Principles of Engineering Dynamics

Concise Theory and Applications

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Preface

In the name of Allah, the most merciful the most beneficent, the Almighty who has given strength to me towards the completion of this book. This book entitled "*Principles of Engineering Dynamics Concise Theory and Applications*" is intended for use in a first course in "Dynamics" for undergraduates in Mechanical, Civil or Aerospace Engineering who are focusing merely to planar two-dimensional problems. Three-dimensional approaches and some advance topics related to rigid bodies are not discussed in this book.

A classical approach starting from dynamics of particles before discussing rigid bodies is still a choice for undergraduates or for those who firstly study the course related to engineering dynamics. The chapters of this book therefore cover the kinematics and kinetics of particles followed by the kinematics and kinetics of rigid bodies

In the theory parts, only concise explanations with pictures are given in this book and avoid complicated mathematical explanations for new readers. Selected problems related to the topics are then presented in complete solutions to improve and to comprehend some basic theories related to the real applications. This pedagogical approach may improve a better understanding when students refer to books suggested in the references.

There are 86 example problems discussed in this book. The presentation of the example problem is explained in two approaches; a plain explanation and the corresponding symbolic programming codes. In every example problem, the solution strategy is discussed and followed by the detail calculation and results. The solution is accompanied by Mathcad solution codes written in a two-column style. The left column explains the solution approach, relevant equations, calculation procedures and the results, whereas *Mathcad*[1] solution codes are written in the right column. Readers may learn how to use Mathcad while following the explanation in the left column. A solution strategy to help a better understanding of the problem is given prior to the solution in most example problem.

This design style of the problem solution format assisted with mathematical symbolic programming will guide the reader to focus on understanding the so-

[1]Engineering Calculation Software, Copyright@2008, Parametric Technology Corporation (PTC). All rights reserved.

lution approach while at the same time referring the Mathcad detail calculation on the right column. Simple Mathcad codings are chosen to allow new users to comprehend structured symbolic programming.

By completing this book, I would like to sincerely thank to my colleagues, *Prof. Mohd Ghazali*, *En. Izzuddin Zaman*. *En. Saifulnizam Jamian*, *En. Ramhuzaini* and *En Zamani Ngali* who have been contributing to Dynamics teaching in University Tun Hussein Onn Malaysia (UTHM), also to *Dr. Badrul Omar* for his continuous supports to my academic activities.

The preparation of this book, all editing and typesetting were fully performed on LyX[2] (front end of LaTeX[3]) under operating system *Ubuntu Muslim Edition*[4]. The author would like to thank to all developers and contributors working from five continents for the establishment of free open source software.

My special gratitude goes to my wife *Anik*, my daughter *Mutia*, also my sons *Hanif*, and *Yusuf*, for their patients and supports. Their day and night prayers are indispensable. Without them the work would have been most difficult.

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[2] LyX (http://www.lyx.org/) is a document processor, under a *free software*/open source license

[3] LaTeX is a document markup language and document preparation system for the TeX typesetting. Software under LaTeX Project Public License (LPPL) can be regarded as *free software*, however it is not *copylefted*

[4] *Ubuntu Muslim Edition* (http://www.ubuntume.com/) is a *free*, open source operating system based on Ubuntu Linux.

Understanding the problem solution

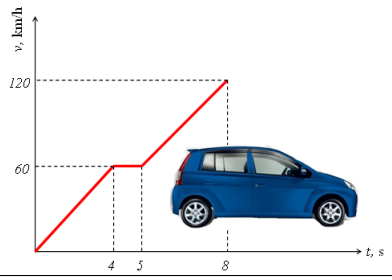
In this book example problems are provided and presented in two formats:

Problem {no}: {name of the problem}

In this box, problem definition is explained and an illustration related to the problem is also shown to provide additional information. Questions are then given in the end of the problem description.

Question a

Question b



Solution strategy:

A strategy to solve the problem is discussed in brief to provide an idea and strategy for the solution.

Solution:

The left column for the explanation, equations, calculation procedures and results.
For example:
It is known
$v_o = 108\,\text{km/h}$
$= 30\,\text{m/s}$
$a = -4.5\,\text{m/s}^2$
$v = 0$

Equation to use
$v^2 = v_o^2 + 2a\,(s - s_o)$

It is assumed when the brakes applied, it is set $s_o = 0$
$v^2 = v_o^2 + 2a\,(s)$
$s = \frac{v^2 - v_o^2}{2a} = 100\,\text{m}$

Mathcad solution code

Right column for Mathcad

$vo := 108kph$

$vo = 30\,\frac{m}{s}$

$v := 0\,\frac{m}{s}$

$a := -4.5\,\frac{m}{s^2}$

$\Delta s := \frac{(v^2 - vo^2)}{2 \cdot a}$

$\Delta s = 100\,m$

Understanding the problem solution

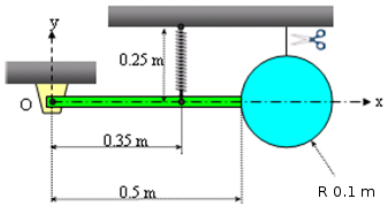
Some example problems are presented in one column format:

Problem {no}: {name of the problem}

In this box, problem definition is explained and an illustration related to the problem is also shown to provide additional information. Questions are then given in the end of the problem description.

Question a

Question b



Solution strategy:

A strategy to solve the problem is discussed in brief to provide an idea and strategy for the solution.

Solution:

Center of mass calculation table:

Part	x (m)	y (m)	m (kg)	xm (m.kg)	ym (m.kg)
slender b	0.25	0	3	0.75	0
circ pl	0.6	0	4	2.4	0
			7	3.15	0

The center of mass of the L-shape structure, $X = \frac{3.15}{7} = 0.45\,m$ and $Y = \frac{0}{7} = 0$

Mathcad solution code:

Calculation of the center of the mass

$$x := \frac{[(0.25m \cdot 3kg) + (0.6m \cdot 4kg)]}{(3kg + 4kg)} \qquad x = 0.45\,m$$

Calculation of the mass of mement inertia about axis O

$ms := 3kg$ $\quad mc := 4kg$ $\quad L := 0.5m$

Slender $\quad Icm\_s := \frac{1}{12} \cdot ms \cdot L^2 \qquad Icm\_s = 0.063\,m^2 \cdot kg$

$ds := 0.25m$

$Io\_s := Icm\_s + ds^2 \cdot ms \qquad Io\_s = 0.25\,m^2 \cdot kg$