

2506/207
THEORY OF FLIGHT
June/July 2023
Time: 3 hours



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

MODULE II

THEORY OF FLIGHT

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:

Answer booklet;

Drawing instruments;

Mathematical tables/Non-programmable scientific calculator.

This paper consists of EIGHT questions.

Answer FIVE questions in the answer booklet provided.

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

Candidates should answer the questions in English.

This paper consists of 3 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. With the aid of a labelled sketch, derive from first principles, the formula of the angular velocity for the best level turn manoeuvring performance. (20 marks)

2. (a) With reference to take-off and landing performance, highlight **three** methods of reducing each of the following distances:
 - (i) lift-off; (6 marks)
 - (ii) landing roll. (6 marks)

- (b) (i) Explain the term 'ground effect'. (2 marks)
- (ii) With the aid of labelled sketches, explain how ground affects change in aircraft trim and stability. (7 marks)
- (iii) With the aid of a labelled sketch, explain the influence of ground effect on trailing edge flaps. (5 marks)

3. (a) Discuss aircraft static longitudinal stability. (6 marks)
- (b) With the aid of sketches, explain dutch roll mode of aircraft instability. (7 marks)
- (c) With the aid of a labelled sketch, explain why an aircraft is designed with a wing and a tailplane. (7 marks)

4. (a) With the aid of labelled sketches, describe the resultant change in single disc attitude through 360° for a maximum pitch change of 4° on a helicopter. (20 marks)

5. Table 1 shows data collected for an aircraft model.

Table 1

Item	Characteristic	Value recorded
1.	Weight	5,000 lbs
2.	Wing span	100 ft ²
3.	Coefficient of a drag	0.015
4.	Oswald's efficiency	0.6
5.	Aspect ratio	6
6.	Velocity	500 ft/s
7.	Sea-level density	0.00237

Determine the drag coefficient during each of the following flight conditions:

- (a) straight and level; (8 marks)
- (b) 30° climb; (10 marks)

- (c) comment on the results in 5(a) and 5(b). (2 marks)
6. (a) With the aid of a labelled sketch, describe the warren truss type helicopter fuselage construction. (8 marks)
- (b) Using labelled sketches, show the difference between an articulator rotor and flexible rigid rotor heads. (9 marks)
- (c) Highlight **three** advantages of a shrouded tail rotor arrangement. (3 marks)
7. (a) The data tabulated in Table 2, is for a jet-powered aircraft. Determine the thrust required at sea-level if the density is 00.002377 slugs. (16 marks)

Table 2

Item	Characteristic	Parameter
1.	Wingspan	53.3 ft
2.	Wingspan	318ft ²
3.	Nominal gross weight	19,815 Ibs
4.	Power-plant two turbo fan engines	3,650 Ibs of thrust each at sea-level
5.	Parasite drag coefficient CD_0	0.02
6.	Osward's efficiency factor, ϵ	0.81
7.	Velocity	500 ft/s

- (b) Explain each of the following terms as applied in aircraft performance:
- (i) excess power; (1 mark)
- (ii) absolute ceiling; (1 mark)
- (iii) service ceiling. (2 marks)
8. With reference to helicopter principles of flight:
- (a) sketch and label a vertical and horizontal hinge; (3 marks)
- (b) explain dragging; (3 marks)
- (c) describe **three** causes of rotor blade dragging. (14 marks)

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