The Hong Kong Polytechnic University

Subject Description Form

Subject Code	AAE1D02
Subject Title	Introduction to Space Exploration
Credit Value	3
Level	1
Pre-requisite/ Co-requisite/ Exclusion	Nil [AAE students are allowed to take this subject.]
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; and • an opportunity to fulfil English reading and English writing requirements.
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 h. fulfil the English Reading and Writing Requirements.

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. **(3 lectures)** 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. **(2 lectures)** 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. (**2 lectures**) Spacecraft structural, mechanical, 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. **(4 lectures)** Launch vehicles and Satellites: 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. **(2 lectures):** 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.

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<tr><td>Teaching/Learning Methodology</td><td>
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 therefore not the intention of the subject to set any pre-requisite for this course. In addition to the traditional classroom lectures, mini project(s) and small group discussions will be used whenever applicable, thus enabling the students to appreciate some of the theories learned in class.
Projects are used to help students to deepen their knowledge on a specific topic through search of information, analysis of data and report writing.
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<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="8">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td><td>g</td><td>h</td></tr>
<tr><td>1. Final Examination</td><td>40%</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td></td></tr>
<tr><td>2. Project Report [EW assessment: 30% to be assessed by Subject Teachers & 10% to be assessed by ELC]</td><td>40%</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>3. Assignments [ER assessment]</td><td>20%</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Total</td><td>100 %</td><td colspan="8"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:
Overall Assessment:
0.4 x Final Examination + 0.6 x Continuous Assessment
Although a written examination can be an important assessment to achieve all the intended learning outcomes for this course, because of the complexity of the aviation industry, it will be beneficial to
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	the students' learning experience should the written examination be supplemented with additional works. There is a major writing task required: a written report (40%) of a mini project performed by every student on a given topic. To meet the requirement of the "EW" (English Writing) requirement, students are required to submit a written report with 1,500 – 2,500 words in English. Before submission, a writing plan and a minimum word length for a draft of 1500 to be submitted to English Learning Centre (ELC). The final report contributes to 40% of the subject grade. This includes the 10% from ELC and 30% from the subject teachers **In order to fulfil the writing component assessment, students should attain a minimum grade D in task 2.** Students will be given "assignments" which will take up 20% of the subject grade. In order to complete the assignment successfully, knowledge obtained from an intensive reading task (approximately 100,000 words or 200 pages) will be required. References should be provided to students by the subject teachers. **In order to fulfil the reading component assessment, student should attain a minimum grade D in task 3.**	
Student Study Effort Expected	Class contact:	
	▪ Lecture/Project	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	Required readings: 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)	

	Supplementary readings: 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.

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