THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING
(AIRFRAMES AND ENGINES 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** of the **EIGHT** questions in the answer booklet provided.*
Maximum marks for each part of a question are as shown.
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. (a) Outline **five** experimental methods used in testing the characteristics of high speed flight. (5 marks)

   (b) With the aid of a labelled sketch, describe the formation of a mach cone in transonic flight regime. (15 marks)

2. (a) Outline **six** factors considered during test flight to improve propeller efficiency. (6 marks)

   (b) Highlight the procedure during test flight when:

   (i) flying low;

   (ii) establishing stability behaviour. (14 marks)

3. With the aid of labelled sketches, differentiate between the construction and operation of turbo-ramjet and turbo-rocket propulsion. (20 marks)

4. (a) From the first principles, derive the relationship between circular velocity and escape velocity. (8 marks)

   (b) Illustrate the typical flight path for launching of a space craft. (8 marks)

   (c) Calculate the approximate circular velocity near the earth's surface of a satellite given the earth's radius is 6370 km. (4 marks)

5. (a) A pipe of cylindrical section suddenly changes from area $0.3 \, m^2$ to $0.1 \, m^2$ and $0.4 \, m^2$ to $0.3 \, m^2$ with the pressure at the smaller part being 85 kPa. Determine the:

   (i) head loss due to sudden enlargement;

   (ii) pressure at the larger part of the pipe. (12 marks)

   (b) A horizontal pipe of 150 m diameter is obstructed by a circular plate of 100 mm diameter. Determine the loss of head due to the destruction in the pipe if the pipe of water is flowing with a velocity of 1.5 m/s in the pipe.

   Take C_c as 0.6. (8 marks)

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6.   With the aid of labelled sketches, discuss each of the following with reference to supersonic flow:

    (a)   Mach lines on the following flows:

        (i)   constant;

        (ii)   accelerating;

        (iii)   decelerating.

                                         (9 marks)

    (b)   Compressive flow.   (11 marks)

7.   (a)   Explain the three Q-code letter groups used in connection to altimeter settings.

                                         (6 marks)

    (b)   With the aid of sketches, describe the construction and operation of an airspeed indicator.   (10 marks)

    (c)   Explain **four** factors that affect gyroscopic rigidity.   (4 marks)

8.   (a)   With the aid of labelled sketches, describe high speed pressure distribution over an aerofoil section.

                                         (11 marks)

    (b)   Show the propagation of pressure waves at a point when:

        (i)   stationary;

        (ii)   moving below the speed of sound;

        (iii)   moving at the speed of sound.   (9 marks)

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