



# UNIVERSITY OF KARACHI

## Department of Mathematics

### MATH 685 • Astronomy I

Course Supervisor: Professor Dr. Syed Arif Kamal

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Time Allowed: 3 hours • Maximum Marks: 100 • Date: Friday, May 27, 2006

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 10, 2006 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) How does the rotation of earth round the sun produce different seasons? Explain with the help of a diagram.
- 1-b) What is the difference between space-flight dynamics, astrodynamics and aerodynamics?
- 1-c) Define the terms: flight-path angle, flight-direction angle, angle of attack, azimuth, angle of elevation, down-range error, cross-range error.
- 1-d) What are the conventions to label x, y, z axes in an aircraft/rocket? What are the rotations about each of these axes called? Which one produces down-range error and which one cross-range error? Why does one introduce roll in the rocket?
  
- 2-a) Compare and contrast space programs of the following agencies: (a) NASA; (b) ESA
- 2-b) What is the major difference between the orbits of satellites and missiles? What is a polarsatellite and a geostationary satellite? Give 1 application of polar satellite and 1 of geostationary satellite .
  
- 3-a) What must be the condition in terms of the solid angles of the moon and the sun so that a total solar eclipse is produced? What precautions need to be taken while observing solar eclipse?
- 3-b) Compare and contrast the salient features of Total Solar Eclipses of October 24, 1995 and August 11, 1999 as reported by the University of Karachi team.
  
- 4-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.
- 4-b) Why an on-board computing system is preferred to telemetric control from ground? Describe one measure taken by the mathematician and one measure taken by the programmer to reduce the computing time of the data-processing system of INS (Inertial Navigation System).
  
- 5-a) What are the basic assumptions taken in the design of a short-range, an intermediate range (IRBM) and an intercontinental ballistic missile (ICBM)? Why is the word "ballistic" used in these names?
- 5-b) What is GMT? How are the different time zones created? If one crosses Dateline International from east traveling towards Japan, does one gain or lose a day?
  
- 6-a) Obtain the ratio of escape velocity from surface of earth and orbital velocity in a near-earth orbit in terms of  $G$  (universal constant of gravitation),  $R_E$  (radius of earth) and  $M_E$  (mass of earth).
- 6-b) What would be the ratio of escape velocity of a rocket from planet 'X' to that from earth if mass of planet 'X' is 5 times the mass of earth and its radius is one-fifth the radius of earth?
  
- 7-a) How are spacetime symmetries related to conservation laws? State "Strong Noether's Theorem" and give an applicaton in astrodynamics.
- 7-b) What are latitudes and longitudes? How can you find direction of Qibla by knowing the latitudes and longitudes of your current location and the city of Makkah Mukarramah?