**FI501 Celestial Mechanics**

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| Module name: | Celestial Mechanics | |
| Module level, if applicable: | Undergraduate | |
| Code: | FI-501 | |
| Sub-heading, if applicable: | - | |
| Classes, if applicable: | - | |
| Semester: | 6th | |
| Module coordinator: | Judhistira Aria Utama | |
| Lecturer(s): | Judhistira Aria Utama | |
| Language: | Bahasa Indonesia | |
| Classification within the curriculum: | Elective Course | |
| Type of Teaching | Contact hours per week during the semester | Class Size |
| 1. Lecture (conceptual, contextual and problem-solving approaches through expository, discussions and practical methods).<br>2. Structured activities (assignments based on conceptual, contextual and problem-solving approaches, Presentation)<br>3. Self-study (Mini research project) | 1 hour 40 minutes | 25 |
| Workload: | The total workload is 91 hours/5440 minutes (3.2 ECTS) per semester, consisting of 25 hour 20 minutes/1400 minutes lectures (0.82 ECTS), 28 hours/1680 minutes structured activities (0.98 ECTS) and 28 hours/1680 minutes self-study (0.98 ECTS) per week for 14 weeks, 11hour 54 minutes/714 minutes for two exams (0.42 ECTS). | |
| Credit points: | 3.2 ECTS | |
| Pre-requisites course(s): | FI121 Basic Physics I, FI340 Mechanics | |
| Course Learning Outcomes (CLO): | After taking this course the students have ability to:<br>CLO1. Explain the formulation of the equations of motion of two objects and mathematical procedures to obtain the solution.<br>CLO2. Explain the consequences of solutions to the equations of motion of two objects and recognize the elements of classical orbits used in determining the size, shape, and orientation of the orbit and placing the position of celestial objects in their orbit. | |

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CLO3. Explain the problem of three finite bodies and the solution steps and understand the existence of gravitational equilibrium points in a 3-body system.<br>
CLO4. Explain procedural knowledge and understanding of orbits and positions determination.<br>
CLO5. Explain the virial theorem and apply it to problems of orbital energy and motion of planets and satellites.<br>
CLO6. Apply the law of conservation of linear momentum in formulating rocket propulsion, explain the factors that affect the dynamics of the artificial satellite orbit, and calculate orbital elements and parameters in performing orbital maneuvers using Hohmann transfer.<br>
CLO7. Extract information from Two Line Element (TLE).<br>
CLO8. Identify various orbit integrators (Windows and Linux based) that can be used to propagate the orbits of celestial bodies.<br>
CLO9. Explain the tools for orbital integrators and be able to use them in conducting mini-research projects.<br>
CLO10. Describe the international issues related to space debris and their impact on space exploration and life on Earth.<br>
CLO11. Apply information and communication technology as well as standard software for studying celestial orbits in the process of data acquisition and ethics in the use of public data.<br>
CLO12. Disseminate the results of mini research in the form of written reports according to standard scientific rules and presents in the classroom.
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<tr><td>Content:</td><td>Equations of motion and solutions of equations of motion of two bodies, Equations of orbits and elements of Keplerian orbits, Restricted 3-body problem and Lagrange points, Determination of orbits and positions in orbits, Virial theorems and an overview of the energy of motion of planets and satellites, Rocket propulsion, Dynamics of artificial satellites of the Earth, Orbit manoeuvre, Introduction to TLE, orbit integrators and related tools, Space debris and conjunction analysis, and Mini research projects.</td></tr>
<tr><td>Study/exam achievements:</td><td>The final mark will be weight as follow:
<table>
<tr><th>No</th><th>CLO</th><th>Assessment Object</th><th>Assessment Techniques</th><th>Weight</th></tr>
<tr><td>1</td><td>CLO1 – CLO7, CLO10</td><td>Subject specific competences:<br>a. Weekly Task<br>b. Exam:<br>- Mid exam<br>- Final exam</td><td>Written<br>Written test<br>Written test</td><td>15%<br>20%<br>20%</td></tr>
<tr><td>2</td><td>LO8, 9, 11, 12</td><td>c. Paper & Presentation</td><td>Report & Performance</td><td>45%</td></tr>
<tr><td colspan="4">Total</td><td>100%</td></tr>
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</td></tr>
<tr><td>Forms of media:</td><td>Board, LCD Projector, Laptop/Computer</td></tr>
<tr><td>Literature:</td><td>
1. Scheeres, D. J. (2012). Orbital Motion In Strongly Perturbed Environments: Applications to Asteroid, Comet and Planetary Satellite Orbiters. Springer.<br>
2. Karttunen, H. et al., (2017). Fundamental Astronomy 6th Edition. Springer<br>
3. Roy, A.E. (2005). Orbital Motion. CRC Press
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|---|---|
| | 4. Roy, A.E., Clark, D., *Astronomy Principles and Practice*. Institute of Physics Publishing<br>5. Serway, R.A., Jewett, J.W., (2004). *Physics for Scientists and Engineers 6 Edition*. Thomson Brooks |

**PLO and CLO mapping**

| | PLO1 | PLO 2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 | PLO11 | PLO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO1 | | √ | | | | | | | | | | |
| CLO2 | | √ | | | | | | | | | | |
| CLO3 | | √ | | | | | | | | | | |
| CLO4 | | √ | | | | | | | | | | |
| CLO5 | | √ | | | | | | | | | | |
| CLO6 | | √ | | | | | | | | | | |
| CLO7 | | √ | | | | | | | | | | |
| CLO8 | | √ | | | | | | | | | | |
| CLO9 | | √ | | | | | | | | | | |
| CLO10 | | √ | | | | | | | | | | |
| CLO11 | | √ | | | | | | | | | | |
| CLO12 | | √ | | | | | | | | | | |