Question Number	Scheme	Marks
7(a)	$y = \mathrm{e}^{-x^2}\sin 3x \Rightarrow \dfrac{\mathrm{d}y}{\mathrm{d}x} = 3\mathrm{e}^{-x^2}\cos 3x - 2x\mathrm{e}^{-x^2}\sin 3x$	M1A1
	$3\mathrm{e}^{-x^2}\cos 3x - 2x\mathrm{e}^{-x^2}\sin 3x = 0 \Rightarrow 3\cos 3x - 2x\sin 3x = 0$ $\Rightarrow 3\cos 3x = 2x\sin 3x \Rightarrow \tan 3x = \dfrac{3}{2x}$	dM1
	$x = \dfrac{1}{3}\arctan\left(\dfrac{3}{2x}\right)$ *	A1*
		(4)
(b)(i)	$x_1 = 0.4 \Rightarrow x_2 = \dfrac{1}{3}\arctan\left(\dfrac{3}{2\times 0.4}\right)$	M1
	$\left(x_2 =\right) 0.4367$	A1
(ii)	$\left(x_4 =\right) 0.4307$	A1
		(3)

Notes:

(a)

M1: Differentiates using the product rule to obtain $\alpha\mathrm{e}^{-x^2}\cos 3x + \beta x\mathrm{e}^{-x^2}\sin 3x$, $\alpha, \beta \neq 0$

A1: Correct derivative in any form

dM1: **Depends on the first method mark.**

Sets their $\dfrac{\mathrm{d}y}{\mathrm{d}x} = 0$ (which may be implied), cancels e^{-x^2} and rearranges to $\pm\tan 3x = ...$

A1*: Correct proof with no errors seen.

Allow e.g. $\tan^{-1}$ or e.g. artan for arctan and allow e.g. $x = \dfrac{1}{3}\arctan\dfrac{3}{2x}$

Ignore any reference or attempts to solve $\mathrm{e}^{-x^2} = 0$

(b)

M1: Attempts to substitute $x = 0.4$ into the formula.

Allow if seen embedded in the formula or may be implied by $x_2 =$ awrt 0.44

A1: Awrt 0.4367

A1: 0.4307 cao **not** awrt 0.4307

Both values correct as defined with no working scores M1A1A1

(c)	e.g. $\mathrm{f}(x)=x-\frac{1}{3}\arctan\left(\frac{3}{2x}\right)$ $\mathrm{f}(0.4305)=0.4305-\frac{1}{3}\arctan\left(\frac{3}{2\times0.4305}\right)\left(=6.38\times10^{-5}\right)$ $\mathrm{f}(0.4295)=0.4295-\frac{1}{3}\arctan\left(\frac{3}{2\times0.4295}\right)\left(=-1.141...\times10^{-3}\right)$ or e.g. $\mathrm{f}(x)=3\mathrm{e}^{-x^2}\cos3x-2x\mathrm{e}^{-x^2}\sin3x$ $\mathrm{f}(0.4305)=3\mathrm{e}^{-(0.4305)^2}\cos3(0.4305)-2(0.4305)\mathrm{e}^{-(0.4305)^2}\sin3\,(0.4305)\left(=-4.968...\times10^{-4}\right)$ $\mathrm{f}(0.4295)=3\mathrm{e}^{-(0.4295)^2}\cos3(0.4295)-2(0.4295)\mathrm{e}^{-(0.4295)^2}\sin3\,(0.4295)\left(=8.885...\times10^{-3}\right)$	M1
	Sign change therefore x is 0.430 to 3dp	A1
		(2)
		Total 9

(c)

M1: Chooses a suitable function and attempts its value at both 0.4305 and 0.4295

For the attempt we need to see embedded values as in scheme or one value correct to 1sf for their suitable function.

The function they are using must be seen or implied by embedded values.

Allowable functions are:

- $x-\frac{1}{3}\arctan\left(\frac{3}{2x}\right)$ or multiples of this
- $3\mathrm{e}^{-x^2}\cos3x-2x\mathrm{e}^{-x^2}\sin3x$ or multiples of this following through on their $\frac{\mathrm{d}y}{\mathrm{d}x}$
- $3\cos3x-2x\sin3x$ or multiples of this following through on their $\frac{\mathrm{d}y}{\mathrm{d}x}$

Unlikely, but it is also acceptable to pick a tighter interval e.g. 0.4305 and 0.4301

A1: Requires correct differentiation (if $\frac{\mathrm{d}y}{\mathrm{d}x}$ is used)

- both values correct (rounded or truncated to 1sf)
- a valid reason that includes a reference to the sign change e.g. < 0, > 0
- a minimal conclusion which could be ✓, QED, root

Note we condone the omission of a reference to continuity.

Attempts to use repeated iteration score no marks.