AS2070: Aerospace Structural Mechanics

Course Project Topics

Instructor: Nidish Narayanaa Balaji

Department of Aerospace Engineering, IIT Madras

January 25, 2025

Project Prompt and Objectives

Prompt

Conduct an experiment that can reveal a technical aspect of one of the modules covered in this course and make a presentation to class.

Think on the following lines:

- Pretend like you are tasked with **creating a theoretical formalism** for what you're studying. What observations **would you deem necessary** before you are ready to develop this?
- Is there an aspect in class that you feel can be brought out more clearly through experiments?
- What would be **the simplest experiment** that will need to be conducted to confirm/inform an aspect from class?

Project Prompt and Objectives

Prompt

Conduct an experiment that can reveal a technical aspect of one of the modules covered in this course and make a presentation to class.

Think on the following lines:

- Pretend like you are tasked with **creating a theoretical formalism** for what you're studying. What observations **would you deem necessary** before you are ready to develop this?
- Is there an aspect in class that you feel can be brought out more clearly through experiments?
- What would be **the simplest experiment** that will need to be conducted to confirm/inform an aspect from class?

Thought Exercise: Inductive vs Deductive Reasoning

Inductive reasoning involves starting from specific premises and forming a general conclusion, while deductive reasoning involves using general premises to form a specific conclusion.

- Consider carefully if what you're doing is induction or deduction[a].
- What would be a more healthy/sustainable approach to science in the 21st century and beyond? Why? Why not?

[a] In a sense, the theory is provided in class so you can trivially argue against any deductive component here, but this is a thought exercise.

Project Deliverables

1. You will be split into groups of 5-6 members each, with a topic that I will assign based on preferences **a week from today**.
2. You are to submit an estimate of material and equipment requirement **two weeks from #1**.
3. Schedule the experiments/specimen preparation sessions with me well in advance. The experimental components have to be concluded **2 weeks before the last day of classes**. I recommend doing this at the earliest to give you enough time to process what you see.
4. We will have group presentations (5-10mts each) on **the last week of classes**.
5. Each group submits a report of maximum size 4 pages before the presentation.

Project Deliverables

1. You will be split into groups of 5-6 members each, with a topic that I will assign based on preferences **a week from today**.
2. You are to submit an estimate of material and equipment requirement **two weeks from #1**.
3. Schedule the experiments/specimen preparation sessions with me well in advance. The experimental components have to be concluded **2 weeks before the last day of classes**. I recommend doing this at the earliest to give you enough time to process what you see.
4. We will have group presentations (5-10mts each) on **the last week of classes**.
5. Each group submits a report of maximum size 4 pages before the presentation.

Please manage your time carefully so this doesn't turn into a painful experience for **both of us**!

Suggested Topics

M1: Elastic Stability

1. Postbuckling of a thin flat beam.
   See animation in website
2. Plate buckling for different aspect ratios.
   See Megson 2013
3. Snap-through buckling of an arch.
   See plots on Google. We won't be covering this in class.

Please email me at nidish@iitm.ac.in if you have other suggestions.

Suggested Topics

M1: Elastic Stability

1. Postbuckling of a thin flat beam.
   See animation in website
2. Plate buckling for different aspect ratios.
   See Megson 2013
3. Snap-through buckling of an arch.
   See plots on Google. We won't be covering this in class.

M2: Composite Mechanics

1. Experimental verification of constitutive properties of a single lamina.
   See Megson 2013
2. Failure of a laminated composite material.
   See Gibson 2012

Please email me at nidish@iitm.ac.in if you have other suggestions.

Suggested Topics

M1: Elastic Stability

1. Postbuckling of a thin flat beam.
   See animation in website
2. Plate buckling for different aspect ratios.
   See Megson 2013
3. Snap-through buckling of an arch.
   See plots on Google. We won't be covering this in class.

M2: Composite Mechanics

1. Experimental verification of constitutive properties of a single lamina.
   See Megson 2013
2. Failure of a laminated composite material.
   See Gibson 2012

M3: Fatigue & Fracture

1. Crack resistance plot for a rubber sheet. See Kumar 2009
2. Stress-strain curve property statistics.
3. S-n fatigue curve for an AA part (of your design).
   See Kumar 2009
4. Crack growth in a Double Cantilever Beam (DCB).
   See Kumar 2009
5. Length dependence for failue. See Gdoutos 2005

Please email me at nidish@iitm.ac.in if you have other suggestions.

Suggested Topics

M1: Elastic Stability

1. Postbuckling of a thin flat beam.
   See animation in website
2. Plate buckling for aspect ratios.
   See Megson 2013
3. Snap-through buckling of an arch.
   See plots on Google. We won't be covering this in class.

M2: Composite Mechanics

1. Experimental verification ... composite material.
   See Gibson 2012

Remember, the key is to choose something very simple and train a disciplined eye at it.

M3: Fatigue & Fracture

1. Crack resistance plot for a rubber sheet. See Kumar 2009
2. Stress-strain curve property statistics.
3. S-n fatigue curve for an AA part (of your design). See Kumar 2009
4. Crack growth in a Double Cantilever Beam (DCB). See Kumar 2009
5. Length dependence for failue. See Gdoutos 2005

Please email me at nidish@iitm.ac.in if you have other suggestions.

References I

[1] T. H. G. Megson. Aircraft Structures for Engineering Students, Elsevier, 2013. ISBN: 978-0-08-096905-3 (cit. on pp. 6–9).

[2] R. F. Gibson. Principles of Composite Material Mechanics, 3rd ed. Dekker Mechanical Engineering. Boca Raton, Fla: Taylor & Francis, 2012. ISBN: 978-1-4398-5005-3 (cit. on pp. 6–9).

[3] P. Kumar. Elements of Fracture Mechanics, 1st Edition. McGraw-Hill Education, 2009. ISBN: 978-0-07-065696-3. URL: https://www.accessengineeringlibrary.com/content/book/9780070656963 (visited on 12/15/2024) (cit. on pp. 6–9).

[4] E. E. Gdoutos. Fracture Mechanics: An Introduction, Springer Science & Business Media, Feb. 2005. ISBN: 978-1-4020-2863-2 (cit. on pp. 6–9).