The Hong Kong Polytechnic University

Subject Description Form

Subject Code	AAE1D02M
Subject Title	Introduction to Space Exploration
Credit Value	3
Level	1
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	This subject aims to provide students: • a basic understanding of space exploration; • a fundamental concept of the propulsion and the mechanics of aerospace vehicles; • a fundamental understanding of the satellite operations; • a fundamental understanding of the challenges and opportunities brought by space missions.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. explain the design of aerospace vehicles and its components. b. explain the basics of flight principles within and beyond atmosphere. c. describe the various propulsion systems of aerospace. d. describe the aerospace structural, mechanical and thermal design. e. identify the basic design of vehicles used for space and the satellites and their limitations. f. describe the applications of satellite and its importance to our daily life. g. describe the unmanned autonomous systems for space exploration application.

Subject Synopsis/ Indicative Syllabus	This class introduces the basics of aeronautics and astronautics through applied physics, hands-on activities, and real-world examples. Students will be exposed to the history and challenges of aeronautics and astronautics. *Introduction*: History of aerospace, atmosphere, classification of aerospace vehicles, basic components of aircrafts and spacecraft, vehicle control surfaces and systems, introduction to aerospace sector, major aerospace industry and manufacturers. *Flight Principle*: Significance of speed of sound, standard atmosphere, Bernoulli's principle, aerodynamic forces acting on aircrafts and spacecraft, aerofoil nomenclature, pressure and velocity distribution, aerodynamic forces, generation of lift and drag, supersonic effects, aerodynamic centre, aspect ratio, centre of pressure, centre of gravity. *Aerospace Propulsion*: Propulsion systems, classifications of propulsion system, location and principle of operation. Basic principle of aircraft and spacecraft thrust production, Brayton cycle and Humphrey cycle, jet engines, propeller engines, rocket engines, Ramjet and Scramjet. *Spacecraft mechanical, structural, and thermal design*: Fundamentals of aerospace structures, aerospace materials, understanding of structural failure modes, external and internal loads in aerospace structures, strength of mechanical components with emphasis on failure and fatigue design, thermal protections from extremely high and cold temperatures, thermal cycling from moving through sunlight and shadow. *Launch vehicles and Satellite engineering*: Launch vehicle dynamics, basic orbital mechanics, history of satellite engineering, satellite applications and orbits, GMAT software, satellite subsystems, space debris removal, mission design philosophy, space environment, closed-loop problem solving management, environmental tests. *Space robotics*: Perception for unmanned autonomous systems Mars and Lunar explorations; Control for unmanned autonomous systems Mars and Lunar explorations; Future challenges in aerospace engineering; Introduction for unmanned autonomous systems (UAS) Mars and Lunar explorations.

Teaching/Learning Methodology	This is an introductory course aiming at arousing students' interest in and awareness of the complex yet challenging aerospace missions and the impact. The latter may bring to the society at large. Due to the fact that this is an introductory course, it is not the intention of the subject to set any pre-requisite for this course. In addition to the traditional lectures, small group discussions, Q&A sessions, and presentations will be used whenever applicable, thus enabling the students to appreciate some of the theories learned in class. Each student must complete an individual essay based on his/her understanding of the course by doing research on relevant materials. The essay assignment is also intended to improve the student's ability to express their views and arguments succinctly on a relevant topic.
Assessment Methods in Alignment with Intended Learning Outcomes	See table below

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)						
		a	b	c	d	e	f	g
1. Class participation, including attendance, engagement in Q&A section, discussions, etc	20%	√	√	√	√	√	√	√
2. Homework (Two assignments, each weighting 10%)	20%		√	√	√	√		
3. Essay (Individual)	60%	√	√	√	√	√	√	√
Total	100 %							

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Overall Assessment:

0.2 x Class participation + 0.2 x Homework + 0.6 x Essay

	This SDF is designed for PolyU International Summer School 2024. Various methods are used for assessing the intended learning outcomes. Class participation is intended to encourage the engagement of students in class with a range of activities, including class attendance, engagement in Q&A section, etc. Two assignments will be designed to allow students to review class material and improve problem-solving ability. An essay is used to not only comprehensively assess student's learning outcomes, but also enhances students' thinking and reasoning ability. A deep understanding of space exploration engineering is to be achieved with all these assessments.	
Student Study Effort Expected	Class contact:	
	▪ Lecture	39 Hrs.
	Other student study effort:	
	▪ Literature Survey and Extensive Reading	35 Hrs.
	▪ Self-Study	39 Hrs.
	Total student study effort	113 Hrs.
Reading List and References	Harland, D. M., & Harvey, B. (2008). *Space exploration* Praxis Pub. Ltd. (60,000 words) McLean, D. (2012). *Understanding aerodynamics: arguing from the real physics*: John Wiley & Sons. (~5,000 words) Morton, Y. J., van Diggelen, F., Spilker Jr, J. J., Parkinson, B. W., Lo, S., & Gao, G. (2021). *Position, navigation, and timing technologies in the 21st century: Integrated satellite navigation, sensor systems, and civil applications, volume 1*: John Wiley & Sons. (~10,000 words) Poghosyan, A., & Golkar, A. (2017). *CubeSat evolution: Analyzing CubeSat capabilities for conducting science missions.* Progress in Aerospace Sciences, 88, 59-83. doi:https://doi.org/10.1016/j.paerosci.2016.11.002 (~25,000 words) Corda, S. (2017). *Introduction to aerospace engineering with a flight test perspective*: John Wiley & Sons. Curtis, H. (2013). *Orbital mechanics for engineering students*: Butterworth-Heinemann. Damon, T. (2001). *Introduction to space: The science of spaceflight*: Krieger Publishing Company. Sutton, G. P., & Biblarz, O. (2016). *Rocket propulsion elements*: John Wiley & Sons.	

May 2024