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Projectile Motion Using Runge Kutta Methods

This book is an introduction to the computational methods used in physics and other scientific fields. It is addressed to an

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audience that has already been exposed to the introductory level of college physics, usually taught during the first two years of an undergraduate program in science and engineering. The book starts with very simple problems in particle motion and ends with an in-depth

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discussion of advanced techniques used in Monte Carlo simulations in statistical mechanics. The level of instruction rises slowly, while discussing problems like the diffusion equation, electrostatics on the plane, quantum mechanics and

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random walks. The book aims to provide the students with the background and the experience needed in order to advance to high performance computing projects in science and engineering. But it also tries to keep the students motivated by considering interesting

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applications in physics, like chaos, quantum mechanics, special relativity and the physics of phase transitions. The book and the

accompanying software is available for free in electronic form at

<http://goo.gl/SGUEkM>
([www.physics.ntua.gr/
%7Ekonstant/Comput](http://www.physics.ntua.gr/%7Ekonstant/Comput)

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ational Physics) and a printed copy can be purchased from lulu.com at

<http://goo.gl/XsSBdP>
(vol I at

<http://goo.gl/Pg1zHc>)

This updated edition provides an introduction to computational physics in order to perform physics experiments on the computer.

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Computers can be used for a wide variety of scientific tasks, from the simple manipulation of data to simulations of real-world events. This book is designed to provide the reader with a grounding in scientific programming. It contains many examples and

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exercises developed
in the context of
physics problems.

The new edition now
uses C++ as the
primary language.

The book covers
topics such as
interpolation,
integration, and the
numerical solutions to
both ordinary and
partial differential
equations. It

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discusses simple ideas, such as linear interpolation and root finding through bisection, to more advanced concepts in order to solve complex differential equations. It also contains a chapter on high performance computing which provides an introduction to parallel

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programming.

FEATURES: Includes some advanced material as well as the customary introductory topics

Uses a comprehensive C++ library and several C++ sample programs ready to use and build into a library of scientific programs

Features problem-

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solving aspects to show how problems are approached and to demonstrate the methods of constructing models and solutions. Computers and computation are extremely important components of physics and should be integral parts of a physicist's education.

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Furthermore,
computational physics
is reshaping the way
calculations are made
in all areas of physics.
Intended for the
physics and
engineering students
who have completed
the introductory
physics course, A
First Course in
Computational
Physics, Second

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Edition covers the different types of computational problems using MATLAB with exercises developed around problems of physical interest. Topics such as root finding, Newton-Cotes integration, and ordinary differential equations are included and

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presented in the context of physics problems. A few topics rarely seen at this level such as computerized tomography, are also included. Within each chapter, the student is led from relatively elementary problems and simple numerical approaches through derivations of more

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complex and sophisticated methods, often culminating in the solution to problems of significant difficulty. The goal is to demonstrate how numerical methods are used to solve the problems that physicists face. Read the review published in Computing in

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Science &
Engineering

magazine,

March/April 2011 (Vol.
13, No. 2) © 2011

IEEE, Published by
the IEEE Computer
Society

In this book, the
author deals with the
mathematical
modelling, nonlinear
control and
performance

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evaluation of a conceptual anti-aircraft gun based mobile air defence system engaging an attacking three-dimensional aerial target. This book is of interest to academic faculty, graduate students and industry professionals working in the fields of mathematical

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modelling and control,
ground vehicles,
mobile air defence
systems and other
related topics.

Computer Simulation
Studies in Condensed-
Matter Physics XIV
Computational
Physics
Transfer Matrix
Method for Multibody
Systems
Introduction to

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Computational
Physics for
Undergraduates
Novel Lights Sources
Beyond Free Electron
Lasers
A Perspective from
México

The noteworthy
findings and
innovative methods
of predicting
projectile trajectory,

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introduced in my
books Exterior

Ballistics: A New
Approach (EBNA),
Xlibris, 2010; and
Exterior Ballistics
with Applications
(EBA3e), Xlibris,
third edition,
December 2011,
require a methodical
approach and further

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development. As result, the amateurs and professionals interested in exterior ballistics of firearms, and especially in long-range shooting with small arms, have a new book, Exterior Ballistics: The Remarkable Methods (EBRM),

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that aims to enrich the foundations of modern exterior ballistics and to lessen the complexity of physics and mathematics techniques in use.

Exterior Ballistics:
The Remarkable
Methods is a book

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that combines and develops further the methods introduced in EBA3e, EBNA, and in the Exterior Ballistics of Small Arms (EBSA, Xlibris 2009). The foundations of the book are mainly the findings and the innovative ballistics

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methods presented in
EBA3e and EBNA.

The remarkable
methods of exterior
ballistics presented
in this new book
include: The
methods of
determining the
function of
resistance $G(v)$ of a
given bullet ($i=1$)

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using range tables,
or the experimental
data measurements
of three or four
coordinates at the
points of projectile
impact. The model
of "Tangent Law of
Trajectory
Refraction" and the
related set of
formulas that we use

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to study the trajectories of projectiles in nonstandard atmosphere. Series expansion method and the techniques of (second to sixth order) parabolas we employ to predict with great accuracy the projectile

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trajectory. The exceptional Siacci's methods that we apply as well for the projectile trajectory in nonstandard atmosphere and in inclined shooting combined with the tangent law of trajectory refraction.

It is important to

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note that using the similarity laws of fluid dynamics we have obtained the "tangent law of projectile refraction," which represents a progress with respect to "Newton Snell's law" on projectile refraction. For better

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understanding of the
information

presented in the
book, the reader
should refer to my
three preceding
books on exterior
ballistics, already
published by Xlibris,
although most of the
material is self-
contained and clear

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enough to be accessed and assimilated by a wide range of readers. The system of units used in the book is the International System (SI). For readers that are unfamiliar with the SI system it is not difficult to

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become accustomed
and use the materials
presented in the
book to benefit from
the simple
illustrations,
exercises, and PC
programs that, at the
same time, give
answers to many
problems
encountered in

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practice. My studies and writing work in exterior ballistics intend to find new and simple mathematical models and methods to predict the elements of the projectile trajectory. I believe that I have achieved some good

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results, which need
to be further

developed. George
Klimi, PhD New
York, December
2012

gklimi@pace.edu

iven24@aol.com gkl

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du

This book discusses
possibilities and

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perspectives for
designing and
practical realization
of novel intensive
gamma-ray crystal-
based light sources
that can be
constructed through
exposure of oriented
crystals—linear, bent
and periodically
bent, to beams of

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ultrarelativistic
positrons and
electrons. The book
shows case studies
like the tunable light
sources based on
periodically bent
crystals that can be
designed with the
state-of-the-art beam
facilities. A special
focus is given to the

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analysis of
generation of the
gamma rays because
the current
technologies based
on particle motion in
the magnetic field
become inefficient
or incapable to
achieve the desired
gamma rays'
intensities. It is

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demonstrated that the intensity of radiation from crystal-based light sources can be made comparable to or even higher than what is achievable in conventional synchrotrons and undulators operating although in the much

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lower photon energy range. By exploring the coherence effects, the intensity can be boosted by orders of magnitude. The practical realization of such novel light sources will lead to the significant technological

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breakthroughs and societal impacts similar to those created earlier by the developments of lasers, synchrotrons and X-rays free-electron lasers.

Readers learn about the underlying fundamental physics and familiarize with

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the theoretical,
experimental and
technological
advances made
during last two
decades in exploring
various features of
investigations into
crystal-based light
sources. This
research draws upon
knowledge from

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many research fields, such as material science, beam physics, physics of radiation, solid-state physics and acoustics, to name but a few. The authors provide a useful introduction in this emerging field to a broad

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readership of
researchers and
scientists with
various backgrounds
and, accordingly,
make the book as
self-contained as
possible.

Dynamics can be a
major frustration for
those students who
don't relate to the

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logic behind the material -- and this includes many of them! Engineering Mechanics:

Dynamics meets their needs by combining rigor with user friendliness.

The presentation in this text is very personalized, giving

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students the sense that they are having a one-on-one discussion with the authors. This minimizes the air of mystery that a more austere presentation can engender, and aids immensely in the students' ability to retain and apply

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the material. The authors do not skimp on rigor but at the same time work tirelessly to make the material accessible and, as far as possible, fun to learn.

Numerical
Calculation for
Physics Laboratory

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Projects Using
Microsoft

EXCEL® Morgan &
Claypool Publishers
Computer Methods
for Engineering with
MATLAB®

Applications,
Second Edition
A First Course in
Computational
Physics

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Process Models and
Techno-Economic
Analysis
Dynamics
Theory and
Applications
Numerical Methods
with Worked
Examples
Exterior Ballistics
with Applications –
Skydiving, Parachute

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Fall, Flying Fragments presents a modern approach to introduce the basics of exterior ballistics and its methods from the simple ideal model of projectile motion to the automatic solution of the differential equations of projectile flight using PC programs. The book uses

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different approaches to solve the differential equations of projectile motion — among them the Siacci method and the numerical methods. The results obtained through the integration of differential equations of projectile flight are mostly analytical formulas that

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describe the projectile trajectory and make the exterior ballistics a comprehensible science. The Differential Equations of Projectile Flight are also integrated numerically using some original PC programs that can be easily modified to be used in similar scenarios or other

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new ones and give the reader the possibility to solve a great variety of Exterior Ballistics problem. Exterior Ballistics with Applications can be considered as an interdisciplinary applied mathematics and physics manuscript for the vast mathematics and

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physics models and techniques employed. It is a great source for applications in physics, calculus, differential equations, numerical methods, and PC programming as well. The book is illustrated with about 140 solved examples related to different artillery and infantry firearms that

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demonstrate the use of formulas and the solution methods of ballistics to find the elements of projectile trajectories. Exterior Ballistics with Applications includes as well two interesting topics that can be considered as applications of exterior ballistics: 1. Skydiving and

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parachute falling related with the trajectory of a parachutist launched from a horizontally flying airplane with un-deployed parachute, in different meteorological conditions, and in presence of air resistance and wind.

2. The ballistics of

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projectile fragments that is an important element of Terminal Ballistics necessary to study the effectiveness of fragmentation ammunitions on the personnel and objects, and other problems related with the construction of fragmentation ammunitions, or with

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Forensic Sciences.
Exterior Ballistics

with Applications is comprehensive and serves as reference material to provide answers to problems encountered in the practice of motion of unguided projectiles, skydiving and flying fragments of antipersonnel ammunitions.

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*Shows how to create realistic action games without assuming college-level Physics (which the majority of gamers won't have); includes necessary physics and mathematics *Ideal for all budding games programmers, with example code in Java, C#, and C

*Complements

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Apress's platform-specific gaming books, like *Advanced Java Games Programming and Beginning .NET Games Programming with C#*, and the forthcoming *Beginning .NET Games Programming in VB.NET* *Palmer has strong contacts in the Microsoft Games

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Division and
Electronic Arts, a
major gaming
producer.

It takes into account
the availability of
desktop computer to
the reader. Analysis in
MS Excel spreadsheet
are shown as worked
examples. Models
with little or no
adjustable parameters
are developed from

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first principles. Thermodynamic and exergy analysis are used to evaluate a process. 5 methods of analysis of a capital project, i.e., AW, annualized worth, PW, present worth, IRR, Internal Rate of Return, FW, future worth and ERR external rate of return are presented. Case Studies are used.

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Simulation and series solutions to model equations are sought when applicable.

Correlations are developed from computer simulations of desired phenomena.

As a segment of the broader science of automation, robotics has achieved tremendous progress

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in recent decades due to the advances in supporting technologies such as computers, control systems, cameras and electronic vision, as well as micro and nanotechnology. Prototyping a design helps in determining system parameters, ranges, and in structuring an overall

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better system.

Robotics is one of the industrial design fields in which prototyping is crucial for improved functionality.

Prototyping of Robotic Systems: Applications of Design and Implementation provides a framework for conceptual,

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theoretical, and applied research in robotic prototyping and its applications. Covering the prototyping of various robotic systems including the complicated industrial robots, the tiny and delicate nanorobots, medical robots for disease diagnosis and

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treatment, as well as the simple robots for educational purposes, this book is a useful tool for those in the field of robotics prototyping and as a general reference tool for those in related fields.

Exterior Ballistics
Projectile Dynamics
in Sport
Advanced

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Mathematics and
Mechanics
Applications Using
MATLAB, Third
Edition
Engineering
Mechanics
Proceedings of the
Fourteenth
Workshop, Athens,
GA, USA, February
19–24, 2001
Mathematical
Modelling, Nonlinear

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Control and
Performance

Evaluation of a
Ground Based Mobile
Air Defence System
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of the major
subject areas of
physics. All
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engineering
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modeling, solid
state physics,
radio astronomy,
Newtonian

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mechanics, and
physics lab
experiments.

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Claycomb, PhD
The Special
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Relativity.
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PhD

Computational
Physics. Darren
Walker, PhD
Quantum
Mechanics.

Dennis Morris,
PhD Basic
Electromagnetic
Theory. James
Babington, PhD
Physics Lab

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Experiments.

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Newtonian

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Raine, PhD Solid

State Physics.

David Schmool,

PhD Multiphysics

Modeling Using

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Pryor, PhD Radio

Astronomy. S.

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Joardar, PhD

Electrical

Engineering

Experiments.

G.P. Chhalotra,

PhD

Exterior

Ballistics with

Applications

Skydiving,

Parachute Fall,

Flying Fragments

presents a

modern approach

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to introduce the
basics of
exterior
ballistics and
its methods from
the simple ideal
model of
projectile
motion to the
automatic
solution of the
differential
equations of
projectile

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flight using PC programs. The book uses different approaches to solve the differential equations of projectile motion among them the Siacci method and the numerical methods. The

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results obtained through the integration of differential equations of projectile flight are mostly analytical formulas that describe the projectile trajectory and make the

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exterior ballistics a comprehensible science. The Differential Equations of Projectile Flight are also integrated numerically using some original PC programs that can be easily

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modified to be used in similar scenarios or other new ones and give the reader the possibility to solve a great variety of Exterior Ballistics problem. Exterior Ballistics with

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Applications can be considered as an interdisciplinary applied mathematics and physics manuscript for the vast mathematics and physics models and techniques employed. It is a great source for applications

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in physics,
calculus,
differential
equations,
numerical
methods, and PC
programming as
well. The book
is illustrated
with about 140
solved examples
related to
different
artillery and

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infantry
firearms that
demonstrate the
use of formulas
and the solution
methods of
ballistics to
find the
elements of
projectile
trajectories.
Exterior
Ballistics with
Applications

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includes as well
two interesting
topics that can
be considered as
applications of
exterior
ballistics: 1.
Skydiving and
parachute
falling related
with the
trajectory of a
parachutist
launched from a

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horizontally flying airplane with un-deployed parachute, in different meteorological conditions, and in presence of air resistance and wind. 2. The ballistics of projectile fragments that is an important

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element of
Terminal
Ballistics
necessary to
study the
effectiveness of
fragmentation
ammunitions on
the personnel
and objects, and
other problems
related with the
construction of
fragmentation

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ammunitions, or
with Forensic
Sciences.

Exterior
Ballistics with
Applications is
comprehensive
and serves as
reference
material to
provide answers
to problems
encountered in
the practice of

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motion of unguided projectiles, skydiving and flying fragments of antipersonnel ammunitions.

This work presents the most recent research in the mechanism and machine science field and its

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applications.
The topics
covered include:
theoretical
kinematics,
computational
kinematics,
mechanism
design,
experimental
mechanics,
mechanics of
robots, dynamics
of machinery,

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dynamics of
multi-body
systems, control
issues of
mechanical
systems,
mechanisms for
biomechanics,
novel designs,
mechanical
transmissions,
linkages and
manipulators, mi
cro-mechanisms,

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teaching
methods, history
of mechanism
science and
industrial and
non-industrial
applications.
This volume
consists of the
Proceedings of
the 5th European
Conference on
Mechanisms
Science

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(EUCOMES) that was held in Guimarães, Portugal, from September 16 – 20, 2014. The EUCOMES is the main forum for the European community working in Mechanisms and Machine Science. An understanding

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of the physical processes involved in throwing, hitting, firing and releasing sporting projectiles is essential for a full understanding of the science that underpins sport. This book

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examines those processes and explains the factors governing the trajectories of sporting projectiles once they are set in motion.

Principles and Applications
Prototyping of Robotic Systems:

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Applications of
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Implementation
Skydiving,
Parachute Fall,
Flying Fragments
From
Fundamentals to
Industrial
Applications
Dynamics of
Systems on the
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Comprehensive

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Modeling and
Numerical
Simulation of
Interior
Ballistic
Processes in
120mm Mortar
With Systematic
Experimental
Validation

**This book
features the
latest
theoretical**

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results and techniques in the field of guidance, navigation, and control (GNC) of vehicles and aircraft. It covers a range of topics, including, but not limited to, intelligent computing

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**communication
and control; new
methods of
navigation,
estimation, and
tracking;
control of
multiple moving
objects; manned
and autonomous
unmanned
systems;
guidance,
navigation, and**

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**control of
miniature
aircraft; and
sensor systems
for guidance,
navigation, and
control.**

**Presenting
recent advances
in the form of
illustrations,
tables, and
text, it also
provides**

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detailed information of a number of the studies, to offer readers insights for their own research. In addition, the book addresses fundamental concepts and studies in the development of

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**GNC, making it a
valuable**

**resource for
both beginners
and researchers
wanting to
further their
understanding of
guidance,
navigation, and
control.**

**Over the last 30
years, Professor
David P.**

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**Landau's
trailblazing
research
achievements and
influential
leadership have
helped establish
computer sim
ulation as a
powerful and
incisive mode of
scientific
investigation,
now on a par in**

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the physical sciences with experimental and theoretical research. This year, we were very pleased to organize a special one-day symposium honoring the 60th birthday of our distinguished colleague and

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friend. This event was held in conjunction with and immediately following the annual computer simulations workshop that Professor Landau founded 14 years ago. Many of the papers presented at this honorary

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symposium are integrated into this proceedings volume, and the accompanying photograph of participants serves to commemorate this very special event. This volume contains both invited

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**papers and
contributed
presentations on
problems in both
classical and
quantum
condensed matter
physics. We hope
that each reader
will benefit
from specialized
results as well
as profit from
exposure to new**

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**algorithms,
methods of
analysis, and
conceptual devel
opments.**

**Computational
Modeling, by Jay
Wang introduces
computational
modeling and
visualization of
physical systems
that are
commonly found**

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**in physics and
related areas.**

**The authors
begin with a
framework that
integrates model
building,
algorithm
development, and
data
visualization
for problem
solving via
scientific**

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**computing.
Through
carefully
selected
problems,
methods, and
projects, the
reader is guided
to learning and
discovery by
actively doing
rather than just
knowing physics.
Since its**

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**introduction in
1984, MATLAB's
ever-growing
popularity and
functionality
have secured its
position as an i
ndustry-standard
software
package. The
user-friendly,
interactive
environment of
MATLAB 6.x,**

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**which includes a
high-level
programming
language,
versatile
graphics
capabilities,
and abundance of
intrinsic
functions, helps
users focus on
their
applications
rather than on**

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**programming
errors. MATLAB**

**has now leapt
far ahead of
FORTRAN as the
software of
choice for
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Proceedings of a
Conference
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**Singapore,
Singapore
Institute of
Manufacturing
Technology, Co-
sponsored by
American Society
for Materials
International
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Materials
Information
Society), Held
December 6-8,**

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**2004 at Pan-
Pacific Hotel,
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MLI Physics
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- of the techniques
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Wang and Jianshu

Zhang - Nanjing

University of Science

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new method of

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dynamics, this book

introduces the transfer

matrix method

systematically for the

first time. First

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author and his research team, this method has found numerous engineering and technological applications. Readers are first introduced to fundamental concepts like the body dynamics equation, augmented operator and augmented eigenvector before

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ship weaponry. •

Comprehensively
introduces a new
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for engineers •

Provides a logical
development of the
transfer matrix
method as applied to
the dynamics of
multibody systems that

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multibody systems

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the Fourier
transform to
calculate the normal
modes of a double
pendulum, matrix
calculations to solve
coupled linear*

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*equations of a DC
circuit, animation of
waves and
Lissajous figures,
electric and
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calculations from
the Poisson
equation and its 3D
surface graphs,
variational calculus
such as Fermat's
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trajectories.*

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related scientific fields. It is addressed to an audience that has already been exposed to the introductory level of college physics, usually taught during the first two years of an undergraduate program in science

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and engineering. It assumes no prior knowledge of numerical analysis, programming or computers and teaches whatever is necessary for the solution of the problems addressed in the text. C++ is used for programming the

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core programs and data analysis is performed using the powerful tools of the GNU/Linux environment. All the necessary software is open source and freely available. The book starts with very simple problems in particle motion and ends with an in-

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depth discussion of advanced techniques used in Monte Carlo simulations in statistical mechanics. The level of instruction rises slowly, while discussing problems like the diffusion equation, electrostatics on the

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*plane, quantum
mechanics and
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programmingskills,
while the acquired
programming skills
augment their ability
to solve physics
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systems,
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coverage of the subject and it contains abundant worked examples which provide easy understanding through a clear and concise theoretical treatment.

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scientific fields. It is addressed to an audience that has already been exposed to the introductory level of college physics, usually taught during the first two years of an undergraduate program in science and engineering. The book starts with very simple problems in

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particle motion and ends with an in-depth discussion of advanced techniques used in Monte Carlo simulations in statistical mechanics. The level of instruction rises slowly, while discussing problems like the diffusion equation, electrostatics on the

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plane, quantum mechanics and random walks. The book aims to provide the students with the background and the experience needed in order to advance to high performance computing projects in science and engineering. But it also tries to keep the students motivated by

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considering
interesting
applications in
physics, like chaos,
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& Technology
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*A three-
dimensional*

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*mortar interior
ballistic (3D-MIB)
model and code
have been
developed and
stage-wise
validated with
multiple sets of
experimental data
in close
collaboration
between The*

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*Pennsylvania
State Univ. (PSU)
and Army
Research and
Development
Engineering
Center. This newly
developed MIB
model and
numerical code
realistically
simulates the*

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*combustion and
pressurization
processes in
various
components of the
120mm mortar
system. Due to
the complexity of
the overall interior
ballistic processes
in the mortar
propulsion*

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system, the overall problem has been solved in a modular fashion, i.e., simulating each component of the mortar propulsion system separately. The physical processes in the mortar system are two-

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phase and were simulated by considering both phases as an interpenetrating continuum. Mass and energy fluxes from the flash tube into the granular bed of M1020 ignition cartridge were

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determined from a semiempirical technique. For the tail-boom section, a transient one-dimensional two phase numerical code based on method of characteristics (MOC) was developed and

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*validated by
experimental test
results. The
mortar tube
combustion
processes were
modeled and
solved by using a
two-phase Roe-
Pike method with
van Leer flux
limiter, a fourth*

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order Runge-Kutta scheme, and an adaptive mesh generator to account for the projectile motion. For each component, the predicted pressure-time traces showed significant pressure wave

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phenomena, which closely simulated the measured pressure-time traces. The experimental data for the flash tube and ignition cartridge were obtained at PSU whereas the

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pressure-time traces at the breech-end of the mortar tube were obtained from the tests conducted at Yuma Proving Ground (YPG). The 3D-MIB code was also used to simulate the effect of flash

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*tube vent-hole
pattern on the
pressure-wave
phenomenon in
the ignition
cartridge. A
comparison of the
pressure
difference
between primer-
end and projectile-
end locations of*

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