AC – 11/07/2022
Item No. 6.15 (R)

UNIVERSITY OF MUMBAI

Revised Syllabus for
F.Y.B.Sc.
(Physics)

Semester: I & II
(CBCS)

(With effect from the academic year 2022-23)

New Syllabus.

Syllabus for B.Sc. Physics (Theory & Practical)

As per Choice Based and Credit System
First Year B.Sc 2022-2023

The revised syllabus in Physics as per Choice Based and Credit System for the First Year B.Sc Course will be implemented from the academic year 2022-2023.

Preamble:
The systematic and planned curricula from these courses shall motivate and encourage learners to understand basic concepts of Physics.

Objectives:

- To develop analytical abilities towards real world problems
- To familiarize with current and recent scientific and technological developments
- To enrich knowledge through problem-solving, hands-on activities, study visits, projects etc

Course Code	Title	Credits
	Semester I	
USPH101	Classical Physics	02
USPH102	Modern Physics	02
USPHPI	Practical I	02
		Total = 06
	Semester II	
USPH201	Optics I	02
USPH202	Electricity and Electronics	02
USPHPII	Practical II	02
		Total = 06

Scheme of Examination:

- Each theory paper of each semester will have 20% Internal Assessment (IA) and 80% External Assessment (EA). All external examinations will be held at the end of each semester and will be conducted by the University as per existing norms
- There will be no internal assessment for practical. A candidate will be allowed to appear for the semester end practical examination only if the candidate submits a certified journal at the time of practical examination of the semester or a certificate from the Head of the Department/Institute to the effect that the candidate has completed the practical course of that

SEMESTER-I

Name of the Programme	Duration	Semester	Subject
B.Sc.in Physics	Six semesters	I	Physics
Course Code	Title	Credits	
USPH101	Classical Physics	2	

Learning Objectives:

1. Understand Newton's laws and applications in daily life.
2. Understand the concepts of friction
3. Understand Work and Energy Equivalence
4. Understand the concepts of Elasticity, Viscosity and Fluid dynamics
5. Understand behavior of real gases in relation to their thermo dynamical response.

Learning Outcomes:

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

1. Apply Newton's laws for the calculations of the motion of simple systems.
2. Use Work and Energy equivalence and its applications through suitable numerical.
3. Use Elasticity, Viscosity and Fluid dynamics in daily life.
4. Understand Real gases and validity of the laws of thermodynamics.
5. Demonstrate quantitative problem solving skills in all the topics covered

15 Lectures

Unit I

1. Newton's Laws of Motion: Newton's first, second and third laws of motion, interpretation an applications, pseudo forces, inertial and non-inertial frames of reference

Worked out examples (with friction present)

HCV: 5.1 to 5.5

2. Friction: Advantages & disadvantages of friction in daily life, Friction as the componen Contact force, Kinetic Friction, Static friction, laws of friction, Understanding friction at At le[redacted].

HCV: 6.1 to 6.5

3. Work and Energy: Kinetic Energy, Work and Work-energy theorem, Potential Energy Conservative and Non Conservative Forces, Different forms of Energy: Mass Energy Equiv

Worked out Examples

HCV: 8.1, 8.2, 8.5, 8.6, 8.11

Main References:

1. HCV: H. C. Verma, Concepts of Physics – Part I, (Second Reprint of 2020) Bharati Bhavan Publishers and Distributers
2. BSH: BrijLal, Subrahmanyam and Hemne, Heat Thermodynamics and Statistical Physics, S. Chand , Revised, Multi-coloured, (Reprint 2019)

Additional References:

1. Halliday, Resnick and Walker, Fundamental of Physics (extended) – (6th Ed.), John Wiley & Sons.
2. D.S Mathur, P.S Hemne, Mechanics, 2012, S. Chand
3. M. W Zemansky and R. H Dittman, Heat and Thermodynamics, McGraw Hill.
4. Thornton and Marion, Classical Dynamics (5th Ed.)
5. D. S Mathur, Element of Properties of Matter, S. Chand & Co.
6. R. Murugeshan and K. Shivprasath, Properties of Matter and Acoustics, S. Chand.
7. D. K Chakrabarti, Theory and Experiments on Thermal Physics,(2006 Ed.), Central books.
8. Hans and Puri, Mechanics, (2nd Ed.) Tata McGraw Hill

15 Lectures

Unit II

1. Radiation Detectors: Interaction between particles and matter, plot of variation of ionization current with applied voltage, Gas filled radiation detectors- Ionization chamber (qualitative), Proportional Counter and GM Counter

Problems

SBP: 1.1.1, 1.1.2, 1.1.3 (i, ii)

SNG: Figure: 7.3 (exclude mode of operation), 7.4

2. Nuclear Reactions: Introduction, types of nuclear reactions, conservation laws (mass, energy and charge), concept of compound and direct reaction, Q value equation and solution of the C equation, threshold energy

Problems

SBP: 3.1, 3.2, 3.3, 3.4, 3.5

15 Lectur

Unit III

Review (Photoelectric effect, Black body, Black Body spectrum, Wien's displacement law)

1. Origin of Quantum theory: Matter waves: De Broglie waves, Concept of wave packet, pha velocity, group velocity and relation between them, wave particle duality, Davisson-Germ experiment, Heisenberg's Uncertainty Principle

AB: 3.1, 3.2, 3.3, 3.4, 3.5, 3.7, 3.8, 3.9

2.X-Rays: Production and properties, X-Ray spectra, X-Ray Diffraction, Bragg's Law, Comp Effect, Pair production, Photons and Gravity, Gravitational Red Shift, Black holes

AB: 2.5, 2.6, 2.7, 2.8, 2.9

Note: A good number of numerical examples are expected to be covered during the prescribed lectures

Main References:

1. AB: Arthur Beiser, Concepts of Modern Physics, 6th Edition
2. SBP: S.B. Patel, Nuclear Physics: An Introduction, New Age International Publishe Edition
3. SNG: S.N, Ghoshal, Nuclear Physics
4. DCT: D.C. Tayal, Nuclear Physics, Himalaya Publishing House, 5th Edition

Additional References:

1. S.L Kakani and Shubhra Kakani, Nuclear and Particle Physics, Viva Books, 2nd Edition
2. Kenneth S. Krane, Modern Physics, 4th Edition, Wiley.
4. Ronald Gautreau, Schaum's Outline of Modern Physics, Second Edition, McGraw Hill

Besides reference books, Standard websites are expected to be referred

SEMESTER II

Name of the Programme	Duration	Semester	Subject
B.Sc.in Physics	Six semesters	II	Physics
Course Code	Title	Credits	
USPH202	Electricity and Electronics	2	

Learning Outcomes:

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

1. Understand the basic concepts of Alternating current theory, AC bridges and Circuit Theorems
2. Understand the basics of Analog and Digital Electronics and apply them in real life situations
3. Demonstrate quantitative problem solving skills in all the topics covered

15 lectures

Unit I: Electricity

Alternating current theory: (Review: Concept of L, R, and C)
AC circuit containing pure R, pure L and pure C, representation of sinusoids by complex numbers, Series L-R, C-R and LCR circuits, Resonance in LCR circuit (both series and parallel), Power in ac circuit. Q- Factor.
TT: 11.29, 11.30, 11.32, 12.5, 12.6, 13.1, 13.7, 13.9, 13.10, 13.11, 13.12, 13.13, 13.14, 13.17, 13.19, 14.2

2. **AC bridges**: General AC Bridge, Maxwell's Inductance Bridge, Maxwell's L/C Bridge, De Sauty Bridge, Wien Bridge.
(Bridge diagram, balancing condition derivation, applications)
TT: 16.1, 16.2, 16.3, 16.9, 16.11

3. **Circuit Theorems**: (Review: Ohm's law, Kirchhoff's laws) Ideal Current and Voltage Sources, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem. Problems related to circuit analysis using the above theorems.
TT: 2.15, 2.16, 2.18, 2.25, 2.30

15 lectures

Unit II: Analog Electronics

1. **DC Power Supply**: Block diagram of a dc power supply – concept of a transformer,(Review: Half wave rectifier, Full wave rectifier) Bridge rectifier, PIV, Efficiency and Ripple factor of full wave rectifier, Capacitor Filter, Need for voltage regulation - Zener diode as voltage stabilizer, Clipper and Clampers (Basic diode based circuits only).
BN: 1.15, 2.6, 2.7, 2.8, 2.9, 2.10, 15.2, 15.3
AD: 4.2, 22.1

SEMESTER-II

Name of the Programme	Duration	Semester	Subject
B.Sc.in Physics	Six semesters	II	Physics
Course Code	Title	Credits	
USPHP2	Practical II	2	

Instructions:

1. All the measurements and readings should be written with proper units in SI system only.
2. After completing all the required number of experiments in the semester and recording them in journal, student will have to get their journal certified and produce the certified journal at the time of practical examination.
3. While evaluating practical, weightage should be given to circuit/ray diagram, observations, tabular representation, experimental skills and procedure, graph, calculation and result.
4. Skill of doing the experiment and understanding physics concepts should be more important than the accuracy of final result.

Learning Outcome:

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

1. Understand & practice the skills while performing experiments.
2. Understand the use of apparatus and their use without fear & hesitation.
3. Correlate the physics theory concepts to practical application.
4. Understand the concept of errors and their estimation.

Note: Exemption of two experiments from section A and / or B and / or C may be given if student carries out any one of the following activity.

- Collect the information of at least five Physicists with their work or any three events on physics, report that in journal.
- Execute a mini project to the satisfaction of teacher in-charge of practical.
- Participate in a study tour or visit & submit a study tour report.
- For practical examinations, the learner will be examined in two experiments (one from each group).

- A Minimum 4 from each group and in all minimum 8 experiments must be reported in journal.
- All the skill experiments are required to be completed compulsorily. Students are required to report all these experiments in the journal. Evaluation in viva voce will be based on regular experiments and skill experiments.

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

A. Regular Experiment:

r No	Name of the Experiment
	GROUP A
1	Torsional Oscillation: To determine modulus of rigidity η of a material of wire by Torsional oscillations
2	Bifilar Pendulum: Determination of moment of inertia of rectangular and cylindrical ba about an axis passing through its centre of gravity
3	Moment of inertial of Flywheel
4	Constant volume air thermometer
5	Frequency of AC Mains: To determine frequency of AC mains (Sonometer wire)
6	LDR Characteristics: To study the dependence of LDR resistance on intensity of light
	GROUP B
7	Study of Logic gates & To verify De Morgan's Theorems
8	To study EX-OR Gate and verify its truth table
9	To study half adder and full adder and verify their truth table Ex-OR Gate
10	To study load regulation of a Bridge Rectifier
11	To study Zener Diode as Regulator
12	Study of LASER Beam Divergence

SEMESTER-II

Name of the Programme	Duration	Semester	Subject
B.Sc.in Physics	Six semesters	II	Physics
Course Code	Title	Credits	
USPH201	**Optics I**	2	

Learning Objectives:
To acquire knowledge of fundamental optics

Learning Outcomes:
After successful completion of the course, the student will be able to:

1. Understand the concept of lens, lens defects and their minimization.
2. Significance of combination of lenses implied to eyepiece of optical instrument.
3. Understand interference of light with few well known daily life examples.
4. Understand Lasers and Optical fibers, their applications in day to day life.

(15 lectures)

UI Geometrical Optics

1. Lenses and Lens Maker's Equation: Introduction to lenses, Terminology and sig conventions, Introduction to Thin lenses and Lens equation for single convex lens, Lens maker' equation: Positions of the Principal Foci and Newton's Lens equation.
SBA: 4.1, 4.2, 4.3, 4.7, 4.8, 4.9, 4.10, 4.10.1, 4.11

2. Magnification by a lens and power of lens: Lateral, Longitudinal and Ang magnification, Deviation by a thin lens and its power, Necessity to combine the lense equivalent focal length & power of two thin lenses, Concept of cardinal points and significance
SBA: 4.12, 4.12.1, 4.12.2, 4.12.3, 4.15, 4.16, 4.17, 4.17.1, 4.17.2, 4.17.3, 4.17.4, 5.2

3. Introduction to Aberration in lenses: Spherical aberration & reduction, chromatic aber & reduction (Qualitative)
SBA: 9.2, 9.5, 9.5.1, 9.10
Suitable numerical with appropriate difficulty level.

11	LCR series Resonance: To determine resonance frequency of LCR series circuit
12	To study Thermistor characteristics: Resistance vs. Temperature
	GROUP C: DEMONSTRATION EXPERIMENT
1	Radius of ball bearings (single pan balance)
2	Use of Oscilloscope: Wave forms at output of half wave , bridge rectifiers with and without Capacitor filter, Ripple
3	Use of PC for graph plotting
4	I-V Characteristics of LED
5	Testing of components (Resistors , Diode , Transistor , capacitor)
6	Study of I-V characteristics of solar cell

lote: inimum **8** experiments (Four From each group) and **4** Demo experiments should be ɔmpleted and reported in the journal, in the first semester. **Certified Journal is a must,** to be igible to appear for the semester end practical examination.

UNIVERSITY OF MUMBAI

SYLLABUS FOR SEM - V & VI

Program: B.Sc.

Course: Physics

(Credit Based Semester and Grading System
w. e. f. the academic year 2018–2019)

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	6
USPH606	Practicals of Course USPH603 + Course USPH604		2.5	6
Project				
USPHPR2	USPH601 + USPH602 + USPH603 + USPH604		1	4

Component	Maximum Marks	Minimum Passing Marks
USPHP07	80	20
USPHP08	80	20
Project 2	40	10
Total	200	80

Scheme of Examination:

1. The University (external) examination for Theory and Practical shall be conducted at the end of each Semester and the evaluation of Project work at the end of the each Semester.
2. The candidate should appear for **THREE** 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 80 marks and presentation of project work carrying 20 marks at the end of each semester.
4. The candidates shall also appear for internal presentation of project work carrying 20 marks at the end of each semester.
5. The candidate shall prepare and submit for practical examination a certified Journal based on the practical course with 6 experiments from each group.
6. The certified journal must contain a minimum of 12 regular experiments (6 from each group), **with** minimum 5 demonstration experiments in semester VI. A separate index and certificate in journal is must for each semester course.
7. At the time of practical examination, the candidate must also submit the certified Project Report prepared as per the guidelines given in the Syllabus.

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

section 2: 1-5, 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 functions and differential equations**	(15 lect.)

1. 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: 2.11 to 2.16

Expected to cover all solved problems. In addition, solve the following problems:

section 2: 16 – 2, 3, 8, 9, 10.

2. Second-order nonhomogeneous equations with constant coefficients, partial differential equations, some important partial differential equations in physics, method of separation of variables.

Ref : CH :5.2.4, 5.3.1 to 5.3.4

Expected to cover all solved problems. In addition, solve the following problems:

5.17 a to e, 5.23, 5.26, 5.29 to 5.35.

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

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,

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.)

The crystalline state, Basic definitions of crystal lattice, basis vectors, unit cell, primitive and non-primitive cells, The fourteen Bravais lattices and the seven crystal systems, elements of symmetry, nomenclature of crystal directions and crystal planes, Miller Indices, spacing between the planes of the same Miller indices, examples of simple crystal structures, The reciprocal lattice and X-ray diffraction.

Ref: Elementary Solid State Physics-Principles and Applications: M. Ali Omar, Pearson Education, 2012 : (1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 2.6)

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

1. Classical free electron theory of metals, Drawbacks of classical theory, Relaxation time, Collision time and mean free path
2. Quantum theory of free electrons, 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

Sons: Topics from Chapter 12.

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.

3. Nuclear magnetic resonance: Introduction, principle and NMR instrumentation.
Ref – Unit – IV - 1. BM: 6.11, 6.1.3. 2. BM: 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.2.3, 4.3.1. GA: 8.6.1 2. GA: 11.1,11.2and 11.3 3. GA: 10.1,10.2,10.3

References:

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

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.)
1. Review of Coulomb & Gauss law, The divergence of **E**, Applications of Gauss'		

waves at oblique incidence. DG : 8.1.1, 8.1.2 DG : 9.2.1 to 9.2.3, 9.3.1 to 9.3.3

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 and the project. There will be separate passing head for project work. 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

2	Surface tension of soap solution
3	Elastic constants of a rubber tube
4	Determination of dielectric constant
5	Logarithmic decrement
6	Searle's Goniometer
7	Determination of Rydberg's constant
8	Edser's 'A' pattern
9	Determination of wavelength by Step slit
10	Determination of e/m by Thomson's method
11	R. I. by total internal reflection
12	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

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 (using D'Alembert's principle), properties of Lagrange's equations, illustrative problems, canonical momentum, cyclic or ignorable coordinates. PVP: 4.2 to 4.9, 5.2 to 5.4, 7.2, 7.3.		

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 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, multiplexer, voltage controlled resistor, Current sourcing.

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 half wave rectifier and Variable full wave rectifier, Current ratings of SCR.

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.

References	
1.	MB: Electronic Principles, Malvino & Bates -7th Ed 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 Ed)(TMH).
5.	LF: Communication Electronics: Principles and applications, Louis E Frenzel 4th edition TMH Publications.

IIT Kharagpur

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 -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, Quark model (Qualitative).

1. SBP: 8.6
2. DCT: 18.1, 18.2,18.3, 18.4 , 18.5 to 18.9 AB: 13.5

References	
1.	AB: Concepts of Modern Physics: Arthur Beiser, Shobhit Mahajan, S Rai Choudhury (6th Ed.) (TMH).
2.	SBP: Nuclear Physics, S.B. Patel (Wiley Eastern Ltd.).
3.	IK: Nuclear Physics, Irving Kaplan (2nd Ed.) (Addison Wesley).
4.	SNG: Nuclear Physics, S. N. Ghoshal (S. Chand & Co.)
5.	DCT: Nuclear Physics, D. C. Tayal (Himalayan Publishing House) 5th ed.
Additional References	
1.	Modern Physics: Kenneth Krane (2nd Ed.), John Wiley & Sons.
2.	Atomic & Nuclear Physics: N Subrahmanyam, Brij Lal. (Revised by Jivan Seshan.) S. Chand.
3.	Atomic & Nuclear Physics: A B Gupta & Dipak Ghosh Books & Allied (P) Ltd.
4	Introduction to Elementary Particles: David Griffith, Second Revised Edition, Wiley-VCH.

Unit -II		(15 lect.)
Relativistic Kinematics - II: The relativistic addition of velocities, acceleration transformation equations, Aberration and Doppler effect in relativity, The common sense of special relativity. **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: 2.6 to 2.8, Supplementary topics A1, A2, A3, B1, B2, B3.		
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. The principle of equivalence and general relativity, Gravitational red shift. RR: 4.1 to 4.7. Supplementary topic C1, C2, C3, C4. **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.

iii) Project Details:

a)	**Project Includes:** Review articles/Simulation on PC on any concept in Physics/ Comparative & differentiative study/Improvement in the existing experiment (Design and fabrication concept) /Extension of any regular experiment/Attempt to make experiment open-ended/Thorough survey of existing active components (devices, ICs, methods, means, technologies, generations, applications etc. / any innovative projects using the concept of physics.
b)	Students/project : 02 (maximum)
c)	Evaluation of the project: The following points shall be considered. • Working model (Experimental or Concept based simulation) • Understanding of the project • Data collection • Data Analysis • Innovation/difficulty • Report

There will be **THREE** 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)

B) The Students offering electives PSPH305, PSPH306. (i.e. Electronics I)

The student has to perform a minimum of 10 experiments from Group A and Group B

Group A:

A1: 8085/8086 Microprocessor based experiments:

(Any one experiment from 1 & 2. Experiment no. 3 is compulsory)

1. Study of 8085 interrupts (Vector Interrupt 7.5).
2. Study of PPI 8255 as Handshake I/O (mode 1): *interfacing switches and LED's.*
3. 8086 assembly language programming:
   Simple data manipulation programs.(8/16-bit addition, subtraction, multiplication, division, 8/16 bit data transfer, finding greatest/smallest number, finding positive/negative numbers, finding odd/even numbers, ascending/descending of numbers, converting BCD nos. into Binary using INT 20, displaying a string of characters using INT 20)

   ***Please note**: Assembly language programming of 8086 may be done by operating PC in real mode by using 'Debug' program. Separate 8086 study kit not needed.*

A2: Microcontroller 8031/8051 based experiments:

(Experiment no. 1 is compulsory and any two experiments from 2, 3 & 4)

1. 8031/51 assembly language programming:
   Simple data manipulation programs.(8/16-bit addition, subtraction, multiplication division, 8/16 bit data transfer, cubes of nos., to rotate a 32- bit number, *finding greatest/smallest number from a block of data, decimal / hexadecimal counter)*
2. Study of IN and OUT port of 8031/51 by Interfacing switches, LEDs and Relays: *display bit pattern on LED's, to count the number of "ON" switches and display on LED's, to trip a relay depending on the logic condition of switches, event counter(using LDR and light source)*

3. Generation of FM signal using IC 566/XR 2206
4. Characteristics of PLL IC 565/4046.
5. Frequency multiplication using PLL IC 565/4046.
6. FM modulator and demodulator using PLL IC 565/4046.
7. Loss measurements and numerical aperture in optical fiber.
8. Linear control system using fiber optical communication method.
9. Telemetry using optical fiber system.
10. Study of reflex Klystron modes using X-band and oscilloscope.
11. Study of propagation characteristics in a waveguide.
12. Simulation of radiation patterns of various antennas.

nputation

1. Least squares fit / curve-fitting
2. Interpolation

ences:

i) Op-amp and linear ICs by Ramakant Gayakwad (3rd ed. 1993, Prentice Hall of India).

ii) Modern Electronic Communication by Gary M. Miller (6th ed., 1999, Prentice Hall International, Inc.).

ii) Op-amp and linear integrated circuits by Coughlin and Driscoll (4th ed. 1992, Prentice Hall of India).

/) Integrate Circuits by K. R. Botkar (8th ed., Khanna Publishers, Delhi).

) Design with Operational Amplifiers and Analog Integrated Circuits by Sergio Franco (3rd ed., Tata McGraw Hill).

) Analog and Digital Communication Systems by Martin S. Roden (5th ed., Shroff Publishers and Distributors Pvt. Ltd.).

) Microwaves by K. C. Gupta (New Age International Ltd.).

i) Electronic Communications by Dennis Roddy and John Coolen (4th ed., Pearson Education).

Basic microwave techniques and laboratory manual by M. L. Sisodia and G. S. Raghuvanshi (Wiley Eastern Ltd. 1987.).

Electronic communication systems by George Kennedy and Bernard Davis (4th ed., Tata McGraw Hill Publishing Company Ltd., New Delhi).

Digital communication systems by Harold Kolimbiris (Pearson Education Asia).

Optical fiber communication by G. Keiser (3rd ed., McGraw Hill).

C) Students offering elective ESPH407, 408, (i.e. Electronics II), have to perform at least [illegible] experiments out of the following:

[illegible]

1. [illegible] of CMOS switch IC CA 4016/4066 or IC LF398.
2. Study of A/D, D/A system using ADC 0804/0808 and DAC 0800/0808
3. [illegible] Modulation (PAM) using CMOS switch IC CA [illegible] FET.
4. [illegible] (PWM) & pulse position modulation (PPM) using IC555, 566.
5. Time division multiplexing (TDM) using IC CA 4016/4066 or FET.
6. FSK modulator using IC 555 or PLL IC 565 and demodulation using PLL IC 4046.
7. Study of PCM – Transmission and reception using CODEC IC.
8. Two channel analog multiplexer using CMOS switch CA4016/CA4066/LF398.
9. PC to PC communication through serial port.
10. PC to PC communication through parallel port.
11. Study of Manchester coding and decoding using CODEC IC.
12. Experiments using Phoenix kit
13. Computation : Computer program for file handling
14. Any one classical Experiment (available in department or affiliated institutions) e.g.
    - Millikan's oil-drop method,
    - Raman effect in liquids,
    - e/m by Thomson's method
    - Rydberg's constant using constant deviation prism.

References:

1. Op-amp and linear ICs by Ramakant Gayakwad (3rd ed. 1993, Prentice Hall of India).
2. Modern Electronic Communication by Gary M. Miller (6th ed., 1999, Prentice Hall International, Inc.).
3. Op-amp and linear integrated circuits by Coughlin and Driscoll (4th ed. 1992, Prentice Hall of India).
4. Integrate Circuits by K. R. Botkar (8th ed., Khanna Publishers, Delhi).
5. Design with Operational Amplifiers and Analog Integrated Circuits by Sergio Franco (3rd ed., Tata McGraw Hill).

students have to submit two separate project reports / dissertation consisting of the problem definition, literature survey and current status, objectives, methodology and some preliminary experimental work in Semester III and actual experimental work, result and analysis in semester IV with four credits each. Those who have opted for two separate projects will also have to submit two separate project reports at each examination. The project can be a theoretical or experimental project related to assigned topic, electronic circuits or a mini project. Training in a research institute, training of handling of sophisticated equipments etc.

Maximum three students can do a joint project. Each one of them will submit a separate project report with details/part only he/she has done. However he/she can in brief (in a page one or two) mention in Introduction section what other group members have done. In case of electronic projects, use of readymade electronic kits available in the market should be avoided. The electronics project / models should be demonstrated during presentation of the project. In case a student takes training in a research institute/training of handling sophisticate equipment, he/she should mention in a report what training he/she has got, which instruments he/she handled and their principle and operation etc.

Each project will be of 100 marks with 50% by internal and 50% by external evaluation.

The project report should be file bound/spiral bound/hard bound and should have following format

- Title Page/Cover page
- Certificate endorsed by Project Supervisor and Head of Department
- Declaration
- Abstract of the project
- Table of Contents
- List of Figures
- List of Tables
- Chapters of Content –
- Introduction and Objectives of the project
- Experimental/Theoretical Methodology/Circuit/Model etc. details
- Results and Discussion if any
- Conclusions
- References

2. Equivalent focal length of two thin lenses, thick lens, cardinal points of thick lens, Ramsdenand Huygens eyepiece.
3. Aberration: Spherical Aberration, Reduction of Spherical Aberration, Chromatic aberration and condition for achromatic aberration.
3. Interference: Interference in thin films, Fringes in Wedge shaped films, Newton's Rings (Reflective).

15 lectures

UNIT III

1. Behavior of real gases and real gas equation, Van der Waal equation
2. Thermodynamic Systems, Zeroth law of thermodynamics, Concept of Heat, The first law, Non Adiabatic process and Heat as a path function, Internal energy, , Heat Capacity and specific heat, Applications of first law to simple processes, general relations from the first law, Indicator diagrams, Work done during isothermal and adiabatic processes, Worked examples, Problems.

· ***Note: A good number of numerical examples are expected to be covered during the prescribed lectures.***

References:

1. Halliday, Resnick and Walker, Fundamental of Physics (extended) – (6th Ed.), John Wiley and Sons.
2. H. C. Verma, Concepts of Physics – (Part–I), 2002 Ed. BharatiBhavan Publishers.
3. Iradov
4. Brijlal, Subramanyam and Avadhanulu A Textbook of Optics, 25th revised ed.(2012) S. Chand
5. Brijlal, Subramanyam and Hemne, Heat Thermodynamics and Statistical Physics, S Chand, Revised, Multi-coloured,2007 Ed.
6. Jenkins and White, Fundamentals of Optics by (4th Ed.), McGraw Hill International.

dditional References :

1. Thornton and Marion, Classical Dynamics – (5th Ed)
2. D S Mathur, Element of Properties of Matter, S Chand & Co.
3. R Murugeshan and K Shivprasath, Properties of Matter and Acoustics S Chand.
4. M W Zemansky and R H Dittman, Heat and Thermodynamics, McGraw Hill.
5. D K Chakrabarti, Theory and Experiments on Thermal Physics, (2006 Ed) Central books.
6. C L Arora, Optics, S Chand.
7. Hans and Puri, Mechanics –, 2nd Ed. Tata McGraw Hill

HJ pain d

3. Wave Motion: Transverse waves on string, Travelling and standing waves on a string. Normal modes of a string, Group velocity, Phase velocity, Plane waves, Spherical waves, Wave intensity.

Note: A good number of numerical examples are expected to be covered during the prescribed lectures.

fundamental of Vibration by Pain
chapter 2

References:

1. MS:Murray R Spiegel, Schaum's outline of Theory and problems of Vector Analysis, Asian Student Edition
2. CH: Charlie Harper, Introduction to Mathematical Physics , 2009 (EEE) PHI Learning Pvt. Ltd.
3. CR: D. Chattopadhyay, P C Rakshit , Electricity and Magnetism 7th Ed. New Central Book agency.
4. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons. 71-78
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

Additional References:

1. BrijLal,N. Subrahmanyam , JivanSeshan, Mechanics and Electrodynamics, , (S. Chand) (Revised & Enlarged ED. 2005)
2. A K Ghatak, Chua, Mathematical Physics, 1995, Macmillan India Ltd.
3. Ken Riley, Michael Hobson and Stephen Bence, Mathematical Methods for Physics and Engineering, Cambridge (Indian edition).
4. H. K. Dass, Mathematical Physics, S. Chand & Co.
5. Jon Mathews & R. L. Walker, Mathematical Methods of Physics: W A Benjamin Inc.

B. Skill Experiments:

1.	Use of Vernier calipers, Micrometer Screw Gauge, Travelling Microscope
2.	Graph Plotting : Experimental, Straight Line with intercept, Resonance Curve etc.
3.	Spectrometer: Schuster's Method
4.	Use of DMM
5	Absolute and relative errors calculation.

C) Any one out of following is equivalent to two experiments from section A and/ or B

1. Students should collect the information of at least five Physicists with their work. Report that in journal.
2. Students should carry out mini-project up to the satisfaction of professor In-charge of practical.
3. Study tour. Students participated in study tour must submit a study tour report.

Minimum 8experimentsfrom the list should be completed in the first semester. Any four skill experiments are to be reported in journal Certified journal is a must to be eligible to appear for the semester end practical.

The scheme of examination for the revised course in Physics at the First Year B.Sc. Semester end examination will be as follows.

Semester End Practical Examination:
Scheme of examination:

There will be no internal assessment for practical.
A candidate will be allowed to appear for the semester end practical examination only if candidate submits a Certified journal at the time of practical examination of the semester c certificate from the Head of the Department /Institute to the effect that the candidate completed the practical course of that semester of F.Y.B.Sc. Physics as per the minim requirement. The duration of the practical examination will be two hours per experim There will be two experiments through which the candidate will be examined in practical. questions on slips for the same should be framed in such a way that candidate will be ab complete the task and should be evaluated for its skill and understanding of physics.

Leaning Outcome:

i) To understand and practice the skills while doing physics practical.
ii) To understand the use of apparatus and their use without fear.
iii) To correlate their physics theory concepts through practical.
iv) Understand the concepts of errors and their estimation.

A) Regular experiments:

1	Flywheel
2	To study Zener Diode as Regulator
3	To study load regulation of a Bridge Rectifier
4	LR Circuit: To determine the value of given inductance and phase angle
5	CR Circuit: To determine value of given capacitor and Phase angle
6	Frequency of AC Mains: To determine frequency of AC mains.
7	LCR series Resonance: To determine resonance frequency of LCR series circuit.
8	To study NAND and NOR gates as Universal Building Blocks
9	To study EX-OR Gate, half adder and full adder and verify their truth tables.
10	To verify De Morgan's Theorems
11	Thevenin's Theorem: To verify Thevenin's theorem for DC circuits
12	Norton's Theorem: To verify Norton's Theorem for DC circuits
13	LDR Characteristics: To study the dependence of LDR resistance on intensity of light.

List of Demo-experiments: (Min. four)

1.	Angular Momentum conservation (Rotating Platform)
2.	Light dependent switch
3.	Laser beam divergence, Intensity
4.	Use of Oscilloscope
	Charging and discharging of a capacitor
	Use of PC for graph plotting

SEMESTER II

Name of the Programme	Duration	Semester	Subject
B.Sc. in Physics	Six semesters	II	Physics
Course Code	Title	Credits	
USPH202	Electricity and Electronics	2for USPH202	

Unit I : **15 lectures**

1. Alternating current theory:(Concept of L, R, and C: Review)
AC circuit containing pure R, pure L and pure C, representation of sinusoids by complex numbers, Series L-R, C-R and LCR circuits. Resonance in LCR circuit (both series and parallel), Power in ac circuit. Q-factor.
2. AC bridges: AC-bridges: General AC bridge, Maxwell, de-Sauty, Wien Bridge , Hay Bridge.

Unit II: Electronics **15 lectures**

1.Circuit theorems: (Review: ohm's law, Kirchhoff's laws)
Superposition Theorem, Thevenin's Theorem, Ideal Current Sources, Norton's Theorem, Reciprocity Theorem, Maximum Power Transfer Theorem.
Numericals related to circuit analysis using the above theorems.
2.DC power supply:Half wave rectifier , Full wave rectifier, Bridge rectifier, PIV and Ripple factor of full wave rectifier, Clipper and Clampers(Basic circuits only), Capacitor Filter. Zener diode as voltage stabilizer.
3.Digital electronics : Logic gates(Review), NAND and NOR as universal building blocks. EXOR gate: logic expression, logic symbol, truth table, Implementation using basic gates and its applications, Boolean algebra, Boolean theorems. De-Morgan theorems, Half adder and Full adder

Unit III : Electrostatics and Magnetostatics **15 lectures**

1.The Electric Field : Introduction, Coulomb's Law, The Electric Field, Continuous charge Distribution, Electric Potential, Introduction to Potential, Comments on Potential, The Potential of a Localized Charge Distribution
2.Work and Energy in Electrostatics: The Work Done to Move a charge, The Energy of a Point Charge Distribution
3.Magnetostatics: Magnetic Fields
4.TheBiotSavart Law: Steady Currents,The Magnetic Field of a Steady Current Helmholtz coil and solenoid.

F.Y.B.Sc. Revised Syllabus

Course wise Reference Books

USPH 101 CLASSICAL PHYSICS

Unit: I

1.Newton's Laws:

HCV: H. C. Verma, Concepts of Physics – (Part–I),2002 Ed. Bharati Bhavan Publishers. : Worked out examples (with friction): 1, 2, 3, 4 of Chapter 6 – HCV

HCV: Ch. 5.1 to 5.5 and 5.7 Ch. 6 (Worked out problems 1 to 4)

2.Elasticity and Fluid Dynamics : HP: Hans and Puri, Mechanics –, 2nd Ed. Tata McGraw Hill. : HP: 15.3.A to 15.5.A and 15.7.A and HP: 15.2B to 15.6B

Unit: II

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

BS: 4.9 to 4.12, 4.17.1 to 4.17.4, 6.2, 6.2.1 to 6.2.3, 6.3.1.1 to 6.3.1.3, 10.10, 10.11.

BS: 9.2, 9.3, 9.4, 9.5, 9.5.1, 9.6, 9.10, 9.11, 9.12, 9.13(1) (2)

BS: 15.1, 15.2.1 to 15.2.5, 15.3, 15.5, 15.6.1, 15.6.2, 15.6.3

UNIT III

BSH : Brijlal, Subramanyam and Hemne, Heat Thermodynamics and Statistical Physics, S Chand, Revised, Multi-coloured, 2007 Ed.

BSH: 2.1 to 2.12, 4.1 to 4.14

USPH 102 MODERN PHYSICS

Unit: I

1.Structure of Nuclei: Kaplan 9.4, 9.5, SBP 4.1.1, 4.1.2

2. Radioactivity: 3 (Dr. S. B. Patel, Nuclear Physics Reprint 2009, New Age International) SBP : 2.1 to 2.3, 2.6 to 2.10, 2.12, 2.1

Unit II

Interaction between particles and matter : SBP: 1.1.2, 1.1.3(i and ii) Kaplan 2.8

Nuclear Reactions: SBP: 3.1 to 3.5

Fusion and fission : BSS 12.3, 12.7 (N Subrahmanyam, Brijlal and Seshan, Atom and Nuclear Physics Revised Ed. Reprint 2012, S. Chand)

Unit : III

AC 11-02-2017

Item No. 4.222

UNIVERSITY OF MUMBAI

Essential Elements of the Syllabus

Title : Syllabus for the B.Sc. Course in Physics (from academic year 2017-18) for Semester III & IV

Course Code : USPH

Preamble :

This is a revised part of the undergraduate programme (Six Semesters) in Physics, to be taught in Semester III & IV from the academic year 2017-18 onwards.

Developing Curriculum that is progressive and purposeful to create positive improvement in the education system is the logic behind this revision.

Out of the three courses in each Semester, **two** courses are devoted to core Physics, catering to Mechanics, Thermodynamics, Optics , Electrodynamics, Quantum Mechanics, Mathematical Physics and Digital and Analog Electronics. These have been tailored to fit in with the existing FYBSc syllabus (Sem I and Sem II) in terms of continuity and to ensure delivery of quality content to the learner.

The science of Physics has diversified immensely in recent times and numerous new fields in Physics, such as Biophysics, Geo-Physics, Radio-Physics, Physics of metals and materials, etc. have come into existence. The fundamentals and the generality of many principles of Physics are common to all these specialized diverse fields. Most problems in applied areas have been discussed

Revised Syllabus in Physics (Theory and Practical)

as per Choice based Credit and Grading system

Second year B.Sc. 2017-2018

The revised syllabus in Physics as per credit based system (with choice) of the Second Year B.Sc course will be implemented from the academic year 2017-2018.

Objectives:

- To develop analytical abilities towards real world problems
- To familiarize with current and recent scientific and technological developments
- To enrich knowledge through problem solving hands on activities, study visits, projects etc.

Semester	Paper	Title	Credits
III	USPH301	Mechanics and thermodynamics	2
III	USPH302	Vector calculus ,Analog Electronics	2
III	USPH303	Applied Physics -I	2
III	USPHP3	Practical course -3 (Group A,B,C and Skill)	3
		Total	**9**
IV	USPH401	Optics and Digital Electronics	2
IV	USPH402	Quantum Mechanics	2
IV	USPH403	Applied Physics-II	2
IV	USPHP4	Practical course -4 (Group A,B,C and Demo)	3
		Total	**9**

UNIT –II **15 Lectures**

(Review of zeroth and first law of thermodynamics)

I Conversion of heat into work, heat engine, Carnot's cycle: its efficiency.

Ii Second law of thermodynamics, Statements, Equivalence of Kelvin and Plank statement, Carnot's theorem, Reversible and irreversible process, Absolute scale of temperature.

iii Clausius theorem, Entropy, Entropy of a cyclic process, Reversible process, Entropy change, Reversible heat transfer, Principle of increase in entropy, generalized form of first and second law, entropy change of an ideal gas, entropy of steam, entropy and unavailable energy, entropy and disorder, absolute entropy.

UNIT –III **15 Lectures**

i Third law of thermodynamics, Nernst heat theorem, Consequences of the third law, Maxwell's thermodynamic relations, Clausius – Clapeyron equation, Thermal Expansion.

ii Steam engine, Rankine cycle, Otto engine, Efficiency of Otto cycle, Diesel cycle, Efficiency of Diesel cycle, Otto and diesel comparison

iii Low temp Physics: Different methods of liquefaction of gases, methods of freezing, Cooling by evaporation, cooling by adiabatic expansion
Joule - Thompson effect, JT effect of Van der Waal's gas, Liquefaction of helium, properties and uses of liquid Helium

References:

Resnick and Halliday : Physics – I

Mechanics – H. S. Hans and S. P. Puri, Tata McGraw Hill (2_{nd} ED.)

Thermal Physics, AB Gupta and H. Roy, Book and Allied (P) Ltd, Reprint 2008, 2009.

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

Unit II: Analog Electronics **15 Lectures**

1.Transistor Biasing, Inherent Variations of Transistor Parameters, Stabilisation, Essentials of a Transistor Biasing Circuit, Stability Factor, Methods of Transistor Biasing, Base Resistor Method, Emitter Bias Circuit, Circuit analysis of Emitter Bias, Biasing with Collector Feedback Resistor, Voltage Divider Bias Method, Stability factor for Potential Divider Bias.

2.General amplifier characteristics: Concept of amplification, amplifier notations, current gain, Voltage gain, power gain, input resistance, output resistance, general theory of feedback, reasons for negative feedback, loop gain.

3.Practical circuit of transistor amplifier, phase reversal, frequency response, Decibel gain and Band width.

Unit III: Analog Electronics **15 Lectures**

1. Oscillators: Introduction, effect of positive feedback. Requirements for oscillations, phase shift oscillator, Wien Bridge Oscillator, Colpitt's oscillator, Hartley oscillator

2. Operational Amplifiers: Introduction, Schematic symbol of OPAMP, Output voltage from OPAMP, AC analysis, Bandwidth of an OPAMP, Slew rate, Frequency Response of an OPAMP, OPAMP with Negative feedback, Inverting Amplifier, Non-Inverting Amplifier, Voltage Follower, Summing Amplifier, Applications of Summing amplifier, OPAMP Integrator and Differentiator, Critical frequency of Integrator, Comparator

References:

Introduction to Electrodynamics 3rd Ed by D.J. Griffith

Principles of Electronics – V. K. Mehta and Rohit Mehta. (S. Chand – Multicoloured illustrative edition)

Electronic devices and circuits – An introduction Allan Mottershead (PHI Pvt. Ltd.– EEE – Reprint – 2013)

Unit II : Biophysics **15 Lectures**

Introduction, definition, History & scope of biophysics, biological fluids, physico-chemical properties, viscosity, surface tension, pH, osmosis, osmotic pressure. Diffusion, Ficks' laws of diffusion, dialysis, Cell is unit of life, fundamental understanding prokaryotic and eukaryotic cell structure and function, eukaryotic cell membrane, Fundamentals of transport process through biological membrane, membrane channels. electrical properties of cell, Action potential, propagation of action potential, methods of measurement of action potential, Nernst equation, Golman equation, The Hodgkin-Huxely model of action potential, voltage clamp technique, Patch clamp technique, cell impedance and capacitance .

References:

1. Cellular and Molecular Biology: Concept and Experiment by Gerald Karp
2. The Cell: A Molecular Approach by Geoffery Cooper
3. Introductory Biophysics: Perspective on living state by James Claycomb
4. Medical Physiology by Guyton
5. Molecular Biology of Cell by Bruce Albert
6. Text Book of Biophysics by R N Roy

Unit III : Materials – properties and applications **15 Lectures**

Introduction to Materials

Classification of Materials based on structures (Crystalline and Amorphous, single crystal, polycrystalline and nanomaterials) and Functionality (Conducting, insulating, superconducting, reflecting, transmitting etc)
Types of Materials: Metals and alloys, Ceramics, Polymers and Composites, Thin Films, Nanomaterials; Some Physical and Chemical methods of materials synthesis (5L)

Properties of materials

Electrical Properties: Review of energy band diagram for materials - conductors, semiconductors and insulators, Electrical conductivity in metals, semiconductors and insulators (dielectrics), effect of temperature on conductivity

Learning outcomes :

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

i) Understand & practice the skills while performing experiments.
ii) Understand the use of apparatus and their use without fear & hesitation.
iii) Correlate the physics theory concepts to practical application.
iv) Understand the concept of errors and their estimation.

Note: Exemption of two experiments from section A and / or B and / or C may be given if student carries out any one of the following activity.

1) Collect the information of at least five Physicists with their work or any three events on physics, report that in journal.
2) Execute a mini project to the satisfaction of teacher in-charge of practical.
3) Participate in a study tour or visit & submit a study tour report.

For practical examinations, the learner will be examined in three experiments (one from each group) .
Each experiment will be of three hours' duration .
A Minimum 3 from each group and in all minimum 12 experiments must be reported in journal.
All the skill experiments are required to be completed compulsorily. Students are required to report all these experiments in the journal. Evaluation in viva voce will be based on regular experiments and skill experiments.

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

Group A

1 Y by bending.
2 Kater's pendulum
3 Searle's experiment: determination of Y and □.
4 Flat spiral spring (Y)
5 Flat spiral spring (n)
6 Young's modulus by Koenig's method.
7 Determination of thermal conductivity of bad conductor by Lee's Method.
8 Helmholtz resonator- determination of unknown frequency.

12. Assignment & literature survey (equivalent to 2 practical sessions).

Skill experiments

1. Soldering technique
2. Wiring of a simple circuit using bread board
3. Use of DMM
4. Use of oscilloscope
5. Travelling microscope (radius of capillary)
6. Spectrometer: mean μ of yellow doublet of mercury source.
7. Spectrometer: optical leveling and Shuster's method
8. Component testing, colour code of resistors, capacitors etc.
9. Drawing of graph on semi logarithmic / logarithmic scale.
10. Radius of ball bearings (single pan balance)

References:

1) Advanced course in Practical Physics D. Chattopadhya, PC Rakshit & B Saha. (6^{th} Edition) Book and Allied Pvt.Ltd.
2) B.Sc Practical Physics – Harnam Singh S.Chand & Co. Ld. 2001
3) A test book of advanced practical PHYSICS _ SAMIR Kumar Ghosh, New Central Book Agency (3^{rd} edition)
4) B.Sc. Practical Physics – CL Arora (1^{st} Edition) -2001 S.Chand and Co Ltd.
5) Practical Physics CL Squires (3^{rd} Edition) Cambridge University
6) University Practical Physics – DC Tayal. Himalaya Publication
7) Advanced Practical Physics – Worsnop &Flint.

Unit II **(15 Lectures)**

Polarization: Types of polarization, Plane polarized light, Circularly polarized light, Elliptically polarized light, Partially polarized light, Production of Plane polarized light, Polarization by reflection from dielectric surface, Polarization by refraction –pile of plates, Polarization by scattering, Polarization by selective Absorption, Polarization by double refraction, Polarizer and Analyzer, Malus' Law, Anisotropic crystal, Calcite crystal, Optic Axis, Double refraction in calcite crystal, Huygens' explanation of double refraction, Ordinary and Extra ordinary rays, Positive and Negative crystals, Superposition of waves linearly polarized at right angles, Superposition of e-Ray and o-Ray, Retarders, Quarter wave plate, Half wave plate, Production of linearly polarized light,Production of elliptically polarized light, Production of circularly polarized light, Analysis of polarized light, Applications of polarized light.

Unit – III

Digital Electronics: **(15 Lectures)**

Background knowledge (devote one lecture at commencement):

i. Binary number system , Arithmetic building blocks , Types of registers

Digital IC signal levels, Binary to Decimal ,Decimal to binary , Hexadecimal number, Hexadecimal to decimal Conversion, Decimal to hexadecimal conversion, Hexadecimal to binary conversion, Binary to hexadecimal conversion, Binary addition, Unsigned binary numbers, Sign magnitude numbers , 1's complement , 2's complement , Converting to and from 2's complement representation , 2's complement arithmetic, The adder-subtractor (ignore IC specific diagrams)

RS Flip-Flops (only NOR gate latch, NAND gate latch) , Gated Flip-Flops, Edge-Triggered RS Flip-Flop, Edge- Triggered D Flip-Flop, Edge-Triggered J-K Flip-Flop, JK Master- Slave Flip-Flops, Bounce elimination switch

Types of registers : SISO , SIPO, PISO , PIPO [in this chapter the teacher should make all IC specific diagrams into general diagrams ie. Ignore pin numbers and IC numbers]

Asynchronous counter -3 bit (ignore IC specific diagrams), Synchronous counter only mod 8, Decade Counters Mod5 and Mod10

5. Postulates of Quantum Mechanics.
6. Analogy between Wave equation and Schrodinger equation.
7. Time dependent and time independent (Steady State) Schrodinger equation, Stationary State
8. Superposition principle.
9. Probability current density, Equation of continuity and its physical significance.

Unit-II: Applications of Schrodinger steady state equation- 15 Lectures

1. Free particle.
2. Particle in infinitely deep potential well (one - dimension).
3. Particle in finitely deep potential well (one - dimension).
4. Step potential.
5. Particle in three dimension rigid box, degeneracy of energy state.

Unit-III: Applications of Schrodinger steady state equation –II 15 Lectures

1. Potential barrier (Finite height and width) penetration and tunneling effect (derivation of approximate transmission probability)
2. Theory of alpha particle decay from radioactive nucleus.
3. Harmonic oscillator (one-dimension), correspondence principle.

[Note: A good number of numerical examples are expected to be covered during the prescribed lectures].

Reference Books:

1. Concepts of Modern Physics – A. Beiser (6th Ed.) Tata McGraw Hill.
2. Quantum Mechanics – S P Singh, M K Bagade, Kamal Singh, - S. Chand : 2004 Ed.
3. Quantum Mechanics of Atoms, Molecules, Solids, Nuclei and particles. - By R. Eisberg and R. Resnik Published by Wiley.
5. Introduction to Quantum Mechanics. - By D. Griffiths Published by Prentice Hall.
6. Quantum Mechanics. - By Ghatak and Lokanathan Published by Mc. Millan.
7. Quantum Mechanics. - By L. I. Schiff.
8. Quantum Mechanics. - By Powell and Crasemann, Addison-Wesley Pub. Co.

Suggested Textbooks and References

1. *Geomagnetism: Solid Earth and Upper Atmosphere Perspectives.* Nathani Basavaiah, Springer (2011).
2. *Introduction to Applied Geophysics: Exploring the Shallow Subsurface.* H.R. Burger, A.F. Sheehan and C.H. Jones. W.W. Norton, New York (2006).
3. *Earth Science.* E.J. Tarbuck, F.K. Lutgens and D. Tasa, Prentice & Hall (2005).
4. *Mantle Plumes and Their Record in Earth History.* K.C. Condie, Cambridge University Press, Cambridge, UK (2001)
5. *The Magnetic Field of the Earth: Paleomagnetism, the Core, and the Deep Mantle.* R.T. Merrill, M.W. McElhinny and P.L. McFadden, International Geophysical Series 63, Academic Press (1996).
6. *Applied Geophysics (Paperback).* W.M. Telford, L.P. Geldart and R.E. Sheriff, Cambridge University Press, Cambridge (1990).

CHAPTER 2 : GEO-ENVIRONMENTAL SCIENCES

2.1 Environmental Magnetic Analysis relating to magnetic minerals and environmental systems, soil magnetism, mineral magnetic studies of lake and marine sediments and magnetic monitoring of air-, land- and water-pollution.

2.2 Geo-Environmental Studies relating to mining, urban, industrial, coastal and desert management, palaeoclimate, palaeoenvironment, medical geology, climate change and studies related to their impact on ecosystem.

2.3 Natural Hazard Investigations including scientific studies related to natural hazards such as earthquakes, landslides, floods and tsunamis.

2.4 Impact Assessment of Anthropogenic Activities such as heavy metal pollution in Mumbai aquatic system with industries and thermal power plants, urbanization, disposal of industrial and radio-active waste, excessive withdrawal of ground water and use of fertilizers.

Problems.

Suggested Textbooks and References

1. *Energy and Environment, 3rd Edition.* Robert A. Ristinen and Jack P. Kraushaar, John Wiley and Sons, Inc. (2015).
2. *Geomagnetism: Solid Earth and Upper Atmosphere Perspectives.* Nathani Basavaiah, Springer (2011).
3. *Textbook of Environmental Chemistry.* Balaram Pani, I.K. International Publishing House (2007).

Unit III : **15 Lectures**

A)Radiation Physics

1: Basics of Radiation Science 3L

Electromagnetic Spectrum, Introduction to radioactivity, Sources of radiation: Alpha, beta and gamma radiation, high energy electron radiation and X-rays, Radiation units, Sources of radiation: natural and man-made, Radiation protection

2: Radiation Detectors and Beam Calibration 4L

Types of radiation detectors, Ionization detectors, scintillation detectors, particle detectors, TLD, thin film detectors, Radiation field analyzer, Basic principles of beam profile measurement

Recommended Books:

1. Course in DRP by Dept of Atomic Energy

B) Radio communication :

1: Basics of Communication 3L

Block diagram of communication system, types of communication system: simplex, duplex, analog and digital communication,

Electromagnetic spectrum, base band and broad band communication. Noise

concept and types, signal to noise ratio, noise figure, noise temperature.

2: Amplitude Modulation 2 L

Need of modulation, concept of modulation, AM waveform, mathematical expression of AM, concept of sideband, demodulation principles. AM Receiver: TRF and super-heterodyne receiver,

3: Frequency Modulation 2 L

FM modulation: definition, mathematical representation, frequency spectrum, bandwidth and modulation index.

4.Concept of ASK, PSK, FSK, PAM, PWM, PPM, PCM. 1 L

Recommended Books:

1. Communication Electronics: Principles and applications by Louis E Frenzel 3rd edition TMH Publications.

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

Group A

1. Optical lever: determination of μ
2. Cylindrical obstacle: determination of λ
3. Single slit diffraction
4. Fresnel's bi-prism: determination of λ
5. Determination of Couchy's constants.
6. R.P. of telescope.
7. R.P. of grating
8. R. P. of prism
9. Brewster's law: determination of μ
10. Double refraction
11. Polarimeter
12. Laser beam profile
13. Determination of wavelength of laser using grating
14. Determination of R.I. of liquid by laser
15. μ by total internal reflection

Group B

1. Square wave oscillator using gates.
2. Half adder and full adder (7486, 7408)
3. Study of MS-JK flip flop
4. Study of Latch (74LS373)
5. Study of 3:8 Decoder (74LS138)
6. Study of 8:3 Priority Encoder (74LS148)
7. Counters mod 2,5 and 10
8. Shift registers
9. Transistorized Astable multivibrator
10. Transistorized Monostable multivibrator
11. Transistorized Bistable multivibrator
12. Op-Amp as Astable multivibrator
13. IC 555 timer as Astable multivibrator
14. IC 555 timer as Monostable multivibrator
15. IC 555 timer as a Ramp generator