S.Y.B. Sc. (Physics)

Semester I (Paper I)

PH211: MATHEMATICAL MEHODS IN PHYSICS

Syllabus

1. Complex Numbers

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

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

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

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. ÑxÑϕ = 0
b. Ñ.(ÑX **V**) = 0
c. Ñ.(Ñϕ) =Ñ2ϕ
d. Ñ.(ϕ**A**) =Ñϕ. **A** + ϕ (Ñ.**A**)
e. ÑX (ϕ **A**) = ϕ(ÑX **A**) + (Ñϕ) X **A**
f. Ñ.(**A** X **B**) = **B**. (ÑX **A**) – **A**.(ÑX **B**)
4.9 Problems.

5. Differential Equation

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 = ∞)
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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FOR S.Y.B. Sc. (Physics)
Semester II (Paper I)
PH221: OSCILLATIONS, WAVES AND SOUND

Syllabus

1. Undamped Free Oscillations

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

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

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

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

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

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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