**MENG474 – Space Flight Dynamics**

**Eastern Mediterranean University**
**Faculty of Engineering**

**Department:** Mechanical Engineering

| **Program Code:** 23 | **Program:** Mechanical Engineering | **Year/Semester:** 2020-2021 FALL |
|---|---|---|
| **Course Code:** MENG474 | **Course Title:** Space Flight Dynamics | **Credit hours** |

| **Lec.** | **Tut/Lab** | **Total** |
|---|---|---|
| **4** | **1/-** | **4** |

**Categorization of Course:**
- ☐ Engineering or Area Core
- ☐ Engineering Course offered by other programs
- ☒ Engineering or Area Elective
- ☐ Mathematics and Basic Sciences
- ☐ General Education

**Categorization of Credits:**
- a. Mathematics & Basic Science: -
- b. **Engineering Topics:** **2**
- c. General Education: -
- d. **Major Engineering Design:** **2**

**Instructor Name:** Assoc. Prof. Dr. Qasim Zeeshan | **Office no:** ME141 | **Office Tel:** 6301361

**Course Web Page:** https://staff.emu.edu.tr/qasimzeeshan/en/teaching/

**Textbook(s):**
- Ashish Tewari, Atmospheric/Space Flight Dynamics, Springer, 2007
- Walter, Ulrich, Astronautics - The Physics of Space Flight, Springer, 2019

**Reference(s):**
- W. E. Wiesel, Spaceflight Dynamics, McGraw-Hill, 1989
- Vladimir A. Chobotov, Orbital Mechanics (Third Edition), 2002
- Wertz, J. R., and Larson, W. J., eds., Space Mission Analysis and Design, 3rd ed., Microcosm Press, El Segundo, CA,1999.
- David Vallado, Fundamentals of Astrodynamics and Applications, 3rd Edition, 2007

**Catalog Description:** The aims of this course are to: introduce the methods of space flight dynamics; demonstrate how these methods are applied to real space systems; introduce the use of spaceflight dynamics in space systems engineering, by developing an understanding of orbital/celestial mechanics, its analytical and mathematical principles, satellite orbits, trajectories and maneuvers, orbital perturbations, dynamics of spacecraft moving under the influence of forces common to the space flight environment, as well as an insight to spacecraft attitude dynamic and control methods. The major topics covered include: Co-ordinate Systems, Orbital Mechanics, Two Body problem, Satellite Ground Tracks, Launch Trajectory, Orbital Maneuvers, Space Environment, Orbital Perturbations, Spacecraft Attitude Dynamics and Control, Satellite Constellations, Re-entry Dynamics and Interplanetary spaceflight.

| **Prerequisite(s)** | (MENG233 or MENG231) and (MENG332 or EENG320) and MATH373 |
|---|---|
| **Type of Course** | ☐ Required ☒ Selected Elective ☐ Elective |

| **Student Outcomes** | | |
|---|---|---|
| **1** | an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics | ☒ |
| **2** | an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors | ☒ |
| **3** | an ability to communicate effectively with a range of audiences | ☐ |
| **4** | an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts | ☐ |
| **5** | an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives | ☐ |
| **6** | an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions | ☒ |
| **7** | an ability to acquire and apply new knowledge as needed, using appropriate learning strategies. | ☒ |

| Course Learning Outcomes | | Student Outcomes | | | | | | | Assessments and Percentages |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| **1** | Understand the fundamentals of spaceflight | X | | | | | | | Midterm Exam: 20%<br>Final Exam: 30%<br>Project: 50%<br><br>*Quiz: Subject to Face to Face Teaching<br><br>*Project is individual submission |
| **2** | Understand the orbital parameters and orbital characteristics for different orbits. | X | | | | | | | |
| **3** | Understand the definitions of the reference frames and coordinate systems, how to make a transformation | X | | | | | | | |
| **4** | Mathematically model and simulate satellite ground tracks | X | X | | | | X | X | |
| **5** | Understand launch trajectory dynamics, launch vehicle staging requirements and simulate launch vehicle trajectories using 3 DOF Equations of Motion. | X | X | | | | X | X | |
| **6** | Understand the various types of orbital maneuvers. | X | X | | | | X | X | |
| **7** | Understand the effect of Orbital Perturbations - Drag, Solar Radiation Pressure, Third-body effects, etc. | X | X | | | | X | X | |
| **8** | Understand the spacecraft attitude dynamics and control requirements | X | | | | | | | |
| | **Weight of Student Outcomes** | **H** | **M** | | | | **M** | **M** | |

| **Topics Covered and Class Schedule:** | |
|---|---|
| **Week 1** | History of Space flight and introduction to Space flight Dynamics |
| **Week 2** | Co-ordinate Systems |
| **Week 3** | Orbital Mechanics |
| **Week 4** | Two Body problem |
| **Week 5** | Satellite Ground Track Modeling |
| **Week 6** | Launch Vehicle staging and Trajectory Modeling |
| **Week 7** | Orbital Transfer and Maneuvers |
| **Week 8 & 9** | **Midterm Examination** |
| **Week 10** | Space Environment |
| **Week 11** | Orbital Perturbations - Drag, Solar Radiation Pressure, Third-body effects, etc. |
| **Week 12** | Spacecraft Attitude Dynamics and Control |
| **Week 13** | Satellite Constellations |
| **Week 14** | Interplanetary Space flight |
| **Week 15** | Re-entry Dynamics |
| **Week 16** | **Final Examination and Project Presentations** |

**Important Notes Regarding the Course:** University rules and regulations are applied to this course. For details, please see http://mevzuat.emu.edu.tr

**Exam and Quiz Policy:**

The midterm and final exams are OPEN book in Case of Online Teaching

**Makeups:**

1. There is no make-up or resit for the Quiz.
2. A student who fails to sit for an examination for a valid reason is given a make-up exam. Within three working days after the examination, students who wish to take a make-up must submit a **written statement** to the course instructor explaining the reason(s) for his/her request.
3. Eligibility to take a **Make-Up Exam**:
   a. Student must contact the Instructor immediately within "**three working days**" after the examination when (s)he has missed the mid-term exam or final exam and to discuss with the faculty about the date and time to take the make-up exam.
   b. Student must secure a "**Make-Up Exam Form**" from the department Office or from instructor website & fill-out the Form. For each Make-Up Exam, please use separate Form.
   c. Student must secure the approval from the instructor for taking the Make-Up Exam.
   d. Failure to take the Make-Up Exam at the agreed date and time will lead to a "NG" Grade for the Make-Up Exam, midterm or final.

**NG Policy:**

1. **"NG" Nil Grade/ Failing from Absenteeism:** Students who do not comply with the required level attendance and/or not fulfilling the requirements for the evaluation of the course are given the "NG" grade by the Instructor of the Course based on the criteria determined by the Faculty/School Academic Council. Students are informed about the criteria for receiving the "NG" grade by the related course instructor at the beginning of the semester. "NG" grade is included in the computation of GPA and CGPA.
2. Student attendance is monitored and assessed by the course instructor. A student who fails to meet the requirements of a course or who is absent more than the limit specified by the Faculty is considered to be unsuccessful in that course.
3. Students who do not attend any of the above assessment activities (such as mid-term exam, final exam, lab exam, design project report etc.) will be given NG (Nil Grade).
4. Late Submissions of the Assignments, Lab Reports and Project will be graded as zero.

**Appeals:**

Any appeal against the marks of any assessment component must be made to the course instructor within one week following the announcement of the marks. Any appeal concerning a semester grade must be made to the course instructor no later than the end of the registration period of the following semester.