

2107/304
FLIGHT MECHANICS
Oct./Nov. 2016
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;

Non-programmable scientific calculator;

Drawing instruments.

This paper consists of EIGHT questions.

Answer FIVE questions in the answer booklet provided.

All questions carry equal marks.

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, describe the **four** tail designs features which may affect the restoring moment of positive static longitudinal stability in flight. (20 marks)
2. With the aid of a labelled sketch, highlight the procedure of launching a satellite to the moon. (20 marks)
3. (a) Describe **two** methods of achieving "K" coupling effect on pure helicopters. (8 marks)
(b) Explain **four** reasons why the forward speed of helicopters is limited. (12 marks)
4. (a) With the aid of sketches, differentiate between each of the following as applied to fluid flow:
 - (i) main to main and main to lateral;
 - (ii) reservoir to reservoir and pipe to reservoir. (8 marks)
(b) An aircraft maintenance cleaning facility pipe 100 ft long and 20 inches in diameter contains water at 200° F, flowing at a mass flow rate of 700 lb m/sec. The water has a density of 60 lb/ft³, viscosity of 1.98×10^{-4} and relative roughness of the pipe is 0.00008. Using Darcy formula, calculate the head loss for the pipe. Take $f = 0.012$. (12 marks)
5. (a) Outline **eight** checks to be carried out on an aircraft released from a check "C" before subjecting it to a test flight. (8 marks)
(b) Explain how an aircraft pilot can ascertain the maximum and minimum speeds in level flight. (12 marks)
6. (a) Discuss each of the following:
 - (i) **two** effects of shockwaves on pressure distribution over an aircraft wing;
 - (ii) buffet boundary layer on an aircraft;
 - (iii) area rule in aircraft design;
 - (iv) main features of a supersonic aircraft wing. (8 marks)
(b) State **four**:
 - (i) advantages of rectangular aircraft wing planforms;
 - (ii) disadvantages of elliptical aircraft wing planforms. (4 marks)

- (c) Explain:
- (i) why the angle of attack corresponding to CL_{max} on sweptback wings planforms of low aspect ratio cannot be used for landing;
 - (ii) **four** general features of an aircraft crescent wing. (8 marks)
7. (a) With aid of a pressure-volume graph, explain the principle of operation of an aeropiston engine for one complete cycle. (10 marks)
- (b) With the aid of a labelled sketch, describe the operation of a turbojet engine. (10 marks)
8. (a) Outline **three** factors that maximize each of the following on a jet aircraft:
- (i) range;
 - (ii) endurance. (6 marks)
- (b) A Kenya Airways Boeing 737 weighing 250,000 kg has a wing span and cord of 50 ft and 10 ft respectively. The lift coefficient and drag ratio are 0.65 and 15 respectively. If the engines failed at 40,000 ft where the air density is 0.0024091 slugs, determine the:
- (i) maximum glide angle,
 - (ii) maximum range measured along the ground;
 - (iii) equilibrium glide velocity. (10 marks)
- (c) Explain the effects of each of the following during gliding:
- (i) wing;
 - (ii) lift to drag ratio;
 - (iii) wing area;
 - (iv) wind. (4 marks)

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