Question	Scheme	Marks
7(a)(i)+(ii)	$cos\,5\theta + i\,sin\,5\theta = (cos\,\theta + i\,sin\,\theta)^5$ o.e.	M1
	$= c^5 + 5c^4 s\mathrm{i} - 10c^3 s^2 - 10c^2 s^3 \mathrm{i} + 5cs^4 + s^5 \mathrm{i}$ $\Rightarrow \sin 5\theta = ..., \cos 5\theta = ...$	M1
	$\sin 5\theta \equiv 5\cos^4\theta \sin\theta - 10\cos^2\theta \sin^3\theta + \sin^5\theta$ *	A1*
	$\cos 5\theta \equiv \cos^5\theta - 10\cos^3\theta \sin^2\theta + 5\cos\theta \sin^4\theta$	A1
		(4)
(b)	$\tan 5\theta = \dfrac{\sin 5\theta}{\cos 5\theta} = \dfrac{5\cos^4\theta \sin\theta - 10\cos^2\theta \sin^3\theta + \sin^5\theta}{\cos^5\theta - 10\cos^3\theta \sin^2\theta + 5\cos\theta \sin^4\theta} \times \dfrac{\cos^{-5}\theta}{\cos^{-5}\theta}$	M1
	$\dfrac{\frac{5\sin\theta}{\cos\theta} - \frac{10\sin^3\theta}{\cos^3\theta} + \frac{\sin^5\theta}{\cos^5\theta}}{1 - \frac{10\sin^2\theta}{\cos^2\theta} + \frac{5\sin^4\theta}{\cos^4\theta}} = \dfrac{5\tan\theta - 10\tan^3\theta + \tan^5\theta}{1 - 10\tan^2\theta + 5\tan^4\theta}$	A1*
		(2)
(c)	$x = \tan\theta,\ 2x^5 - 15x^4 - 20x^3 + 30x^2 + 10x - 3 = 0$ $\Rightarrow \dfrac{5\tan\theta - 10\tan^3\theta + \tan^5\theta}{1 - 10\tan^2\theta + 5\tan^4\theta} = \dfrac{3}{2} \Rightarrow \tan 5\theta = \dfrac{3}{2}$	M1
	$\theta = \dfrac{1}{5}\tan^{-1}\dfrac{3}{2}$ $(= 0.19655$ radians, $11.2619...°)$ Others that you may see which would also score: In radians {0.19655 …, 0.82487…, 1.45319…, 2.0815…, 2.7098…} In degrees {11.2619 …, 47.2619 …, 83.2619 …, 119.2619 …, 155.2619 …}	A1
	$\Rightarrow x = \tan 0.196555..., ...$	M1
	Two of: $x = 0.1991...$, $1.0822...$, $8.464...$, $-1.7847...$, $-0.4607...$	A1
	All of: $x = -1.785$, -0.461 , 0.199 , 1.082 , 8.464	A1
		(5)
		(11 marks)

Notes:

(a)(i)+(ii)

M1: Demonstrates use of De Moivre such as $\cos 5\theta + i\sin 5\theta = (\cos\theta + i\sin\theta)^5$, $\sin 5\theta = Im\,(\cos\theta + i\sin\theta)^5$ or $\cos 5\theta$ = their real terms from the expansion of $(\cos\theta + i\sin\theta)^5$

M1: Attempts to expand, need not be simplified. Accept sign errors but should have the correct evaluated coefficients (allow terms with correct ${}^nC_r$ values if the correct coefficients are subsequently seen) the correct powers on the sin and cos terms and equate **either** the real or imaginary parts.

A1*: Correct expression for $\sin 5\theta$ derived from **fully correct working**. Allow notational slips with nCr etc as long as the intention is clear. To score this mark we need to see either a full expansion if working with $(\cos\theta + i\sin\theta)^5$ or the imaginary terms if working with $Im\,(\cos\theta + i\sin\theta)^5$

Note: Consistent omission of i's is 2nd M0, but condone the occasional slip for the M marks

A1: Correct expression for cos 5θ. Allow recovery from slips, e.g. missing arguments for this mark, and allow if seen in part (b).

(b)

M1: Applies $\tan 5\theta = \dfrac{\sin 5\theta}{\cos 5\theta}$ and shows or clearly states the intention to divide numerator and denominator through by $\cos^5\theta$ or equivalent work (e.g. factorising $\sin\theta$ from the numerator and $\cos\theta$ from the denominator and then dividing all terms by $\cos^4\theta$ to obtain $\tan\theta$ terms)

A1*: Correct given expression reached from **fully correct work with no errors**

Note: Do not penalise slips in notation or missing arguments already penalised in (a)

(c)

Note: Must use (b) so calculator methods to solve by e.g. tracing the points or eq. solver scores 0

M1: Substitutes $x = \tan\theta$ into the equation and rearranges to identify the $\tan 5\theta$ within the equation. May be slips when rearranging, but look for the attempt to reach $\tan 5\theta$

A1: Obtains a correct value for θ either in degrees or radians, or as an expression. May be implied.

M1: Uses at least one value of θ and undoes the substitution to find at least one value for x (may have to check for their θ value(s))

A1: At least two correct values of x found correct to at least 2 s.f. (So accept 0.20,1.1,8.5 etc)

A1: All five solutions correct to 3 decimal places, and no extra solutions.