

2107/304

FLIGHT MECHANICS

Oct./Nov. 2000

Time: 3 hours

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THE KENYA NATIONAL EXAMINATIONS COUNCIL  
DIPLOMA IN AERONAUTICAL ENGINEERING  
(AIRFRAMES AND ENGINES OPTION)

FLIGHT MECHANICS

3 hours

**Instructions to candidates:**

You should have the following for this examination:

- Answer book
- Drawing instruments
- Mathematical table/Non programmable calculator

Answer any FIVE of the following EIGHT questions.  
All questions carry equal marks.  
Maximum marks for each part of a question are indicated.

This paper consists of 3 printed pages

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1. ✓ (a) With respect to fluid flow characteristics on an aircraft wing, explain and illustrate each of the following;

- (i) Laminar flow
- (ii) Turbulent flow
- (iii) Transition point
- (iv) Separation point.

(8 marks)

(b) With the aid of sketches, describe the stages of shockwave development between 0.75 to 2.2 mach number. (12 marks)

2. (a) Describe the construction of the 'K' coupling on helicopters and state its importance. (8 marks)

(b) With the aid of a sketch, describe the construction and operation of the swashplate assembly on helicopters. (12 marks)

3. ✓ (a) A satellite is located 7500km from the earth radius. Determine how long it would take to orbit the earth. (8 marks)

(b) Discuss the THREE methods of re-entry paths of space vehicles into the earth. Illustrate your answers. (12 marks)

4. (a) Explain the aerodynamic factors that determine the thrust available in an aircraft Propeller. (4 marks)

(b) Using sketches, show how the aircraft propeller efficiency versus advance ratio varies on untwisted aircraft propeller blades. (6 marks)

(c) Explain;

(i) TWO conditions on which the value of the propeller efficiency is zero on an aircraft.

(ii) THREE factors that contribute to the propeller power loss on an aircraft.

(10 marks)

5. ✓ Outline the checks to be carried out during test flight in the following flight configurations;

(a) Turning . (8 marks)

(b) Climbing. (12 marks)

6. ✓ A straight winged aircraft with a critical Mach Number of 0.8 is to be sweptback  $35^\circ$ . With aid of sketches:

(a) Determine the new Mach number. (8 marks)

(b) Explain the effects of:

(i) the sweepback on the aircraft performance.

(ii) increasing or reducing the sweepback angle.

(12 marks)

7.

(a) With the aid of a sketch show and explain how the positioning of the following contribute to an aircraft stability.

- (i) centre of pressure/aerodynamic centre.
- (ii) centre of gravity.

(6 marks)

(b) With the aid of sketches, explain the behaviour after disturbance of an aircraft whose static stability is;

- (i) stable.
- (ii) unstable.

(14 marks)

8. (a) The freestream airflow recorded on the cross-section of a wing was, pressure 1760 lb/ft<sup>2</sup> velocity 220 mi/h and density 0.0012459 slug/ft<sup>3</sup>. At a given point 'A' on the wing cross-section the pressure recorded was 1664 lb/ft<sup>2</sup>. Determine the velocity at point A. (8 marks)

(b) An airliner is flying at an altitude of 13.7 km where the pressure is 1.4854x10<sup>4</sup> N/m<sup>2</sup>. A Pitot tube at the wing-tip measures a pressure of 5.25x10<sup>4</sup> N/m<sup>2</sup>. If the ambient temperature is 250K and  $\gamma=1.4$  for air at normal conditions, calculate

- (i) Mach Number
- (ii) True airspeed.

(12 marks)

7451

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| 6370  |
| + 800 |
| 7170  |

7.067  
2 hrs ✓