CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

Principles of Engineering Physics 1

This is a textbook for an introductory course in engineering physics. It provides a coherent treatment of the basic principles and theories of engineering physics and offers a balance between theoretical concepts and their applications. Beginning with a comprehensive discussion on oscillations and waves with applications in the field of mechanical and electrical engineering, it goes on to explain basic concepts such as Huygen's principle, Fresnel's biprism, Fraunhofer diffraction and polarization.

All chapters are interspersed with rich pedagogical features such as solved problems, unsolved exercises and multiple choice questions with answers. It will help undergraduate students of engineering acquire skills for solving difficult problems in quantum mechanics, electromagnetism, nanoscience, energy systems and other engineering disciplines.

Md. N. Khan is Associate Professor at the Department of Physics, Indira Gandhi Institute of Technology (IGIT), Odisha. He has more than 22 years of teaching experience and has taught courses on engineering physics, physics of semiconductor devices and materials science. His areas of interest include X-ray scattering and materials science.

S. Panigrahi is Senior Professor at the Department of Physics and Astronomy, National Institute of Technology (NIT), Rourkela. He has more than two decades of teaching and research experience in the field of solid state physics, materials science and ferroelectrics.

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

Principles of Engineering Physics 1

Md. N. Khan
S. Panigrahi

CAMBRIDGE UNIVERSITY PRESS

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

CAMBRIDGE
UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom
One Liberty Plaza, 20th Floor, New York, NY 10006, USA
477 Williamstown Road, Port Melbourne, vic 3207, Australia
4843/24, 2nd Floor, Ansari Road, Daryaganj, Delhi – 110002, India
79 Anson Road, #06–04/06, Singapore 079906

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781316635643

© Cambridge University Press 2016

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First published 2016

Printed in India

A catalogue record for this publication is available from the British Library

ISBN 978-1-316-63564-3 Paperback

Additional resources for this publication at www.cambridge.org/9781316635643

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

To all our beloved people who have sacrificed their lives for the betterment of the world through science, technology and social service.

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

Contents

Preface *xxi*
Acknowledgment *xxiii*

1. Oscillations and Waves

1.1 Introduction 1
1.1.1 Parameters of an oscillatory system 1
1.2 Simple Harmonic Oscillation (SHO) 2
1.2.1 Energy of a simple harmonic oscillator 4
1.2.2 Characteristics of SHO 6
1.3 Damped Harmonic Oscillation (DHO) 10
1.3.1 Damping of an oscillator 14
1.4 Forced Vibrations 21
1.4.1 Velocity of the forced harmonic oscillator 25
1.4.2 Total energy of the forced harmonic oscillator 25
1.4.3 Power of the forced harmonic oscillator 27
1.5 Displacement Resonance 30
1.5.1 Resonant amplitude 31
1.5.2 Sharpness of resonance 32
1.5.3 Quality factor of a forced harmonic oscillator 33
1.5.4 Examples of resonance 34
1.6 Coupled Oscillators 36
1.6.1 Experiment on a two-body coupled oscillator 43
1.7 Analogy of Mechanical and Electrical Oscillations 44

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

1.8 Wave as a Periodic Variation Quantity in Space and Time 48
1.8.1 Wave equation 48
1.8.2 Wave equation in differential form 49
1.9 Longitudinal and Transverse Waves 50
1.9.1 Longitudinal waves 50
1.9.2 Transverse waves 50
1.9.3 Difference between longitudinal waves and transverse waves 52
1.9.4 Characteristic of progressive waves 52
1.10 Stationary Waves 53
1.10.1 Formation of stationary waves 53
1.10.2 Characteristics of stationary waves 56
1.10.3 Differences between progressive and stationary waves 56
1.11 Reflection of a Wave at the Boundary of Two Media 57
1.11.1 Reflection of transverse waves 57
1.11.2 Reflection of longitudinal waves 59
1.12 Refraction of a Wave at the Boundary of Two Media 60
1.12.1 Refraction of transverse waves 60
1.12.2 Refraction of longitudinal waves 61
1.13 Wave Packet 64
1.14 Phase Velocity and Group Velocity 66
1.14.1 Phase velocity 66
1.14.2 Group velocity 66
1.14.3 Relation between phase velocity and group velocity 68
1.15 Uncertainty Principle 70
1.15.1 Uncertainty principle for classical waves 70
1.15.2 Heisenberg's uncertainty principle 72
1.16 Superposition of Waves 76
1.16.1 Basis for the principle of superposition 76
1.16.2 Principle of superposition 77
1.16.3 Two beams superposition in one direction 77
1.16.4 Multiple beam superpositions 82
1.16.5 Coherent and incoherent superposition 85
Questions *87*
Problems *91*
Multiple Choice Questions *94*
Answers *97*

2. Interference
2.1 Introduction 98
2.2 Huygens' Principle 98

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

2.2.1 Explanation 99
2.2.2 Construction of a new wavefront 101
2.2.3 Absence of backward waves 102
2.2.4 Applications 103
2.3 Interference of Water Waves 103
2.4 Young's Double Slit Experiment 104
2.5 Coherent Sources 105
2.5.1 Methods of practical realization of coherent sources 106
2.6 Classification of the Interference Phenomenon 106
2.7 Theory of Interference 107
2.7.1 Constructive interference ($I = I_{max}$) 109
2.7.2 Destructive interference ($I = I_{min}$) 110
2.7.3 Fringe spacing β 110
2.7.4 Intensity distribution curve 114
2.8 Conservation of Energy in Interference 114
2.9 Conditions for Interference of Light 115
2.10 Shape of Interference Fringes 118
2.10.1 Shape of interference fringes on XY-plane (Hyperbolic) 119
2.11 Interference Fringes in 3-D Space 123
2.11.1 Shape of interference fringes on the ZX-plane (Circular) 125
2.11.2 Shape of interference fringes on the XY-plane (Hyperbolic) 126
2.11.3 Shape of interference fringes on the YZ-plane (Hyperbolic) 127
2.12 Newton's Rings 127
2.12.1 Experimental setup 127
2.12.2 Theory 129
2.12.3 Calculations 130
2.12.4 Diameter of the *n*th order Newton's ring 135
2.12.5 Diameter of the *n*th order bright Newton's ring 136
2.12.6 Diameter of the *n*th order dark Newton's ring 136
2.12.7 Central fringe as seen by the reflected light 137
2.13 Newton's Rings by Transmitted Light 137
2.13.1 Diameter of the *n*th order Newton's ring 141
2.13.2 Diameter of the *n*th order bright Newton's ring 141
2.13.3 Diameter of the *n*th order dark Newton's ring 142
2.13.4 Central fringe as seen by the transmitted light 142
2.13.5 Discussions 143
2.14 Determination of Wavelength of Light using Newton's Ring 153
2.14.1 Theory for the experiment 154

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

2.15 Determination of Refractive Index of Liquids using Newton's Rings 155
2.15.1 Theory for the experiment 156
2.16 Fresnel's Biprism 158
2.16.1 Determination of wavelength of light using a biprism 158
2.17 Interferometers 163
2.17.1 Michelson interferometer 163
Questions *174*
Problems *178*
Multiple Choice Questions *181*
Answers *185*

3. Diffraction
3.1 Introduction 186
3.2 Classification of Diffraction 186
3.3 Fresnel's Explanation of Rectilinear Propagation of Light 187
3.3.1 Fresnel's assumptions 187
3.3.2 Calculation of the resultant amplitude 188
3.3.3 Average distance of the *n*th Fresnel's half period zone from the pole 191
3.3.4 Phase difference among half period zones 192
3.3.5 Schuster's method of summing the series 194
3.4 Zone Plate 197
3.4.1 Types of zone plates 197
3.4.2 Action of the zone plate 198
3.4.3 Principle behind zone plates 203
3.4.4 Multiple foci of a zone plate 203
3.4.5 Presence of odd numbered foci 204
3.4.6 Intensity of fifth order focus 206
3.4.7 Absence of even numbered foci 208
3.4.8 Intensity of the fourth order focus 209
3.4.9 Comparison of a zone plate with a convex lens 210
3.5 Fraunhofer Diffraction 215
3.5.1 Fraunhofer diffraction due to a single slit 215
3.5.2 Intensity distribution 220
3.5.3 Width of the principal maximum 225
3.6 Plane Diffraction Grating 231
3.6.1 Theory of plane diffraction grating under normal incidence 231
3.6.2 Theory of plane diffraction grating under oblique incidence 237
3.6.3 Angular width of the principal maxima 238
3.6.4 Formation of spectra by diffraction grating 241
3.7 Dispersion 256

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

3.8 Determination of Wavelength of Light by Grating 260
3.8.1 Theory 260
3.8.2 Adjustments 261
3.8.3 Measurement of θ 262
3.8.4 Calculation of λ 263
3.8.5 Alternative application 263
Questions *263*
Problems *266*
Multiple Choice Questions *268*
Answers *271*

4. Polarization
4.1 Introduction 272
4.2 Polarization of Waves 272
4.2.1 Mechanical demonstration of polarization of waves 273
4.2.2 Demonstration of optical polarization of waves 274
4.2.3 Pictorial representation of light 274
4.2.4 Few definitions 275
4.3 Classification of Polarized Light 275
4.3.1 Plane polarized light 276
4.3.2 Circularly polarized light 277
4.3.3 Elliptically polarized light 277
4.4 Polarization by Reflection 277
4.4.1 Explanation of polarization by reflection 277
4.4.2 Brewster's law 279
4.5 Polarization by Refraction 281
4.5.1 Malus's law 282
4.6 Polarization by Scattering 284
4.7 Double Refraction 285
4.7.1 Few terms connected with the double refraction phenomenon 287
4.7.2 Difference between ordinary ray and extraordinary ray 290
4.7.3 Polarization by double refraction 290
4.7.4 Huygens' experiment on polarization by double refraction 291
4.7.5 Huygens' theory of double refraction 293
4.7.6 Phenomenon of double refraction at normal incidence 294
4.7.7 Phenomenon of double refraction at oblique incidence 297
4.7.8 Special cases 299
4.8 Nicol Prism 305
4.8.1 Principle 305

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

4.8.2 Construction 305
4.8.3 Action of a Nicol prism 305
4.8.4 Limitations 306
4.8.5 Parallel and crossed Nicol prisms 306
4.9 Retardation Plates 309
4.9.1 Half-wave plate 311
4.9.2 Quarter-wave plate 312
4.10 Production of Circularly Polarized Light 314
4.10.1 Principle 314
4.10.2 Production 315
4.10.3 Analysis of circularly polarized light 316
4.11 Production of Elliptically Polarized Light 317
4.11.1 Principle 317
4.11.2 Production 318
4.11.3 Analysis of elliptically polarized light 319
4.12 Analysis of Light 321
4.13 Optical Rotation 321
4.13.1 Laws of optical rotation 322
4.13.2 Fresnel's theory of optical rotation 323
4.13.3 Mathematical analysis of Fresnel's theory of optical rotation 325
4.13.4 Calculation of the angle of optical rotation 328
4.13.5 Specific rotation 329
4.14 Polarimeter 332
4.14.1 Laurent's half-shade polarimeter 333
Questions *341*
Problems *344*
Multiple Choice Questions *346*
Answers *353*

5. Electromagnetism
5.1 Introduction 354
5.2 Vector Calculus 354
5.2.1 Line integrals 355
5.2.2 Surface integrals 357
5.2.3 Volume integral 359
5.2.4 Gradient of scalar function 361
5.2.5 Divergence of a vector function 364
5.2.6 Curl of a vector function 368
5.2.7 Gauss's divergence theorem 373
5.2.8 Stokes' theorem 376

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

5.2.9 Green's theorem 379
5.2.10 Useful vector relations 383
5.3 Gauss's Law 387
5.3.1 Gauss's law of electrostatics in free space 387
5.3.2 Gauss's law of electrostatics in a dielectric medium 388
5.3.3 Applications of Gauss's law 388
5.4 Magnetic Induction 401
5.4.1 Units of magnetic induction 403
5.4.2 Special cases of magnetic induction 403
5.5 Magnetic Field Strength (Intensity) 405
5.6 Ampere's Circuital Law 406
5.6.1 Ampere's circuital law in differential form 408
5.6.2 Applications of Ampere's circuital law 408
5.7 Faraday's Law of Electromagnetic Induction 413
5.7.1 Integral form of Faraday's law 414
5.7.2 Differential form of Faraday's law 415
5.8 Displacement Current 417
5.8.1 Physical significance of displacement current 419
5.8.2 Distinction between conduction current and displacement current 420
5.9 Maxwell's Electromagnetic Equations 427
5.9.1 Maxwell's electromagnetic equations in differential form 427
5.9.2 Special cases 429
5.9.3 Maxwell's electromagnetic equations in integral form 432
Questions *433*
Problems *438*
Multiple Choice Questions *441*
Answers *446*

6. Electromagnetic Waves
6.1 Introduction 447
6.2 Electromagnetic Energy Density 447
6.2.1 Interpretation of the left-hand side of Eq. (6.8) 449
6.2.2 Interpretation of the right-hand side of Eq. (6.8) 451
6.3 Poynting's Vector 451
6.4 Poynting's Theorem 454
6.5 Vector Potential and Scalar Potential 454
6.5.1 Magnetic scalar potential 454
6.5.2 Magnetic vector potential 455
6.6 Electromagnetic Wave Equations for $\vec{E}$ and $\vec{B}$ 460
6.6.1 Electromagnetic wave equations for $\vec{E}$ 460

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

6.6.2 Electromagnetic wave equations for $\vec{H}$ 460
6.6.3 Electromagnetic wave equations for $\vec{B}$ 461
6.7 Wave Equation in Terms of Scalar and Vector Potentials 461
6.7.1 Wave equation in terms of vector potential $\vec{A}$ 462
6.7.2 Wave equation in terms of scalar potential φ_E 463
6.8 Plane Electromagnetic Waves 464
6.9 Transverse Nature of Electromagnetic Waves 466
6.9.1 Transverse nature of vector $\vec{E}$ 466
6.9.2 Transverse nature of vector $\vec{H}$ 467
6.9.3 Relative orientation of $\vec{E}$ and $\vec{H}$ 467
6.10 Speed of Electromagnetic Waves 473
6.11 Average Value of Poynting's Vector 475
6.12 Propagation of Electromagnetic Waves in Plasma Medium 478
6.12.1 Conductivity of ionized medium 480
6.12.2 Wave equation in ionized medium 481
6.12.3 Propagation constant in an ionized medium 482
6.13 Reflection and Refraction of Electromagnetic Waves at Non-conducting and Conducting Boundaries 487
6.13.1 Reflection and refraction of electromagnetic waves at a non-conducting surface 488
6.13.2 Reflection and refraction of electromagnetic waves at a conducting surface 512
Questions *537*
Problems *541*
Multiple Choice Questions *544*
Answers *548*

7. Elementary Concepts of Quantum Physics
7.1 Introduction 549
7.2 Need for Quantum Physics 549
7.3 Particles and Waves 550
7.4 Particle Aspect of Waves 551
7.4.1 Blackbody radiation 551
7.4.2 Photoelectric effect 563
7.4.3 Compton effect 568
7.4.4 Pair production 574
7.4.5 Characteristics of photon 576
7.5 Wave Aspect of Particles 576
7.5.1 Matter waves 576
7.5.2 Davisson–Germer experiment 580
7.5.3 Properties of matter wave 583

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

7.6 Atom Models 586
7.6.1 Rutherford's atom model 586
7.6.2 Bohr's atom model 587
7.7 Heisenberg's Uncertainty Principle 598
7.7.1 Statement 598
7.7.2 Explanation 599
7.7.3 Experimental illustration of the uncertainty principle 599
7.7.4 Applications of uncertainty principle 602
7.8 Transition from Deterministic Classical Physics to Probabilistic Quantum Physics 606
7.9 Wave Function ψ 607
7.9.1 Characteristics of the wave function of a matter wave 608
7.9.2 Probability density 608
7.9.3 Dimensional analysis of a wave function 611
7.10 Superposition Principle 612
7.11 Normalization 612
7.11.1 Procedures for calculation of the normalization constant 612
7.12 Observables and Operators 617
7.13 Eigenvalues 618
7.14 Eigenfunctions 618
7.15 Operators, Eigenfunctions and Eigenvalues 619
7.16 Expectation Value 622
7.16.1 Procedures for calculation of the expectation value 625
7.17 Schrödinger's Equation 632
7.17.1 Schrödinger's time-dependent equation 632
7.17.2 Schrödinger's time-independent equation 633
7.17.3 Newton's equation and Schrödinger's equation 634
Questions *634*
Problems *639*
Multiple Choice Questions *641*
Answers *645*

8. Applications of Quantum Mechanics
8.1 Introduction 646
8.2 One-Dimensional Problems 646
8.3 Boundary Conditions on ψ 647
8.4 Free Particle 648
8.5 Potential Steps 650
8.5.1 Reflection and transmission at the boundary at $x = 0$ 655
8.5.2 Potential energy barrier 666

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

8.6 Infinity Deep Potential Well 687
8.6.1 Quantization of de Broglie wavelengths 690
8.6.2 Quantization of energy (energy eigenvalues) 690
8.6.3 Quantization of speed (speed eigenvalues) 692
8.6.4 Eigenfunctions 692
Questions *694*
Problems *698*
Multiple Choice Questions *698*
Answers *700*

9. Special Theory of Relativity
9.1 Introduction 701
9.2 Frame of Reference 701
9.2.1 Inertial frame of reference 701
9.2.2 Non-inertial frame of reference 702
9.3 Galilean Transformation 702
9.4 Michelson–Morley Experiment 703
9.5 Einstein's Principles of Relativity 707
9.6 Lorentz Transformation 707
9.6.1 Mathematics of the Lorentz transformation 707
9.6.2 Consequences of the Lorentz transformation equations 711
9.7 Relativity of Simultaneity 714
9.8 Relativistic Addition of Velocity 715
9.9 Relativistic Momentum 720
9.10 Variation of Mass with Speed 724
9.11 Mass–Energy Equivalence 726
9.12 Massless Particles ($m_0 = 0$) 729
9.13 Generalization of Newton's Second Law 730
Questions *731*
Problems *732*
Multiple Choice Questions *733*
Answers *735*

10. Architectural Acoustics
10.1 Introduction 736
10.2 Basic Requirements of an Acoustically Good Hall 736
10.3 Reverberation and Reverberation Time 737
10.3.1 Sabine's formula for reverberation time 738
10.4 Sound Absorption 744
10.4.1 Room averaged sound absorption coefficient 745

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

10.4.2 Measurement of absorption coefficient 746
10.5 Factors Affecting the Acoustics of Buildings 747
10.5.1 Requisites for good acoustics 749
10.6 Decibel Scale 749
10.7 Acoustic Quieting 753
10.7.1 Aspects of acoustic quieting 753
10.7.2 Methods of quieting 754
10.7.3 Quieting for specific observers 756
10.7 4 Mufflers 756
10.8 Soundproofing 758
10.8.1 Airborne soundproofing 759
10.8.2 Structure-borne soundproofing 759
Questions *760*
Problems *761*
Multiple Choice Questions *761*
Answers *763*

11. Ultrasonics

11.1 Introduction 764
11.2 Production of Ultrasonic Waves 764
11.2.1 Galton's whistle 764
11.2.2 Magnetostriction oscillator 766
11.2.3 Piezoelectric oscillator 767
11.3 Detection of Ultrasonic Waves 769
11.4 Properties of Ultrasonic Waves 770
11.5 Wavelength Determination of Ultrasonic Waves 770
11.6 Ultrasound Cavitation 773
11.6.1 Parameters affecting ultrasonic cavitation 773
11.6.2 Consequences of ultrasonic cavitation 774
11.7 Applications of Ultrasonic Waves 775
11.8 Sonograms 779
11.9 Sonar 779
11.9.1 Applications of sonar 780
11.10 Hazards of Ultrasound 782
Questions *782*
Problems *783*
Multiple Choice Questions *783*
Answers *784*

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

12. Non-Destructive Testing

12.1 Introduction 785
12.2 Objectives of NDT 785
12.3 Methods of NDT 786
12.3.1 Visual and optical testing (VOT) 786
12.3.2 Dye penetrant testing (DPT) 787
12.3.3 Magnetic particle testing 788
12.3.4 Electromagnetic or eddy current testing 789
12.3.5 Radiographic testing 790
12.3.6 Ultrasonic testing 791
12.3.7 Pulse–echo system 795
12.4 Relative Merits of Various NDT Methods 800
12.5 Non-Destructive Testing Methods and Applications 801
Questions *802*
Problems *802*
Multiple Choice Questions *802*
Answers *804*

13. Nuclear Accelerators

13.1 Introduction 805
13.2 Need of Nuclear Accelerators 805
13.3 Basic Mechanism of a Nuclear Accelerator 806
13.4 Main Components 807
13.4.1 Ion sources 807
13.4.2 Accelerating tube 807
13.5 Performance Index 808
13.6 Types of Accelerators 808
13.7 D.C. Accelerators 808
13.7.1 Cockcroft–Walton accelerator (D.C. accelerator) 809
13.7.2 Van de Graaff accelerator (D.C. accelerator) 811
13.7.3 Tandem accelerator (D.C. accelerator) 816
13.8 R.F. Accelerators 818
13.8.1 Linear accelerators 818
13.8.2 Cyclotron 822
13.9 Electron Accelerators 827
13.9.1 Betatron 828
13.10 Applications of Accelerators 836
13.10.1 Radiation processing of materials 837
13.10.2 Uses of isotopes 838

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

Questions 840
Problems 842
Multiple Choice Questions 843
Answers 845

14 Holography

14.1 Introduction 846
14.2 Basic Principles of Holography 846
14.3 Types of Holograms 853
14.3.1 Reflection holograms 853
14.3.2 Transmission holograms 853
14.3.3 Comparison of transmission and reflection holograms 854
14.4 White Light Holograms 855
14.5 Necessity of Laser Source 856
14.6 Basic Requirements of a Holographic Laboratory 856
14.7 Viewing a Hologram 857
14.8 Difference between Photography and Holography 857
14.9 Applications of Holography 858
14.9.1 Common applications of holography 858
14.9.2 Application of holographic interferometry 860
14.9.3 Application of holographic microscopy 861

Questions 862
Multiple Choice Questions 862
Answers 863

Bibliography 865
Index 867

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

Preface

Science in general may be described as organized common sense. In the real world of science, nothing prevails except rationality and logics. Science does not believe in miracles. Clear understanding of the basic principles of science is essential for technological and social development. Once upon a time, the base of engineering was mainly empirical; however, now it is completely scientific. Physics is a fundamental aspect of science on which all engineering sciences have been built upon. Nowadays, more stress is given to the understanding of the basic principles rather than on remembering specific procedures. The fundamental concepts of physics have paved the way for the development of technologies. All modern technological advances from laser micro surgery to television, from computers to dishwashers to mobile phones, from remote controlled toys to space vehicles, trace back directly to the principles of physics. Accordingly, the syllabus of engineering courses includes physics as an essential ingredient.

This book, entitled *Principles of Engineering Physics 1,* is designed as a textbook keeping in view the engineering physics course curricula prescribed by most technical universities of India. The present book begins with oscillations and waves and ends with holography, containing altogether fourteen chapters. This book is written in a logical and coherent manner for easy understanding. The concepts of physics are mathematized without losing the beauty of the physical ideas involved. Emphasis has been given to an understanding of the basic concepts and their applications to a number of engineering problems. Each topic has been discussed in detail, both conceptually and mathematically, so that students do not face any kind of difficulties. All the derivations and solutions of numerical examples are given in detail. Each chapter contains a large number of solved numerical examples, unsolved numerical problems with answers, practical applications, theoretical questions, and multiple choice questions with answers. Certain topics and derivations that are not included directly in the syllabi have also been included in the book for the sake of continuity and completeness. The scope of the book thus has been expanded beyond the basic needs of undergraduate engineering students. We hope this book will be of immense help not only to the students but also to the teachers.

The authors sincerely request the readers for their constructive criticisms via emails *mdnkhan1964@yahoo.com* and *spanigrahi@nitrkl.ac.in* for future modification of the book.

© in this web service Cambridge University Press www.cambridge.org

CAMBRIDGE

Cambridge University Press
978-1-316-63564-3 — Principles of Engineering Physics 1
Md Nazoor Khan , Simanchala Panigrahi
Frontmatter
More Information

Acknowledgment

It is a pleasure to express our deep appreciation to the engineering students (both continuing and passed out) of IGIT Sarang and NIT Rourkela who have borne with us in our class teachings. Many suggestions from our colleagues, students and reviewers have gone a long way in the development of this book. Our sincere thanks are due to them. We gratefully acknowledge the ideas received from a number of standard books on physics as given in the bibliography. We sincerely thank the editorial team at Cambridge University Press, India, for their keen interest in publishing this book in a nice format. We particularly wish to thank Gauravjeet Singh Reen for many helpful suggestions and improvements.

© in this web service Cambridge University Press www.cambridge.org