



کراچی یونیورسٹی

University of Karachi

Department of Mathematics

Pre-requisite: MATH 685

MATH 686: Astronomy II (3+0)

Activity	Dates	Class Schedule
Introduction day		Friday 1030h – 1149h
Teaching	July 16 – November 14	Saturday 1115h – 1254h
Proposal Presentations	October 10	Room No. 9, Mathematics
Semester Examinations	November 16 – December 5	<i>Office Hours</i>
Vacations	December 6–31 (Winter)	Saturday 1255h

Course Supervisor: Professor Dr. Syed Arif Kamal

Member AIAA (USA), IBRO (France)

MS (Indiana, Bloomington, USA); MA (Johns Hopkins, USA); PhD

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Homepage: <http://ngds-ku.org/kamal> (Handout address: http://ngds-ku.org/M685-6/MATH686_09.pdf) *

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Directions: <http://www.ngds-ku.org/kamal/contact.htm#Directions>

Course Objectives

To give the students a sound background in the techniques & the methods of astrodynamics & spaceflight dynamics so that they can apply these ideas to different branches of science & engineering, *e. g.*, orbit computation for satellites & satellite-launch vehicles, stability consideration for launching of satellites, auto-pilot designing for spacecrafts & attitude control of satellites.

Higher Education and Job Opportunities

MS/PhD from Department of Mathematics or ISPA, MS from IST (Islamabad); jobs in SUPARCO, NDC, PAF & other R&D organizations

Course Outline

Section A: Projectile dynamics, orbital & escape velocities, geostationary & polar satellites, satellite-launch

vehicle (SLV), satellite & SLV orbits; down-range & cross-range error for short-range projectiles; mathematics of inertial-navigation & telemetry systems

Section B: Review of lagrangian & hamiltonian dynamics; two-body problem in plane-polar- & elliptic-astrodynamical-coördinate meshes (first one done in detail, second one only introduced)

Section C: Hohmann-transfer orbit; introduction of control laws (cross-product, extended-cross-product, normal-component-cross-product, dot-product, normal-component-dot-product & ellipse-orientation steering)

Section D: Introduction of guidance schemes (delta, Lambert, inverse-Lambert multi-stage-Lambert, Q, inverse-Q & multi-stage-Q)

Section E: Three-body problem & stability of satellites

Recommended Reading

- R. H. Battin, *An Introduction to the Mathematics and the Methods of Astrodynamics*, AIAA Education Series, New York (1987 & 1999)
- R. Deusch, *Orbital Dynamics of Space Vehicles*, Prentice Hall, Englewood Cliffs, New Jersey, USA (1963)

* For course announcements, assignments and past papers, go to *Pedagogical Section*, click on “Courses (offered during the current semester)”.



MATH 686: Course Plan

<i>Date</i>	<i>Topic to be covered on FRIDAY</i>	<i>Date</i>	<i>Topic to be covered on SATURDAY</i>
SEPTEMBER			
04	Transformation theory	05	Infinitesimal transformations
11	<i>General Discussion</i>	12	Coördinate systems in astronomy
18	<i>No Class (Jumma-tul-Widaa)</i>	19	Curvilinear coördinates
25	Mathematics of INS and telemetry systems	26	Projectile dynamics
OCTOBER			
02	Down-range & cross-range errors for SRBM	03	Rev of lagrangian & hamiltonian dynamics
09	<i>No Class</i>	10	<i>Proposal Presentations</i>
16	2-body problem in plane-polar-coörd. mesh I	17	2-body problem in plane-polar-coörd. mesh II
23	Three-body problem & stability of satellites	24	2-body problem in elliptic-astrodyn. coörd. mesh
30	Hohmann-transfer orbit	31	Introduction of control laws
NOVEMBER			
06	Introduction to guidance schemes I	07	Introduction to guidance schemes II
13	<i>Revision</i>	14	<i>Exam-taking strategy</i>

MATH 686: Marks Breakdown

<i>Evaluation Parameter</i>	<i>Marks</i>
Class Attendance	10
Presentations on Research Proposals @	20
Final Examination	70
<i>Total</i>	100

@ Sample proposals, which won Dean's Research Grant may, now be downloaded from my homepage: <<http://www.ngds-ku.org/Industrial/DGS2005.pdf>>, <<http://www.ngds-ku.org/Industrial/DGS2007.pdf>>