



# UNIVERSITY OF KARACHI

## Department of Mathematics

### MATH 685 • Astronomy I

Course Supervisor: Professor Dr. Syed Arif Kamal

Homepage: <http://ngds-ku.org/kamal> • e-mail: [kamal\(at the rate of\)ngds-ku.org](mailto:kamal(at the rate of)ngds-ku.org)

Time Allowed: 3 hours • Maximum Marks: 100 • Date: Friday, May 24, 2007

Student's Name \_\_\_\_\_ (in CAPITAL LETTERS using a "marker") • Paper Format A

Attempt **Question 1** and 5 other questions. Each part of **Question 1** is of 4 marks & of **Questions 2-7** is of 8 marks. Note down the time spent on solving each part of question and time spent on revision by making the following "Time Chart" on the answerbook front page (2 marks). Time spent on revision must be at least 10% of the total time

| Question No.   | 1a | 1b | 1c | 1d | 2a | 2b | 3a | 3b | 4a | 4b | 5a | 5b | 6a | 6b | 7a | 7b | Revision |
|----------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----------|
| Time (minutes) |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |          |

a) DO NOT TURN PAPER AROUND unless the invigilator says: *Start* now

b) This is a closed book examination. Deposit all BOOKS, NOTES, MOBILE PHONES (switched off), DIGITAL DIARIES and LAPTOPS in the designated area. Remove everything from your desk except markers, pens, pencils, stapler and calculator.

c) If you want to use a calculator, **it must bear a "sticker"** displaying your NAME and your SEAT NUMBER large enough so that it is visible from a distance of 5 meters. **Absolutely, NO sharing of calculators.**

d) Use your own material. **Nothing can be borrowed from or given to** a friend.

e) The papers may be of different formats. Therefore, work on your own **without consulting anyone** (We have a record of your seating arrangement).

f) Write your "NAME" on all pages of **your question paper** (5 marks shall be deducted for failing to comply) [NOTHING ELSE SHOULD BE WRITTEN ON THE QUESTION PAPER] and "**PAPER FORMAT**" on the front page of **your answerbook** (the upper right-hand corner) and **the Yellow Sheet** using a "**marker**". Start your work from **Page 2** of your answerbook. The only thing that could be written on the front page is the "**Time Chart**" (see above) and the "**Honor Statement**" (see below).

g) The following statement must be copied on the front page of your answerbook and signed (2 marks): "*My signatures below testify that I am the person whose name and photograph appear on the Admit Card. Upon my honor, I declare that the following work is my own, completed without giving or receiving unacknowledged help, without copying, or the use of any unfair means.*" Signatures \_\_\_\_\_

h) This paper contains TWO PAGES (This page and the back page). On invigilator's signal (*Start now*) turn paper around, check if you have the back

page printed correctly. Last line of the second page is: <END>. Start working on the paper immediately.

i) Put your pens down and your papers turned (so that this page is facing you) and the FRONT PAGE of your answerbook should be facing you as soon as you hear "**ALL PENS DOWN**". Failure to do as directed shall result in "deduction of 5 marks" from your score.

j) If you use extra copies, it is "your responsibility" to write YOUR NAME, COPY NUMBER and all OTHER INFORMATION on each copy used. All the extra copies must be stapled with the main copy before turning in your paper (you may wish to bring in a stapler with you for this purpose).

k) If you have a question of "Fill in the blanks" in your paper you must write the complete sentence with the filled word underlined.

l) Nobody is allowed to leave the examination hall, **for whatsoever reason**, once the examination has started. Bring your own DRINKING WATER.

m) Students are not allowed to LEAVE THEIR SEATS or STAND UP during the examination. If you have a query, "raise your hand" and someone will help you.

n) All work, including rough work, must be on the official answerbook. No extra sheet may be used.

o) Students are *not* allowed to use RED anywhere. All work (except figures) must be in pen or ballpoint.

p) The result shall be displayed on my homepage on **Saturday, June 9, 2007** at **0900h**. DO NOT contact the Course Supervisor. Students are not permitted to see the answerbooks.

q) Anyone found cheating in the examination should be facing disciplinary action, which may result in **EXPLUSION** or **SUSPENSION** for 2 or more years. **Absolutely, no conversation among students. DON'T TURN THE PAPER, YET. Wait for "signal" from the invigilator.**

Student's Name \_\_\_\_\_ (in CAPITAL LETTERS using a "marker")

- 1-a) (Write entire statement in answerbook and circle correct answer) (i) Which one of the following is not a jovian planet? jupiter, mars, uranus, saturn, neptune; (ii) The ice caps at the south pole of mars are formed by:  $\text{CO}_2$ ,  $\text{NH}_4$ ,  $\text{H}_2$
- 1-b) (i) Earth has equal days and nights on: October 20 & April 8, September 9 & March 4, September 23 & March 21; (ii) Which planet has no satellite? saturn, neptune, venus
- 1-c) What is International Dateline? If one crosses dateline from west to east, what sort of adjustments are made in the calendar? Why is it not a smooth curve?
- 1-d) Define longitudes and latitudes in terms of angles in spherical-polar coordinate mesh. Write down the equation(s) of equator and meridian in terms of longitude and latitude.
- 2-a) Explain the terms navigation, guidance and control in the context of a targeted spacecraft by posing questions (*Where is the spacecraft currently located? On which path it should be moving? How to take the spacecraft to the desired path?*).
- 2-b) What is the difference in the guidance schemes (boost phase, midcourse, terminal) of a satellite-launch vehicle, a surface-to-surface missile and an antiballistic missile (ABM)?
- 3-a) Differentiate between inertial and gravitation mass. Suggest an experiment for determination of each of these masses.
- 3-b) A mass  $m$  is suspended from a spring balance in an elevator. When the elevator is at rest, the spring balance reads 30 N. If the elevator starts moving up with acceleration twice the acceleration due to gravity, what would be the reading on the spring balance?
- 4-a) Show that two infinitesimal rotations commute by taking a specific example.
- 4-b) What do you understand by geocentric, heliocentric and barycentric coordinate systems. Is the geocentric coordinate system consisting of coordinates  $(R_E, j, l)$  [radius of earth, longitude, latitude] inertial? If not, what is the practical geocentric inertial coordinate system used in space-flight dynamics?
- 5-a) Starting from the state  $(XYZ)$  go the final state  $(X'Y'Z')$  through the intermediate states  $(X_1Y_1Z_1)$  and  $(X_2Y_2Z_2)$  by the Euler-angle sequence  $(y, q, f)$  [about  $z$  axis, about  $y_1$  axis, about  $x_2$  axis]. Write down the expression of transformation matrix, which accomplishes this operation.
- 5-b) Draw the following table in your answerbook and fill in the blanks:

| <b><i>Spacetime Symmetry</i></b>           | <b><i>Mathematical Representation</i></b> | <b><i>Conserved Quantity</i></b> |
|--------------------------------------------|-------------------------------------------|----------------------------------|
| Space-translational symmetry (homogeneity) |                                           |                                  |
| Rotational symmetry (isotropy)             |                                           |                                  |
| Time-translational symmetry (stationary)   |                                           |                                  |

- 6-a) What sort of detector is needed for products in a head-on ICBM-ABM collision? ICBM is "Intercontinental Ballistic Missile". ABM is Anti Ballistic Missile".
- 6-b) What is the origin of magnetism of earth? Does the magnetic north pole coincide with the geographical north pole? If not, what effect does it have on the duration of day and night and temperature distribution in different parts of earth? Illustrate by drawing a diagram.
- 7-a) What is the major difference between a 'firecracker' and a 'missile'; a 'rocket engine' and a 'jet-aircraft engine'? Describe salient features of space program of Pakistan.
- 7-b) What is a GPS? Give some of its applications in communications, military operations and entertainment.