BHAKTA KAVI NARSINH MEHTA UNIVERSITY
JUNAGADH 362263

SYLLABUS

Faculty of Science

M.Sc. - Physics

Semester – II

Under Choice Based Credit System (CBCS)

Effective From June - 2019

Syllabus

MASTER OF SCIENCE

SEMESTER – II

PHYSICS

Choice Based Credit System (CBCS)

M.Sc. PHYSICS
(CBCS)
Semester-II

DEPARTMENT OF PHYSICS
Bhakta Kavi Narsinh Mehta University Junagadh

Effective from June 2019

M. Sc. (Physics) Program
Choice Based Credit System
(CBCS)
Semester-I to IV

The Master of Science (M.Sc.) PHYSICS programme with Choice Based Credit System (CBCS) comprises of total **16 theory papers** classified as TWELVE core (compulsory) theory papers, FOUR elective (optional) theory papers to be selected out of 12 elective papers. It is to be noted that out of the 12 core compulsory papers, two papers *"Physics and Chemistry of nano-materials"* and "*Experimental Techniques with interdisciplinary applications"* are of *interdisciplinary nature* so that the students of Chemistry, Bio-sciences, Electronics and Pharmaceutical sciences can take these courses. The students will get a choice to select any two elective theory papers out of a set of six elective theory in semester-3 and two elective theory papers in semester-4 out of the six offered elective papers. However, the Department will offer a set of elective papers at the beginning of third and fourth semester depending upon the availability of teachers in the Department. In each semester, there will be 4 theory papers and one Practical course. Examination in each theory paper will be of 2½ hours duration and will carry 70 marks and each practical and/or project examination of 3 hours duration and of 200 marks. This 200 marks will consist of 150 marks for the practical's and/or project and 50 marks for Viva-voce.

As regards the Practical's, the students shall perform general practical's during Semester-I to IV. The students may also be allowed to perform Project work in Semester-IV which can be experimental or theoretical. The students can also take-up in-depth and detailed study of a specific topic in Physics as a project work. In case of project work the students are required to submit a dissertation (project report) at the end of Semester-IV and also required to make presentation of the project work during practical examination. In Semester-IV for the students taking up projects, the bifurcation of marks for practical's examination will be as follows: Practical (75 marks) + Project work (75 marks) + Viva voce (50 marks) = 200 marks.

The educational tour will be conducted for the students for exposure to the advanced technology, equipments and research facilities in national laboratories, institutes and industries in accordance with their study of elective papers, interdisciplinary papers and projects upon receiving proposal for educational tour from the concerned teachers.

The M. Sc. (Physics) CBCS Course is full time and is divided into 4 semesters (2 years) Grant of term (admission to examination) will be based on satisfactory attendance as per the University rules. The Course Structure of the M. Sc. (Physics) CBCS Program Semester-I to IV is summarized as follows:

The Course Structure of the M.Sc. (Physics) Program Semester-I to IV
M.Sc. Physics Four Semester course: Total Credits: 96 Total marks: 2400

Semester I	Course	No. of hrs/wk	Credits	Marks
THEORY (includes lectures, tutorials and assignments)	Core Theory Courses - 1 – 4	16	16	400
PRACTICALS	Practical Course – 1 (includes experimental work, data analysis, library work and viva-voce preparation)	08	08	200
	Total	**24**	**24**	**600**

Semester II	Course	No. of hrs/wk	Credits	Marks
THEORY (includes lectures, tutorials and assignments)	Core Theory Courses - 5 – 8	16	16	400
PRACTICALS	Practical Course – 2 (includes experimental work, data analysis, library work and viva-voce preparation)	08	08	200
	Total	**24**	**24**	**600**

Semester III	Course	No. of hrs/wk	Credits	Marks
THEORY (includes lectures, tutorials and assignments)	Core Theory Course - 9	04	04	100
	Core Theory Course - 10	04	04	100
	Elective Courses 1 - 2	08	08	200
PRACTICALS	Practical Course – 3 (includes experimental work, data analysis, library work and viva-voce preparation)	08	08	200
	Total	**24**	**24**	**600**

Semester IV	Course	No. of hrs/wk	Credits	Marks
THEORY (includes lectures, tutorials and assignments)	Core Theory Course-11	04	04	100
	Core Theory Course-12	04	04	100
	Elective Courses 3 - 4	08	08	200
PRACTICALS AND PROJECTS	Practical Course – 4 (includes Practicals and/or Project work)	08	08	200
	Total	**24**	**24**	**600**
		Total	**96**	**2400**

Theory Papers

The titles of the core theory papers and elective theory papers are given below. The core theory papers (CT-1 to CT-12) are compulsory for all the students.

The Department shall announce a set of six Elective theory papers to be offered on the beginning of Semester-III and IV. A student can choose any two elective theory papers out of a set of six elective papers in Sem-3 and similarly two elective papers out of a set of six elective papers. However, number of elective theory papers will be offered depending upon the availability of expert faculty members.

A student shall study total 16 theory papers during the M.Sc. Physics four semester programme.

Titles of Core Theory Courses CT1 – CT12 (Compulsory for all students) and Elective papers (ET1 to ET12).

Semester: 1

CT1	Mathematical Physics and Classical
CT2	Mechanics Solid State Electronic Devices and
CT3	Circuits Quantum Mechanics - 1
CT4	Electrodynamics and Plasma Physics

Semester: 2

CT5	Quantum Mechanics - 2 and Statistical Mechanics
CT6	Atomic and Molecular Physics
CT7	Space Physics
CT8	Solid State Physics

Semester: 3

CT9	Nuclear and Particle Physics
CT10	Physics and Chemistry of Nano-materials

Six Elective Theory Papers: (a student has to select any two out of the following)

ET1	Synthesis of Materials
ET2	Physics of ionosphere-magnetosphere system
ET3	Space Technology
ET4	Analog and Digital Systems
ET5	Nuclear Radiation Detectors & Accelerators
ET6	Neutron Physics and Nuclear Reactor Theory

Semester: 4

CT11	Numerical Analysis and Computer Programming
CT12	Experimental Techniques with interdisciplinary applications

Six Elective Theory papers: (a student has to select any two)

ET7	Materials Characterization
ET8	Functional Materials
ET9	Remote sensing and Applications
ET10	Pulse & Microwave Electronics
ET11	Electronic Communications
ET12	Nuclear Reactions, Nuclear Energy and Nuclear Models

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-II

Core Paper: CT-5: Quantum Mechanics – II and Statistical Mechanics

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Quantum Mechanics-II and Statistical Mechanics (CT-5)
Course (Paper) Unique Code: 1603010502020500
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	2	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks
Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Semester-2

Course Content

Unit 1 **08 hrs**

Classical Statistical Mechanics

The postulate of classical statistical mechanics, Derivation of thermodynamics, Classical ideal gas, Gibbs Paradox

Canonical Ensembles and Grand Canonical Ensembles

Canonical Ensemble, Energy fluctuations in canonical ensemble, Grand canonical ensemble, Density fluctuations in grand canonical ensemble

Unit 2 08 hrs Quantum Statistical Mechanics

Postulate of Quantum Statistical mechanics, Density matrix, Macro – Canonical ensemble, canonical ensemble, The ideal gases, Micro – canonical ensemble

Unit 3 08 hrs Super Fluids

Liquid Helium, Why helium does not solidify? Tisza‟s two – fluid model

The Ising Model

Definition of the Ising model, Lattice gas, Binary alloys

Unit 4 **08 hrs**

Scattering Theory

Kinematics of the scattering process, Differential and total cross – sections, Wave mechanical picture of scattering, The scattering amplitude, Green‟s functions, Formal expression for the scattering amplitude, Born approximation, The screened Coulomb potential, Validity of Born approximation, Born series, The eikonel approximation

Unit 5 **08 hrs**

Partial Wave Analysis

Definition of partial waves, Asymptotic behavior of partial waves: phase shifts (a) partial waves (b) asymptotic form of radial function (c) phase shifts, The scattering amplitude in terms of phase shifts, The differential and total cross – sections, Optical theorem, Phase shifts: Relation to the potential, Expression for the phase shift

References Books

1. Statistical Mechanics – K. Huang (Wiley)
2. Quantum Mechanics – Mathews and Vankatesan

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-II

Core Paper: CT-6: Atomic and Molecular Physics

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Atomic and Molecular Physics (CT-6)
Course (Paper) Unique Code: 1603010602020600
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	2	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks
Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Semester-2

Course Content

ATOMIC PHYSICS

Unit 1 **08 hrs**

Electronic Spectroscopy Of Atoms

The Structure of Atoms

The shape of Atomic Orbitals; Atomic Quantum Numbers – The Energies of Atomic Orbitals; Hydrogen Atom Spectrum

Electronic Angular Momentum

Orbital Angular Momentum – Electron Spin Angular Momentum – Total Electronic Angular Momentum – The Fine Structure of the Hydrogen Atom Spectrum

Many-Electron Atoms
The Building-Up Principle – The Spectrum of Lithium and Other Hydrogen-like Species
The Angular Momentum of Many-Electron Atoms
Summation of Orbital Contributions – Summation of Spin Contributions – Total Angular Momentum – Term Symbols

Unit 2 **08 hrs**
The Vector Atom Model
Quantum Numbers Associated with the Vector Atom Model – Coupling Schemes: The L-S Coupling, The j-j Coupling – Important Principles: Pauli‟s Exclusion Principle, The Selection Rules, The Intensity Rules, The Interval Rule, The Lande Splitting Factor "g" – Magnetic Moment Due to Orbital Motion; The Bohr Magneton – Magnetic Moment Due to Electron Spin – Zeeman Effect – Paschen-Back Effect – Stark Effect

MOLECULAR PHYSICS
Unit 3 08 hrs Rotation of Molecules

Classification of Molecules, Interaction of Radiation with Rotating Molecule, Rotational Spectra of Rigid Diatomic Molecules, Isotope Effect in Rotational Spectra, Intensity of Rotational Lines, Non-rigid Rotator, Linear Polyatomic Molecules

Unit 4 **08 hrs**
Symmetric Top Molecules, Asymmetric Top Molecules, Stark Effect, Microwave Spectrometer, *Infrared Spectroscopy*: Vibrational Energy of a Diatomic Molecule; The Morse Curve and the Energy Levels of a Diatomic Molecule, Infrared Spectra (Preliminaries)

Unit 5 **08 hrs**
Vibrating Diatomic Molecule, Diatomic Vibrating Rotator, Normal Vibrations of CO_2 and H_2O Molecules, Interpretation of Vibrational Spectra, I-R Spectrophotometer-Instrumentation

References Books

1. Fundamentals of Molecular Spectroscopy by Colin N. Banwell (Tata MacGraw-Hill, New Delhi)
2. Atomic Physics by J. B. Rajam (S. Chand & Company, New Delhi)
3. Molecular Structure and Spectroscopy by G. Aruldhas (Prentice - Hall of India, New Delhi)
4. Elements of Spectroscopy by Gupta-Kumar-Sharma (Pragati Prakashan, Meerut)
5. Introduction to Atomic Spectra by H. E. White (Tata McGraw Hill, New Delhi)
6. Spectroscopy Vol. 1, 2 & 3 by Straughan B. P. and Walker M. A. (Chapman and Hall, London)
7. Spectra of Atoms and Molecules by Peter Bernath (Oxford Uni. Press, USA)
8. Atomic Spectroscopy by K. P. Rajappan Nair (MJP Publishers, Chennai)
9. Atom, Laser and Spectroscopy by S. N. Thakur – D. K. Rai (PHI Learning Private Ltd., Delhi)

10. Introduction to Atomic and Molecular Spectroscopy by Vimal Kumar Jain (Narosa Publishing House, New Delhi)
11. Atomic & Nuclear Physics by C. R. Basu (New Central Book Agency Pvt. Ltd., Culcutta)
12. Atoms, Molecules and Lasers by K. P. Rajappan Nair (Narosa Publishing House, Delhi)
13. Introduction to Molecular Spectroscopy by G. M. Barrow (McGraw-Hill, New York)

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Semester-2

FACULTY OF SCIENCE
M. Sc. (Physics) Semester-II

Core Paper: CT-7: Space Physics

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Space Physics (CT-7)
Course (Paper) Unique Code: 1603010702020700
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	2	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks
Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Semester-2

Course Content

Unit 1 **10 hrs**

Basic Concepts of Earth's Atmosphere

Atmospheric nomenclature, Hydrostatic equation scale height, Geopotential height, Exosphere and gaseous escape, Chemical concepts of atmosphere, Thermodynamic considerations, elementary chemical kinetics composition and chemistry of middle atmosphere and thermosphere. Thermal balance in the atmosphere, models of neutral atmosphere (CIRA, US Standard atmosphere)

Unit 2 12 hrs Solar Radiation and its Effects on the Atmosphere

Solar radiation at the top of the atmosphere, Attenuation of solar radiation in the atmosphere, radiative transfer, thermal effect of radiation, photochemical effects of radiation, Airglow

Structure and Variability of Earth's Ionosphere

Introduction to ionosphere, photochemical processes, Chapman‟s theory of photo ionization, production of ionospheric layers, loss mechanisms and chemistry of ionospheric regions, morphology of the ionosphere

Unit 3 08 hrs Ionosphere Propagation and Measurement Techniques

Effect of Ionosphere on radiowave propagation, Refraction, Dispersion and polarization, Magnetoionic theory, critical frequency and virtual height, Oblique propagation and maximum usable frequency, Ground based techniques: ionosondes, radars, scintillation and TEC, ionospheric absorption, rocket and satellite borne techniques: Langmuir probe, electric field probe mass spectrometer

Unit 4 **06 hrs**

Elements of Solar Physics

Structure and composition of the Sun, sun as a source of radiation, sunspots an solar cycles, solar flares, coronal mass ejection

Magnetosphere of Earth

Solar wind and its characteristics, Interplanetary magnetic field and sector structure, Formation of geomagnetic cavity, magnetopause, magnetosheath and bow shock, polar cusp and magnetotail, Plasmasphere and Van Allen radiation belts

Unit 5 04 hrs Concepts and Foundations of Remote Sensing

Energy sources and Radiation principles, Energy interactions in the atmosphere, energy interactions with earth surface features, Data acquisition and Interpretations, Reference data, The Global Positioning System An ideal remote sensing system, Characteristics of real remote sensing system, Practical applications of remote sensing, Land and Geographic Information System

References Books:

1. Physics of the Space Environment T.I. Gombosi, (CUP)
2. The Solar-Terrestrial Environment: JK. Hargreaves (CUP)
3. Remote Sensing and Image Interpretation: T.M. Lillesand and R.L. Kiefer, (John Wiley & Sons, 4th Edition)

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FACULTY OF SCIENCE
M. Sc. (Physics) Semester-II

Core Paper: CT-8: Solid State Physics

Syllabus

Faculty Code: 03 Subject Code: 01 Level Code: 02
Name of Programme: M.Sc. Subject: PHYSICS
Course (Paper) Name & No.: Solid State Physics (CT-8)
Course (Paper) Unique Code: 1603010802020800
External Examination Time Duration: 2½ hours

Name of Programme	Semester	Course Group	Credit	Internal Marks	External Marks	Practical /Viva Marks	Total Marks
M.Sc.	2	Core	04	30	70	--	100

Total Contact hours: 48 (Including tutorials)

Structure of Question paper for Semester end Examination
Maximum Marks: 70 and Time: 2½ hours
All FIVE questions are of equal weightage: 14 marks
Q.1 Answer the following: Any SEVEN out of TEN objective type short questions from whole syllabus, 2 marks each
Q.2 Answer the following : Any two out of three questions (7 marks each)
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
OR
Q.3 Answer the following : a,b,c/a,b , 5,5,4 OR 7 marks each (all compulsory)
Q.4 Answer the following : Any two out of three questions (7 marks each)
Q.5 Answer the following : Any TWO out of FOUR questions (7 marks each)

Semester-2

Course Content

Unit 1 **08 hrs**

Physics of Crystalline Solids

Crystalline State, Basic Definitions, Bravais and Non-Bravais Lattices, Elements of Symmetry, Crystal Planes and Miller Indices, Examples of Simple Crystal Structures, Principals of X-Ray, Neutron and Electron Diffraction in Crystalline Solids, Bragg‟s Law, Concept of Reciprocal Lattice, Experimental Techniques of X-Ray Diffraction

Defects in Solids

Types of Defects - Point Defects, Line Defects, Plane Defects, Grain Boundaries, Stacking Faults, Diffusion in Solids

Unit 2 **08 hrs**

Band Theory of Solids

Electron in Periodic Potential, Bloch Theorem, Kronig-Penney Model, Effective Mass, Tight Binding Approximation, Brillouin Zones, Cellular and Pseudo Potential Methods, Fermi Surfaces, De Hass Van Alfon Effect, Cyclotron Resonance, Classification of Solids, Limit of Band Theory – Metal Insulator Transition

Unit 3 08 hrs Superconductivity

Definition, Types of Superconductors, Properties, Meissner Effect, Isotope Effect, BCS Theory – Qualitative Approach, Outcomes of BCS Theory, Josephson Effects, SQUID, Applications of Superconductivity

Unit 4 08 hrs Diamagnetism and Paramagnetism

Classical Theory, Paramagnetism – Origin of Paramagnetic Moment, Langevin‟s Theory, Quantum Theory, Paramagnetism in Rare Earth and Iron Group Ions, Paramagnetism of Conduction Electrons

Unit 5 **08 hrs**

Ferromagnetism, Antiferromagnetism and Ferrimagnetism

Weiss Theory, Temperature Dependence of Saturation Magnetization (M_S), Heisenberg‟s Exchange Model, Slater‟s Criterion, Concept of Magnons, Ferromagnetic Domains, Origin of Domains, Antiferromagnetism and Ferrimagnetism, Ferrites

References Books:

1. Introduction to Solid State Physics - C. Kittel (Wiley Eastern)
2. Elementary Solid State Physics - M. Ali Omar (Addison Wesley)
3. Elements of solid state physics - J. P. Srivastava (Prentice Hall India)
4. Solid State Physics - M.A. Wahab (Nerosa Publishers)
5. Solid State Physics - Dan Wei (Cengage Learning)

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