Question	Scheme	Marks	AOs
7(a)(i)	$2-\mathrm{i}$	B1	1.2
(ii)	Roots of polynomials with real coefficients occur in conjugate pairs, β and γ form a conjugate pair, α is real so δ must also be real. or Quartics have either 4 real roots, 2 real roots and 2 complex roots or 4 complex roots. As 2 complex roots and 1 real root therefore so δ must also be real. or As α real and only one root δ remaining, if complex it would need to have a complex conjugate, which it can't have so must be real	B1	2.4
		(2)	
(b)	$\alpha+\beta+\gamma+\delta=6$ $\Rightarrow 3+2+\mathrm{i}+2-\mathrm{i}+\delta=6 \Rightarrow \delta=\ldots$	M1	3.1a
	$\delta=-1$	A1	1.1b
		(2)	
(c)	$\mathrm{f}(z)=(z-3)(z+1)(z-(2+\mathrm{i}))(z-(2-\mathrm{i}))=\ldots$ Alternative pair sum $=(3)(2+\mathrm{i})+(3)(2-\mathrm{i})+(3)(-1)+(-1)(2+\mathrm{i})$ $+(-1)(2-\mathrm{i})+(2+\mathrm{i})(2-\mathrm{i})=\ldots\{10\}$ triple sum $=(3)(2+\mathrm{i})(2-\mathrm{i})+(3)(-1)(2+\mathrm{i})$ $+(3)(-1)(2-\mathrm{i})+(-1)(2+\mathrm{i})(2-\mathrm{i})=\ldots\{-2\}$ product $=(3)(2+\mathrm{i})(2-\mathrm{i})(-1)=\ldots\{-15\}$	M1	3.1a
	$=(z^2-2z-3)(z^2-4z+5)$ $=z^4-6z^3+10z^2+2z-15$ $p=10,\ q=2,\ r=-15$	A1 A1	1.1b 1.1b
		(3)	
(d)	$z=\frac{1}{2},-\frac{3}{2}$	B1ft	1.1b
	$z=-1\pm\frac{\mathrm{i}}{2}$	B1ft	1.1b
		(2)	
		(9 marks)	

Notes

(a)(i)

B1: Correct complex number

(a)(ii)

B1: Correct explanation.

(b)

M1: Uses 2 ± i and 1 together with the sum of roots = ± 6 to find a value for δ

A1: Correct value

(c)

M1: Uses (z – 3) and (z – their δ) and their conjugate pair correctly as factors and makes an attempt to expand

Alternatively attempts to find the pair sum, triple sum and product

A1: Establishes at least 2 of the required coefficients correctly

A1: Correct quartic or correct constants

(d)

B1ft: For $-\frac{3}{2}$ and $-\frac{\delta}{2}$ as the real roots

B1ft: For $-1-\frac{i}{2}$ and $-\frac{\gamma}{2}$ as the complex roots