

Physics 380H - Wave Theory

Fall 2004

Class readings/content:

Week 1, starting Monday, September 13:

- Read Chapter 1 “Waves” in “Simple Nature” by Crowell
- Review the use of complex numbers and sinusoidal functions, Towne, Appendix I
- Read Chapter 1 “Transverse Waves on a String” in “Wave Phenomena” by Towne

Week 2, starting Monday, September 20:

- Read Chapter 1 “Waves” in “Simple Nature” by Crowell
- Read Chapter 2 “The Acoustic Plane Wave” in “Wave Phenomena” by Towne, omit 2-6

Week 3, starting Monday, September 27:

- Read Chapter 2 “The Acoustic Plane Wave” in “Wave Phenomena” by Towne, omit 2-6
- Read Chapter 3 “Boundary value problems” in “Wave Phenomena” by Towne, omit 3-9

Week 4, starting Monday, October 4:

- Read Chapter 3 “Boundary value problems” in “Wave Phenomena” by Towne, omit 3-9
- Read Chapter 4 “Energy in a Sound Wave; Isomorphisms” in Towne, omit 4-7

Week 5, starting Monday, October 11:

- Read Chapter 4 “Energy in a Sound Wave; Isomorphisms” in Towne, omit 4-7
- Read Chapter 6 “The Electromagnetic Plane Wave” in Towne, omit 6-4, 6-5
- Read Chapter 7 “Analytical Description of Polarized Electromagnetic Plane Waves” in Towne

Week 6, starting Monday, October 18:

- Mid term test Friday October 22, up to and including material from Chapter 6.
- Read Chapter 7 “Analytical Description of Polarized Electromagnetic Plane Waves” in Towne

Week 7, starting Monday, November 1:

- Read Chapter 11 “Interference Pattern from a Pair of Point Sources” in Towne, omit 11-8 through 11-15
- Read Chapter 12 “Continuous Distributions of Coherent Sources; the Fraunhofer Approximation” in Towne, omit 12-15

Week 8, starting Monday, November 8:

- Read Chapter 12 “Continuous Distributions of Coherent Sources; the Fraunhofer Approximation” in Towne, omit 12-15

Week 9, starting Monday, November 15:

- Read Chapter 13 “Fresnel Diffraction” in Towne
- Read Chapter 14 “The Double Slit; Multiple-slit Arrays; Diffraction Gratings” in Towne

Week 10, starting Monday, November 22:

– Read Chapter 15 “Waves Confined to a Limited Region” in Towne, omit 15-14, 15-15

Week 11, starting Monday, November 29:

– Read Chapter 15 “Waves Confined to a Limited Region” in Towne, omit 15-14, 15-15

Week 12, starting Monday, December 6:

– Review notes, review texts, review assignments, learn material, do well on exam

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Class readings/content details

Week 1, starting Monday, September 13:

- Read Chapter 1 “Waves” in “Simple Nature” by Crowell
- Review the use of complex numbers and sinusoidal functions, Towne, Appendix I
- Read Chapter 1 “Transverse Waves on a String” in “Wave Phenomena” by Towne
 - Section 1-1 “Introduction”
 - Section 1-2 “Derivation of the wave equation”
 - Section 1-3 “Solution of the one-dimensional wave equation”
 - Section 1-4 “Wave propagation velocity on a string”
 - Section 1-5 “The most general solution to the one-dimensional wave equation”
 - Section 1-6 “Kinematics associated with the waveform”
 - Section 1-7 “Description of a sinusoidal progressive wave”
 - Section 1-8 “Initial conditions applied to the case of a string of infinite length”

Week 2, starting Monday, September 20:

- Read Chapter 1 “Waves” in “Simple Nature” by Crowell
- Read Chapter 2 “The Acoustic Plane Wave” in “Wave Phenomena” by Towne, omit 2-6
 - Section 2-1 “Definition of the variables”
 - Section 2-2 “Derivation of the wave equation”
 - Section 2-3 “The velocity of sound”

Week 3, starting Monday, September 27:

- Read Chapter 2 “The Acoustic Plane Wave” in “Wave Phenomena” by Towne, omit 2-6
 - Section 2-4 “Simplified form of the equation for acoustic waves”
 - Section 2-5 “Detailed description of a progressive sinusoidal wave”
- Read Chapter 3 “Boundary value problems” in “Wave Phenomena” by Towne, omit 3-9
 - Section 3-1 “Reflection at a fixed end of transverse waves on a string”
 - Section 3-2 “Reflection of acoustic waves at a rigid surface”
 - Section 3-3 “Waves produced by the specified motion of a boundary surface”

Week 4, starting Monday, October 4:

- Read Chapter 3 “Boundary value problems” in “Wave Phenomena” by Towne, omit 3-9
 - Section 3-4 “Reflection and transmission at an interface”
 - Section 3-5 “Reflection of a sinusoidal wave; partial standing wave”
 - Section 3-6 “Extreme mismatch of impedances; rigid and free surfaces”
 - Section 3-7 “Reflection of a sinusoidal wave from a pair of interfaces”
 - Section 3-8 “Reflection of a sinusoidal wave at a pair of interfaces, alternate method”
- Read Chapter 4 “Energy in a Sound Wave; Isomorphisms” in Towne, omit 4-7
 - Section 4-1 “Energy density and energy flux for a plane sound wave”
 - Section 4-2 “The law of conservation of energy”
 - Section 4-3 “Separability of energy into + and – components”
 - Section 4-4 “Convective and radiative energy terms”
 - Section 4-5 “Relative radiative intensities in reflection and transmission at a single interface”
 - Section 4-6 “Intensity relations for progressive sinusoidal waves”

Week 5, starting Monday, October 11:

- Read Chapter 4 “Energy in a Sound Wave; Isomorphisms” in Towne, omit 4-7
- – Section 4-8 “Interference between superposed waves”
- – Section 4-9 “Measurement of intensity in decibels”
- – Section 4-10 “Energy definitions for transverse waves on a string”
- – Section 4-11 “Energy relations for transverse waves on a string; isomorphisms”
- – Section 4-12 “Boundary value problems for transverse waves on a string”
- Read Chapter 6 “The Electromagnetic Plane Wave” in Towne, omit 6-4, 6-5
- – Section 6-1 “Maxwell’s equations”
- – Section 6-2 “A solution to Maxwell’s equations for a special situation”
- – Section 6-3 “Implications of the electromagnetic theory of light”
- – Section 6-6 “A linearly polarized transverse plane wave”
- Read Chapter 7 “Analytical Description of Polarized Electromagnetic Plane Waves” in Towne
- – Section 7-1 “Introduction”
- – Section 7-2 “More complete description of the linearly polarized sinusoidal plane wave”
- – Section 7-3 “Reflection from a dielectric surface obtained by appeal to an isomorphism”
- – Section 7-4 “Reflection from a perfect conductor; direct evidence of standing waves”
- – Section 7-5 “Consideration of a more general sinusoidal plane wave”

Week 6, starting Monday, October 18:

- Mid term test Friday October 22, up to and including material from Chapter 6.
- Read Chapter 7 “Analytical Description of Polarized Electromagnetic Plane Waves” in Towne
- – Section 7-6 “Types of polarization”
- – Section 7-7 “Natural light”
- – Section 7-8 “Energy relations for the general progressive plane wave”
- – Section 7-9 “Reflections by a thin film”

Week 7, starting Monday, November 1:

- Read Chapter 11 “Interference Pattern from a Pair of Point Sources” in Towne, omit 11-8 through 11-15
- – Section 11-1 “Introduction”
- – Section 11-2 “Sources close together compared with a wavelength; the dipole source”
- – Section 11-3 “Various interference patterns for $d \sim \lambda$ ”
- – Section 11-4 “Total power radiated from a pair of point sources”
- – Section 11-5 “The phenomenon of beats”
- – Section 11-6 “Interference patterns when $kd \gg 1$ ”
- – Section 11-7 “Young’s experiment”
- Read Chapter 12 “Continuous Distributions of Coherent Sources; the Fraunhofer Approximation” in Towne, omit 12-15
- – Section 12-1 “Introduction”
- – Section 12-2 “Radiation pattern from coherent sources continuously distributed along a line segment”
- – Section 12-3 “The Fraunhofer approximation”
- – Section 12-4 “Study of the Fraunhofer pattern”
- – Section 12-5 “Vibration curve for the Fraunhofer approximation”

Week 8, starting Monday, November 8:

- Read Chapter 12 “Continuous Distributions of Coherent Sources; the Fraunhofer Approximation” in Towne, omit 12-15
- Section 12-6 “Diffraction by an extremely narrow slit”
- Section 12-7 “Diffraction by an extremely long slit”
- Section 12-8 “The Fraunhofer approximation applied to a rectangular distribution of coherent point sources”
- Section 12-9 “Diffraction by a rectangular aperture”
- Section 12-10 “Oblique incidence”
- Section 12-11 “Reflection of a plane wave from a rectangular surface”
- Section 12-12 “Fraunhofer diffraction by a circular aperture”
- Section 12-13 “Acoustic radiation from a circular piston”
- Section 12-14 “Limit of resolution of image forming instruments”

Week 9, starting Monday, November 15:

- Read Chapter 13 “Fresnel Diffraction” in Towne
- Section 13-1 “Introduction”
- Section 13-2 “Fresnel Approximation for the radiation pattern of a linear distribution of coherent sources”
- Section 13-3 “The Fresnel integrals and the Cornu spiral”
- Section 13-4 “The Fresnel diffraction pattern of a single slit”
- Section 13-5 “Fresnel diffraction by a wide slit”
- Read Chapter 14 “The Double Slit; Multiple-slit Arrays; Diffraction Gratings” in Towne
- Section 14-1 “Introduction”
- Section 14-2 “The double slit”
- Section 14-3 “Multiple-slit arrays”
- Section 14-4 “The diffraction grating”

Week 10, starting Monday, November 22:

- Read Chapter 15 “Waves Confined to a Limited Region” in Towne, omit 15-14, 15-15
- Section 15-1 “Introduction”
- Section 15-2 “Transverse waves on a string segment with fixed ends”
- Section 15-3 “Sinusoidal solutions”
- Section 15-4 “Solutions of product form”
- Section 15-5 “Linear combination of normal-mode solutions”
- Section 15-6 “Determination of the coefficients in a normal-modes expansion”
- Section 15-7 “Independence of the energy contributions from different modes”
- Section 15-8 “Normal-modes expansion of a rectangular pulse”
- Section 15-9 “Energy spectrum of the rectangular pulse”

Week 11, starting Monday, November 29:

- Read Chapter 15 “Waves Confined to a Limited Region” in Towne, omit 15-14, 15-15
- Section 15-10 “A too literal interpretation of the normal-modes expansion”
- Section 15-11 “Normal-modes expansion of a sinusoidal wavetrain of limited extent”
- Section 15-12 “Forced motion of a string”
- Section 15-13 “Eigenfrequencies as resonance frequencies of a string driven sinusoidally at one end”
- Section 15-16 “Normal modes of a uniformly stretched rectangular membrane”
- Section 15-17 “Fourier integral analysis on a semi-infinite string”
- Section 15-18 “Fourier analysis over the whole x -axis”

Week 12, starting Monday, December 6:

– Review notes, review texts, review assignments, learn material, do well on exam

– Of possible use in Lab, but not directly covered in non-lab portion of course:

– – Chapter 8 “The Production and Detection of Linearly Polarized Light”,

– – Chapter 9 “The Production and Detection of Elliptically Polarized Light”,

– – Sections 11-8 through 11-15 on various interference patterns.

– Of possible interest for term papers, presentations, etc, but not directly covered in non-lab portion of course:

– – Chapter 5 “Experimental Aspects of Acoustics”,

– – Sections 6-3 through 6-5 on electromagnetic plane waves,

– – Chapter 10 “Additional Optical Properties of Matter”, and

– – the various omitted sections of covered chapters.

– Explicitly not covered in the course at all:

– – Chapter 16 “Waves in a Dispersive Medium”,

– – Chapter 17 “The Acoustic Wave Equation in Three Dimensions”