

7. The line  $l_1$  has equation

$$\mathbf{r} = \mathbf{i} - 2\mathbf{j} + 3\mathbf{k} + \lambda(2\mathbf{i} + \mathbf{j} - 4\mathbf{k})$$

and the line  $l_2$  has equation

$$\mathbf{r} = 5\mathbf{i} + p\mathbf{j} - 7\mathbf{k} + \mu(6\mathbf{i} + \mathbf{j} + 8\mathbf{k})$$

where  $\lambda$  and  $\mu$  are scalar parameters and  $p$  is a constant.

The plane  $\Pi$  contains  $l_1$  and  $l_2$

(a) Show that the vector  $3\mathbf{i} - 10\mathbf{j} - \mathbf{k}$  is perpendicular to  $\Pi$

(2)

(b) Hence determine a Cartesian equation of  $\Pi$

(2)

(c) Hence determine the value of  $p$

(2)

Given that

- the lines  $l_1$  and  $l_2$  intersect at the point  $A$
- the point  $B$  has coordinates  $(12, -11, 6)$

(d) determine, to the nearest degree, the acute angle between  $AB$  and  $\Pi$

(4)