I. CATALOG INFORMATION

A. Discipline: PHYSICS

B. Subject Code and Number: PHYS M20C

C. Course Title: Wave Motion, Optics, and Modern Physics

D. Credit Course units:

Units: 4

Lecture Hours per week: 4

Lab Hours per week : 0

Variable Units : No

E. Student Learning Hours:

Lecture Hours:

Classroom hours: 70 - 70

Laboratory/Activity Hours:

Laboratory/Activity Hours 0 - 0

Total Combined Hours in a 17.5 week term: 70 - 70

F. Non-Credit Course hours per week

G. May be taken a total of: [X] 1 [ ] 2 [ ] 3 [ ] 4 time(s) for credit

H. Is the course co-designated (same as) another course: No [X] Yes [ ]
If YES, designate course Subject Code & Number:

I. Course Description:

Introduces the basic principles of wave motion, optics, and modern physics using calculus to develop the subject matter. Includes the following topics: classical wave theory, wave-particle duality, reflection, refraction, interference, diffraction, optical elements and systems, applications of Schrodinger's equation, atomic structure, molecular structure, the quantum nature of solids, consequences of special and general relativity, nuclear physics, particle physics, and cosmology.

J. Entrance Skills

*Prerequisite: No [ ] Yes [X] Course(s)
PHYS M20B and MATH M25C

*Corequisite: No [X] Yes [ ] Course(s)

Limitation on Enrollment: No [X] Yes [ ]

Recommended Preparation: No [X] Yes [ ] Course(s)

Other: No [X] Yes [ ]

K. Other Catalog Information:

Course Credit Limitation:

UC - PHYS M10A, PHYS M10B and PHYS M20A, PHYS M20B, PHYS M20C combined: maximum credit, one series.

II. COURSE OBJECTIVES

Upon successful completion of the course, a student will be able to:

		Methods of evaluation will be consistent with, but not limited by, the following types or examples.
1	analyze basic physical situations involving reflection and refraction and use this analysis to predict the path of a light ray.	Written assignments and in-class discussions
2	analyze situations involving interference and diffraction of light waves and apply these to situations including double slits, diffraction gratings, and wide slits.	Written assignments and in-class discussions
3	apply concepts from special relativity to analyze physical situations, including time dilation, length contraction, and the Lorentz transformation; solve basic problems involving relativistic momentum and energy.	Written assignments and in-class discussions
4	apply basic concepts of quantum mechanics to analyze basic physical setups, including a particle in a box and simple atomic models.	Written assignments and in-class discussions
5	recognize and apply the equations that describe physical phenomena involving wave motion, optics, and modern physics.	Written midterm and final exams
6	demonstrate ability to analyze and solve physics problems of greater than average difficulty.	Written homework assignments
7	demonstrate ability to analyze, synthesize physics problems of reasonable complexity and evaluate and judge the results of the solutions to these problems.	Written assignments and in-class discussions

III. COURSE CONTENT

Estimated %	**Topic**	**Learning Outcomes**
Lecture (must total 100%)		
30.00%	Part I: Wave Motion Harmonic waves Waves in one, two, and three dimensions Waves and boundaries The Doppler effect	1, 2, 5, 6,

	Superposition of waves Standing waves The Fourier series Wave packets and dispersion	7
30.00%	Part II: Geometric Optics Maxwell's equations in differential form – solving the wave equation Properties of light Wave-particle duality EM (electromagnetic) spectra Sources of EM waves The speed of light EM wave propagation Reflection and refraction Polarization of EM waves Huygen's and Fermat's Principles Optical Images (Wave Optics) Mirrors Lenses Optical aberrations Optical instruments The matrix theory of paraxial ray optics Interference and Diffraction (Physical Optics) Phase difference and coherence Interference in thin films Multi-slit interference Single-slit diffraction Diffraction from various apertures Chromatic and spatial resolution Propagation of Gaussian beams Diffraction gratings Holography	2, 3, 5, 6, 7
	Part III: Modern Physics Applications of Schrodinger's equation An introduction to the wave function and quantum mechanical systems Barrier transmission, reflection, and tunneling Schrodinger's equation in two and three dimensions Schrodinger's equation for two identical particles Atomic Theory The Bohr and Sommerfeld models Schrodinger's equation applied to hydrogen-like atoms Fine and hyperfine structure The Periodic Table of the Elements Atomic spectra Molecules Molecular bonds and interactions Electronic, vibrational, and rotational structure Molecular orbital theory Molecular spectra Wave-Particle Duality and Quantum Physics Photons DeBroglie waves Interpretation of the wave function Solutions to Schrodinger's equation for simple QM systems Particle in an infinite square well Particle in a finite square well The quantum mechanical simple harmonic oscillator Hydrogen-like atoms and ions Solids	

40.00%	The structure of solids Microscopic picture of electrical conduction The Fermi electron gas Quantum theory of electrical conduction The band theory of solids Conductors, semiconductors, and insulators Superconductors The Fermi-Dirac distribution Introduction to Relativity Newtonian relativity The two postulates of special relativity The Lorentz transformation Relativistic energy and linear momentum Relativistic addition of velocities Space-time diagrams General relativity and the Principle of Equivalence Nuclear Physics Properties of nuclei Radioactive decay The strong and the weak interactions Nuclear reactions, transmutation of elements Fission, fusion, and nuclear reactors Stars Particle Physics Classifications of particles Particles and antiparticles Pair production and annihilation Properties of particles The conservation laws Quarks Field particles The electroweak theory Grand Unification Theories/the “Standard Model” Evolution of the Universe Big Bang, Big Chill, Big Crunch, Oscillating Universe Dark matter Selected current topics in astrophysics and cosmology	3, 4, 5, 6, 7

IV. TYPICAL ASSIGNMENTS

A. Writing assignments

Writing assignments are required. Possible assignments may include, but are not limited to:	
1	solve relativity problem sets and explain the solution in written form.
2	write a short report on nuclear physics.
3	solve conservation of mass and energy problem sets.

B. Appropriate outside assignments

Appropriate outside assignments are required. Possible assignments may include, but are not limited to:	
1	field trips to local engineering and science companies.
2	homework consists of physics problems that correspond to the lecture topics in class. For each topic listed in the course content section, the assignment will include at least three problems, one of which will be of greater than average difficulty.

C. Critical thinking assignments

Critical thinking assignments are required. Possible assignments may include, but are not

limited to:	
1	analyze quantum mechanical data.
2	distinguish and analyze various nuclear reactions.
3	calculate the efficiencies of various nuclear reactions.

V. METHODS OF INSTRUCTION

Methods of instruction may include, but are not limited to:

- [ ] Distance Education – When any portion of class contact hours is replaced by distance education delivery mode (Complete DE Addendum, Section XV)
- [X] Lecture/Discussion
- [ ] Laboratory/Activity
- [X] Other (Specify) In-class experiments
- [X] Optional Field Trips
- [ ] Required Field Trips

VI. METHODS OF EVALUATION

Methods of evaluation may include, but are not limited to:

[ ] Essay Exam	[X] Classroom Discussion	[X] Skill Demonstration
[X] Problem Solving Exam	[X] Reports/Papers/ Journals	[X] Participation
[X] Objective Exams	[X] Projects	[X] Other (specify)

Short answers on homework problems.

VII. REPRESENTATIVE TEXTS AND OTHER COURSE MATERIALS

Giancoli, Douglas C. Physics for Scientists and Engineers with Modern Physics. 4th ed. Addison-Wesley, 2008.

Serway, Raymond A., and John W. Jewett. Physics for Scientists and Engineers with Modern Physics. 9th ed. Brooks Cole, 2013.

Thornton, Stephen T. Modern Physics for Scientists and Engineers. 4th ed. Brooks Cole, 2012.

VIII. STUDENT MATERIALS FEES

[X] No [ ] Yes

IX. PARALLEL COURSES

College	*Course Number*	*Course Title*	*Units*
CSU Northridge	PHYS 227	Thermodynamics and Modern Physics	4

UC Los Angeles	PHYSICS 1C	Physics for Scientists and Engineers: Electrodynamics, Optics and Special Relativity	5
CSU Long Beach	PHYS 254	Applied Modern Physics	3
CSU Stanislaus	PHYS 2270	General Physics III	3
San Diego State	PHYS 197	Principles of Physics	3
Los Angeles Pierce College	PHYSICS 105	Physics for Engineers and Scientists I	5

X. MINIMUM QUALIFICATIONS

Courses Requiring a Masters Degree:
Master's in physics, astronomy, or astrophysics OR Bachelor's in physics or astronomy AND Master's in engineering, mathematics, meteorology, or geophysics OR the equivalent.

XI. ARTICULATION INFORMATION

A. Title V Course Classification:

1. This course is designed to be taken either:

   [ ] Pass/No Pass only (no letter grade possible); or
   [X] Letter grade (P/NP possible at student option)

2. Degree status:
   Either [X] Associate Degree Applicable; or [ ] Non-associate Degree Applicable

B. Moorpark College General Education:

1. Do you recommend this course for inclusion on the Associate Degree General Education list?
   Yes: [X] No: [ ] If YES, what section(s)?

   [ ] A1 - Natural Sciences - Biological Science
   [X] A2 - Natural Sciences - Physical Science
   [ ] B1 - Social and Behavioral Sciences - American History/Institutions
   [ ] B2 - Social and Behavioral Sciences - Other Social Behavioral Science
   [ ] C1 - Humanities - Fine or Performing Arts
   [ ] C2 - Humanities - Other Humanities
   [ ] D1 - Language and Rationality - English Composition
   [ ] D2 - Language and Rationality - Communication and Analytical Thinking
   [ ] E1 - Health/Physical Education
   [ ] E2 - PE or Dance
   [ ] F - Ethnic/Gender Studies

C. California State University(CSU) Articulation:

1. Do you recommend this course for transfer credit to CSU? Yes: [X] No: [ ]

2. If YES do you recommend this course for inclusion on the CSU General Education list?
   Yes: [X] No: [ ] If YES, which area(s)?

   A1 [ ] A2 [ ] A3 [ ] B1 [X] B2 [ ] B3 [ ] B4 [ ]

C1 ☐ C2 ☐ D1 ☐ D2 ☐ D3 ☐ D4 ☐ D5 ☐
D6 ☐ D7 ☐ D8 ☐ D9 ☐ D10 ☐ E ☐

D. University of California (UC) Articulation:

1. Do you recommend this course for transfer to the UC? Yes: ☒ No: ☐
2. If YES do you recommend this course for the Intersegmental General Education Transfer Curriculum (IGETC)? Yes: ☒ No: ☐

IGETC Area 1: English Communication

- ☐ English Composition
- ☐ Critical Thinking-English Composition
- ☐ Oral Communication

IGETC Area 2: Mathematical Concepts and Quantitative Reasoning

- ☐ Mathematical Concepts

IGETC Area 3: Arts and Humanities

- ☐ Arts
- ☐ Humanities

IGETC Area 4: Social and Behavioral Sciences

- ☐ Anthropology and Archaeology
- ☐ Economics
- ☐ Ethnic Studies
- ☐ Gender Studies
- ☐ Geography
- ☐ History
- ☐ Interdisciplinary, Social & Behavioral Sciences
- ☐ Political Science, Government & Legal Institutions
- ☐ Psychology
- ☐ Sociology & Criminology

IGETC Area 5: Physical and Biological Sciences (mark all that apply)

- ☐ Physical Science Lab or Physical Science Lab only (none-sequence)
- ☐ Physical Science Lecture only (non-sequence)
- ☐ Biological Science
- ☐ Physical Science Courses
- ☐ Physical Science Lab or Biological Science Lab Only (non-sequence)
- ☐ Biological Science Courses
- ☐ Biological Science Lab course

☐ First Science course in a Special sequence
☐ Second Science course in a Special Sequence
☐ Laboratory Activity
☒ Physical Sciences

IGETC Area 6: Language other than English

☐ Languages other than English (UC Requirement Only)
☐ U.S. History, Constitution, and American Ideals (CSU Requirement ONLY)
☐ U.S. History, Constitution, and American Ideals (CSU Requirement ONLY)

XII. REVIEW OF LIBRARY RESOURCES

A. What planned assignment(s) will require library resources and use?

The following assignments require library resources:
Research, using the Library's print and online resources, in preparing a short written report on a subject appropriate to the course.

B. Are the currently held library resources sufficient to support the course assignment?

YES: ☒ NO: ☐

If NO, please list additional library resources needed to support this course.

XIII. PREREQUISITE AND/OR COREQUISITE JUSTIFICATION

Requisite Justification for PHYS M20B

☒ A. Sequential course within a discipline.

1. analyze simple static charge distributions and calculate the resulting electric field and electric potential.

2. analyze simple current distributions and calculate the resulting magnetic field.

3. predict the trajectory of charged particles in uniform electric and magnetic fields.

4. analyze DC and AC circuits in terms of current, potential difference, and power dissipation for each element.

5. recognize, recall, and apply the equations that describe physical phenomena involving thermodynamics and electromagnetism.

6. demonstrate ability to analyze and solve physics problems of greater than average difficulty using calculus.

7. demonstrate ability to analyze and synthesize physics problems of greater than average complexity and evaluate and judge the results of the solutions to these problems.

☐ B. Standard Prerequisite or Corequisite required by universities.

☐ C. Corequisite is linked to companion lecture course.

☐ D. Prerequisite or Corequisite is authorized by legal statute or regulation.
Code Section: _____

☐ E. Prerequisite or Corequisite is necessary to protect the students' health and safety.

☐ F. Computation or communication skill is needed.

☐ G. Performance courses: Audition, portfolio, tryouts, etc. needed.

and

Requisite Justification for MATH M25C

☐ A. Sequential course within a discipline.

☒ B. Standard Prerequisite or Corequisite required by universities.

CSU Northridge, UC Los Angeles, UC Santa Barbara

☐ C. Corequisite is linked to companion lecture course.

☐ D. Prerequisite or Corequisite is authorized by legal statute or regulation.
Code Section: _____

☐ E. Prerequisite or Corequisite is necessary to protect the students' health and safety.

☐ F. Computation or communication skill is needed.

☐ G. Performance courses: Audition, portfolio, tryouts, etc. needed.

XIV. WORKPLACE PREPARATION

PHYS M20C: Not Applicable

XV. DISTANCE LEARNING COURSE OUTLINE ADDENDUM

PHYS M20C: Not Applicable

XVI. GENERAL EDUCATION COURSE OUTLINE ADDENDUM

General Education Division of Learning [check all applicable boxes]:

- [X] Natural Sciences
  - [ ] Biological Science
  - [X] Physical Science
- [ ] Social and Behavioral Sciences
  - [ ] American History/Institutions
  - [ ] Other Social Science
- [ ] Humanities
  - [ ] Fine or Performing Arts
  - [ ] Other Humanities
- [ ] Language and Rationality
  - [ ] English Composition
  - [ ] Communication and Analytical Thinking
- [ ] Health/Physical Education
- [ ] Ethnic/Women's Studies

Check either Option 1 or Option 2

- [X] **OPTION #1:** Moorpark College has already received approval from the CSU and/or UC systems for this course to fulfill a GE requirement. Note: This option applies only to technical revisions and updated courses.
- [ ] **OPTION #2:** Moorpark College has not received approval from the CSU and/or UC systems for this course to fulfill a GE requirement. This option applies to all new and substantively revised courses.

XVII. STUDENT MATERIALS FEE ADDENDUM

PHYS M20C: Not Applicable

XVIII. REPEATABILITY JUSTIFICATION TITLE 5, SECTION 55041

PHYS M20C: Not Applicable

XIX. CURRICULUM APPROVAL

Course Information:

Discipline: PHYSICS

Discipline Code and Number: PHYS M20C

Course Revision Category: Outline Update

Course Proposed By:

Originating Faculty Ronald Wallingford 03/27/2013

Faculty Peer: Scarlet Relle 10/22/2013

Curriculum Rep: Robert Keil 04/01/2013

Department Chair: Ronald Wallingford 10/18/2013

Division Dean: Julius Sokenu 10/28/2013

Approved By:

Curriculum Chair: Jerry Mansfield 12/14/2013

Executive Vice President: Lori Bennett 12/18/2013

Articulation Officer: Letrisha Mai 11/19/2013

Librarian: Mary LaBarge 11/19/2013

Implementation Term and Year: Fall 2014

Approval Dates:

Approved by Moorpark College Curriculum Committee: 12/03/2013

Approved by Board of Trustees (if applicable): _____

Approved by State (if applicable): _____