UNIVERSITY OF PUNE

FOR

S.Y.B. Sc. (Physics)

FROM ACADEMIC YEAR

2014-2015

Equivalence of Courses in 2013 pattern with 2008 pattern

Semester I

Paper	2008 Pattern (Old Course)	2013 Pattern (New Course)
Paper I (PHY211)	Mathematical Methods in Physics I	Mathematical Methods in Physics I
Paper II (PHY 212)	Electronics I	Electronics I
Paper II (PHY 212)	Instrumentation	Instrumentation

Semester II

Paper	2008 Pattern (Old Course)	2013 Pattern (New Course)
Paper I (PHY221)	Oscillations, Waves and Sound	Oscillations, Waves and Sound
Paper II (PHY 222)	Optics	Optics

S.Y.B. Sc. (Physics)

Semester I (Paper I)

PH211: MATHEMATICAL MEHODS IN PHYSICS

Learning Outcomes: After the completion of this course students will be able to

- Understand the complex algebra useful in physics courses
- Understand the concept of partial differentiation.
- Understand the role of partial differential equations in physics
- Understand vector algebra useful in mathematics and physics
- Understand the singular points of differential equation.

1. Complex Numbers (12)

1.1 Introduction to complex numbers.
1.2 Rectangular, polar and exponential forms of complex numbers.
1.3 Argand diagram
1.4 Algebra of complex numbers using mathematical and Argand diagram
1.5 De-Moivre's Theorem
1.6 Powers, roots and log of complex numbers.
1.7 Trigonometric, hyperbolic and exponential functions.
1.8 Applications of complex numbers to determine velocity and acceleration in curved motion
1.9 Problems.

2. Partial Differentiation (12)

2.1 Definition of partial differentiation
2.2 Successive differentiation
2.3 Total differentiation
2.4 Exact differential
2.5 Chain rule
2.6 Theorems of differentiation
2.7 Change of variables from Cartesian to polar co-ordinates.
2.8 Implicit and explicit functions
2.9 Conditions for maxima and minima (without proof)
2.10 Problems.

3. Vector Algebra (06)

3.1 Introduction to scalars and vectors:
3.2 dot product and cross product of two vectors and its physical significance
3.3 Scalar triple product and its geometrical interpretation.
3.4 Vector triple product and its proof.
3.5 Problems.

4. Vector Analysis (12)

4.1 Introduction
4.2 Scalar and vector fields
4.3 Differentiation of vectors with respect to scalar.
4.4 Vector differential operator and Laplacian operator
4.5 Gradient of scalar field and its physical significance.

4.6 Divergence of scalar field and its physical significance
4.7 Curl of vector field
4.8 Vector identities
a. $\nabla x \nabla \phi = 0$
b. $\nabla.(\nabla x \mathbf{V}) = 0$
c. $\nabla.(\nabla \phi) = \nabla^2 \phi$
d. $\nabla.(\phi \mathbf{A}) = \nabla \phi. \mathbf{A} + \phi (\nabla.\mathbf{A})$
e. $\nabla X (\phi \mathbf{A}) = \phi(\nabla X \mathbf{A}) + (\nabla \phi) X \mathbf{A}$
f. $\nabla.(\mathbf{A} X \mathbf{B}) = \mathbf{B}. (\nabla X \mathbf{A}) – \mathbf{A}.(\nabla X \mathbf{B})$
4.9 Problems.

5. Differential Equation (06)
5.1 Frequently occurring partial differential equations (Cartesian coordinates)
5.2 Degree, order, linearity and homogeneity of differential equation.
5.3 Concept of Singular points. Example of singular points ($x = 0$, $x = x0$ and $x = \infty$) of differential equation.
5.4 Problems.

Additional Activity:
Four tutorials containing 10 unsolved problems each from suggested references.

Reference Books:
1. Methods of Mathematical Physics by Laud, Takwale and Gambhir
2. Mathematical Physics by B. D. Gupta
3. Mathematical Physics by Rajput and Gupta
4. Mathematical Methods in Physical Science by Mary and Boas
5. Vector analysis by Spiegel and Murrey
6. Mathematical Methods for Physicists by Arfken and Weber, 5th Edition, Academic Press.

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Semester I (Paper II)

PH212: ELECTRONICS

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

- Apply laws of electrical circuits to different circuits.
- Understand the relations in electricity
- Understand the properties and working of transistors.
- Understand the functions of operational amplifiers.
- Design circuits using transistors and operational amplifiers.
- Understand the Boolean algebra and logic circuits.

1. NETWORK THEOREMS (06)

1.1 Kirchhoff's laws (revision)
1.2 Voltage and Current divider circuits
1.3 Thevenin's theorem
1.4 Norton's theorem
1.5 Super-position theorem
1.6 Maximum power transfer theorem (All theorems 1.3 to 1.6 with proof)
1.7 Problems.

2. STUDY OF TRANSISTOR (14)

2.1) BIJUNCTION TRANSISTOR

1. Revision of bipolar junction transistor, types, symbols and basic action
2. Configurations (Common Base, Common Emitter & Common Collector)
3. Current gain factors (α &β) and their relations.
4. Input, output and transfer characteristics of CE, CB & CC configurations.
5. Biasing methods: Base bias, Emitter feedback and voltage divider
6. DC load lines (CE), Operating point (Q point)
7. Transistor as a switch
8. Problems.

2.2) UNI- JUNCTION TRANSISTOR

1. Symbol, types, construction, working principle, I-V characteristics, Specifications, Parameters of: Uni-Junction Transistor(UJT)
2. Use of UJT as a relaxation oscillator

3. OPERTAIONAL AMPLIFIERS (10)

3.1 Introduction
3.2 Ideal and practical Characteristics
3.3 Operational amplifier: IC 741- Block diagram and Pin diagram
3.4 Concept of virtual ground
3.5 Inverting and non-inverting operational amplifiers with concept of gain.

3.6 Operational amplifier as an adder and substracter.
3.7 Problems.

4. OSCILLATROS (04)

4.1 Concept of positive and negative feedback
4.2 Barkhausein criteria for an oscillator
4.3 Construction, working and applications of
Phase shift oscillator using IC-741
4.4 Problems.

5. POWER SUPPLY (06)

5.1 Concept and working of rectifier half wave, full wave and bridge rectifier
5.2 Ripple voltage
5.3 RC filter circuit
5.4 Unregulated and regulated power supply
5.5 Concept of load and line regulation
5.6 Zener as regulator
5.7 Problems.

6. NUMBER SYSTEM AND LOGIC GATES (08)

6.1 Number systems: Binary, Binary coded decimal (BCD), Octal, Hexadecimal
6.2 Addition and subtraction of binary numbers and binary fractions using one's and two's complement.
6.3 Basic logic gates (OR, AND, NOT)
6.4 Derived gates: NOR, NAND, EXOR, EXNOR with symbols and truth tables
6.5 Boolean Algebra
6.6 De Morgan's theorems and its verification
6.7 Problems.

Reference Books:

1. Electronics Principles, Malvino, 7th Edition TaTa Mc-Graw Hills.
2. Principles of Electronics, V. K. Mehta, S. Chand Publication New Delhi.
3. Op Amp and Linear integrated circuits, Ramakant Gaikwad, Prentice Hall of India Pub.
4. Integrated Circuts, Botkar, Khanna Publications, New Delhi
5. Digital Principles and Applications, Malvino and Leech Tata Mc-Graw Hills Pub

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Semester I (Paper II)

PH212: INSTRUMENTATION

(For the students who have offered Electronic Science at F. Y. B. Sc.)

Learning outcomes: After successful completion of this course the students will be able to

- Understand the functions of different instruments.
- Use different instruments for measurement of parameters.
- Design experiments using sensors.

1. Fundamentals of measurement (08)

1.1 Aims of measurement [Ref 1, Pages: 1-2]
1.2 Functional elements of typical measurement system (block diagram and its explanation) [Ref 1, Pages: 6-8]
1.3 Standard measurements and types of calibration methods [Ref 1, Pages: 19-27]
1.4 Static characteristics (accuracy, precision, sensitivity, linearity, repeatability, reproducibility, drift, hysteresis, resolution) [Ref 1, Pages: 29-33]
1.5 Dynamic characteristics: concepts, first and second order systems, examples of first-order resistance thermometer and thermal element, examples of second order: U-tube manometer and seismic motion [Ref 1, Pages: 81-106]
1.6 Errors in measurement
1.7 Problems.

2. Transducers (12)

2.1 Measurement of displacement: variable resistance, inductance and capacitance methods. Variable capacitance transducers [Ref 1, Pages: 815-825] and Piezoelectric transducers [Ref 1, Pages: 826-829]
2.2 Measurement of force: Load cell, column type devices, cantilever beam
2.3 Measurement of temperature:
I) Scales of temperature (Kelvin, Celsius, Fahrenheit etc.)
II) Methods of temperature measurement:
a) Non-electrical method – liquid filled thermometer, bimetallic thermometer.
b) Electrical method – Platinum resistance thermometer
c) Thermistor – PTC and NTC with characteristics
d) Radiation method – Type of pyrometers, selective radiation pyrometer (solar radiation) [Ref 1, Pages: 739-758, 788-793]
2.4 Problems.

3. Measurement of pressure, flow and magnetic field (10)

3.1 Unit of pressure, concept of vacuum, absolute gauge, and differential pressure
3.2 Elastic transducer – diaphragm, corrugated diaphragm, bellows, Bourdon tube

3.3 Electric type - LVDT, strain gauge
3.4 Pressure transducer – calibration by dead weight tester method.
3.5 Problems.

4. Signal conditioning and processing (12)

4.1 OP-AMP and its characteristics (ideal and practical), basic modes of operation
4.2 OP-AMP circuit used in instrumentation – inverter, adder, subtracter, multiplier, divider, integrator, differentiator, active rectifier, comparator , logarithmic convertors, current to voltage and voltage to current converters, buffer amplifier,
4.3 Instrumentation amplifier (three OP-AMP configuration) [Ref 1, Pages: 873-903]
4.4 Filters [Ref 1, Pages: 913-918]
4.5 Problems.

5. Display, Recorders and Activators (06)

5.1 Type of recorders, graphic recorders (chart and X-T recorders),
5.2 Oscillographic recorders [Ref 1, Pages: 1034-1040]
5.3 Problems.

Ref Book:

1. A course in Electrical and Electronic Instrumentation [19th edition, 2012], A. K. Sawhney (Dhanpat Rai & Co. Pvt. Ltd., New Delhi)

Additional Reading:

1. Instrumentation devices and systems :- Rangan, Sarma, Mani [Tata Mc Graw Hill]
2. Instrumentation Measurement and Analysis – Nakra, Choudhari [Tata Mc Graw Hill]
3. Electronics Instrumentation – H.S.Kalsi [Tata Mc Graw Hill]
4. Sensor and Transducers – Patranabis [PHI]
5. Fundamental of Industrial Instrumentation- Alok Barua [Wiley India]

FOR S.Y.B. Sc. (Physics)

Semester II (Paper I)

PH221: OSCILLATIONS, WAVES AND SOUND

Learning outcomes:
On completion of this course, the learner will be able to:

- Understand the physics and mathematics of oscillations.
- Solve the equations of motion for simple harmonic, damped, and forced oscillators.
- Formulate these equations and understand their physical content in a variety of applications,
- Describe oscillatory motion with graphs and equations, and use these descriptions to solve problems of oscillatory motion.
- Explain oscillation in terms of energy exchange, giving various examples.
- Solve problems relating to undamped, damped and force oscillators and superposition of oscillations.
- Understand the mathematical description of travelling and standing waves.
- Recognise the one-dimensional classical wave equation and solutions to it.
- Calculate the phase velocity of a travelling wave.
- Explain the Doppler effect, and predict in qualitative terms the frequency change that will occur for a stationary and a moving observer.
- Define the decibel scale qualitatively, and give examples of sounds at various levels.
- Explain in qualitative terms how frequency, amplitude, and wave shape affect the pitch, intensity, and quality of tones produced by musical instruments

1. Undamped Free Oscillations (09)

1.1 Different types of equilibria (stable, unstable, and neutral equilibrium)
1.2 Potential well and periodic oscillations, Approximation of a general potential well V(x) to a parabola for small oscillations
1.3 Definition of linear and angular S.H.M.
1.4 Differential equation of S.H.M. and its solution (exponential form)
1.5 Composition of two perpendicular linear S.H.Ms. for frequencies 1:1 and 1:2 (analytical method)
1.6 Lissajous's figures and its uses, Applications (mechanical, electrical and optical)
1.7 Problems.

2. Damped Oscillations (09)

2.1 Introduction
2.2 Differential equation of damped harmonic oscillator and its solution, discussion of different cases.
2.3 Logarithmic decrement
2.4 Energy equation of damped oscillations
2.5 Power dissipation
2.6 Quality factor
2.7 Application: LCR series circuit
2.8 Problems.

3. Forced Oscillations **(10)**

3.1 Forced oscillation with one degree of freedom
3.2 Differential equation of forced oscillation and its solution (transient and steady state) Amplitude of forced oscillation
3.3 Resonance and its examples: mechanical (Barton's pendulum), optical (sodium vapour lamp),
3.4 Velocity and Amplitude resonance
3.5 Sharpness of resonance
3.6 Energy of forced oscillations
3.7 Power dissipation
3.8 Quality factor and Bandwidth
3.9 Application of forced oscillations
3.10 Equation of coupled oscillations,
3.11 Problems.

4. Wave Motion **(08)**

4.1 Differential equations of wave motion in continuous media
4.2 Equations for longitudinal waves and it's solution (one dimension only)
4.3 Equation for transverse waves and its solution (one dimension only)
4.4 Energy density and intensity of a wave
4.5 Discussion of seismic waves
4.6 Problems.

5. Doppler Effect **(06)**

5.1 Explanation of Doppler effect in sound
5.2 Expression for apparent frequency in different cases.
5.3 Asymmetric nature of Doppler effect in sound
5.4 Doppler effect in light, symmetric nature of Doppler effect in light.
5.5 Applications: Red shift, Violet shift, Radar,
5.6 Problems.

6. Sound **(06)**

6.1 Definition of sound intensity, loudness, pitch, quality and timber
6.2 Acoustic intensity level measurement
6.3 Acoustic pressure and it's measurement
6.4 Reverberation time and Reverberation of a hall
6.5 Sabine's formula (without derivation)
6.6 Stroboscope
6.7 Problems

Reference Books:

1. Waves and Oscillations, Stephenson
2. The physics of waves and oscillations, N. K. Bajaj, Tata McGraw- Hill, Publishing co. ltd.
3. Fundamentals of vibration and waves, SPPuri,Tata McGraw-Hill Publishing co. ltd.
4. A text book of sound, Subramanyam and Brijlal, Vikas Prakashan
5. Sound, Mee, Heinmann, Edition - London
6. Waves and Oscillations, R.N. Chaudhari, New age international (p) ltd.

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SEMESTER II (PAPER II)

PH222: OPTICS

Learning Outcomes

This course will enable you to:

- acquire the basic concepts of wave optics
- describe how light can constructively and destructively interfere
- explain why a light beam spreads out after passing through an aperture
- summarize the polarization characteristics of electromagnetic waves
- appreciate the operation of many modern optical devices that utilize wave optics
- Understand optical phenomena such as polarisation, birefringence, interference and diffraction in terms of the wave model.
- analyse simple examples of interference and diffraction phenomena.
- be familiar with a range of equipment used in modern optics.

1. Geometrical Optics: (10)

1.1 Introduction
1.2 Lenses: thin and thick
1.3 Sign convention
1.4 Thin lenses: lens equation
1.5 Lens maker equation
1.6 Magnification of thin lens
1.7 Deviation by thin lens
1.8 Power of thin lens
1.9 Equivalent focal length of two thin lenses
1.10 Cardinal points
1.11 Problems.

2. Lens Aberrations (10)

Introduction
Types of aberration: Monochromatic and chromatic
Types of monochromatic aberrations and their reductions
Types of chromatic aberrations
Achromatism : lenses in contact and separated by finite distance
Problems.

3. Optical Instruments (10)

3.1 Introduction
3.2 Simple Microscope
3.3 Compound Microscope
3.4 Ramsdens eye piece
3.5 Huygens eye piece

3.6 Problems.

4. Interference and Diffraction (12)

4.1 Revision to Interference
4.2 Phase change on reflection (Stokes Treatment)
4.3 Interference by parallel sided thin films
    4.3.1 Interference due to reflected light
    4.3.2 Interference due to refracted light
4.4 Interference due to Wedge Shaped thin film
4.5 Types Diffraction : Fresenel's diffraction and Fraunhoffer's diffraction
4.6 Fraunhoffer's diffractions at a double slit
4.7 Plane diffraction grating
4.8 Newton's Rings
4.9 Rayleigh's criterion for resolution
4.10 Problems.

5. Polarization (06)

5.1 I ntroduction
5.2 Brewster's law
5.3 Law of Malus
5.4 Polarization by double refraction.
5.5 Nicol prism.
5.6 Problems.

Reference Books:

1. Optics, fourth edition, Pearson education, E. Hetch, A. R. Genesan
2. A Text book of Optics, N.Subhramanyam, Brijlal, M. N. Avadhanulu, S. Chand publication.
3. Physical Optics by A.K.Ghatak, McMillan, New Delhi
4. Fundamental of Optics, F.A.Jenkins, H.E.White, McGraw-Hill international Edition.
5. Principles of optics, D.S. Mathur, Gopal Press, Kanpur

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PAPER III (SEMESTER I and II)

PH223: PRACTICAL COURSE

Learning Outcomes

- After completing this practical course students will be able to
- Use various instruments and equipment.
- Design experiments to test a hypothesis and/or determine the value of an unknown quantity.
- Investigate the theoretical background to an experiment.
- Set up experimental equipment to implement an experimental approach.
- Analyse data, plot appropriate graphs and reach conclusions from your data analysis.
- Work in a group to plan, implement and report on a project/experiment.
- Keep a well-maintained and instructive laboratory logbook.

Section I:

1) Oscillations, Waves and Sound (Any 4 experiments)

1. Logarithmic decrement (in air and water)
2. Study of coupled oscillators comprising two simple pendulum (Mechanical) and determination of coupling coefficient.
3. Study of musical scales using a signal generator and musical instruments.
4. Determination of frequency of AC mains using sonometer.
5. Measurement of coefficient of absorption of sound for different materials (cork, thermocol, mica, paper etc.)
6. Velocity of sound by phase shift method.
7. Determination of speed of sound by Quincke's method interferometer.
8. Directional characteristics of Microphone.

2) Optics (Any 4 experiments)

1. Newton's Ring: Determination of wavelength of monochromatic light source (λ)
2. Dispersive power of glass prism
3. Total internal reflection (using a LASER beam and glass prism).
4. Diffraction at the edge of a razor blade.
5. Optical activity of sugar solution (polarimeter)
6. Goniometer to determine cardinal points and focal length.
7. To determine temperature of sodium flame.
8. Double refracting prism.

Section II:

1) Electronics/Instrumentation (Any 6 experiments)

1. Circuit Theorems. (Thevenin's, Norton's and Maximum power transfer theorem)
2. Transistor characteristics (CE configuration):

3. Transistor amplifier (single stage)
4. Study of rectifiers (half wave and full wave) with different filters.
5. I-V characteristics of UJT
6. UJT as a Relaxation Oscillator.
6. Zener as a regulator, line and load regulation.
7. Study of Phase shift oscillator (using IC 741)
8. OPAMP as inverting and non inverting amplifier
9. OPAMP as an audio mixer.
10. Study of logic gates (using IC) and verification of De Morgan's theorem.
11. Use of CRO (AC/DC voltage measurement, frequency measurement).
12. To measure displacement (linear and angular) using potentiometer/variable inductor/variable capacitor.
13. To measure force using load cell.
14. To measure pressure using elastic diaphragm (in variable Capacitor/Bourden Tube)
15. To measure magnetic field using Hall probe for a system of ring magnets.

2) Computer (2 experiments)

1. Plotting various trigonometric functions using spreadsheet/any graphic softwares: sinx, cosx, tanx, e^{x}, e^{-x}, logx, lnx, x^{n} and
2. equations for the following figures: circle, ellipse, parabola, hyperbola.
3. Inverse, determinant of matrix, solution of linear equations.

Additional Activities (Any Two)

1. Demonstrations- Any 4 demonstrations equivalent to 2 experiments
2. Study tour with report equivalent to 2 experiments
3. Mini project equivalent to 2 experiments
4. Computer aided demonstrations (Using computer simulations or animations)(Any

Demonstrations equivalent to 2 experiments)

Students have to perform at least two additional activities in addition to sixteen experiments mentioned above. Total laboratory work with additional activities should be equivalent to twenty experiments.