|  |  |
| --- | --- |
| **Course Title:** | **Celestial Mechanics (1)** |
| **Course Code:** | **ASTR 341** |
| **Program:** | **ASTR-MATH** |
| **Department:** | **Astronomy** |
| **College:** | **Science** |
| **Institution:** | **King AbdulAziz University** |

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# A. Course Identification

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **1. Credit hours:** | | | |  | | | | | | | | | | | | |
| **2. Course type** | | | | | | | | | | | | | | | | |
| **a.** | University | |  | | College | | |  | Department | | | | **✓** | Others |  |  |
| **b.** | | Required | | | | **✓** | Elective | | |  |  | | | | | |
| **3. Level/year at which this course is offered:** | | | | | | | | | | | | **7th Level / 4th Year** | | | | |
| **4. Pre-requisites for this course** (if any)**: ASTR 331** | | | | | | | | | | | | | | | | |
| **5. Co-requisites for this course** (if any)**: None** | | | | | | | | | | | | | | | | |
|  | | | | | | | | | | | | | | | | |

## 6. Mode of Instruction (mark all that apply)

| **No** | **Mode of Instruction** | **Contact Hours** | **Percentage** |
| --- | --- | --- | --- |
| **1** | **Traditional classroom** | **3** | **100%** |
| **2** | **Blended** |  |  |
| **3** | **E-learning** |  |  |
| **4** | **Correspondence** |  |  |
| **5** | **Other** |  |  |

**7. Actual Learning Hours** (based on academic semester)

|  |  |  |
| --- | --- | --- |
| **No** | **Activity** | **Learning Hours** |
| **Contact Hours** | | |
| **1** | **Lecture** | **30** |
| **2** | **Laboratory/Studio** |  |
| **3** | **Tutorial** | **15** |
| **4** | **Others** (specify) |  |
|  | **Total** | **45** |
| **Other Learning Hours\*** | | |
| **1** | **Study** | **60 (minimum)** |
| **2** | **Assignments** | **30** |
| **3** | **Library** |  |
| **4** | **Projects/Research Essays/Theses** |  |
| **5** | **Others** |  |
|  | **Total** | **90** |

**\*** The length of time that a learner takes to complete learning activities that lead to achievement of course learning outcomes, such as study time, homework assignments, projects, preparing presentations, library times

# B. Course Objectives and Learning Outcomes

|  |
| --- |
| 1. Course Description This course contains the following subjects: Analytical study of Kepler's and Newton's laws; The potential of the gravitational field. Earth's rotation; Rectilinear motion near the Earth's surface; Central motion; The two body problem; Space orbital elements and their computations; Expansions of elliptic motion; Oblate ness perturbation on the motion of the artificial satellites; Drag effect on the motion of artificial satellites; Dynamics of stellar systems. |
| 2. Course Main Objective  * Give a knowledge for the students about the two body problem (the dominant problem in space) in different cases. * Present the different effects of perturbations on celestial objects. * Teach the students the mathematical tools required in space dynamics. * Determine and calculate the station coordinates on oblate planets. * Introduce the basics of orbit determinations and computation. |
|  |

## 3. Course Learning Outcomes

| **CLOs** | | **Aligned****PLOs** |
| --- | --- | --- |
| 1 | **Knowledge:** |  |
| 1.1 | Define Kepler and Newton’s laws. | K1, K2 |
| 1.2 | Outline the dynamical laws describing the two body motion in space. | K10 |
| 1.3 | Describe the motion around center of mass. | K9, K10 |
| 1.4 | Describe the drag effect on the motion of artificial satellites | K9 |
| 1.5 | Memorize the space orbital elements. | K1, K2 |
| 1.6 | Define the time Kepler Equation | K1, K10 |
| **2** | **Skills :** |  |
| 2.1 | Formulate the two body problem. | S2, S5 |
| 2.2 | Interpret the time and station coordinates. | S2, S5 |
| 2.3 | Illustrate the computations for space orbital elements. | S3, S5 |
| 2.4 | Interpret the two body differential equation of motion and its solution | S2, S5 |
| 2.5 | Explain the relation between the conservations laws and constants of motion | S2, S5 |
| 2.6 | Explain the potential of the gravitational field and Earth's rotation. | S2, S5, S9 |
| **3** | **Competence:** |  |
| 3.1 | Work in groups to build mathematical algorithms to compute orbit transformation. | C1 |
| 3.2 | Ability to solve problems in celestial mechanics | C3, C4 |

# C. Course Content

|  |  |  |
| --- | --- | --- |
| **No** | **List of Topics** | **Contact Hours** |
| 1 | Kepler's and Newton's laws. | 3 |
| 2 | Tow body differential equation of motion and its solution | 3 |
| 3 | The conservations laws and constants of motion | 3 |
| 4 | The mathematical relation for the two bodies. | 3 |
| 5 | The time Kepler Equation and it’s solution | 3 |
| 6 | The escape velocity, the velocity at infinity and canonical units | 3 |
| 7 | Motion around center of mass | 3 |
| 8 | Time and Station Coordinates. | 3 |
| 9 | Coordinate transformations | 3 |
| 10 | The potential of the gravitational field and Earth's rotation. | 3 |
| 11 | Oblate ness perturbation on the motion of the artificial satellites. | 3 |
| 12 | Drag effect on the motion of artificial satellites. | 3 |
| 13 | Expansions of elliptic motion. | 3 |
| 14 | Space orbital elements and their computations (I). | 3 |
| 15 | Space orbital elements and their computations (II). | 3 |
| **Total** | | **45** |

# D. Teaching and Assessment

## 1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

| **Code** | **Course Learning Outcomes** | **Teaching Strategies** | **Assessment Methods** |
| --- | --- | --- | --- |
| **1.0** | **Knowledge** | | |
| 1.1 | Define Kepler and Newton’s laws. | Lectures using power-point presentations and whiteboard. | Homework, Exams |
| 1.2 | Outline the dynamical laws describing the two body motion in space. |
| 1.3 | Describe the motion around center of mass. |
| 1.4 | Describe the drag effect on the motion of artificial satellites |
| 1.5 | Memorize the space orbital elements. |
| 1.6 | Define the time Kepler Equation |
| **2.0** | **Skills** | | |
| 2.1 | Formulate the two body problem. | Lectures using power-point presentations and whiteboard. | Assignments, Homework, Exams |
| 2.2 | Interpret the time and station coordinates. |
| 2.3 | Illustrate the computations for space orbital elements. |
| 2.4 | Interpret the two body differential equation of motion and its solution |
| 2.5 | Explain the relation between the conservations laws and constants of motion |
| 2.6 | Explain the potential of the gravitational field and Earth's rotation. |
| **3.0** | **Competence** | | |
| 3.1 | Work in groups to build mathematical algorithms to compute orbit transformation. | Group discussion | Project report and presentation |
| 3.2 | Ability to solve problems in celestial mechanics |

## 

## 2. Assessment Tasks for Students

| **#** | **Assessment task\*** | **Week Due** | **Percentage of Total Assessment Score** |
| --- | --- | --- | --- |
| **1** | Assignments + Homework | weekly | 15% |
| **2** | Major exams I | 6th | 15% |
| **4** | Major exams II | 12th | 15% |
| **5** | Project report and presentation | weekly | 15% |
| **6** | Final Exam | 15th | 40% |

**\*Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

# E. Student Academic Counseling and Support

|  |
| --- |
| **Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice :** |
| Office hours: 3 hours per week |

# F. Learning Resources and Facilities

## 1.Learning Resources

|  |  |
| --- | --- |
| **Required Textbooks** | * Lecture notes * Nautical Almanac and Astronomical Ephemeris |
| **Essential References Materials** | * Orbital and celestial mechanics: 1998, John, P. Vinti. Edited by Gim, J. Der. Nino, L. Bonavito. AIAA Education Series, USA. * An Introduction to Mathematics and Method of Astrodynamics: 1999, Battin. AIAA Education Series, USA. * Satellite Orbits: 2000, O. Montenbruck. Springer, Germany. * Analytical Mechanics of Space Systems:2003, Schaub, H. and Junkins, J. L., AIAA Education Series, USA. |
| **Electronic Materials** | The web sites related to the space orbital data. |
| **Other Learning Materials** |  |

## 2. Facilities Required

| **Item** | **Resources** |
| --- | --- |
| **Accommodation**  (Classrooms, laboratories, demonstration rooms/labs, etc.) | Class room with 15 seats, Computer Lab |
| **Technology Resources**  (AV, data show, Smart Board, software, etc.) | Data show |
| **Other Resources**  (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list) | Satellite Toll Kit Program. |

# G. Course Quality Evaluation

| **Evaluation**  **Areas/Issues** | **Evaluators** | **Evaluation Methods** |
| --- | --- | --- |
| Course contents | Students | Course evaluation questionnaire (Direct) |
| Learning resources and equipment | Students | Student experience questionnaire (Direct) |
| Effectiveness of teaching and assessment | Students | Student experience questionnaire (Direct) |
| Course contents and materials | Faculty members | By department council discussion (Indirect) |

**Evaluation areas** (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

**Evaluators** (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

**Assessment Methods** (Direct, Indirect)

# H. Specification Approval Data

|  |  |
| --- | --- |
| **Council / Committee** |  |
| **Reference No.** |  |
| **Date** | September 2017 |