University of Mumbai

Website – mu.ac.in
Email id - dr.aams@fort.mu.ac.in
aams3@mu.ac.in

Academic Authorities,
Meetings &Services (AAMS)
Room No. 128, M. G. Road, Fort,
Mumbai – 400 032.
Tel.022-68320033

Re- accredited with A ++ Grade (CGPA 3.65) by NAAC
Category- I University Status awarded by UGC

No. AAMS_UGS/ICC/2024-25/247 Date: 06th March, 2025

CIRCULAR:-

All the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Departments is invited to this office Circular No. AAMS_UGS/ICC/2024-25/14 dated 01st July, 2024 relating to the revised syllabus T.Y.B.Sc. (Physics) – (Sem V & VI) (CBCS).

They are hereby informed that the recommendations made by the **Board of Studies in Physics** at its meeting held on 09th January, 2025 and subsequently passed by the Board of Deans at its meeting held on 27th January, 2025 **vide** Item No. 6.3 (R) have been accepted by the Academic Council at its meeting held on 27th January, 2025 **vide** item No. 6.3 (R) and that in accordance therewith syllabus for T.Y.B.Sc (Physics) (Sem V &VI) (CBCS) Major 75:25 was revised as per appendix with effect from the academic year 2024-25.

(The Circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
06th March, 2025

(Dr. Prasad Karande)
REGISTRAR

To

All the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Departments.

AC./6.3(R) 27/01/2025

Copy forwarded with Compliments for information to:-

1) The Chairman, Board of Deans,
2) The Dean, Faculty of Science & Technology,
3) The Chairman, **Board of Studies in Physics**
4) The Director, Board of Examinations and Evaluation,
5) The Director, Department of Students Development,
6) The Director, Department of Information & Communication Technology,
7) The Director, Centre for Distance and Online Education (CDOE) Vidyanagari,
8) The Deputy Registrar, Admission, Enrolment, Eligibility & Migration Department (AEM),

Copy forwarded for information and necessary action to :-	
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), dr@eligi.mu.ac.in
2	The Deputy Registrar, Result unit, Vidyanagari drresults@exam.mu.ac.in
3	The Deputy Registrar, Marks and Certificate Unit,. Vidyanagari dr.verification@mu.ac.in
4	The Deputy Registrar, Appointment Unit, Vidyanagari dr.appointment@exam.mu.ac.in
5	The Deputy Registrar, CAP Unit, Vidyanagari cap.exam@mu.ac.in
6	The Deputy Registrar, College Affiliations & Development Department (CAD), deputyregistrar.uni@gmail.com
7	The Deputy Registrar, PRO, Fort, (Publication Section), Pro@mu.ac.in
8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
9	The Deputy Registrar, Research Administration & Promotion Cell (RAPC), rapc@mu.ac.in
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in ar.tau@fort.mu.ac.in
11	The Deputy Registrar, College Teachers Approval Unit (CTA), concolsection@gmail.com
12	The Deputy Registrars, Finance & Accounts Section, fort draccounts@fort.mu.ac.in
13	The Deputy Registrar, Election Section, Fort drelection@election.mu.ac.in
14	The Assistant Registrar, Administrative Sub-Campus Thane, thanesubcampus@mu.ac.in
15	The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan, ar.seask@mu.ac.in
16	The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri, ratnagirisubcentar@gmail.com
17	The Director, Centre for Distance and Online Education (CDOE), Vidyanagari, director@idol.mu.ac.in
18	Director, Innovation, Incubation and Linkages, Dr. Sachin Laddha pinkumanno@gmail.com
19	Director, Department of Lifelong Learning and Extension (DLLE), dlleuniversityofmumbai@gmail.com

Copy for information :-	
1	P.A to Hon'ble Vice-Chancellor, vice-chancellor@mu.ac.in
2	P.A to Pro-Vice-Chancellor pvc@fort.mu.ac.in
3	P.A to Registrar, registrar@fort.mu.ac.in
4	P.A to all Deans of all Faculties
5	P.A to Finance & Account Officers, (F & A.O), camu@accounts.mu.ac.in

To,

1	The Chairman, Board of Deans pvc@fort.mu.ac.in
2	**Faculty of Humanities,** **Dean** 1. Prof.Anil Singh Dranilsingh129@gmail.com **Associate Dean** 2. Dr.Suchitra Naik Naiksuchitra27@gmail.com 3.Prof.Manisha Karne mkarne@economics.mu.ac.in
	Faculty of Commerce & Management, **Dean** 1. Dr.Kavita Laghate kavitalaghate@jbims.mu.ac.in **Associate Dean** 2. Dr.Ravikant Balkrishna Sangurde Ravikant.s.@somaiya.edu 3. Prin.Kishori Bhagat kishoribhagat@rediffmail.com

	Faculty of Science & Technology **Dean** 1. Prof. Shivram Garje ssgarje@chem.mu.ac.in **Associate Dean** 2. Dr. Madhav R. Rajwade Madhavr64@gmail.com 3. Prin. Deven Shah sir.deven@gmail.com
	Faculty of Inter-Disciplinary Studies, **Dean** 1.Dr. Anil K. Singh aksingh@trcl.org.in **Associate Dean** 2.Prin.Chadrashekhar Ashok Chakradeo cachakradeo@gmail.com
3	Chairman, Board of Studies,
4	The Director, Board of Examinations and Evaluation, dboee@exam.mu.ac.in
5	The Director, Board of Students Development, dsd@mu.ac.in DSW direcotr@dsw.mu.ac.in
6	The Director, Department of Information & Communication Technology, director.dict@mu.ac.in

AC – 27/01/2025
Item No. 6.3 (R)

University of Mumbai

Revised Syllabus for

T.Y.B.Sc. (Physics)

(Sem V and VI)

(Choice Based Credit System)

(With effect from the academic year 2024-25)

University of Mumbai

Syllabus for Approval

Sr.No.	Heading	Particulars
1	**O: _____ Title of Course**	T.Y.B.Sc. (Physics)
2	**O: _____ Eligibility**	As per University Ordinance
3	**R: _____ Passing Marks**	40
4	**No. of years/Semesters:**	1 Year (2 Semesters)
5	**Level:**	U.G.
6	**Pattern:**	Semester
7	**Status:**	Revised
8	**To be implemented from Academic Year :**	From Academic Year: 2024-25

Chairman,
Prof. Dr.T.N.GHORUDE
Board of Studies in
Physics

Sign of the
Offg. Associate Dean
Dr.Madhav R.Rajwade
Faculty of Science
&Technology

Sign of the
Offg. Dean
Prof.Shivram S.Garje
Faculty of Science
&Technology

T.Y.B.Sc. (Physics) Syllabus:

To be implemented from the Academic year 2024-2025.

SEMESTER V				
Theory				
Course	**UNIT**	**TOPICS**	**Credits**	**Lectures per Week**
USPH501	I	Mathematical Methods in Physics	**2.5**	**4**
	II	Mathematical Methods in Physics		
	III	Thermal and Statistical Physics		
	IV	Thermal and Statistical Physics		
USPH502	I	Solid State Physics	**2.5**	**4**
	II	Solid State Physics		
	III	Solid State Physics		
	IV	Solid State Physics		
USPH503	I	Atomic Physics	**2.5**	**4**
	II	Atomic Physics		
	III	Molecular Physics		
	IV	Molecular Physics		
USPH504	I	Electrodynamics	**2.5**	**4**
	II	Electrodynamics		
	III	Electrodynamics		
	IV	Electrodynamics		
Practicals				
USPHP05	Practicals of Course USPH501 + Course USPH502		**2.5**	**8**
USPHP06	Practicals of Course USPH503 + Course USPH504		**2.5**	**8**

SEMESTER VI				
Theory				
Course	**UNIT**	**TOPICS**	**Credits**	**Lectures per Week**
USPH601	I	Classical Mechanics	**2.5**	**4**
	II	Classical Mechanics		
	III	Classical Mechanics		
	IV	Classical Mechanics		
USPH602	I	Electronics	**2.5**	**4**
	II	Electronics		
	III	Electronics		
	IV	Electronics		
USPH603	I	Nuclear Physics	**2.5**	**4**
	II	Nuclear Physics		
	III	Nuclear Physics		
	IV	Nuclear Physics		
USPH604	I	Special Theory of Relativity	**2.5**	**4**
	II	Special Theory of Relativity		
	III	Special Theory of Relativity		
	IV	Special Theory of Relativity		
Practicals				
USPH605	Practicals of Course USPH601 + Course USPH602		**2.5**	**8**
USPH606	Practicals of Course USPH603 + Course USPH604		**2.5**	**8**

SCHEME OF THEORY & PRACTICALS EXAMINATION (SEM- V & VI)

I.	**Theory: External Examination: 75 marks, INTERNAL: 25 Marks**			
	Each theory paper shall be of **Two and Half** hours duration.			
	Each paper shall consist of FIVE questions. All questions are compulsory and will have internal options. Choice in papers has to be TWO times.			
	Q – I :	From Unit – I		
	Q – II :	From Unit – II		
	Q – III :	From Unit – III		
	Q – IV :	From Unit – IV		
	Q – V :	Will consist of questions from all the FOUR Units with equal weightage of marks allotted to each Unit.		
II.	**Practicals:** The External Practical Examination will be conducted as per the following scheme.			
Sr. No.	**Particulars of External Practical Examination**			**Total Marks**
1	Laboratory Work	Experiment-1= 80 M	Experiment-2 = 80 M	160
2	Journal	10	10	20
3	Viva	10	10	20
			Grand Total	**200**

Passing Criteria:

1. A student should be considered as passed in the practical examination provided he/she fulfills the following passing criteria
   a. Minimum of 40 marks in each practical component - i.e. **USPHP07** and **USPHP08.**
   b. And cumulatively scoring 80 marks (i.e. 40 % of 200 marks)

Component	Maximum Marks	Minimum Passing Marks
USPHP07	100	40
USPHP08	100	40
Total	**200**	**80**

Scheme of Examination:

1. The University (external) examination for Theory and Practical shall be conducted at the end of each Semester.
2. The candidate should appear for **Two** Practical sessions of **three hours each** as part of his/her Practical course examination.
3. The candidates shall appear for external examination of 2 practical courses each carrying 100 marks at the end of each semester.
4. The candidate shall prepare and submit for practical examination a certified Journal based on the practical course with **6** experiments from each group.
5. The certified journal must contain a minimum of **12** regular experiments (**6** from each group), **with** minimum **6** skills in semester V and minimum **6** demonstration experiments in semester VI. A separate index and certificate in journal is must for each semester course.

A candidate will be allowed to appear for the practical examination only if the candidate submits a certified journal of TYBSc Physics or a certificate from the Head of the Department to the effect that the candidate has completed the practical course of TYBSc Physics as per the minimum requirements .

SEMESTER V

Theory Course - USPH501: Mathematical, Thermal and Statistical Physics

Learning outcomes: From this course, the students are expected to learn some mathematical techniques required to understand the physical phenomena at the undergraduate level and get exposure to important ideas of statistical mechanics.

The students are expected to be able to solve simple problems in probability, understand the concept of independent events and work with standard continuous distributions. The students will have idea of the functions of complex variables; solve nonhomogeneous differential equations and partial differential equations using simple methods. The units on statistical mechanics would introduce the students to the concept of microstates, Boltzmann distribution and statistical origins of entropy. It is also expected that the student will understand the difference between different statistics, classical as well as quantum.

Unit -I	**Probability**	**(15 lect.)**

Review of basic concepts, introduction, sample space, events, independent events, conditional probability, probability theorems, methods of counting (derivation of formulae not expected), random variables, continuous distributions (omit joint distributions), binomial distribution, the normal distribution, the Poisson distribution.

Ref: **MB** – 15.1-15.9.

Expected to cover solved problems from each section and solve at least the following problems: Section 1: 1 to 5, Section 2: 11-15, Section 3: 1, 3, 4, 5, Section 4: 1, 3, 5,13, 21, Section 5: 1, 10, 13, Section 6: 1 to 9, section 8: 1 and 3, section 9: 2, 3, 4, 9.

Unit -II	**Complex Numbers and Complex functions**	**(15 lect.)**

Introduction, Real and imaginary parts of the complex numbers, the complex plane, the terminology and notation, the complex algebra: (i) simplifying to $x + iy$ form, (ii) complex conjugate of a complex expression, (iii) Finding the absolute value of z, (iv) Complex equations, (v) Graphs, (vi) Physical Applications; Complex infinite series, Complex power series, Disk of conversions. Elementary functions of complex numbers, Euler's formula, Powers and roots of complex numbers, Functions of complex variables: The exponential and trigonometric functions, hyperbolic functions, logarithms, complex roots and powers, inverse trigonometric and hyperbolic functions, some applications.

Ref.: MB: 2. 1 to 2.16. Expected to cover all the solved problems. In addition, solve the following problems: Section4: 1, 2, 3. 8, 12, Section 5: 1 to 6, 26, 27, 35 – 38, Section 6: 2 to 4, Section 9: 1 to 5, Section 10: 1 to 5, Section 16: 2, 3, 8, 9, 10.		
Unit -III	**Statistical Thermodynamics**	**(15 lect.)**
Microstates and configurations, derivation of Boltzmann distribution, dominance of Boltzmann distribution, physical meaning of the Boltzmann distribution law, definition of the canonical ensemble, relating Q to q for an ideal gas, translational partition function, equipartition theorem, energy, entropy **Ref.: ER:** 13.1 to 13.5, 14.1, 14.2, 14.4, 14.8, 15.1, 15.4		
Unit -IV	**Classical and Quantum Statistics**	**(15 lect.)**
The probability of a distribution, The most probable distribution, Maxwell-Boltzmann statistics, Molecular speeds. Bose-Einstein statistics, Black-body radiation, The Rayleigh-Jeans formula, The Planck radiation formula, Fermi-Dirac statistics, Comparison of results. **Ref.: AB**: 15.2 to 15.5, 16.1 to 16.6		

References:

1.	MB: Mathematical Methods in the Physical sciences: Mary L. Boas Wiley India, 3rd ed.
2.	ER: Thermodynamics, Statistical Thermodynamics and Kinetics: T. Engel and P. Reid (Pearson).
3.	AB: Perspectives of Modern Physics: Arthur Beiser, (Mc Graw Hill International).

Additional References:

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

Theory Course - USPH502: Solid State Physics

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

1. Understand the basics of crystallography, Electrical properties of metals, Band Theory of solids, demarcation among the types of materials, Semiconductor Physics and Superconductivity.
2. Understand the basic concepts of Fermi probability distribution function, Density of states, conduction in semiconductors and BCS theory of superconductivity.
3. Demonstrate quantitative problem solving skills in all the topics covered.

Unit - I	**Crystal Physics**	**(15 lect.)**

Crystal Physics: Lattice points and space lattice, The basis and crystal structure, Unit Cells and lattice parameters, Primitive Cells, Crystal Systems, Bravais space lattices, Metallic crystal structures, Relation between the density of crystal material and lattice constant in a cubic lattice, Other Cubic Structures - Diamond Cubic Structure, Sodium Chloride Structure, Directions, Planes, Miller Indices, Important planes in simple cubic structure, Separation between lattice planes in a cubic crystal.

Ref.: Solid State Physics: S. O. Pillai, New Age International Publishers, 7th Ed.

SOP: Chapter 4: II, III, IV, V, VI, XIV, XV, XVI, XVII, XVIII, XIX, XX, XXII.

Unit -II	**Electrical properties of metals**	**(15 lect.)**

1. Introduction of Physical Properties of metal, Classical free electron theory of metals, Determination of thermal Velocity. Ohms law, Discussions on Resistivity dependence on various factor, Drawbacks of classical theory, Relaxation time, Collision time and mean free path, Relation between electrical conductivity and Thermal conductivity (Wiedemann Franz law)

   Ref.: Solid State Physics: S. O. Pillai, New Age International. Sixth Ed. Chapter 6: II, III, IV
2. Quantum theory of free electrons Somerfield free electron model, Potential energy Box, Fermi Dirac statistics and electronic distribution in solids, Density of energy states and Fermi energy, The Fermi distribution function, Heat capacity of the Electron gas, Mean energy of electron gas at 0 K, Electrical conductivity from quantum mechanical considerations, Failure of Sommerfeld's free electron Theory
3. Thermionic Emission: Richardson-Dushman equation

   Ref.: Solid State Physics: S. O. Pillai, New Age International. Sixth Ed. Chapter 6: V, XIV,

XV, XVI, XVII, XVIII, XX, XXXV, XXXI.

Unit -III	**Band Theory of Solids and Conduction in Semiconductors**	**(15 lect.)**

1. Band theory of solids, The Kronig- Penney model (Omit solution of determinant), Brillouin zones, Number of wave functions in a band, Motion of electrons in a one-dimensional periodic potential, Distinction between metals, insulators and intrinsic semiconductors.

   Ref.: Solid State Physics: S. O. Pillai, New Age International, Sixth Ed.

   Chapter 6: XXXVI, XXXVII, XXXVIII, XXXIX, XXXX, XXXXI

2. Electrons and Holes in an Intrinsic Semiconductor, Conductivity of a Semiconductor, Carrier concentrations in an intrinsic semiconductor, Donor and Acceptor impurities, Charge densities in a semiconductor, Fermi level in extrinsic semiconductor, Hall Effect.

   Ref.: Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit. (Third Ed.) Tata McGraw Hill.: 4.1 to 4.6, 4.10.

Unit -IV	**Diode Theory and superconductivity**	**(15 lect.)**

1. Semiconductor-diode Characteristics: Qualitative theory of the p-n junction, The p-n junction as a diode, Band structure of an open-circuit p-n junction, The current components in a p-n junction diode (omit derivation), Quantitative theory of p-n diode currents, The Volt-Ampere characteristics, The temperature dependence of p-n characteristics, Diode resistance.

   Ref.: Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit. (Third Ed.) Tata McGraw Hill.: 5.1 to 5.8

2. Superconductivity: Experimental Survey, Occurrence of Superconductivity, destruction of superconductivity by magnetic field, The Meissner effect, London equation, BCS theory of superconductivity, Type I and Type II Superconductors, Vortex state.

   Ref.: Solid state physics :R. K. Puri & V. K. Babar. S.Chand Publications (Third Ed.) 10.1 to 10.6, 10.12.1

Main References:

1.	Elementary Solid State Physics-Principles and Applications: M.Ali Omar, Pearson Education, 2012.
2.	Solid State Physics: S. O. Pillai, New Age International, 6th Ed.
3.	Electronic Devices and Circuits: Millman, Halkias & Satyabrata Jit. (3rd Ed.) Tata McGraw Hill.
4.	Introduction to Solid State Physics - Charles Kittel, 7th Ed. John Wiley & Sons.
5.	Modern Physics and Solid State Physics: Problems and solutions New Age International.

Additional References:

1.	Solid State Physics: A. J. Dekker, Prentice Hall.
2.	Electronic Properties of Materials: Rolf Hummel, 3rd Ed. Springer.
3.	Semiconductor Devices: Physics and Technology, 2nd Ed. John Wiley & Sons.
4.	Solid State Physics: Ashcroft & Mermin, Harcourt College Publisher.

Theory Course - USPH503: Atomic and Molecular Physics

Learning Outcome: Upon successful completion of this course, the student will understand

- the application of quantum mechanics in atomic physics
- the importance of electron spin, symmetric and antisymmetric wave functions and vector atom model
- Effect of magnetic field on atoms and its application
- Learn Molecular physics and its applications.
- This course will be useful to get an insight into spectroscopy.

Unit -I		**(15 lect.)**

1. Hydrogen atom: Schrödinger's equation for Hydrogen atom, Separation of variables, Quantum Numbers: Total quantum number, principal quantum number Orbital quantum number, Magnetic quantum number. Angular momentum, Electron probability density (Radial part).

2. Electron spin: The Stern-Gerlach experiment, Pauli Exclusion principle, electron configuration, quantum states, Spectral notations of quantum states. symmetric and Anti-symmetric wave functions.

Ref – Unit – I - B: 9.1 to 9.9, B: 10.1, 10.3. 2

Unit -II		**(15 lect.)**

1. Spin orbit coupling, Total angular momentum, Vector atom model, L-S and j-j coupling. Origin of spectral lines, Selection rules.

2. Effect of Magnetic field on atoms, the normal Zeeman effect (Review – Classical explanation) based on Quantum mechanics, The Lande g - factor, Anomalous Zeeman effect

Reference – Unit – II

1. B: Perspectives of Modern Physics: Arthur Beiser McGraw Hill - 10.2, 10.6, 10.7, 10.8, 10.9, 11.1 and 11.2
2. SA: Introduction to Atomic & Nuclear Physics : H. Semat & J. R. Albright (5th Ed.) Chapman & Hall. - 9.14, 9.15, 9.16, 9.17. 2.

Unit -III		**(15 lect.)**

1. Molecular spectra (Diatomic Molecules): Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibrational-Rotational spectra. Electronic Spectra of Diatomic molecules: The Born-Oppenheimer approximation, Intensity of vibrational-electronic spectra: The Franck-Condon principle.

2. Infrared spectrometer & Microwave spectrometer

Reference:B: Perspectives of Modern Physics: Arthur Beiser McGraw Hill (14.1, 14.3, 14.5, 14.7)

Additional Reference:

Atomic Physics (Modern Physics): S.N.Ghoshal. S.Chand Publication (for problems on atomic Physics).

Unit -IV		**(15 lect.)**

1. Raman effect: Quantum Theory of Raman effect, Pure Rotational Raman spectra: Linear molecules, symmetric top molecules, Asymmetric top molecules, Vibrational Raman spectra: Raman activity of vibrations, Experimental set up of Raman Effect.

2. Electron spin resonance: Introduction, Principle of ESR, ESR spectrometer

3. Nuclear magnetic resonance: Introduction, principle and NMR instrumentation.

Reference – Unit – IV

BM: Fundamentals of Molecular Spectroscopy: C. N. Banwell & E. M. McCash (TMH).(4th Ed.)

GA: Molecular structure and spectroscopy: G Aruldhas (2nd Ed) PHI learning Pvt Ltd.

1. BM: 4.1.1, 4.2.1, 4.2.2, 4.2.3, 4.3.1. GA: 8.6.1

2. GA: 11.1, 11.2 and 11.3

3. GA: 10.1, 10.2, 10.3

Theory Course - USPH504: Electrodynamics

Learning outcomes:

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

1) Understand the laws of electrodynamics and be able to perform calculations using them.
2) Understand Maxwell's electrodynamics and its relation to relativity
3) Understand how optical laws can be derived from electromagnetic principles.
4) Develop quantitative problem solving skills.

Unit - I	**Electrostatics**	**(15 lect.)**

Electrostatics

1. Dirac Delta Function**,** The divergence of E, The curl of E, Electric Potential, The Work Done to Move a Charge, The Energy of a Point Charge Distribution, Continuous Charge Distribution.

2. Conductors basic electrostatic properties of ideal conductors, Induced Charges, Surface Charge and the Force on a Conductor

3. The classic image problem- Point charge and grounded infinite conducting plane and conducting sphere.

Unit -II	**Electrostatics in Matter and Magnetostatics**	**(15 lect.)**

1. Dielectrics, Induced Dipoles, Alignment of polar molecules, Polarization, Bound charges and their physical interpretation, Gauss' law in presence of dielectrics, A deceptive parallel, Susceptibility, Permittivity, Dielectric constant and relation between them, Energy in dielectric systems.

2. Review of Biot-Savart's law and Ampere's law, Straight-line currents, The Divergence and Curl of **B**, Applications of Ampere's Law in the case of a long Straight wire and a long solenoid, Comparison of Magneto-statics and Electrostatics, Magnetic Vector Potential.

Unit -III	Magnetostatics in Matter and Electrodynamics	(15 lect.)
1. Torques and Forces on Magnetic Dipoles, Effect of a Magnetic Field on Atomic Orbits Ampere's law in magnetized materials, deceptive parallel, Boundary Conditions, 2. Electrodynamics before Maxwell, Maxwell's correction to Ampere's law, Maxwell's equations, Magnetic charge, Maxwell's equations in matter, Boundary conditions.		
Unit IV	**Electromagnetic Waves**	**(15 lect.)**
1. The continuity equation, Poynting's theorem 2. The wave equation for **E** and **B**, Monochromatic Plane waves, Energy and Momentum in electromagnetic waves, Propagation in linear media, Reflection and Transmission of EM waves at normal incidence, Reflection and transmission of EM		

References	
1.	DG: Introduction to Electrodynamics, David J. Griffiths (3rd Ed) Prentice Hall of India.
Additional References	
1.	Introduction to Electrodynamics: A. Z. Capria and P. V. Panat, Narosa Publishing House.
2.	Engineering Electrodynamics: William Hayt Jr. & John H. Buck (TMH).
3.	Foundations of Electromagnetic Theory: Reitz, Milford and Christy.
4.	Solutions to Introduction to Electrodynamics: David J. Griffiths (3rd Ed) Prentice Hall of India.

PRACTICALS - SEMESTER V

The T. Y. B. Sc. Syllabus integrates the regular practical work with a series of skill experiments. During the teaching and examination of Physics laboratory work, simple modifications of experimental parameters may be attempted. Attention should be given to basic skills of experimentation which include:

i)	Understanding relevant concepts.
ii)	Planning of the experiments
iii)	Layout and adjustments of the equipments
iv)	Understanding designing of the experiments
v)	Attempts to make the experiments open ended
vi)	Recording of observations and plotting of graphs
vii)	Calculation of results and estimation of possible errors in the observation of results

i) Regular Physics Experiments: A minimum of **06** experiments from each of the course are to be performed and reported in the journal.

ii) Skill Experiments: 5 skill experiments are compulsory and must be reported in the journal. Skills will be tested during the examination through viva or practical.

The certified journal must contain a minimum of **12** regular experiments (**06** from each group), **with 6** Skill experiments in semester V. A separate index and certificate in journal is must for each semester course.

There will be **THREE** turns of **3Hrs each** for the examination of practical courses.

SEMESTER V	
PRACTICAL COURSE: USPHP05	
Sr. No.	**Name of the Experiment**
1	Determination of 'g' by Kater's pendulum
2	Surface tension of soap solution
3	Elastic constants of a rubber tube
4	Logarithmic decrement
5	Searle's Goniometer
6	Determination of Rydberg's constant
7	Edser's 'A' pattern
8	Determination of wavelength by Step slit
9	Determination of e/m by Thomson's method
10	Velocity of sound in air using CRO
PRACTICAL COURSE: USPHP06	
Sr. No.	**Name of the Experiment**
1	Mutual inductance by BG.
2	Capacitance by parallel bridge
3	Hysteresis loop by CRO
4	L/C by Maxwell's bridge
5	Band gap energy of Ge diode
6	Design and study of transistorized astable multivibrator (BB)
7	Design and study of Wien bridge oscillator
8	Design and study of first order active low pass filter circuit (BB)
9	Design and study of first order active high pass filter circuit (BB)

10	Application of IC 555 timer as a ramp generator (BB)
11	LM 317 as constant current source
12	Counters Mod 2, 5, 10 (2 x 5, 5 x 2)

SKILL EXPERIMENTS

Sr. No.	**Name of the Experiment**
1	Estimation of errors from actual experimental data
2	Soldering and testing of an astable multivibrator (Tr./IC555) circuit on PCB
3	Optical Leveling of Spectrometer
4	Schuster's method
5	Laser beam profile
6	Use of electronic balance: Find the density of a solid cylinder
7	Dual trace CRO: Phase shift measurement
8	C1/C2 by B G
9	Internal resistance of voltage and current source
10	Use of DMM to test diode, transistor and β factor

References:

1.	Advanced course in Practical Physics: D. Chattopadhya, PC. Rakshit & B. Saha (8th Edition) Book & Allied Pvt. Ltd.
2.	BSc Practical Physics: Harnam Singh. S. Chand & Co. Ltd. – 2001.
3.	A Text book of Practical Physics: Samir Kumar Ghosh New Central Book Agency (4th edition).
4.	B Sc. Practical Physics: C. L. Arora (1st Edition) – 2001 S. Chand & Co. Ltd.
5.	Practical Physics: C. L. Squires – (3rd Edition) Cambridge University Press.
6.	University Practical Physics: D C Tayal. Himalaya Publication.
7.	Advanced Practical Physics: Worsnop & Flint.

SEMESTER VI

Theory Course – USPH601: Classical Mechanics

Learning outcomes:

This course will introduce the students to different aspects of classical mechanics. They would understand the kinds of motions that can occur under a central potential and their applications to planetary orbits. The students should also appreciate the effect of moving coordinate system, rectilinear as well as rotating. The students are expected to learn the concepts needed for the important formalism of Lagrange's equations and derive the equations using D'Alembert's principle. They should also be able to solve simple examples using this formalism. The introduction to simple concepts from fluid mechanics and understanding of the dynamics of rigid bodies is also expected. Finally, they should appreciate the drastic effect of adding nonlinear corrections to usual problems of mechanics and nonlinear mechanics can help understand the irregularity we observe around us in nature.

Unit - I	**Central Force**	**(15 lect.)**
1. Motion under a central force, the central force inversely proportional to the square of the distance, Elliptic orbits, The Kepler problem. 2. Moving origin of coordinates, Rotating coordinate systems, Laws of motion on the rotating earth, The Foucault pendulum, Larmor's theorem. KRS: 3.13 - 3.15, 7.1 - 7.5.		
Unit -II	**Lagrange's equations**	**(15 lect.)**
1. D'Alembert's principle, Constraints, Examples of holonomic constraints, examples of nonholonomic constraints, degrees of freedom and generalized coordinates, virtual displacement, virtual work, D'Alembert's principle, illustrative problems. 2. Lagrange's equations: D'Alembert's principle, Generalized coordinates, Lagrange's equations using D'Alembert's principle, Examples, Systems subject to constraints, Examples of systems subject to constraints, Constants of motion and ignorable coordinates. HG: 1.4 KRS: 9.1 to 9.6		
Unit -III	**Fluid Motion and Rigid body rotation**	**(15 lect.)**

1. Kinematics of moving fluids, Equation of motion for an ideal fluid, Conservation laws for fluid motion, Steady flow.
2. The rotation of a Rigid body: Motion of a rigid body in space, Moments and Product of Inertia, Euler's equations of motion for a rigid body, Euler's angles, The symmetrical top (without nutation).

KRS : 8.6 to 8.9
PVP: 16.1 to 16.10

KRS: 11.1, 11.2, 11.4 and 11.5

BO: 6.7

Unit -IV	**Non- Linear Mechanics**	**(15 lect.)**

1. Non-linear mechanics: Qualitative approach to chaos, The anharmonic oscillator, Numerical solution of Duffing's equation.
2. Transition to chaos: Bifurcations and strange attractors, Aspects of chaotic behavior (Logistic map).

BO: 11.1, 11.3 to 11.5

References

1.	KRS: Mechanics: Keith R. Symon (Addision Wesely, 3rd Ed.)
2.	HG: Classical Mechanics: Herbert Goldstein, (Narosa 2nd Ed.)
3.	BO: Classical Mechanics-a Modern perspective (Mc Graw Hill International 1995 Ed.): V. D. Barger and M. G. Olsson.

Additional References

1.	An Introduction to Mechanics: Daniel Kleppner & Robert Kolenkow
2.	Tata Mc Graw Hill (Indian Ed. 2007)
3.	Chaotic Dynamics- an introduction: Baker and Gollup.
4.	Classical Mechanics: P. V. Panat (Narosa)
5.	Introduction to Classical Mechanics: P. S. Puranik and R. G. Takwale (Tata McGraw-Hill)
6.	Classical Mechanics – System of Particles and Hamiltonian Dynamics: Walter Greiner (Springer)

Theory Course – USPH602: Electronics

Learning Outcome:

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

1. Understand the basics of semiconductor devices and their applications.
2. Understand the basic concepts of operational amplifier: its prototype and applications as instrumentation amplifier, active filters, comparators and waveform generation.
3. Understand the basic concepts of timing pulse generation and regulated power supplies
4. Understand the basic electronic circuits for universal logic building blocks and basic concepts of digital communication.
5. Develop quantitative problem solving skills in all the topics covered.

Unit - I		**(15 lect.)**
	1. Field effect (15 lect.) transistors: JFET: Basic ideas, Drain curve, The transconductance curve, Biasing in the ohmic region and the active region, Transconductance, JFET common source amplifier, JFET analog switch, voltage controlled resistor. 2. MOSFET: Depletion and enhancement mode, MOSFET operation and characteristics, digital switching. 3. SCR – construction, static characteristics, Analysis of the operation of SCR, Gate Triggering Characteristics, Variable full wave rectifier, SCR as phase control. 4. UJT: Construction, Operation, characteristics and application as a relaxation oscillator. 1. MB: 13.1 to 13.9 2. MB: 14.1, 14.2, 14.4, 14.6. 3. AM: 28.1, 28.5	
Unit -II		**(15 lect.)**
	1. Differential Amplifier using transistor: The Differential Amplifier, DC and AC analysis of a differential amplifier, Input characteristic-effect of input bias, offset current and input offset voltage on output, common mode gain, CMRR. 2. Op Amp Applications: Log amplifier, Instrumentation amplifiers, First order Active filters, Astable using OP AMP, square wave and	

	triangular wave generator using OP AMP, Wein-bridge oscillator using OP AMP, Comparators with Hysteresis, Window Comparator. 1. MB: 17.1 to 17.5 2. 2. MB: 20.5, 21.4, 22.2, 22.3,22.4, 22.7, 22.8,23.2	
Unit-III		**(15 lect.)**
	1. Transistor Multivibrators: Astable, Monostable and Bistable Multivibrators. 2. 555 Timer: Monostable and Astable operation, Voltage Controlled Oscillator, Pulse Width Modulator, Pulse Position Modulator. 3. Voltage Regulation- Elements of a regulated power supply, stabilization, emitter follower regulator, Series Regulators, Shunt Regulators. 4. Power Supply, Switch Mode Power Supply-(schematic diagram, working, Characteristic),Uninterrupted Power Supply, Inverter- (schematic diagram, working, Characteristic) 1. KVR: 14.5.2.1, 14.5.2.5, 14.5.2.6, 14.5.4.1 3. MB: 23.8, 23.9 4. MB: 24.1, 24.3, 24.4	
Unit-IV		**(15 lect.)**
	1. Logic families: Standard TTL NAND, TTL NOR, Open collector gates, Three state TTL devices, CMOS inverters, CMOS characteristics, CMOS NAND and NOR gates, 2. Digital Communication Techniques: Digital Transmission of Data, Benefits of Digital Communication, Advantages and Disadvantages of Digital Communication, Parallel and Serial Transmission, Pulse Modulation, Comparing Pulse-Modulation Methods (PAM, PWM, PPM), Pulse-Code Modulation. 1. ML: 6.2, 6.4, 6.6, 6.7, 7.2 to 7.4. 2. 2. LF: 7.1, 7.2, 7.4 3.	

References

1	MB: Electronic Principles, Malvino & Bates -7th Edition TMH Publication.
2	AM: Electronic Devices and Circuits, Allen Mottershead -PHI Publication.
3	KVR: Functional Electronics, K.V. Ramanan-TMH Publication

4	ML: Digital Principles and Applications, Malvino and Leach (4th Edition) (TMH).
5	LF: Communication Electronics: Principles and applications, Louis E Frenzel 4th Edition TMH Publications.
6	VKM: Principles of Electronics: V.K. Mehta &Rohit Mehta , Multicolour Illustrative Edition, S. Chand & Company

Theory Course – USPH603: Nuclear Physics

Objectives:

The course is built on exploring the fundamentals of nuclear matter as well as considering some of the important applications of nuclear physics. Topics include decay modes – (alpha, beta & gamma decay), nuclear models (liquid drop model, introduction to shell model), Applications of Nuclear Physics in the field of particle accelerators and energy generation, nuclear forces and elementary particles. The lecture course will be integrated with problem solving.

Learning Outcomes:

- Upon successful completion of this course, the student will be able to understand the fundamental principles and concepts governing classical nuclear and particle physics and have a knowledge of their applications interactions of ionizing radiation with matter the key techniques for particle accelerators the physical processes involved in nuclear power generation.
- Knowledge on elementary particles will help students to understand the fundamental constituents of matter and lay foundation for the understanding of unsolved questions about dark matter, antimatter and other research-oriented topics.

Unit-I	**Alpha & Beta Decay**	**(15 lect.)**

1. Alpha decay: Velocity, energy, and Absorption of alpha particles, Range, Geiger Nuttal law, Ionization and stopping power, nuclear energy levels, alpha particle spectrum, Fine structure, Disintegration Energy of spontaneous alpha-decay, Alpha decay paradox: Barrier penetration (Gamow's theory of alpha decay)

2. Beta decay: Introduction, velocity and energy of beta particles, Different modes of beta disintegration, Energetics of beta decay Continuous beta ray spectrum and difficulties in understanding it, Pauli's neutrino hypothesis, Detection of neutrino - Cowan and Reines Experiment

1. IK: 13. 1, 13.2, 13.5, SBP: 4. II. 1, 4. II. 2, 4. II. 3, 1.II.3
2. IK: 14.1, 14.7, SBP: 4. III. 1, 4. III. 2, 4. III. 3, 4. III. 5, SNG : 5.5.

Unit -II	Gamma Decay & Nuclear Models	(15 lect.)

1. Gamma decay: Introduction, selection rules, Internal conversion, nuclear isomerism, Mossbauer effect.

2. Nuclear Models: Liquid drop model, Weizsacker's semi-empirical mass formula, Mass parabolas - Prediction of stability against beta decay for members of an isobaric family, Stability limits against spontaneous fission. Shell model (Qualitative), Magic numbers in the nucleus.

1. SBP: 4. IV. 1, 4. IV.2, 4. IV. 3, 4. IV. 4, 9.4
2. SBP: 5.1, 5.3, 5.4, 5.5. AB: 11.6-pages (460,461).

Unit -III	Nuclear Energy & Particle Accelerators	(15 lect.)

1. Nuclear energy: Introduction, Asymmetric fission - Mass yield, Emission of delayed neutrons by Fission Fragments, Energy released in fission of U235, Fission chain reaction, Neutron cycle in a thermal nuclear reactor (Four Factor Formula), Nuclear reactors

Natural fusion-Energy production in stars, Possibility of controlled fusion

2. Particle Accelerators: Van de Graaff Generator, Cyclotron, Synchrotron, Betatron and Idea of Large Hadron Collider (Qualitative)

1. SBP : 6.1,6.3,6.4,6.5,6.7,6.8,6.9
   SBP : 9.6,9.7
2. SBP: 1.I.4 (i), 1.I.4 (ii), 1.I.4 (iii), 1.I.4 (iv)

https://home.cern/science/accelerators/large-hadron-collider

Unit -IV	Nuclear force & Elementary particles	(15 lect.)

1. Nuclear force: Introduction, Deuteron problem, Meson theory of Nuclear Force- A qualitative discussion.

2. Elementary particles: Introduction, Classification of elementary particles, Particle interactions, Conservation laws (linear &angular momentum, energy, charge, baryon number & lepton number), particles and antiparticles (Electrons and positrons, Protons and anti-protons, Neutrons and anti- neutrons, Neutrinos and anti- neutrinos), Photons, Mesons.

1. SBP: 8.1, 8.2, 8.3, 8.6
2. DCT: 18.1, 18.2,18.3, 18.4 , 18.5 to 18.9

References

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

Additional References

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

Theory Course – USPH604: Special Theory of Relativity

Learning outcomes:

This course introduces students to the essence of special relativity which revolutionized the concept of physics in the last century by unifying space and time, mass and energy, electricity and magnetism. This course also gives a very brief introduction of general relativity. After the completion of the course the student should be able to

1. Understand the significance of Michelson Morley experiment and failure of the existing theories to explain the null result
2. Understand the importance of postulates of special relativity, Lorentz transformation equations and how it changed the way we look at space and time, Absolutism and relativity, Common sense versus Einstein concept of Space and time.
3. Understand the transformation equations for: Space and time, velocity, frequency, mass, momentum, force, Energy, Charge and current density, electric and magnetic fields.
4. Solve problems based on length contraction, time dilation, velocity addition, Doppler effect, mass energy relation and resolve paradoxes in relativity like twin paradox etc.

Unit - I		**(15 lect.)**

Introduction to Special theory of relativity:- Introduction, Inertial and Non-inertial frames of reference, Galilean transformations, Newtonian relativity, Electromagnetism and Newtonian relativity. Attempts to locate absolute frame: Michelson- Morley experiment (omit derivation part), Attempts to preserve the concept of a preferred ether frame: Lorentz Fitzgerald contraction hypothesis, Ether drag hypothesis (conceptual), Stellar aberration, Attempt to modify electrodynamics.
RR: 1.1 to 1.8

Relativistic Kinematics - I:

Postulates of the special theory of relativity, Simultaneity, Derivation of Lorentz transformation equations. Some consequences of the Lorentz transformation equations: length contraction, time dilation and meson experiment. The observer in relativity

RR: 1.9, 2.1 to 2.5

Unit -II		(15 lect.)

Relativistic Kinematics - II: The relativistic addition of velocities, Velocity and acceleration transformation equations, Aberration and Doppler effect in relativity, The common sense of special relativity.
RR: 2.6 to 2.8

The Geometric Representation of Space-Time: Space-Time Diagrams, Simultaneity, Length contraction and Time dilation, The time order and space separation of events, The twin paradox.
RR: Supplementary topics: A-1, A-2, A-3, B-1, B-2, B-3.

Unit -III		(15 lect.)

Relativistic Dynamics: Mechanics and Relativity, The need to redefine momentum, Relativistic momentum, Alternative views of mass in relativity, The relativistic force law and the dynamics of a single particle, The equivalence of mass and energy, The transformation properties of momentum, energy and mass. **RR: 3.1 to 3.7**

Unit -IV		(15 lect.)

Relativity and Electromagnetism: Introduction, The interdependence of Electric and Magnetic fields, The Transformation for **E** and **B**, The field of a uniformly moving point charge, Force and fields near a current-carrying wire, Force between moving charges, The invariance of Maxwell's equations.
RR: 4.1 to 4.7
The principle of equivalence and general relativity: Introduction, The principle of Equivalence, Gravitational red shift, General Relativity theory.
RR: Supplementary topics: C-1, C-2, C-3, C-4

Note: (A good number of problems to be solved from Resnick).

References	
1.	RR: Introduction to Special Relativity: Robert Resnick (Wiley Student Edition).
2.	Special theory of Relativity: A. P. French.
3.	Very Special Relativity – An illustrated guide: by Sander Bais - Amsterdam University Press.
4.	Chapter 1: Concepts of Modern Physics by Arthur Beiser.

5.	Chapter 2: Modern Physics by Kenneth Krane.

SEMESTER VI Practicals

The T. Y. B. Sc. Syllabus integrates the regular practical work with a series of demonstration experiments. During the teaching and examination of Physics laboratory work, simple modifications of experimental parameters may be attempted.

Regular Physics Experiments: A minimum of **06** experiments from each of the practical course are to be performed and reported in the journal.

Demonstration Experiments: The demonstration experiments are to be performed by the teacher in the laboratory and students should be encouraged to participate and take observation wherever possible.

Demonstration experiments are designed to bring about interest and excitement in Physics. Students are required to enter details of these 'demonstration' experiments in their journal.

The certified journal must contain a minimum of **12** regular experiments (**06** from each practical course), **MINIMUM 06** demonstration experiments in semester VI. A separate index and certificate in journal is must for each course in each semester.

There will be **Two** turns of **three hours each** for the examination of practical courses.

SEMESTER VI	
PRACTICAL COURSE: USPHP07	
Sr. No.	**Name of the Experiment**
1	Surface tension of mercury by Quincke's method
2	Thermal conductivity by Lee's method
3	Study of JFET characteristics
4	JFET as a common source amplifier
5	JFET as switch (series and shunt)
6	UJT characteristics and relaxation oscillator
7	Study of Pulse width modulation (BB)

8	Study of Pulse position modulation (BB)
9	R. P. of Prism
10	Double refraction
11	Lloyd's single mirror: determination of wavelength
PRACTICAL COURSE: USPHP08	
Sr. No.	**Name of the Experiment**
1	Determination of M/C by using BG
2	Self-inductance by Anderson's bridge
3	Solar cell characteristics and determination of V_{oc}, I_{sc} and P_{max}
4	Design and study of transistorized monostable multivibrator (BB)
5	Design and study of transistorized bistable multivibrator (BB)
6	Application of Op-Amp as a window comparator
7	Application of Op-Amp as a Log amplifier
8	Application of IC 555 as a voltage to frequency converter (BB)
9	Application of IC 555 as a voltage to time converter (BB)
10	LM-317 as variable voltage source
11	Shift register
DEMONSTRATION EXPERIMENTS	
Sr. No.	**Name of the Experiment**
1	Open CRO, Power Supply, and Signal Generator: block diagrams
2	Data sheets: Diodes, Transistor, Op-amp & Optoelectronic devices
3	Zeeman Effect
4	Michelson's interferometer
5	Constant deviation spectrometer (CDS)
6	Digital storage oscilloscope (DSO)
7	Determination of Op-Amp parameters (offset voltage, slew rate,

	input impedance, output impedance, A_{CM})
8	Transformer (theory, construction and working), types of transformers and energy losses associated with them.
9	Use of LCR meter
10	Lux meter / Flux meter

References:

1.	Advanced course in Practical Physics: D. Chattopadhya, PC. Rakshit & B. Saha (8th Edition) Book & Allied (P) Ltd.
2.	BSc Practical Physics: Harnam Singh. S. Chand & Co. Ltd. – 2001.
3.	A Text book of Practical Physics: Samir Kumar Ghosh New Central Book Agency (4th edition).
4.	B Sc. Practical Physics: C. L. Arora (1st Edition) – 2001 S. Chand & Co.
5.	Practical Physics: C. L. Squires – (3rd Edition) Cambridge Univ. Press.
6.	University Practical Physics: D C Tayal, Himalaya Publication.
7.	Advanced Practical Physics: Worsnop & Flint.

Chairman,
Prof. Dr.T.N.GHORUDE
Board of Studies in Physics

Sign of the
Offg. Associate Dean
Dr. Madhav R.Rajwade
Faculty of Science &Technology

Sign of the
Offg. Dean
Prof. Shivram S.Garje
Faculty of Science &Technology