## Subject Description Form

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| **Subject Code** | AAE5204 |
| **Subject Title** | Autonomous Flight - Mechanics and Control |
| **Credit Value** | 3 |
| **Level** | 5 |
| **Pre-requisite/ Co-requisite/ Exclusion** | Nil |
| **Objectives** | 1. To provide students with the key knowledge relevant to the flight mechanics, dynamics, and control.<br>2. To provide students with the capacity to formulate the flight control system by using modern engineering tools and algorithms.<br>3. To provide students with the knowledge about intelligent planning and control methods to achieve autonomous flight for manned or unmanned aircraft. |
| **Intended Learning Outcomes** | Upon completion of the subject, students will be able to:<br>a. understand fundamental concepts aircraft coordinate systems and forces;<br>b. able to analysis the longitudinal and lateral direction flight mechanics;<br>c. evaluate aircraft flight stability, controllability and handling quality;<br>d. understand classic and modern flight control system;<br>e. understand search-based and sample-based planning methods and trajectory generation methods; and<br>f. extend their knowledge to analyse and develop new modules or algorithms for desired autonomous flight by flight simulation. |

<table>
<tr><td>Subject Synopsis/ Indicative Syllabus</td><td>Aircraft Six Degrees of Freedom (6-DOF) Equations of Motion: Aircraft coordinate systems; Kinematic model; Dynamic model; Propulsion system model; Model linearization method<br><br>Longitudinal and Lateral Flight Dynamics and Control: Longitudinal motion and mode approximations; Lateral motion and mode approximations; Handling quality<br><br>Classic and Modern Flight Control System: Classic flight control system; Modern flight control system; State space modelling; Stability, controllability and observability; State feedback design and optimal control<br><br>Planning for Autonomous Flight: Global path planning methods including search-based methods and sample-based methods; Local smooth trajectory generation methods<br><br>Autopilot System Integration and Flight Simulation: Open-source flight controller; Flight simulation platform; Programming and hardware interface; Implementation of control and planning algorithms; Introduction to autonomous aerial robotic system</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>The teaching and learning methods include lectures, assignment, test, mini project and examination. The tutorials and case study are aimed at providing students with integrated knowledge required for unmanned aircraft systems. Technical/practical examples and problems will be raised and discussed in class/hands on sessions.<br><br>
<table>
<tr><td rowspan="2">Teaching/Learning Methodology</td><td colspan="6">Outcomes</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td></tr>
<tr><td>Lecture</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td><td>√</td></tr>
<tr><td>Tutorial/Case Study</td><td>√</td><td></td><td>√</td><td></td><td>√</td><td></td></tr>
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**Assessment Methods in Alignment with Intended Learning Outcomes**

| Specific assessment methods/tasks | % weighting | Intended subject learning outcomes to be assessed (Please tick as appropriate) | | | | | |
|---|---|---|---|---|---|---|---|
| | | a | b | c | d | e | f |
| 1. Assignment/Test | 20% | √ | √ | √ | √ | √ | |
| 2. Mini Project | 30% | √ | √ | | √ | √ | √ |
| 3. Examination | 50% | √ | √ | √ | √ | √ | √ |
| Total | 100% | | | | | | |

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

Overall Assessment:

$$0.5 \times \text{Continuous Assessment} + 0.5 \times \text{Final Examination}$$

Examination is adopted to assess students on the overall understanding and the ability of applying the concepts. It is supplemented by continuous assessment including assignment, closed-book test and mini-project. The continuous assessment is aimed at enhancing the students' comprehension and assimilation of various topics of the syllabus. Mini-project is used to assess the students' capacities of self-learning and problem-solving and effective communication skill in English so as to fulfil the requirements of being aircraft design engineers.

**Student Study Effort Expected**

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|---|---|
| Class contact: | |
| ▪ Lecture | 30 Hrs. |
| ▪ Tutorial/case study | 9 Hrs. |
| Other student study effort: | |
| ▪ Course work and mini project | 42 Hrs. |
| ▪ Self-study | 25 Hrs. |
| Total student study effort | 106 Hrs. |

**Reading List and References**


1. Pamadi B.N. Performance, stability, dynamics, and control of airplanes. AIAA, 2015.
2. Stevens B.L., Lewis F.L., Johnson E.N., Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, Wiley, 2015.
3. Nonami K., Kendoul F., Suzuki S., Wang W., Nakazawa D., Autonomous flying robots: unmanned aerial vehicles and micro aerial vehicles, Springer, 2010.