

2506/302
FLIGHT MECHANICS
Oct./Nov. 2021
Time: 3 hours



THE KENYA NATIONAL EXAMINATIONS COUNCIL
DIPLOMA IN AERONAUTICAL ENGINEERING
(AVIONICS OPTION)

MODULE III

FLIGHT MECHANICS

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.

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 reference to the airspeed indicator:
 - (a) differentiate between each of the following range markings:
 - (i) lower and upper limit of the white arc;
 - (ii) white and green arc;
 - (iii) lower and upper limit of the green arc;
 - (iv) yellow arc and red line. (8 marks)
 - (b) with the aid of a labelled sketch, describe its construction and operation. (12 marks)
2. With the aid of a labelled sketch, show:
 - (a) a super critical aerofoil used in transonic flight and highlight **three** advantages and **three** disadvantages; (10 marks)
 - (b) a blow-through type high speed wind tunnel; (6 marks)
 - (c) an incipient shockwave and state its effect on the airflow over an aerofoil. (4 marks)
3. With the aid of labelled sketches, outline the development of shockwaves at increasing mach numbers from subsonic speeds to fully supersonic speeds. (20 marks)
4. (a) With the aid of labelled sketches, describe the operation of a turbo-ram jet at each of the following mach numbers:
 - (i) low;
 - (ii) high. (12 marks)
- (b) Discuss the principle of operation of a centrifugal flow compressor. (8 marks)
5. (a) Explain the Kepler's laws of planetary motion. (3 marks)
- (b) With the aid of a sketch, describe each of the following types of orbits:
 - (i) circular;
 - (ii) elliptical;
 - (iii) parabolic;
 - (iv) hyperbolic. (8 marks)

- (c) To leave the moon, the Apollo astronauts had to take-off and reach the escape velocity of the moon. If the radius of the moon is 1.74×10^6 m, and the mass of the moon is 7.35×10^{22} kg, and taking the universal gravitational constant as 6.673×10^{-11} N.m²/kg², determine the:
- (i) velocity of the space shuttle in order to leave the moon; (6 marks)
 - (ii) circular velocity. (3 marks)
6. (a) Differentiate between each of the following types of flow:
- (i) steady uniform and steady non-uniform;
 - (ii) unsteady uniform and unsteady non-uniform. (4 marks)
- (b) A jet of water is discharged through nozzle with an effective diameter (d), of 75 mm and velocity (v), of 22.5 m/s. If the nozzle is supplied from a reservoir which is 30 m above it, determine:
- (i) power of the issuing jet; (7 marks)
 - (ii) loss of head in the pipe and nozzle; (4 marks)
 - (iii) efficiency of power transmission. (5 marks)
7. (a) With reference to test flight, outline the typical instrument parameters recorded. (8 marks)
- (b) Discuss the test flight execution process. (12 marks)
8. With the aid of labelled sketches, discuss the:
- (a) zones of influence with reference to space flight; (12 marks)
 - (b) effect of the curvature of the earth's surface on the path of a projectile. (8 marks)

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