Mechanics

Spring 2017

Last updated:
17th April 2017 at 02:17

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http://www.jamescannon.net/teaching/mechanics

http://raw.githubusercontent.com/NanoScaleDesign/Mechanics/master/mechanics.pdf

Contents

Chapter 0

Course information

0.1 This course

This is the Spring 2017 Mechanics course studied by 2nd-year undegraduate international students at Kyushu University.

0.1.1 What you need to do

- Borrow the book "Engineering Mechanics: Dynamics", 6th edition, by Meriam and Kraige from the Kikan-kyoiku office in the centre-zone. The course will be based on that book and you will need to refer to it in class.
- Prepare a challenge-log in the form of a workbook or folder where you can clearly write the calculations you perform to solve each challenge. This will be used in the final assessment and will be occasionally reviewed by the teacher.
- Submit a weekly feedback form by **9am on Monday** before class at `https://goo.gl/forms/2PgFF0eqTOvbK0to2`.
- Please bring a wifi-capable internet device to class, as well as headphones if you need to access online components of the course during class. If you let me know in advance, I can lend computers and provide power extension cables for those who require them (limited number).

0.1.2 How this works

- This booklet forms part of an active-learning segment in the course. The learning is self-directed in contrast to the traditional lecture-style model.
- Learning is guided through solving a series of challenges combined with instant feedback about the correctness of your answer.
- Traditional lectures are replaced by discussion time. Here, you are encouraged to discuss any issues with your peers, teacher and any teaching assistants. You can also learn from explaining concepts to your peers.
- Discussion-time is from 13:00 to 14:30 on Mondays at room W4-766.
- Peer discussion is encouraged, however, if you have help to solve a challenge, always make sure you do understand the details yourself. You will need to be able to do this in an exam environment. The questions on the exam will be similar in nature to the challenges. If you can do all of the challenges, you can get 100% on the exam.
- Every challenge in the book typically contains a **Challenge** with suggested **Resources** which you are recommended to utilise in order to solve the challenge. **Solutions** will be given. Occasionally the teacher will provide extra **Comments** to help guide your thinking.
- For deep understanding, it is recommended to study the suggested resources beyond the minimum required to complete the challenge.
- The challenge document has many pages and is continuously being developed. Therefore it is advised to view the document on an electronic device rather than print it. The date on the front page denotes the version of the document. You will be notified when the document is updated.
- A target challenge will be set each week. This will set the pace of the course and define the examinable material. It's ok if you can't quite reach the target challenge for a given week, but you should be careful not to fall behind, since the date of the exam cannot be delayed.

0.1.3 Assessment

In order to prove to outside parties that you have learned something from the course, we must perform summative assessments. Details will be released at a later date, but will include your answers to the challenges and a final exam, so be sure to keep a record showing how you calculated the answers to all the challenges.

0.2 Timetable

	Discussion	Target	Note
1	10 April	-	
2	17 April	1.3	
3	24 April	1.5	
4	8 May		
5	15 May		
6	22 May		
7	29 May		
8	5 June		
9	12 June		
10	19 June		
11	26 June		
12	3 July		
13	10 July		
14	13 July		
15	24 July	-	Final exam

Chapter 1

Kinetics of systems of particles

1.1 System centre-of-mass position, mass and velocity: I

Resources

- Book sections 4/1 to 4/2

Challenge

1. $\overline{\boldsymbol{r}}$, $\dot{\boldsymbol{r}}$ and $\ddot{\boldsymbol{r}}$ of Question 4/1.

2. Question 4/4, but replace the word "lb" with "kg" and the word "ft" with "m". *Do not convert units mathematically; just replace word-for-word. I realise that this will make for heavy monkeys.*

Solution

1. Given in book.

2. 533.6 N

1.2 System centre-of-mass position, mass and velocity: II

Resources

- Book sections 4/1 to 4/2

Challenge

Question 4/5. Determine the *magnitude* of the acceleration.

Solution

Given in book.

1.3 System centre-of-mass position, mass and velocity: III

Resources

- Book sections 4/1 to 4/2

Challenge

Question 4/13, but change the force to a $10\,\mathrm{N}$ force and the mass of each bar to $8\,\mathrm{kg}$.

Solution

$0.42\,\mathrm{m/s^2}$

1.4 Kinetic and potential energy

Resources

- Book section 4/3

Challenge

1. Calculate T in question 4/1
2. Question 4/10

Solution

1. Given in book.
2. To check your final answer, substitute $b = 2m$ into your final answer. You should obtain 5.27 m/s.

1.5 Cross-product

Resources

- `https://www.khanacademy.org/science/physics/magnetic-forces-and-magnetic-fields/electric-motors/v/calculating-dot-and-cross-products-with-unit-vector-notation`

Challenge

1. Determine the angle between the two vectors $\boldsymbol{a} = [3, 0, 0]$ and $\boldsymbol{b} = [3, 1, 0]$ and use it to calculate $\boldsymbol{c} = \boldsymbol{a} \times \boldsymbol{b}$. Which direction does the vector $\boldsymbol{c}$ point?

2. Determine the cross product $\boldsymbol{f} = \boldsymbol{d} \times \boldsymbol{e}$ where $\boldsymbol{d} = 4\hat{\imath} + 2\hat{\jmath} + 1\hat{k}$ and $\boldsymbol{e} = -2\hat{\imath} - 4\hat{\jmath} + 8\hat{k}$ without calculating the angle between them.

Solution

Please compare your answer with your partner and discuss in class if answers differ.