

2107/304
FLIGHT MECHANICS
Oct./Nov. 2009
Time: 3 hours

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 booklet

Drawing instruments

Mathematical tables /Non-programmable Calculator

Answer any FIVE of the EIGHT questions in this paper.

All questions carry equal marks.

Maximum marks for each part of a question are as indicated.

This paper consists of 4 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

1. (a) Outline **six** effects of lowering the aircraft trailing edge flaps in flight without changing any other control position. (6 marks)
- (b) State **four** advantages of using aircraft trailing edge flaps in flight. (4 marks)
- (c) An aircraft has a wing span of 40.5 ft and wing chord of 15.2 ft. The weight of the aircraft is 5500 lbs and can fly at a speed of 341 miles per hour at sea level where the air density is 0.002377 slugs. If the Oswald efficiency and parasite drag are 0.7 and 0.035 respectively, determine:
- (i) Lift coefficient;
 - (ii) Aspect ratio;
 - (iii) Drag coefficient;
 - (iv) Thrust required. (10 marks)
2. (a) Explain the term Reynolds number as applied to fluid flow. (2 marks)
- (b) With aid of sketches, explain how each of the following shockwaves are formed as an aerofoil:
- (i) Normal;
 - (ii) Oblique;
 - (iii) Bow. (18 marks)
3. (a) Differentiate between the following terms as applied to space crafts:
- (i) Apogee and perigee;
 - (ii) Circular and escape velocity;
 - (iii) Zone of influence and law of universal gravitation. (6 marks)
- (b) Explain the characteristics of each of the following in the upper atmosphere:
- (i) Wind;
 - (ii) Speed of sound. (4 marks)
- (c) In relation to space craft operations, outline:
- (i) the procedure of skip re-entry;
 - (ii) **three** advantages of glide re-entry;
 - (iii) **three** disadvantages of ballistics re-entry. (10 marks)

4. Discuss the effects of torque generation, causes of drift, compensation and design considerations for minimizing torque effects as the engines are accelerated to full power on single rotor helicopters. Illustrate your answers. (20 marks)

5. (a) Explain **two** design considerations on fixed wing aircrafts to ensure that it is longitudinally statically stable. (4 marks)

(b) Outline **four** disadvantages of having a large static stability margin on an aircraft. (4 marks)

(c) Determine the load required to balance the tail plane on an aircraft which is positioned 10m behind the centre of gravity to maintain balance in a horizontal plane given that:

- weight of aircraft is 1000 kgf
- drag in normal horizontal flight is 125kgf. centre of pressure position is 0.025m behind the centre of gravity.
- line of drag is 0.15m above the thrust line.

Show the forces and measurement layout. (12 marks)

6. Discuss each of the following as applied to aircraft performance.

(a) causes of stall and its effects at low and high speeds; (10 marks)

(b) spin and recovery from a spin; (4 marks)

(c) causes of flutter and its indications on primary control surfaces. (6 marks)

7. Describe the construction and operation of each of the following types of aircraft engines:

(a) Pure turbo jet; (8 marks)

(b) Front fan engine. (12 marks)

8. (a) (i) Outline **three** take-off procedures or techniques depending on the available runway.
- (ii) Explain each of the **three** components of an aircraft take-off to be checked during test flight for certification. (9 marks)
- (b) An aircraft on test flight rolled off 100 metres before reaching a normal take-off speed of 40 knots. Determine the effect on ground roll distance if:
- (i) the head wind was 5 knots.
- (ii) tail wind was 5 knots. (6 marks)
- (c) State **five** reasons for lifting off the nose wheel earlier and holding it there during a test flight take-off. (5 marks)