, Visit to industrial unit, business houses, service sector etc. Submission of Survey based report on one successful / one unsuccessful entrepreneur.

### Text and reference books:

1 Entrepreneurship Development; Dr.C.B.Gupta

2 Dynamics of Entrepreneurial Development and Management; Vasant Desai

3 Innovation and Entrepreneurship; Peter F.Drucker

4 Entrepreneurship Development; G.A.Kaulgud

5 Entrepreneurship-Need of the Hour; Dr.Vidya Hattangadi

6 Entrepreneurship Development; Dipesh D. Uike

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## M. Sc. I Semester PHY – 106 [Laboratory Course –I (Electrical)]

At least 10 practicals based on electricity and general electronics.

## M. Sc. I Semester PHY – 107[ Comprehensive Viva voce]

A Comprehensive viva voce examination will be conducted at the end of each semester of the programme by a board of four examiners.

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## VIKRAM UNIVERSITY, UJJAIN



## **Faculty of Science**

M. Sc. (Physics) II Semester (As per Common Ordinance No. 14) Scheme of Examination and Courses of Studies Including Recommended Books for the Examination of year 2018-19 and onwards

Based on Choice Based Credit System (CBCS) and Ordinance 14

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Course	Course Title	Credits	Equivalent Marks Alloted	Passing
Code			(End Semester Examination+CCE)	Marks (As per Item No. 10.4 0f ordinance 14)
PHY-201 Core	Atomic and Molecular Physics	4	100 (60+40)	35
PHY-202 Core	Classical Mechanics	4	100 (60+40)	35
PHY-203 Core	Quantum Mechanics-II	4	100 (60+40)	35
PHY-204 Core	Electronic Devices	4	100 (60+40)	35
PHY-205 Elective Generic	Communication Skills	4	100(60+40)	35
PHY-206	Laboratory Course II (Non-Electrical)	6	100	35
PHY-207	Comprehensive Viva voce	4	100	35
	Total Credits/Marks	30	700	outpares of
Con	Physic: and service, as	*	and more all	
	Chaisica Aigham		Gi	
PHY 205 Core	, Quantum Machanica-II		G	
PHN -204 Care	Electronic Devices	. 4	- Lubrahaup	
PAN-201 Elective Genutie				
PHA-206	Laboratory Course () (Non-Electriciti)	1	100 Million	
PHY-207	Coquerencial Vision voce			
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## Scheme of M. Sc. (Physics) II-Semester Examination (from January to June) Choice Based Credit System

## M. Sc. II Semester PHY - 201 [Atomic and Molecular Physics]

#### Unit-I

**Raman Spectroscopy:** Introduction: Characteristic properties of Raman Lines; Difference between Raman and Infrared Spectra; Mechanism of Raman Effect: Classical theory of Raman Effect, (a) Effect of vibrations, (b) Effect of Rotation; Quantum theory of Raman Effect, Pure Rotational Raman Spectra, Polarization of light and Raman Effect, Structure determination from Raman and Infrared Spectroscopy, Instrumentation of Raman Spectroscopy.

#### Unit -II

**Electronic Spectroscopy:** Electronic Spectra of Diatomic Molecules, The Born-Oppenheimer Approximation, Vibrational Coarse Structure, Frank-Condon Principle, Dissociation energy and Dissociation Products, Rotational Fine Structure of Electronic-Vibration Transitions, Fortrat Diagram, Predissociation, Applications of Electronic Spectra to Transition Metal Complexes.

#### Unit-III

**Nuclear Magnetic Spectroscopy:** Nuclear Magnetic Resonance, Quantum Description of Nuclear Magnetic Resonance, Instrumentation, Chemical Shift, Spin-Spin Coupling, Applications of NMR Spectroscopy, Limitations of NMR Spectroscopy.

#### Unit-IV

**Electron Spin Resonance Spectroscopy:** Electron Spin Resonance, Types of Substances, Comparison between NMR and ESR, Instrumentation, Presentation of ESR spectrum, Hyperfine Splitting, Determination of g value, Line width, Applications of ESR Spectroscopy.

#### Text and References books

- 1. Gurdeep Chatwal and Sham Anand, *Spectroscopy* (Atomic and Molecular) (Himalaya Publishers)
- 2. C. N. Banwell, Fundamentals of Molecular Spectroscopy. (Tata Mcgraw-Hill Publishers Company Ltd.)
- 3. Gerhard Herzberg, Infrared and Raman Spectra (D. Vannostrand Company, New York)

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Electron Spin Resonance Spectroscopy: Electron Spin Resonance Eps-Subscinets, Comparison (1996), by II 5211 and Contention. Burgeration of spectrum, inspective Spin inc. Description of a value, three weather to this state CMP Security for

of Nuclear Magnetic Renormed, issummer 4 Chan Cars

#### Text and References books

C. Granices Chatwar and Sharp Autors,

### M. Sc. II Semester PHY II – 202 [Classical Mechanics]

#### Unit-I

Constraints and their classifications, D'Alembert's principle, Generalized coordinates; Lagrange's equations, Gauge invariance, Generalized coordinates and momenta; Integrals of motion; Symmetries of space and time with conservation laws.

#### Unit-II

Rotating frames; Inertial forces; Terrestrial and astronomical applications of Coriolis force, Central force; Definition and characteristics, Two-body problem; Kepler's laws and equations, Artificial satellites; Rutherford scattering.

#### Unit-III

The Hamiltonian function, Hamilton's equation of motion, Hamilton's principle, modified Hamilton's principle, Derivation of Hamilton's equation from variational principle, Principle of least action.

#### **Unit-IV**

Canonical transformation, Generating function, Poisson bracket and their properties, Invariance of Poisson bracket with respect to canonical transformation, equation of motion in Poisson bracket form, Hamilton-Jacobi equation, Hamilton's characteristics or principle function, Hamilton-Jacobi equation for Hamilton's characteristic function, Jacobi's identity, Small oscillation, Normal modes and coordinates.

#### **Text and Reference Books**

1. N. C. Rana and P. S. Joag: Classical Mechanics (Mcgraw-Hill Education (India) (P) Ltd.)

2. H. Goldstein: Classical Mechanics (Narosa Publishing House, New Delhi)

3. A. Sommerfeld: Mechanics (Lectures on theoretical Physics Vol.1, Acadmic Press)

4. I. Peroceival and D. Richards: Introduction to Dynamics (Cambridge University Press)5. J. C. Upadhyaya: Classical Mechanics (Ramprasad and Sons)

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#### Text and Reference Gooky

 N. C. Raba and P. S. Joag: Classical Mechanics (Megrav-Hill Education (India) (P) Etd.)

H. Goldslein: Classical Mechanics (Nerosa Publishing House, New Dain).

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## M. Sc. II Semester PHY III – 203 [Quantum Mechanics-II]

#### Unit-I

Variation method, Ground state of helium, Vander wall's interaction, Polarizability of hydrogen, Exchange degeneracy.

#### Unit-II

Time-dependent perturbation theory, WKB method,  $\alpha$ -decay of radioactive nucleus, Penetration of barrier, Adiabatic approximation, Sudden approximation.

#### Unit-III

Identical particles; Symmetric and anti-symmetric wave functions, Collision of identical particles, Spin angular momentum, Spin functions for a many-electron system.

#### **Unit-IV**

Semi classical theory of radiation; Transition probability for absorption and induced emission, Electric dipole and forbidden transitions; Selection rules.

## Text and reference books

- 1. L I Schiff: Quantum Mechanics, (Mcgraw-Hill Education (India) (P) Ltd.)
- 2. S Gasiorowicz: Quantum Physics
- 3. B Craseman and JD Powell: Quantum Mechanics, (Addison Wesley Publishing Company)
- 4. A P Messiah: Quantum Mechanics, (North Holland)
- 5. J J Sakurai: Modern Quantum Mechanics, (Pearson Education, Singapore)
- 6. Mathews and Venkatesan: Quantum Mechanics, (Tata Mcgraw-Hill Publishers Company Ltd.)

Unit-IV

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3. M Sayer and A Mansingle Mansurement of management on and experimental (ssign) in the spectra of the spectra

#### Text und reference limbs.

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- 2. S Carsionwicz: (Manana Physics)
- B Constrain and D Powell: Quantum Methodies, (<u>Splittion</u> Syl-Jey Publishers Company)
- 4. A P Messiah: (Doublem Machanics, (North Hellind)
- 5. J J Sakural, Modern Cast num Mechaniki 13 carson Education, Sangapore)
- Monews and Venkats for Quantum Mitchardss, (Yota Mograw-100) Pupilishers Company 11(4)

## M. Sc. II Semester PHY – 204 [Electronic Devices]

#### Unit-I

(i) **Transistors:** BJT, JFET, MOSFET and MESFET: Structure, working, derivations of equations for I-V characteristics under different conditions, High frequency limits.

(ii) Microwave devices: Tunnel diode, Transfer electron devices (Gunn diode), Avalanche transit time devices, Impatt diodes and parametric devices.

#### Unit-II

(i) Memory devices: Static and dynamic random access memories (SRAM and DRAM), CMOS and NMOS, NON-volatile-NMOS, Magnetic, Optical and Ferroelectric memories, Charge coupled devices (CCD).

(ii) Transistor as a switch, OR, AND and NOT gates; NOR and NAND gates, Boolean algebra, Demorgan's theorem; Exclusive OR gates; Decoder/Demultiplexer data selector/multiplexer; Encoder.

#### Unit-III

**Oscillators:** The phase shift oscillator, Wein bridge oscillator, LC-tunable oscillators, Multivibrator; Monostable and Astable, Comparators, Square wave and triangle wave generators.

#### Unit-IV

Voltage regulators: Fixed voltage regulators, Adjustable voltage regulators, Switching regulators.

#### Text and reference books

- 1. S M Sze: Semiconductor devices, (John Wiley & Sons)
- 2. M S Tyagi: Introduction to semiconductor materials and devices, (John Wiley & Sons)
- 3. M Sayer and A Mansingh: Measurement, instrumentation and experimental design in physics and engineering, (Prentice Hall of India, New Delhi)
- 4. Ajoy Ghatak and K Thyagarajan: Optical electronics, (Cambridge University Press)
- 5. J Millmann and C C Halkias: Integrated electronic: Analog and digital circuits and systems, (Tata Mcgraw-Hill Education, New Delhi)
- 6. G K Mithal: Electronic devices and circuits, (Khanna Publishers)

#### Unit-Ull

Oscillators: The phase shift oscillator. Wein bridge oscillator, I C-tunable oscillators Multivibrator: Monostable and Astable, Comparators, Square wave and triangle wa generators.

#### Unit-1

Voltage regulators: Foxed voltage regulators, Adjustable voltage regulators. Switching regulators.

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#### Text and reference books (

1. S M Szer Semiconductor devices, (John Wiley & Socar

2. M 5 Tyagi: introduction to semicoorductor materials and devices, chan Wiley & Sonah

3. M Sayer and A Monsinght Measurque of instrumentation and experimental design in

## M. Sc. II Semester PHY – 205 [Communication Skills]

#### **Unit I: Introduction:**

Definition, nature, objects, elements and importance of communication, principles and practices, models of communication, types of communication,.

#### Unit II: Communication skills and soft skills

Interviewing and group discussion, resume preparation, etiquette and manners, self management, body and sign language, presentation skills, feedback & questioning technique: objectiveness in argument (Both one on one and in groups).

#### Unit III: Concept to effective communication

Dimensions and directions of communication, means of communication, 7C's for effective communication.

#### Unit IV: Listening skills

Importance of listening skills, good & bad listening , communication channels, types of communication medium- audio, video, digital, barriers of communication.

#### Unit V: public speaking and reporting

effective public speaking and its principles, interpretation and techniques of report writing, letter writing, negotiation skills.

#### Text and reference reading:

Business Communication- Royan and V.lesikar, John D. Pettit, JR.Richard D.Irwin, INC Business communication- K.K. Sinha Business Etiquettes – David Robinson Business communication – Dr. Nageshwar Rao and Dr. R.P. Das Effective business communication- Morphy Richards

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Unit IV: Listening skills importance of belening skills, good A car that the coporate is communication mediume action video, element in the sourcementation

Unit V: public speaking and reporting effective public speaking and its principles, interpretation solv recentques of rewriting letter writing negociation shills

Text and reference renaing: Business Communication - Layan and Value and Toursal People, (B.R. and D.L. and Business communication - L.R. Smith Business Stiguetter - David Rohmson Business communication - Up, Nage, Dward and D.L. R.P. Das Effective business communication - Structure Magnetonication

## M. Sc. II Semester PHY – 206 [Laboratory Course –II (Non-Electrical)]

At least 10 Practicals based on Optics, mechanics etc. (other than electrical based)

## M. Sc. II Semester PHY – 207 [Comprehensive Viva Voce]

A Comprehensive viva voce examination will be conducted at the end of each semester of the programme by a board of four examiners.

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# VIKRAM UNIVERSITY, UJJAIN



## **Faculty of Science**

M. Sc. (Physics) III Semester (As per Common Ordinance No. 14) Scheme of Examination and Courses of Studies Including Recommended Books for the Examination of year 2019-20 and onwards

Based on Choice Based Credit System (CBCS) and Ordinance 14

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## Scheme of M. Sc. (Physics) III-Semester Examination (from July to December) Choice Based Credit System

Course Code	Course Title	Credits	Equivalent Marks Alloted (End Semester Examination+CCE)	Passing Marks (As per Item No. 10.4 0f ordinance 14)
PHY-301 Core	Condensed Matter Physics - I	4	100 (60+40)	35
PHY-302 Core	Nuclear and Particle Physics - I	4	100 (60+40)	35
PHY-303 Core	Advanced Quantum Mechanics-I	4	100 (60+40)	35
PHY-304 Elective Centric (Any One)	A. Advanced Electronics (Digital Electronics) B. Advanced Solid State Physics C. Plasma Physics D. Spectroscopy	dy 1 <b>4</b> Loc ( <i>sed Credi</i> () bodian () <i>N</i> bodian () M bodian	E: and alon + CCE;	35 Mail Mail Mail Mail Mail Mail Mail Mail
PHY-305 Elective Generic	Personality Development	4	100(60+40)	35
PHY-306	Laboratory Course III (General)	6	100 <b>100</b> (boord other	35
PHY-307	Comprehensive Viva	4	100	35
PHY-303	Advancvoceuantum	4	100.(00+40)	35
Core	<b>Total Credits/Marks</b>	30	700	
PHY-304 Elective Centric (Any One)	A. Advanced Electronics (Digital Electronics) B. Advanced Solid State Physics C. Plasma Physics D. Spectroscopy	2	100 (00-50)	35
PHY-305 Elective Generic	Personality Development		100(000-00)	

## M. Sc. III Semester PHY – 301 [Condensed Matter Physics-I]

#### Unit-I

(1) Crystal structure and reciprocal lattice: Crystal structure and Bravais lattice, Primitive unit cell, Wigner Seitz cell, Reciprocal lattice, Brillouin zone.

(2) X-ray diffraction: Bragg formulation, Van Laue formulation of X-ray diffraction, Ewald construction, Laue method, Debye-Scherrer method.

#### **Unit-II**

Lattice vibration, Normal modes of a one-dimensional mono-atomic lattice, Normal modes of one-dimensional diatomic lattice, Two ions per cell, The acoustic and optical modes of vibrations, Connection with the theory of elasticity.

#### **Unit-III**

Band theory-I: Periodic potential and Bloch's theorem, Proof of Bloch theorem, Born-Von-Karman boundary condition, Fermi surface, Density of levels, Schrödinger equation in a weak periodic potential (nearly free electron), Energy bands in one dimension, Construction of Fermi surface.

#### **Unit-IV**

Band theory-II: Tight binding method, Cellular method, Muffin-Tin potential, Augmented Plane wave (APW) method, Orthogonalised plane wave (OPW) method, de Haas- Van-Alphen effect.

#### **Text and References Books**

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Solid State Physics: N. W. Ashcroft and N. D. Mermin (Harcourt Asia PTE Ltd.)
 Introduction to Solid State Physics: C. Kittel (John Wiley and Sons, II and III Ed.)

3. Intermediate Quantum theory of Crystalline Solids: A. E. Animalu (Prentice Hall of India Pvt. Ltd.)

4. Principles of Condensed Matter Physics: Chaikin and Lubensky (Cambridge University Press)

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## M. Sc. III Semester PHY – 302 [Nuclear and Particle Physics -I]

#### Unit-I

Introduction to the Nucleus: Mass, Charge and constitution of the nucleus, nuclear size and the distribution of nucleus. Energies of nucleus, angular momentum. Miscellaneous aspects of nuclear structure, masses and binding energies of nuclei. The liquid drop model and semiempirical mass formula, magnetic dipole moments, electric quadrupole moments.

#### Unit -II

**Experimental nuclear physics:** Accelerators, Synchrocyclotron, proton synchrotron, variable energy cyclotron. Detectors: GM counters, scintillation detectors, semiconductor radiation detector, magnetic Beta-ray spectrometer scintillation, Gamma-ray spectrometer.

#### Unit-III

The nuclear force: the deuteron problem, spin states of two nucleon system effects of Pauli's exclusion principle. Magnetic dipole and electric quadrupole moments of a deuteron, The tensor force, exchange forces, meson theory of nuclear force, The nuclear force as we know it.

#### **Unit-IV**

Nuclear structure: The independent particle model, empirical rules for the ground states of the model, the shell model. The unified model; Vibrational and rotational states.

s formula, magnetic dipole moments, electric quadrupole

#### Text and Reference Books:

1. Introductory nuclear physics by Y.R. Waghmare (oxford and IBH)

2. Concepts of nuclear physics by B.L. Cohen (TMH)

3. Experimental Nuclear Physics by R.M. Singru (Wiley-Eastern)

variable energy cyclotron, Detectors! CM counters, schullation, detectors, scance-radiation detector, magnetic Beta-ray  $c_{\text{exectrometer}}$  scintillation, Gamma-ray spectrometer.

#### Unit-III

The unclear force: the deuteron problem, spin states of two buckton system effects of Pauli's exclusion principle. Magnetic dipole and electric quadrupole moments of a deuteron. The tensor force, exchange forces, meson theory of nuclear force. The nuclear force as we know it.

#### Unit-IV

Nuclear structure: The independent particle model, empirical rules for the ground states of the model, the shell model. The unified model; Vibrational and rotational states.

#### Text and Reference Books:

1. Introductory nuclear physics by Y.R. Waghmare (oxford and IBH)

- 2. Concepts of nuclear physics by B.L. Cohen (TMH)
- 3. Experimental Nuclear Physics by R.M. Singer (Willow Fastern)

## M. Sc. III Semester PHY – 303 [Advanced Quantum Mechanics -I]

#### **Unit-I: Angular Momentum**

Angular Momentum: Time displacement symmetry and conservation of energy, Angular momentum and rotation, Rotational Symmetry and conservation of angular momentum, Degeneracy, Reflection invariance and parity, Eigen values of angular momentum operators, Angular momentum matrices, Pauli's spin matrices. Addition of angular momentum, The possible values of J-Clebsh-Gordan coefficients for  $j_1=j_2=1/2$  and  $j_1=1$ ,  $j_2=1/2$ 

#### Unit-II: Bose, Fermi and Particle and Parastatistics

Identical particles in quantum mechanics and permutation symmetry, Symmetrization postulate, Algebraic approach to Bose and Fermi statistics, Parastatistics, Quantization and spin statistics connection.

#### **Unit-III: Radiation Theory**

The quantum theory of radiation, The Hamiltonian quantization of the radiation field (second quantization), Creation and Annihilation operator.

### Unit-IV: Relativistic Theory

The Klein-Gordon equation, The Dirac equation, Probability and Current densities, Covariance of Dirac equation, Plane wave solutions. The electron in electric and magnetic field. Dirac equation in central potential, Energy levels of hydrogen atom, The hole theory and positrons, Prediction of the spin angular momentum.

#### Text and Reference Books:

1. A.K. Ghatak and S. Loknathan: Quantum Mechanics: Theory and Applications (Macmillan India Ltd.)

2. S. N. Biswas: Quantum Mechanics (Books & Allied (P) Ltd.)

3. Messiah: Quantum Mechanics (Dover Publications)

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 Tea and its present species
 C.A.K. Ghauk and S. Cokhathany Granaday Mechanical Lifeory and Application (Magnifilm India Ltd.)

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### M. Sc. III Semester

#### PHY – 304(A) [Advanced Electronics (Digital Electronics)]

#### **Unit-I: Operational Amplifiers and Gates**

OP-Amp: Operational amplifier, Inverting and non-inverting amplifier, Difference amplifier, Analog Integrator and differentiator. Number Systems: Binary, Decimal, Hexadecimal numbers, BCD, ASCII codes, Boolean algebra, De Morgan's Theorems, Gates: OR and AND gates, NOR, NAND, ex-OR and ex-NOR gates

#### Unit-II: TTL circuits and Karnaugh Maps

TTL circuits: 7400 devices, TTL characteristics, TTL overview, Encoders and Decoders, AND-OR-INVERT gates, Multiplexer, Karnaugh maps and Karnaugh simplification.

### Unit-III: Digital Electronics and system

Arithmetic logic unit: Half adder, Binary adder, 2's compliment, 2's compliment adder and subtractor. Flip-Flops: RS-latches, Level clocking, D-latches and flip-flops, JK master slave flip-flops.

#### Unit-IV: Registers and Memories. No. 11 Sentester

Registers and counters: Buffer registers, Shift register, Ripple counters, Synchronous counters, Ring counters, other counters and Bus-organized computer.

Memories: ROMS, PROMS, EPROMS, RAMS, A small TTL memory, Hexadecimal addresses. reality critical and their any crime an

#### Text and Reference Books:

1. Digital Principles and Application: A. P. Melvino & D. P. Leech (Tata McGraw-Hill Education (P) Ltd.)

2. Op-Amps & Linear Integrated circuits: R. A. Gayakwad (Prentice Hall, 2000)

3. Electronics: D. S. Mathur (S. Chand Publishing)

4. Digital Communications: W. Tomasi (Prentice Hall)

5. Digital Computer Electronics: A. P. Malvino and Brown (Tata McGraw-Hill Education (P) Ltd.) Arithmetic logic unit: Half adder, Binary adder, 2's compliment. 2's compliment adder

and subtractor. Flip-Flops: RS-latches Level clocking. D-latches and hip-flops. JK



Registers and counters: Buffer registers. Shift registers deppie counters. Synchronous Memories: ROMS, PROMS, EPROMS, RAMS, A small TTi memory, Hexadecimal

1. Digital Principles and Application: A. P.6 delvino & D. P. Leech (Tata Mediraw-Hill

2. Op-Amps & Linear Integrated circuits: R. A. Gayakwad (Frendee Hall, 2000)

3. Electromes: D. S. Mathur (S. Chand Publishing)

4. Digital Communications: W. Tomasl (Prentice Hall)

## M. Sc. III Semester PHY – 304(B) [Advanced Solid State Physics]

#### Unit-I

**Elastic constants and elastic waves:** Analysis of elastic strains, Elastic compliance and stiffness constants, Central and non-central forces, velocity of sound and crystal elasticity, Dynamical equations of sound wave propagation in crystal of cubic symmetry. Experimental determination of elastic constants.

#### Unit-II

**Optical Properties:** Electronic properties of alkali halides, Optical and thermal electronic excitation, Ultravoilet spectrum of the alkali halides, Exciton, Influence of lattice defects on electronic levels, ionic polarizability, Restrahlen, polarization waves in ionic crystals. Lyddane- Sachs-Teller relation. Optical effects in semiconductors, Direct and indirect transitions, Free carrier absorption

Luminescence, Excitation and emission. Decay mechanisms, Traps, Thermoluminescence, Electroluminescence, Luminescence in semiconductors and ionic solids.

#### **Unit-III**

**Transport Properties:** Boltzmann transport equation, its application for the study of transport phenomena due to electric and magnetic fields, density and temperature gradients. Solution of Boltzmann equation under relaxation time approximation, Transport coefficients, Scattering mechanisms, Calculation of the relaxation time for scattering due to impurity and thermal vibrations of lattice.

#### Unit-IV

**Ferroelecticity:** Classification and general properties of ferroelectrics, Dipole theory. Thermodynamics of ferroelectric transitions, Low frequency optical phonons, Expriments with strontium titanate. Ferroelectric domains. antiferroelectricity. Piezoelectricity and pyroelectricity.

Thermotumineseduce. Electronic structures solids.

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Encoport Prepartous Boltzmann prosport equalion, in application of the state of transport phenomena due to electric and accounte further can be and temperature gradients. Sphillen of holtements equal 7 or under representation approximation. Transport coefficiently Schweing measurements calculation of the representation for scattering due to impurity and thermal views up of hences.

#### Call-IV

#### Text and Reference Books:

- 1. Introduction to solid state physics- C. Kittel (John Wiley 5th edition).
- 2. Solid state physics- A.J. Dekkar (MachMillan).
- 3. Solid State Physics- Ed Seitz and Turnbull (Academic Press) Vol. 2 and 4.
- 4. The use of Thin Films in Physical Investigation- Ed. J.C. Anderson (Academic Press).
- 5. Energy Band Theory- J. Callaway (Academic).
- 6. Wave Mechanics of Crystalline Solids- R.A. Smith (Chapman and Hall).
- 7. The Theory and Properties of Metals and Alloys- M.F. Mott and Jones (Dover).

Text and Reference Books:

1. Introduction to solid state physics- C. Kittel (John Wiley 5" ud (or, 1997) 11-1100 12 0 Solid side physics- Alto Dottes (MachMillah) america to consist abiant carsenant?

Stagle particle motions/Uniform E and B fields, Gravitational fields, New uniform B field, Grade B drift, cu/vature S von uniform E field, True

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- 14.5 The use of Thirl Films in Physicia Investigation Ed. J. (to Aillesson (Aladomic Pleas).
- 5. Energy Band Theory- J. Callaway (Academic).
- 16. Wowe Mechanics of Crystalinie Sectors Phenosinity (Chapilalatin Juan) pointillapa
- 7. The Theory and Properties of Merals and Alloys- M.F. Morenne cores (Do cerument)

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state plasma. Laser and layer fusion.

Waves in plasmas: Representation of waves group velocity. Plasma assiliations, Electron plasma waves, Sound waves, ion waves, Comparision of electron and ion waves, Electrostatic electron oscillations perpendicular to B. Electrostatic ion waves perpendicular to B. The lower hybrid frequency alsolutinusgicide waves. Experimental applications, Electromagnetic wave perpendicular to B, Cor off and resonances, Electromagnetic wave parallel to magnetic field. Experimental consequences of Magnetisonic waves. The CMLA, diagram.

### M. Sc. III Semester PHY – 304(C) [Plasma Physics]

#### Unit-I

**Occurrence of Plasmas in nature:** Defination of plasma, Concept of temperature, Debye shielding, The plasma parameter, Criteria for plasma, Applications of plasma physics with elementary idea about gas discharges, Controlled thermonuclear fusion, Space physics, Astro-physical Plasma, MHD energy conversion and ion propulsion, Solid state plasma, Laser and laser fusion.

Single particle motions: Uniform E and B fields, Gravitational fields, Non uniform B field, Grade B drift, curvature drift, Non uniform E field, Time varying E field, Time varying B field, Guiding center drifts. The first adiabatic invariant, second adiabatic invariant.

#### Unit-II

**Plasma as fluids:** Relation of plasma physics to electromagnetism, classical treatment of magnetic materials and dielectrics. Dielectric constants of plasma fluids, equations of motion, stress tensor collisions, equations of continuity, equation of state, Complete set of fluid equations.

**Equilibrium and Stability:** Hydromagnetic equilibrium, Concept of diffusion of magnetic field into a plasma, Classification of instability, Resistive drift waves.

#### Unit-III with elementary dod about the like horses. Course like horses

motion stress tensor collastic equal

Waves in plasmas: Representation of waves group velocity, Plasma oscillations, Electron plasma waves, Sound waves, ion waves, Comparision of electron and ion waves, Electrostatic electron oscillations perpendicular to B. Electrostatic ion waves perpendicular to B, The lower hybrid frequency electromagnetic waves. Experimental applications, Electromagnetic wave perpendicular to B, Cut off and resonances, Electromagnetic wave parallel to magnetic field. Experimental consequences of Magnetosonic waves. The C.M.A. diagram.

magnetic materians and dis Royes. Preparate consumate of planate third is equations of

Equilibrium and Sainflast (Is a most git aquilibrium, I despre of diffusion of

#### **Unit-IV**

**Kinetic theory:** Meaning of distribution function, equation of Kinetic theory, Derivation of fluid equation, Landau damping without contour integrations, Meaning of Landau damping. The Kinetic energy of a beam of electrons, Experimental verification.

Solid state plasma: Introduction, parameters and physical laws, Passive electro kinetic wave propagation in an infinite and in a finite medium, Macroscopic model of piezoelectric media, Longitudinal Phonon-Plasmon interactions, Transverse Phonon-Helicon interactions, Solid state plasma technology. Travelling wave amplifiers, High frequency isolator, the oscillator, the madistor.

#### Text and Reference Books:

- 1. Introduction to Plasma Physics- F.F. Chen, Plenum Press, III Print.
- 2. Principles of Plasma Mechanics- B.B. Charkraborty, Wiley Eastern Limited.
- 3. Solid State Plasmas- M.F. Hoyaux, Pion Limited, London, 1970.
- 4. Wave Interactions in solid state plasmas- M.C. Steele and B. Vural, McGraw Hill, New York, 1969.s

Kinetic theory: Meaning of distribution function, equation of Kinetic theory. Derivation of fluid equation, Landra camping withon contain integrations: bic anagoof identica damping. The Kinetic energy of a beam of electrons, Laperimental verification.

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2. Principles of Plasma Mechanics- B.B. Charkrabory, Wiley Ecolory Lutgerschool

3. Solid State Plasmas- M.F. Hoyaux, Pion Limited, London, 1970.

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## M. Sc. III Semester PHY – 304(D) [Spectroscopy]

#### Unit-I

Atomic Spectra: Coupling schemes, LS and JJ couplings in spectra of two valence electron systems.

**Hyperfine structure:** Hyperfine multiplets, Magnetic interaction in single electron spectra, Basic relation Hydrogen like atoms: Relativistic and volume correction.

Width of spectral lines: the different causes of line width, The natural or radiation width, Doppler width, External effects.

Molecular Orbitals: Spectroscopic designations for molecules. The unified atom model, separated atomic model, Molecular orbitals, United-separated atom. Correlation diagrams.

#### Unit-II

**Microwave spectroscopy:** Theory of microwave spectroscopy, Linear Molecules, spherical top molecules, symmetric top molecules, Asymmetric top molecules, The stark effect, Instrumentation for Microwave spectroscopy, Applications of microwave spectroscopy.

**Infrared spectroscopy:** Theory of IR absorption spectroscopy, Linear Molecules, Symmetric top molecules, Asymmetric molecules, Instrumentation, Single beam and double beam, spectrophotometers, Modes of vibration of atoms in polyatomic molecules, Applications of infrared spectroscopy to organic and inorganic compounds and complexes.

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#### Unit-III

**Ultraviolet spectroscopy:** Origin and theory of ultraviolet spectra, choice of solvents, Instrumentation, Application of UV absorption spectroscopy.

#### **Unit-IV**

**X-Ray spectroscopy:** Theory of emission spectra-classical, semiclassical and quantum theory of emission of X-ray lines, X-ray energy level diagrams, selection rules of electric and magnetic dipole and higher multipole transitions, Spin doubles, The T-sum and permanence rules Screening doublets and screening constants, Relative intensities in X-ray spectra, Non-diagram lines (theory). Structure of absorption edges and chemical effects in X-ray absorption spectra. Theory of EXAFS; experimental details and its uses.

#### **Text and Reference Books:**

- 1. Spectroscopy part I & II Strughan and S. Walkar, Chapman and Hall.
- 2. Spectra of Diatomic molecules- G. Herzberg, Vannostrand.
- 3. Atomic spectra- H.E. White, McGraw Hill.
- 4. X-ray spectroscopy- B.K. Agrawal, Springer Verlag.
- 5. Elements of diatomic molecular spectra- H. Brian Dunford, Addission Wesley.

Unit-IV and thereis 91 arms 0 miel when V bas arrows - notice normalized and apparture X-Ray spectro-tapy to theory of a nisk of protocological discontracts of med-apparture theory of emission of X-rad files. After and the protocol discontracted end of Section and magnetic dipole and higher multipole relations, spin occurrer. The t-sum and permanence rules Screening doublets and screening constants, Relative instantities in Xray spectra. Non-clagram lines (theory). Structure of absorption edges and chemical effects in X-ray absorption spectra. Theory of ICARS: experimental dealls and its uses:

#### Text and Reference Books?

- 1. Specifoscopy part I & II Strughan and S. Welker, Chaptaen and Bail.
- 2. Spectra of Diatomic molecules- G. Herzberg, Vannostrand.
- 3. Atomic spectra- H.E. White, McGraw Hill.
- 4 X-ray spectroscopy- B.K. Agrawal, Springer Verlag
- 5. Elements of diatomic molecular spectra- H. Brian Duaford, Acd. Sion Wesley

### M. Sc. III Semester PHY – 305[ Personality Development]

#### **Unit I: Introduction**

Personality development- concept, types, role and impact, developing self awareness, projecting a winning personality.

#### Unit II: Personality assessment

Personality assessment and testing- resume writing- types, contents, formats, interviewing skill, group discussion, JAM sessions, persuasive communication.

#### **Unit III: Communication skill**

Practice on oral/spoken communication skill and testing-voice and accent, feedback and questioning techniques, objectives in an argument.

#### **Unit IV: Presentation skills**

Skills and techniques, etiquette, project/assignment presentation, role play and body language, impression management.

#### Unit V: Personality development activities

Leadership activities, motivation activities, team building activities, stress and time management techniques, creativity and ideation.

sente a sector sector sectors.

#### Text and reference bookss:

Business Communication- Royan and V.lesikar, John D. Pettit, JR.Richard D.Irwin, INC. Personality Development and soft skills- Barun K. Mitra, Oxford Publisher. Personality Development –Rajiv K.Mishra, Rupa Publisher.

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Unit IV: Presentation skiller Stells and techniques, ethics in processing present from role play and bries Inneusze, impression transmented

Guit V: Personality operiorment securities headership activities, donation of endoy teap options activities, tress and a management techniques, creations and drashing.

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### M. Sc. III Semester PHY – 306 [Laboratory Course –III (General)]

At least 10 Practicals based on Solid State, Spectroscopy, Nuclear Physics etc (other than electronics)

## M. Sc. III Semester PHY – 307[ Comprehensive Viva Voce]

A Comprehensive viva voce examination will be conducted at the end of each semester of the programme by a board of four examiners.

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# VIKRAM UNIVERSITY, UJJAIN



## **Faculty of Science**

M. Sc. (Physics) IV Semester (As per Common Ordinance No. 14) Scheme of Examination and Courses of Studies Including Recommended Books for the Examination of year 2019-20 and onwards

Based on Choice Based Credit System (CBCS) and Ordinance 14

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## Scheme of M. Sc. (Physics) IV-Semester Examination (from January to June) Choice Based Credit System

Course Code	Course Title	Credits	Equivalent Marks Alloted (End Semester Examination+CCE)	Passing Marks (As per Item No. 10.4 0f ordinance 14)
PHY-401 Core	Condensed Matter Physics- II	4	100 (60+40)	35
PHY-402 Core	Nuclear and Particle Physics-II	4	100 (60+40)	35
PHY-403 Core	Advanced Quantum Mechanics-II	1. 1. <b>4</b> 13. 10 10. 1	100 (60+40)	35
PHY-404 Elective Centric (Any One)	<ul> <li>A. Microprocessor</li> <li>B. Laser &amp; Applications</li> <li>C. Fiber Optics and Integrated Optics</li> <li>D. Physics of Nano- materials</li> </ul>	Credits Credits	100 (60+40)	35
PHY-405 Skill Development	Minor Working Project Model (Internal)	4	100(60 Project Model +40 Presentation)	35
PHY-406	Laboratory Course IV (Electronics)	6	100	35
PHY-407	Comprehensive Viva voce	4	100 eeta	35
Core	Total Credits/Marks	30	700	-
PHY-404	A. Microprocesso	+	100-60-40)	

Elective B. Lasar a Centric (Any Applications One) C. Fiber Optics and 16 Intagrated Optics D. Physics of Nanomaterials Physics Project

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## M. Sc. IV Semester PHY – 401 [Condensed Matter Physics-II]

#### Unit-I

**Electron dynamics:** The semi-classical model; Motion in a DC electric field, the holes, Motion in a uniform magnetic field, Motion in perpendicular uniform electric and magnetic fields, Hall effect and magneto-resistance.

The semi-classical theory of conduction in metals: The relaxation time approximation, DC electric conductivity, AC electric conductivity, Thermal conductivity.

#### Unit-II

**Defects in Solid:** Number of vacancies and interstitial as a function of temperature, Diffusion: Self-diffusion and chemical diffusion, Fick's law, Edge and screw dislocation, Slip, Burger vector, Dislocation mobility and density, Interaction between dislocations, Color center, Excitons, Elementary idea about luminescence.

#### Unit-III

Semiconductors: Typical semiconductor band structures, effective mass in semiconductors, Cyclotron resonance, Number of carriers in thermal equilibrium: Intrinsic and extrinsic cases, Population of impurity levels in thermal equilibrium; Thermal equilibrium carrier density of impure semiconductors, p-n junction in equilibrium.

#### **Unit-IV**

**Superconductivity:** Experimental surveys, Meissner effect, Heat capacity, Energy gap, Microwaves and infrared properties. Thermodynamics of superconducting transition, London equation, Qualitative idea of BCS theory, Type-I and Type-II superconductors, Super conducting devices, isotope effect, Flux quantization, Single particle tunneling, Josephson tunneling, High Tc superconductors.

#### Text and References Books:

condition for

1. Solid State Physics: Neil W. Ashcroft and N. David Mermin (Harcourt college Publishers)

2. Solid State Physics: C. Kittel (John Wiley and Sons, VII Ed.)

3. Intermediate Solid State Physics: AE Animalu (Prentice Hall of India Pvt. Ltd.)

4. Principle of Condensed matter Physics: Chaikin and Lubensky

5. Elementary Solid State Physics: Ali Omar

Superconductivity: Exp. incurat care, 17

## M. Sc. IV Semester PHY – 402 [Nuclear and Particle Physics -II]

#### Unit-I

**Radioactivity:** Alpha decay, calculation of alpha decay rates. The Gamma-decay, transition probability of gamma decay, many particle configuration transition, internal conversion.

#### Unit-II

**Beta Decay:** experimental observations, shape of beta spectrum, neutrino hypothesis. The Kurie plot, Fermi's theory of beta decay, allowed transitions, parity non-conservation in beta decay and its experimental confirmation.

#### Unit-III

**Nuclear reactions:** Elastic scattering reaction cross section, the collision amplitude, elastic scattering of S-wave neutrons. Scattering of charged particle, cross section in terms of the scattering matrix in the general case. Reaction mechanism, compound nuclear reactions. Statistical model nuclear reaction.

**Nuclear Fission:** Neutron emission in fission, Fissile and fertile materials, theory of fission, Nuclear fission and thermonuclear reactions.

#### Unit-IV

**Fundamental particles (Descriptive):** The particles and force between them. Enumeration of various quantum numbers, properties of the muons, pions, kaons, hyperons, quarks. Partons and the  $J_{\Psi}$  contemporary situation regarding elementary particles.

#### Text and References Books:

1. Introductory nuclear physics by Y.R. Waghmare (oxford and IBH)

2. Concepts of nuclear physics by B.L. Cohen (TMH)

3. Experimental Nuclear Physics by R.M. Singru (Wiley-Eastern)

#### Unit-III

Nuclear reactions: Electic scattering reaction cross section, the contribute amplitude, elastic scattering of S-wave neutrons. Scattering of charactering particle cross section in terms of the scattering matrix in the general case. Reaction mechanismic compound nuclear reactions. Statistics model nuclear reaction.

fission. Nuclear fission and thermonicelear reactions.

#### Unit-IV

Fundamental particles (Lescriptive): The particles and force between them Enumeration of various quantum numbers properties of the moons, prons, knows, hyperons, quarks, Partons and the 35 contemporary situation regarding elementary particles.

#### Text and References Boals:

to Internetizery and lead of source by Y. M. Walder, or S. Oxford and a -

## M. Sc. IV Semester PHY – 403 [Advanced Quantum Mechanics -II]

#### Unit-I

**Scattering Theory:** Differential scattering cross section, Total scattering cross section, Relationship between the scattering cross section to the wave function, the scattering amplitude, Method of partial waves, Expansion of plane wave in terms of partial waves, Scattering by a central potential, the scattering length, Scattering by a square well potential, Resonance scattering.

#### Unit-II

The Born approximation, Criterion for the validity of the Born approximation, Scattering of electrons to atoms.

#### Unit-III

**Elements of Field Quantization:** Quantization of the field, Non-relativistic fields, System of Bosons, System of Fermions, Commutators and anti-commutators, unequal times.

#### **Unit-IV**

Relativistic field, The Klein-Gorden field, Invariant delta functions, The Dirac field, Spins and statistics, covariant anti-commutation relations, Feynman diagrams.

#### Text and Reference Books:

1. V. K. Thankappan: Quantum Mechanics

2. Katiyar: Relativistic Quantum Mechanics and Field

3. A. J. Ghatak and S. Loknathan: Quantum Mechanics; Theory and Applications (Macmillan India Ltd.)

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#### Unit-IV

Relativistic field. The Electronagen is dely fortantial dona interficing. The Elegender as Spins and statistics, constitute and contraction on relations. For any or promise

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## M. Sc. IV Semester PHY – 404(A) [Microprocessor]

#### Unit-I

Microprocessor-I

(a) Introduction to microprocessors

(b) **Programming and languages:** Relationship between electronics and programming. Flowcharts, Programming languages, Assembly languages.

(c) System overview: Computer architecture, Microprocessor architecture, specific microprocessor -8085 only.

#### Unit-II

(a) Data transfer instructions: CPU control instructions, Data transfer instructions, Microprocessor 8085 family only.

(b) Addressing modes I: Concept of addressing mode, Paging concept, Basic addressing modes. Microprocessor-8085 family only

(c) Arithmetic and flags: Microprocessors and numbers, Arithmetic instructions, Flag instructions, Microprocessor 8085 family only.

(d) Logic instructions: The AND instruction, The OR instruction, X-OR, X-NOR and NOT instructions.

#### Unit-III

#### SAP

(a) Bistable multivibrators: Stable state of a binary, Fixed bias transistor binary, Self biased transistor binary.

(b) Simple-as-possible computer (SAP-1): Architecture, Instruction set, Programming, Fetch cycle, Execution cycle, Microprogramming, Schematic diagram.

### Unit-IV

(a) Simple-as-possible computer-II (SAP-2): Bidirectional resistors, Architectures, Memory reference instructions, Registers instruction, Jump and call instructions, Logic instructions.

(b) Simple-as-possible computers (SAP-3): Programming model, Arithmetic instructions, Increments, decrements and multiples Logic instructions.

## Text and Reference Books:

 Microprocessor Architecture Programming and Applications: R. S. Gaonkar.
 Digital Computer Electronics: A. P. Malvino and Brown (Tata McGraw-Hill Education (P) Ltd.)

(a) Bistable multivibrators: Stable state of a binary. Fibe Quitansieror binary, Self

(b) Simple-as-possible comparer (SAP=1)20 Architecture, Instruction set, Programming Feter cycle, Execution cycle, Microprogramming, Schemade Gettring,

#### Unit-IV

(a) Simple-as-possible computer-11 (SAP-2): Bidirectional resistory. Architectures Memory veters in astronomy Paristers in the first state of the human and the state of th

## M. Sc. IV Semester PHY – 404(B) [Laser & applications]

#### Unit-I

**Interaction of radiation with matter:** Stimulated and spontaneous emission, Einstein's A & B coefficients, line broadening mechanisms, gain and absorption coefficients, principles of laser, population inversion, population inversion in three and four level lasers, laser amplification, conductions for laser output.

#### Unit-II

Laser beam output modifications: Q-factor of laser oscillations, laser linewidth, resonators, stable and unstable resonators, a laser cavity, active and passive Q-switching, mode looking, detection of pulsed laser output.

#### Unit-III

**Specific Laser and Pumping Mechanisms:** Solid state rare earth ion lasers and optical pumping, Dye lasers and optical pumping, Electron impact excitation, Excitation Transfer, He-Ne lasers, Rate equation model of population inversion in He-Ne lasers, Radial gain variation in He-Ne laser tubes, CO<sub>2</sub> electric discharge lasers, Gas-Dynamic lasers, Free-Electron lasers, Semiconductor lasers.

#### Unit-IV

**Elementary concepts of nonlinear optics:** operating principles and characteristics, introduction: second order optical susceptibility, parametric up and down conversion, second harmonic generation, third order optical susceptibility, nonlinear refraction and absorption, optical phase conjugation.

#### Unit-V

**Applications of lasers:** Distance and Velocity Measurements, The Laser Gyroscope, Holography: The Essential Principle, Practical Aspects, Optical Communications, Lasers in Medicine: Ophthalmology.

#### Text and Reference Books:

- 1. Introduction to laser physics- K. Shimoda
- 2. An introduction to laser and their applications: D.C. O'shea
- 3. Quantum electronics- A. Yariv
- 4. Optical electronics- A.K. Ghatak and K. Thyagarajan
- 5. Lasers and applications: K. Thyagarajan and A.K. Ghatak
- 6. Lasers: Peter W. Milonni and Joseph H. Eberly.
- 7. Nonlinear Optics- R W Boyd.

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## M. Sc. IV Semester PHY – 404(C) [Fiber optics & integrated optics]

#### Unit-I

Introduction : The optical fiber, comparison of optical fiber with other inter connectors, concept of an optical waveguide, rays and modes, principal of light guidance in optical wave guides, fiber types. Electromagnetic analysis of simplest optical waveguide; basic wave guide equation, propagating modes of symmetric step index planar waveguide, TE modes of symmetric step index planer waveguide, the relative magnitude of longitudinal component of electric and magnetic field, power associated with a mode, radiation modes, leaky modes.

#### Unit-II

Optical fiber waveguides: Scalar wave equation and modes of fiber, modal analysis for step index fiber, fractional power in the cone, modal analysis of parabolic index medium. Attenuation in optical fiber, pulse dispersion in optical fiber, losses at fiber splices, measurement of refractive index profile and spot size of an optical fiber.

#### Unit-III

Optical fiber fabrication and cabling: Material consideration, loss and band width limiting mechanisms, mechanical and thermal characteristics, perform fabrication of multicomponent glass fibers, mechanical consideration for optical fiber cabling, fiber cable design, example of cable design. Applications: fiber optic components and devices, fiber optic sensors.

#### Unit-V

EM wave propagation in anisotropic crystals: Index ellipsoid, index ellipsoid in presence of external electric field. Electrooptic (EO) effect in KDP crystals; EO devices, Acoustooptic (AO) effects. Raman-Nath and Bragg AO effect. AO devices.

#### Text and Reference Books:

1. An introduction to optical fibers- A. H. Cherin

- 2. Optical electronics- A. Ghatak & K. Thyagarajan
- 3. Optical fiber communication G. Kasser
- 4. Theory of dielectrics optical waveguides D. Marcuse
- 5. Fiber optics technology & applications- S.D. Personick
- 6. Fiber optics- N. S. Kapany
- 7. Integrated optics- D. Marcuse
- 8. Integrated optics- T. Tamir
- tenistics, perform telefication of 9. Electromagnetic principle of integrated optics- D. Lee

10. Fiber Optic Communication System- G P Agrawal

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## M. Sc. IV Semester PHY – 404(D) [Physics of Nano materials]

#### Unit-I

Systematic Development of Materials: Solid materials and their strength, Perspective of length, Nanoscience and nanotechnology, Nanostructures in nature, Quantum structures, Quantum confinement, Surface effects of nanomaterials, Prime materials, Carbon nanostructures, Metal Oxides, Bright future of nanotechnology.

#### Unit-II

Methods of Generation of Nanomaterials: Nanomaterials synthesis, Physical approaches; Arc discharge method, Laser ablation, Aerosol synthesis, Inert gas condensation, High energy ball milling, Chemical vapor deposition, Plasma synthesis method, Electro-deposition. Chemical approaches; Solvothermal synthesis, Hydrothermal Synthesis, Reverse micellar/ Micro-emulsion method, Sol gel synthesis, Microwave method, Sonochemical process, Co-precipitation.

#### Unit-III

**Properties of Nanomaterials:** Mechanical behavior, Optical Properties, Electrical Properties, Dielectric materials and properties, Magnetic properties, Electrochemical properties, Chemical sensing properties.

#### Unit-IV

aporeaches:

Applications of Nanomaterials: Nanomaterials in medicine, energy sector, next generation computer technology, catalysis, water purification, communication sector, food, fabric industry, for the environment, automobiles, ceramics industry, veterinary applications.

#### Text and Reference Books:

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1. Principles of Nanoscience and Nanotechnology; M.A. Shah & Tokeer Ahmad (Narosa) 2010.

2. Physics of Nanostructures; K.P. Jain (Narosa) 1987.

3. Physics of Low dimensional semiconductors; John H. Davies (Cambridge University Press).

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#### M.Sc. IV Semester

#### PHY-405 [Working Project Model (Internal)]

A working model should be developed and its model and write-up should be submitted. A presentation based on it would be arranged.

#### **M.Sc. IV Semester**

#### PHY-406 [Laboratory Course - IV (Electronics)]

At least 10 experiments based on digital electronics and microprocessor.

## M. Sc. II Semester PHY – 407 [Comprehensive Viva Voce]

A Comprehensive viva voce examination will be conducted at the end of each semester of the programme by a board of four examiners.

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