2003 HIGHER SCHOOL CERTIFICATE EXAMINATION

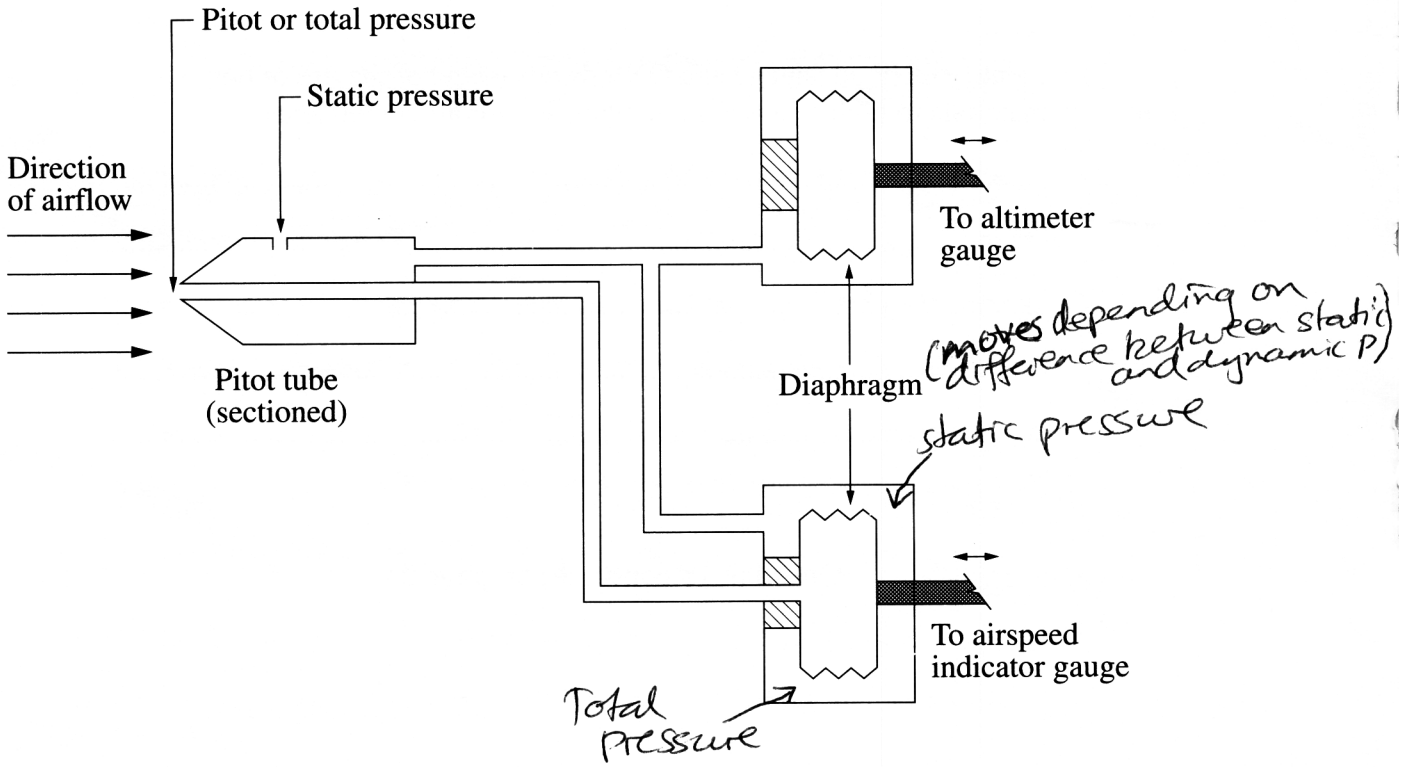
Engineering Studies

Section II (continued)

Marks

Question 15 — Aeronautical Engineering (15 marks)

In common aircraft instruments a pitot tube is connected to both the altimeter and airspeed indicator.



(a) Explain how the airspeed indicator determines airspeed from the pressures sensed by the pitot tube. **3**

The static pressure is simply due to the fluid while the total pressure is the sum of the static pressure and dynamic pressure (due to velocity of air) Therefore the difference between the static and total Pressure can be used to determined. The diaghpraghm between the static and total pressure will deflect depending on the airspeed. This deflection is detected and shown on a calibrated scale as airspeed mechanically or electronically

Question 15 continues on page 22

Marks

Question 15 (continued)

(b) (i) Aluminium and its alloys are generally more active than irons and steels in the galvanic series. Explain why aluminium alloys are more corrosion-resistant than steels. **2**

Aluminium forms a passive oxide layer on the surface which prevents water and oxygen coming into contact with the Al beneath. Since H_2O and O_2 are necessary for corrosion, further corrosion is stopped. Aluminium alloys will also generally form a passive layer due to the Aluminium.

Steel forms a porous corrosion layer (rust) which does not protect the steel. Therefore it is less corrosion resistant than aluminium

(ii) Identify ONE advantage and ONE disadvantage of the use of composite materials to replace aluminium alloys in aircraft components. **2**

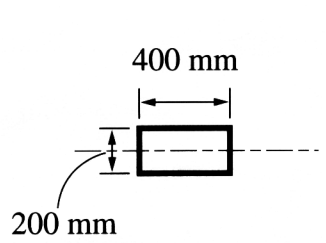
Composites such as fibre reinforced polymers have a higher strength to weight ratio than aluminium. This allows weight to be reduced and therefore less fuel is required. However, since slip is not a possible form of deformation for most composites, failure is often catastrophic and sudden. This is not so with Al, which will show signs of cracking and can be monitored.

Question 15 continues on page 23

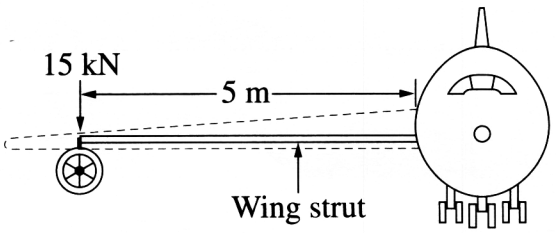
Marks

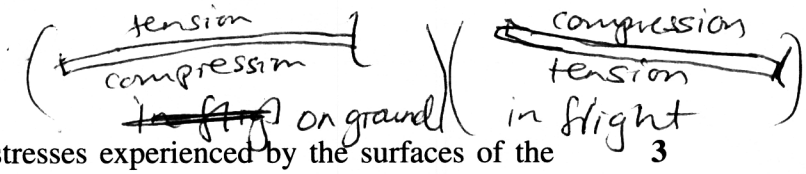
Question 15 (continued)

(c) In the diagram of an aircraft, the wing has been shown as hidden outline to reveal the wing strut, which has uniform section along its length.



Detail of cross-section of wing strut





(i) Compare the nature of the stresses experienced by the surfaces of the wing strut when the aircraft is stationary on the ground and when the aircraft is in flight. **3**

(engine)
On the ground: The 15kN force will cause the wing to hog. Therefore the upper surface will be in tension while the low surface will be in compression. In flight the wing will also experience a lift force. This may cause the wing to sag depending on the position and magnitude of the lift force. This would cause the top to be in compression and the bottom to be in tension

(ii) Determine the maximum value of the bending stress when the strut experiences a force of 15 kN at its end.

Use $I = 267 \times 10^6\,\text{mm}^4$.

reaction moment
at wing root there is a 75kNm ~~force~~ due to 15kN load
maximum bending moment is at wing root

$\therefore BM_{MAX} = 75 \times 10^3\,\text{Nm}$

$= 75 \times 10^6\,\text{Nmm}$

$BS = \frac{My}{I} = \frac{75 \times 10^6 \times 100}{267 \times 10^6}$

$= 28{\cdot}09\,\text{MPa}$

Bending stress = 28·09 MPa

Question 15 continues on page 24

Marks

Question 15 (continued)

(d) Outline TWO conditions that may cause an aircraft to stall during flight. **2**

1) Angle of attack being too great: This will cause a detachment of the airstream over the top of the ~~wing~~ aileron, causing a turbulent flow and thus stall.

2) air speed being too ~~slow~~ slow. A reduction in airflow (speed) will reduce lift and may cause stall.

End of Question 15