Lahore University of Management Sciences

ENGG 203: The Jet Engine: Introduction to Aircraft Propulsion
Fall-II 2021

Instructor	Talha Jamal Pirzada
Room No.	
Office Hours	TBA
Email	talha.pirzada@materials.ox.ac.uk
Telephone	
Teaching Assistants (TAs)	TBA
TA Office Hours	TBA
Course URL (if any)	

Course Teaching Methodology
• Teaching methodology: First preference will be to teach in-person. However, if face-to-face teaching is not possible, then a blend of both synchronous and asynchronous mode of teaching will be employed. • Lecture details: In case of online teaching, the lectures will be live with recording. The recorded lectures will be accessible.

COURSE BASICS				
Credit Hours	3			
Lectures (s)	20	110 minute each		
Lab				
Recitation/Lab (per week)				
Tutorial (per fortnight)				

COURSE DISTRIBUTION	
Core	N/A
Elective	Major Elective, Free Elective
Open for Student Category	Open for All
Closed for Student Category	Open for All

COURSE DESCRIPTION
This course if designed for anyone who is interested in how propulsion works in the aerospace domain, whether it is rockets, missiles, supersonic aircrafts or the commercial planes we fly in, this course will cover it all. It is a comprehensive study of different propulsion systems, focusing specifically on aircraft propulsion systems. The course will provide a background in the design and operation of different types of aerospace propulsion systems. It will focus on engineering principles, describing key functionality and mechanisms used in past and modern designs, along with providing design guidelines and fundamental performance analysis. It will explore the intricacies of a gas turbine in three main areas: materials, mechanics, and its in-flight functionality. It will begin by covering the limitations of materials that must be considered in jet engine component decision-making along with the key material science techniques used to enhance the performance. Next, it will explore how propulsion is generated and the different equations that govern aircraft's flight. The module will examine how in-flight forces can be manipulated using different aircraft's control surfaces. Building on concepts of motion control, the module will explore how an aircraft's stability impacts its movement. Furthermore, to ensure that the jet engine produces the maximum amount of thrust the course will investigate its cooling methodologies. Finally, the module will examine how jet engine performance is sustained through health monitoring. Overall, this module will provide a preliminary understanding of how aircraft propulsion works.

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COURSE PREREQUISITE(S)	
	None

COURSE OBJECTIVES

- To develop an understanding of the different propulsion systems, present in engineering
- To understand how a gas turbine functions and the four different types of gas turbines
- Understand the mechanical properties required for a gas turbine to function
- To learn about the five main components within a gas turbine
- To fully understand the main mechanisms that govern flight
- To visualize what are the different control surfaces that are active in an aircraft and the role of each of them
- To understand why cooling is important within a gas turbine and how it is achieved
- Understanding the importance of maintenance, repair and overhaul

LEARNING OUTCOMES

At the end of this course, students should be able to:

- Full understand what propulsion is and how it is achieved using different propulsion systems
- Students will be able to appreciate the different material properties that are relevant to a jet engine
- Students would be able to differentiate between the different types of gas turbines and why each of them is relevant in current aviation vehicles
- Students should be able to understand how an aircraft produces lift along with the key governing equations. They should also be able to differentiate between the different control surfaces used to control flight
- Students will be able to understand the importance of cooling systems in a gas turbine along with how it is achieved
- Students will be able to appreciate how and why planned maintenance is done, and why it is critical for long term functionality of any machine, especially one as complicated as a jet engine

GRADING POLICY		
Assignments	45 %	Academic style research paper (2500-3000 words)
Attendance and class participation	15 %	
Final Exam	40 %	

EXAMINATION DETAIL	
Midterm Exam	No
Final Exam	Yes

Harassment Policy

Harassment of any kind is unacceptable, whether it be sexual harassment, online harassment, bullying, coercion, stalking, verbal or physical abuse of any kind. Harassment is a very broad term; it includes both direct and indirect behaviour, it may be physical or psychological in nature, it may be perpetrated online or offline, on campus and off campus. It may be one offense, or it may comprise of several incidents which together amount to sexual harassment. It may include overt requests for sexual favours but can also constitute verbal or written communication of a loaded nature. Further details of what may constitute harassment may be found in the LUMS Sexual Harassment Policy, which is available as part of the university code of conduct.

LUMS has a Sexual Harassment Policy and a Sexual Harassment Inquiry Committee (SHIC). Any member of the LUMS community can file a formal or informal complaint with the SHIC. If you are unsure about the process of filing a complaint, wish to discuss your options or have any questions, concerns, or complaints, please write to the Office of Accessibility and Inclusion (OAI, oai@lums.edu.pk) and SHIC (shic@lums.edu.pk) —both of them exist to help and support you and they will do their best to assist you in whatever way they can.

To file a complaint, please write to harassment@lums.edu.pk.

SSE Council of Equity and Belonging

In addition to LUMS resources, SSE's **Council on Belonging and Equity** is committed to devising ways to provide a safe, inclusive and respectful learning environment for students, faculty and staff. To seek counsel related to any issues, please feel free to approach either a member of the council or email at cbe.sse@lums.edu.pk

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COURSE OVERVIEW			
Lec.	Topics	Recommended Readings	Objectives/ Application
Topic 1: Propulsion and history of gas turbine development			
1-2	– What is propulsion – Different types of propulsion systems – Diesel Engine – Petrol Engine – Jet Engine – Rocket Engine – Electric Motor	Lecture slides, paper on Propulsion and power for the 21st century	– To understand the applications of propulsion systems in aerospace and automotive vehicles – To be able to differentiate between the five main types of propulsion systems – To understand the pros and cons of each type of propulsion system – To understand the two main types of electric motors along with how they work and why are they currently seen as a replacement for internal combustion engines
3	– History of the jet engine – The German gas turbine – The British gas turbine – How it evolved over the century – What are the different types	Lecture sides and the Jet Engine (RR), journal articles	– This lecture would make the student understand the history of how the gas turbine was developed. It looks at what effect war had on its development. – The lecture will make the student understand four different types of gas turbines and what makes them different.
– **Topic 2: Mechanical properties of materials**			
4	– The key mechanical properties that play a pivotal role in the functioning of a jet engine – Yield strength – Corrosion resistance	Lecture sides and the Jet Engine (RR), journal articles	– All the key mechanical properties would be looked at in detail in order to understand how the material systems play a role in the functioning of a gas turbine. A detailed understanding is vital to fully appreciate the complexities of how a gas turbine function
5	– Material properties: Grain structure – Material Properties: Creep strength	Lecture sides and the Jet Engine (RR), journal articles	– The microstructure of different materials would be looked at along with understanding how they would play a role in altering the mechanical properties of the system. – Creep would be defined and its relevance in gas turbine applications will be studied.
Topic 3: Engine design			
6	– Fan and Compressor	Lecture sides and the Jet Engine (RR), journal articles	– These lectures go into detail on each of the main components in a gas turbine. They look at how each of them functions along with the theory.
7	– Combustors		
8	– Turbine and Transmission		
Topic 4: Mechanics of Flight			
9	– Stability and control – Fluid and control systems	Lecture sides and the Jet Engine (RR), journal articles	– The mechanics of flight, including lift and drag equations will be covered in this lecture. The Bernoulli's principle and the third law of motion will be discussed in detail. The concept of thrust along with the equations governing thrust would be introduced in this part of the course. – The course will investigate the control mechanisms of flight including the different control surfaces used to control an aircraft. – It will cover how these control surfaces are activated and made to move using hydraulic and pneumatic systems would also be covered.
Topic 5: Cooling Systems			
10	– Internal and external cooling	Lecture sides and the Jet Engine (RR), journal articles	– The effect of cooling on the efficiency of a gas turbine will be studied. The types of cooling mechanisms which are incorporated to increase the turbine entry temperature will be looked at. – This chapter looks at how internal and external cooling systems can be incorporated to help increase engine efficiency.
Topic 6: Maintenance repair and Overhaul (MRO)			

11	– Maintenance of gas turbines	Lecture sides and the Jet Engine (RR), journal articles	– Engineers design for optimal cooling, turning, stability and strength, and to ensure the performance remains within the operating envelope. For these systems to continue to perform well, engineers must monitor the health of a gas turbine carefully. The complexity of the engine means it needs to be monitored and maintained at regular intervals to ensure unplanned maintenance could be minimized. This chapter would go through the theory and application of MRO and how its applied in gas-turbine life cycle.
12	**Final Examination**		

Textbook(s)/Supplementary Readings
These two books are good for supplementary reading. **[Rolls Royce]** The Jet Engine **[Klaus Hunecke]** Jet Engines: Fundamentals of theory, design, and operation Journal articles will be shared which would be discussed in detail in the four tutorial sessions.