

2506/302

FLIGHT MECHANICS

Oct. / Nov. 2017

Time: 3 hours



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:*

*Mathematical tables/non-programmable calculator; and*

*Drawing instruments.*

*Answer **FIVE** of the following **EIGHT** 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 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) State the meaning of each of the standardized system of colour coding for operating ranges for electronic instrument displays according to JAR 25. (5 marks)
- (b) Explain the construction and operation of a mechanical tachometer. (5 marks)
- (c) With the aid of a labelled block diagram, show the layout of the main parts of a magnetic gyroscope. (10 marks)
2. (a) Explain **four** objectives of a test flight on an aircraft. (4 marks)
- (b) Explain the mandatory checks to be carried out before a trial flight under each of the following headings:
  - (i) documentation;
  - (ii) engine;
  - (iii) controls.
 (16 marks)
3. (a) Explain each of the following terms as applied in the study of missiles and satellites:
  - (i) earth satellites;
  - (ii) inter planetary vehicles;
  - (iii) launch;
  - (iv) zone of influence.
 (4 marks)
- (b) Discuss each of the following characteristics of the upper atmosphere according to International Civil Aviation Authority:
  - (i) temperature;
  - (ii) speed of sound;
  - (iii) air;
  - (iv) wind.
 (16 marks)
4. (a) An aircraft is fitted with a turbo jet engine having the following characteristics:
 

inlet area	-	7 ft
exhaust area	-	4.5 ft
pressure	-	640 lb/ft <sup>2</sup>
exhaust velocity	-	1,600 ft/sec
flight level	-	30,000 ft
velocity	-	500 mph

Determine the engine thrust.

 (10 marks)



- (b) Explain when the propeller efficiency of a fixed propeller is zero. (5 marks)
- (c) Discuss the operation of a turbo jet. (5 marks)
5. With the aid of sketches, discuss the events that take place if the speed of a body thrown vertically is progressively increased from rest to approximately 11 km/s at appropriate height, direction and location. (20 marks)
6. (a) With the aid of sketches, compare between a streamline and a stream tube as applied in fluid flow. (5 marks)
- (b) Differentiate between each of the following as applied to fluid flow:
- (i) head and total head;
  - (ii) velocity and pressure head.
- (2 marks)
- (c) With the aid of a labelled sketch, explain how viscosity of fluid contributes to the formation of the boundary layer in laminar and turbulent flow. (6 marks)
- (d) In an aircraft hydraulic system, steady state flow exists in a pipe that undergoes a gradual expansion from a diameter of 60 inches to a diameter of 80 inches. The density of the fluid is constant at 50.2 lbm/ft<sup>3</sup>. If the velocity is 45.4 ft/sec in the 60 inches section, determine the flow velocity in the 80 inches section. (7 marks)
7. (a) Explain **four** effects of shock wave formation on a high speed aircraft. (4 marks)
- (b) Outline **three** advantages and **three** disadvantages of delta wing plan form for high speed flights. (6 marks)
- (c) Explain each of the following terms as applied in high speed flights:
- (i) local mach number ( $M_L$ );
  - (ii) critical mach number ( $M_{CRIT}$ );
  - (iii) critical drag rise mach number ( $M_{CDR}$ ).
- (6 marks)
- (d) The design features selected for a particular aircraft depend on its intended role. Highlight **four** important requirements for supersonic aircraft. (4 marks)



8. (a) (i) Describe **four** characteristics of a super critical aerofoil.  
(ii) With the aid of a labelled sketch of a swept back wing, show the angle of sweep and the taper ratio. (7 marks)
- (b) Explain the process of shock wave formation on high speed aerofoils. (3 marks)
- (c) With the aid of a labelled sketch, describe the formation of a bow shock wave on high speed aerofoils. (10 marks)

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