Engineering Studies

Centre Number

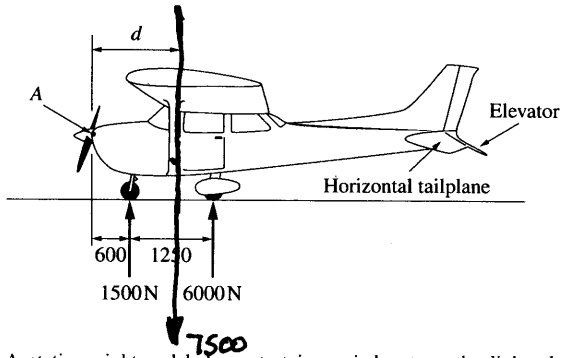
Section II (continued)

Student Number

Marks

Question 15 — Aeronautical Engineering (15 marks)

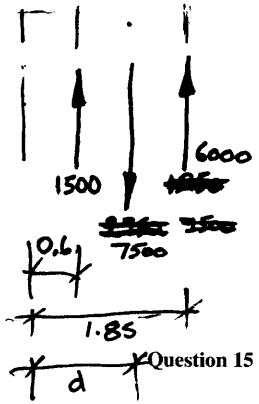
(a) A diagram of a light plane is shown.



(i) A static-weight and balance test is carried out on the light plane to determine the position of the centre of gravity. **2**

A reaction force of 1500 N is measured at the nose wheel, and a total of 6000 N is measured at the main wheels.

Calculate the horizontal distance, d, from point A to the centre of gravity.



$+\circlearrowleft \Sigma M_A = 0$

$= +0.6 \times 1500 + 1.85 \times 6000 - 7500d \times 7500$

$7500d = 0.6 \times 1500 + 1.85 \times 6000$

$d = \frac{900 + 11100}{7500} = \frac{12000}{7500}$

Distance d = 1600 mm

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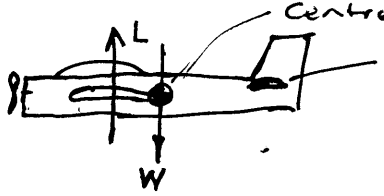

tailplane provides downforce to counteract moment produced by wing acting about C.O.G

Question 15 (continued) tailplane cross section

Marks

(ii) During level flight a vertical force on the horizontal tailplane is usually required to maintain stability. **2**

Explain the aerodynamic features of the tailplane that allow a stabilising force to be produced.

There are four main aerodynamic features of the tailplane that maintain stability.

One is that the tailfin is shaped as a teardrop aerofoil, producing lift; secondly, the tailfin is pitched at an angle to the axis of the plane, deflecting airflow to provide lift. Thirdly, the solid cross-section of the tailplane provides a resistance to gross up/down movement of the tail. Finally, the elevator can be altered to change the aerodynamic properties of the tailplane to maintain level, stable flight to suit.

(iii) The elevator could be controlled by:

- an electric pump/hydraulic ram system;
- a cable/pulley system; or
- an electric motor/gear system.

Explain why electric pump/hydraulic ram systems are more common than other control systems on larger, heavier aircraft, such as the Boeing 747.

The elevator is subjected to a resistance force on all aircraft. This force is larger on a larger/heavier aircraft.

Hydraulics are provide the most control at the high loads experienced; as small volume of hydraulic fluid compressed

- This is superior to cable systems as the cables are subjected to stretching (Hooke's Law) and suffer elastic strain. The longer the distance/larger the plane, then the force will be high amount of stretching will be proportionately larger. This will produce "sloppy" control.

(Question 15 continues on page 21)

- Electric motors/gears are subject to failure and backlash, which is not present in an hydraulic ram filled with an incompressible hydraulic fluid.

* → Vertical thrust