

AAE 537 Hypersonic Propulsion Course Organization and Information

Fall Semester, 2017

Instructor: Professor S. D. Heister (AAE)

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AAE Propulsion Website: <http://roger.ecn.purdue.edu/~propulsi/propulsion/>

Office Hours: MW 1:00-4:00 p.m. (or by appointment)

Teaching Assistant: TBD (e-mail: xxxxxxxx)

Office: ARMS 3xxx Ph. 494-xxxx

Office Hours: TBD

Text: There is no formal text for the class. However, several books have been placed on reserve in the Engineering Library:

Curran, E. T. and Murthy, S.N.B., *Scramjet Propulsion*, 2001

Murthy, S.N.B., *Developments in High-Speed Propulsion*, 1996

Murthy, S.N.B., and Curran, E. T., *High-Speed Flight Propulsion Systems*, 1991

Heiser, W.H. and Pratt, D. T., *Hypersonic Airbreathing Propulsion*, 1994.

Segal, C., *The Scramjet Engine*, Cambridge University Press, 2009

The first four refs. are all part of the AIAA Progress in Astronautics and Aeronautics series.

Prerequisites: AAE 439 and AAE 339 or permission of instructor.

Homework: All assignments will be due at the beginning of class. No late assignments will be accepted for any reason.

Exams: A two hour midterm will be scheduled on TBD.

Final Design Project: Each of the teams will submit a final report providing a detailed design of a hypersonic propulsion system. The report should contain sufficient detail to identify the flow conditions at all stations within the device - more details on the final project to follow.¹

Course Grading:

Homework - 20%

Midterm Exam - 30%

Final Design Project - 50%

¹ Flu Pandemic Procedures: We will communicate via email should the University close for flu pandemic. Instructor reserves the right to modify grading policies in the event of an emergency of this type.

Course Outline

1. Introduction – Hypersonic propulsion missions, classification of systems, mission analysis, modified rocket equation (5-6 lectures)
2. Inlets/Compression Systems – inlet types, inlet starting, analysis of 1, 2, and 3 shock inlets, isentropic spike inlets, isolators (6 lectures)
3. Mixers – constant area and constant pressure mixer, incompressible and compressible shear layers (5 lectures)
4. Turbine-Based Systems for High-Speed Flight: Cycle analysis, water/fluid injection, afterburning, turboramjets, performance calculations (3-4 Lectures)
5. Pulse Detonation Engines: Principles of operation, Chapman-Jouget detonations, performance analysis (5-6 Lectures)
6. Ramjets/Scramjets: Cycle analysis, 1-D internal flow analysis, performance calculation. (5-6 Lectures)
7. RBCC Systems/Ducted Rockets: Cycle analysis, 1-D internal flow analysis, performance prediction (4-5 Lectures)
8. Cooling/heat transfer analysis – film, transpiration and convective cooling, cooling with hydrocarbon fuels (4 lectures)
9. Guest Speakers (1-2 Lectures)
10. X-43 brief, other things I dig up (2 lectures)
11. Presentation of concept designs from each group (6-8 Lectures)

Useful Media

Skylon video:

<http://www.space.com/26753-skylon-space-plane-will-be-both-truck-and-bus-video.html>

Actually this video contains more details on the SABRE engine:

http://www.reactionengines.co.uk/vid_sabre.html

This video shows vehicle operations:

http://www.reactionengines.co.uk/vid_skylonops.html

SABRE precooler:

http://46.233.0.11/ftp/Flight_International%200712.pdf

J-58 engine videos:

<http://youtu.be/F3ao5SCedIk>

<https://www.youtube.com/watch?v=F3ao5SCedIk>

EMERGENCY PREPAREDNESS INFO

As we begin this semester I want to take a few minutes and discuss emergency preparedness. Purdue University is a very safe campus and there is a low probability that a serious incident will occur here at Purdue. However, just as we receive a “safety briefing” each time we get on an aircraft, we want to emphasize our emergency procedures for evacuation and shelter in place incidents. Our preparedness will be critical IF an unexpected event occurs!

Emergency preparedness is your personal responsibility. Purdue University is actively preparing for natural disasters or human-caused incidents with the ultimate goal of maintaining a safe and secure campus. Let’s review the following procedures:

- For any emergency call 911.
- There are nearly 300 Emergency Telephone Systems throughout campus that connect directly to the Purdue Police Department (PUPD). If you feel threatened or need help, push the button and you will be connected to the PUPD.
- If we hear a fire alarm we will immediately evacuate the building and proceed to ***the driveway that borders southwest side of ARMS and CIVL.***
 - **Do not use the elevator.**
 - Go over evacuation route...see specific Building Emergency Plan.
- If we are notified of a Shelter in Place requirement for a tornado warning we will shelter in the lowest level of this building away from windows and doors. Our preferred location is ***Amelia’s Café Area and adjacent classrooms .***
- If we are notified of a Shelter in Place requirement for a hazardous materials release we will shelter in our classroom shutting any open doors and windows.
- If we are notified of a Shelter in Place requirement for a civil disturbance such as a shooting we will shelter in a room that is securable preferably without windows. Our preferred location is ***disperse to lockable offices or barricade door and stay in classroom.***