COURSE OUTLINE FOR STUDENTS AT NTU

Academic Year	2020	**Semester**	2
Course Coordinator	Assistant Professor Ng Bing Feng		
Course Code	MA1700		
Course Title	Aerospace Discovery Course		
Pre-requisites	Nil		
No of AUs	1		
Contact Hours	Lectures, laboratories and design competition: 39 hours		
Proposal Date	Oct 2020		

Course Aims

MA1700 comprises of fundamental lectures alongside 6 experiments and 1 design competition. Students will be briefed for 15 minutes before the commencement of each experiment. This course aims to:

a) provide students with basic hands-on experiments to develop core competencies in aerospace engineering in the area of aerodynamics, propulsion, structures and materials, landing gear systems, and flight mechanics,

b) expose students in a practical manner to glider design in which students will know how the theories and fundamentals that they have learnt can guide and be applied to design work,

c) expose students to the multidisciplinary nature of aerospace systems via the design competition, bringing out the importance of design creativity, flight efficiency and control, and basic optimization methods, Industry 4.0 and

d) enhance students' communication skills from group laboratories, both written and oral.

Intended Learning Outcomes (ILO)

Upon the successful completion of this laboratory-based course, students would be expected to:

1) recognize the historical development and progress made to date in the aerospace field,
2) describe the scope of aerospace engineering,
3) identify the fundamentals of aerodynamics, propulsion, structure and flight mechanics, and hydraulics and landing gear systems,
4) navigate integrated aerospace platforms,
5) discuss Industry 4.0 in the model aerospace industry, and
6) demonstrate your investigative skills through Problem Based Learning and Laboratory activities,
7) recognize the importance of redundancy and safety in aerospace engineering, and
8) develop your creative ideas, basic design capability and adapt basic engineering knowledge via a glider design project.

Course Content

Lectures, Laboratory and Design Competition – 39 hours

The lectures, six experiments and one design competition include the following:

	Topic	**Hours**
1.	*Aerodynamics*: In the lectures, students will be introduced to fundamentals of aerodynamics, including standard atmosphere, governing equations, terminology, phenomena, types of flows, wind tunnels & measuring speed and airfoils. In the experiments, students are introduced to estimating elementary aerodynamic forces on a body from experimentation in a "desktop" wind tunnel. Students will use an inclined manometer to measure the pressure distribution	6

	around a cylinder and convert that measurement to a force via theory and compare and analyze the experimental and theoretical values.	
2.	*Propulsion*: In the lectures, students will be introduced to fundamentals of propulsion, including basic concepts, propeller, reciprocating engine, jet propulsion & the thrust equation, turbojet engine, gas turbine & turbofan engines, ramjet & scramjet and rocket engines. In the experiments, students are exposed to a model gas turbine engine to understand how work is extracted from a thermodynamic cycle. Students will also measure the thrust of a miniature fan/nozzle engine at different fan speeds.	6
3.	*Structures*: In the lectures, students will be introduced to fundamentals of structures, including basic concepts of physics of solids, basic materials characterization, major aircraft structural components, wings, fuselage, empennage, nacelle, pylon-laminated composites and failure analysis of aerospace materials. In the experiments, students are to identify the stress field in a two-dimensional space and apply simple equilibrium equations to obtain the stresses in a thin walled cylindrical vessel subjected to both internal and external pressures. Students will also become familiar with strain gauges and using such gauges to determine the unknown stresses at prescribed conditions.	6
4.	*Vibration*: In the experiments, students will investigate aerodynamic vibrations and relate them to aeroelastic effects such as flutter and wing divergence. Students will predict and observe the natural frequencies and mode shapes of a cantilevered beam and begin to appreciate the various techniques used for vibration control. Students will learn how to use smart sensors for online measurement of vibration.	3
5.	*Flight mechanics*: In the lectures, students will be introduced to fundamentals of flight mechanics, including aircraft performance, performance curves for thrust and power, drag components, steady level flight and analysis, accelerated flight and analysis. In the experiments, students are to explore the effects of aircraft control surfaces' (ailerons, elevator and rudder) and their impact in flight. Students will become familiar with basic flight instruments in the cockpit and relate measurements in flight to theory.	6
6.	*Hydraulics/landing gear*: In the experiments, students will study and understand the design, construction and operation of an actual hydraulic system and its components. Students will also study and analyze the pressure distribution of a landing gear tire subjected to an increasing landing load.	3
7.	*Glider design competition:* Students will have the opportunity to have hands-on experience in designing, building and modifying aircraft. Smart sensing capabilities will be considered in	9

	the design. Students will need to demonstrate the performance of their designs with respect to certain mission objectives in an internal competition setting.	

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team/Individual	Assessment rubrics
Continuous Assessment 1: Quiz	1-5	a, b	40% (20% X 2)	Individual	
Continuous Assessment 2: Design Competition	5-8	a-e, i, j, k	18%	Team	
Continuous Assessment 3: 6 laboratory sessions	1-5	a-e, g	42% (7% x 6)	Team and Individual	
Total			100%		

The list for the Engineering Accreditation Board Student Learning Outcomes is as follows:

a) **Engineering knowledge:** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems
b) **Problem Analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c) **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d) **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
e) **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f) **The engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g) **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
h) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i) **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

j) **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k) **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l) **Life-long Learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Formative feedback

We will provide formative feedback during the Lab sessions and after your CA assignments have been graded. We will also give general feedback for your performance after the glider competition.

Learning and Teaching approach

Approach	**How does this approach support students in achieving the learning outcomes?**
Lectures	Provide students with background knowledge, core competencies in aerospace engineering in the area of aerodynamics, propulsion, structures and materials, landing gear systems, and flight mechanics.
Lab experiments	Provide students with basic hands-on experiments to develop core competencies in aerospace engineering in the area of aerodynamics, propulsion, structures and materials, landing gear systems, and flight mechanics.
Glider project	Expose students in a practical manner to the glider design competition in which students will know how theories and fundamentals learnt can guide and be applied to design work. Students will work as a team to design the glider and perform the competition.

Reading and References

Textbook

John Anderson, Introduction to Flight, 7th Ed, 2011
ISBN 0073380245 / 9780073380247

Course Policies and Student Responsibilities

As a student of the course, you are required to abide by both the University Code of Conduct and the Student Code of Conduct. The Codes provide information on the responsibilities of all NTU students, as well as examples of misconduct and details about how students can report suspected misconduct. The university also has the Student Mental Health Policy. The Policy states the University's commitment to providing a supportive environment for the holistic development of students, including the improvement of your mental health and wellbeing. These policies and codes concerning students can be found in the following link.
http://www.ntu.edu.sg/SAO/Pages/Policies-concerning-students.aspx

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, and collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	**Office Location**	**Phone**	**Email**
Ng Bing Feng (Course co-ordinator)	N3.2-02-78	6790 4163	bingfeng@ntu.edu.sg
Instructors for labs X 6	tbc	tbc	tbc
Instructors for glider X 4	tbc	tbc	tbc
Instructors for lecture X 2	tbc	tbc	tbc

Planned Weekly Schedule

Week	**Lab Topic**	**Course LO**	**Readings/ Activities**	**Lectures**
1	NA	1,2,3,4,5	Lecture notes and reference books	History and anatomy
2	NA	1,2,3,4,5		Aerodynamics
3	NA	1,2,3,4,5		Propulsion
4	NA	1,2,3,4,5		Flight performance
5	NA	1,2,3,4,5		Helicopters
6	NA	1,2,3,4,5		Structures
7	*labs*	1,2,3,4,5,6		NA
Recess week				
8	*labs*	1,2,3,4,5,6	Experiment manual and reference books	NA
9	*Glider design competition*	6,7,8		NA
10	*labs*	1,2,3,4,5,6		NA
11	*labs*	1,2,3,4,5,6		NA
12	*labs*	1,2,3,4,5,6		NA
13	*labs*	1,2,3,4,5,6		NA