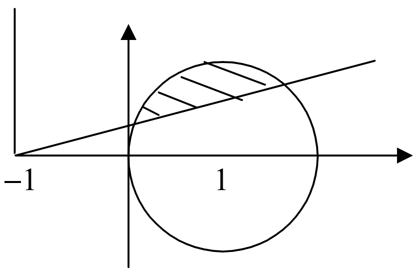
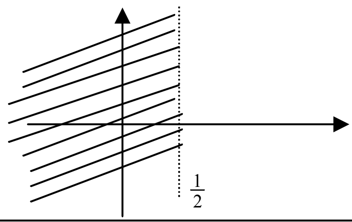
Question number	Scheme	Marks
1.	$\overrightarrow{AB} \times \overrightarrow{AC} = (\mathbf{b} - \mathbf{a}) \times (\mathbf{c} - \mathbf{a}) = (\mathbf{b} \times \mathbf{c}) - (\mathbf{a} \times \mathbf{c}) - (\mathbf{b} \times \mathbf{a}) + (\mathbf{a} \times \mathbf{a})$	M1 A1
	Using $\mathbf{a} \times \mathbf{c} = -\,\mathbf{c} \times \mathbf{a}$ or $\mathbf{b} \times \mathbf{a} = -\,\mathbf{a} \times \mathbf{b}$ or $\mathbf{a} \times \mathbf{a} = \mathbf{0}$	B1
	$\lvert \overrightarrow{AB} \times \overrightarrow{AC} \rvert = AB.\,AC \sin\theta = 2 \times$ area of triangle, or equivalent	M1
	Final result : $\frac{1}{2} \lvert \mathbf{a} \times \mathbf{b} + \mathbf{b} \times \mathbf{c} + \mathbf{c} \times \mathbf{a} \rvert$ (*)	A1 cso **[5]**
2.	$f(1) = 3 \times 7 - 1 = 20$; divisible by 4	B1
	$f(k+1) = (2k+3)7^{k+1} - 1$	B1
	Showing that $f(k+1) = f(k) + 4m$ or equivalent	M1 A1
	e.g. $f(k+1) - f(k) = (2k+3)7^{k+1} - 1 - \{(2k+1)7^{k} - 1\}$	
	$= (12k+20)7^{k} = 4(3k+5)7^{k}$	
	If true for $n = k$, then true for $n = k + 1$	M1
	Conclusion , with no wrong working seen.	A1 **[6]**

(cso = correct solution only)

Question number	Scheme	Marks
3.	(a) Deriving characteristic equation $(4-\lambda)(-9-\lambda)+30=0$	M1 A1
	$\Rightarrow \lambda^2+5\lambda-6=0 \Rightarrow (\lambda+6)(\lambda-1)=0 \Rightarrow \lambda=-6, \lambda=1$	M1 A1 (4)
	(b) Stating, implying or showing $\lambda = 1$ associated with point invariant line.	B1
	$\Rightarrow \begin{pmatrix}4 & -5\\ 6 & -9\end{pmatrix}\begin{pmatrix}x\\ y\end{pmatrix}=\begin{pmatrix}x\\ y\end{pmatrix}$	
	Equation is $4x-5y=x \Rightarrow 3x-5y=0$ any equivalent form	M1 A1 (3) **[7]**
4.	(i) (a) 	
	Circle	M1 A1
	One half line correct	B1
	Second half line	B1 (4)
	[s.c. Allow B1 for two "full" lines in correct position]	
	(b) Shading correct region	A1 ft (1)
	(ii) (a) Rearrange $w=\frac{z-1}{z}$ to give $z=f(w)$ or $z-1=f(w)$	M1
	$\left(z=\frac{1}{1-w}, \Rightarrow\right)$ $z-1=\frac{w}{1-w}$, or $\lvert z-1\rvert = \lvert z\rvert\lvert w\rvert \Rightarrow \lvert z\rvert\lvert w\rvert = 1$	A1
	Completion: ($\lvert z-1\rvert = 1 \rightarrow$) $\lvert w\rvert = \lvert 1-w\rvert = \lvert w-1\rvert$ *	A1 (3)
	(b) 	
	Correct line shown	M1
	Correct shading	A1 (2) **[10]**

(ft = follow-through mark)

Question number	Scheme	Marks
5.	(a) $(\cos\theta + \mathrm{i}\sin\theta)^5 = \cos 5\theta + \mathrm{i}\sin 5\theta$	M1
	$(\cos\theta + \mathrm{i}\sin\theta)^5 = \cos^5\theta + 5\cos^4\theta(\mathrm{i}\sin\theta) + 10\cos^3\theta(\mathrm{i}\sin\theta)^2$	
	$+ 10\cos^2\theta(\mathrm{i}\sin\theta)^3 + 5\cos\theta(\mathrm{i}\sin\theta)^4 + (\mathrm{i}\sin\theta)^5$	M1 A1
	$\cos 5\theta = \cos^5\theta - 10\cos^3\theta\sin^2\theta + 5\cos\theta\sin^4\theta$	M1
	$= \cos^5\theta - 10\cos^3\theta(1-\cos^2\theta) + 5\cos\theta(1 - 2\cos^2\theta + \cos^4\theta)$	M1
	$= 16\cos^5\theta - 20\cos^3\theta + 5\cos\theta$ (*)	A1 cso (6)
	(b) $\cos 5\theta = -1$ (or 1, or 0)	M1
	$5\theta = (2n \pm 1)180° \Rightarrow \theta = (2n \pm 1)36°$	A1
	$x = \cos\theta = -1, -0.309, 0.809$	M1 A1 (4)
		[10]

((*) indicates final line is given on the paper; cso = correct solution only)

Question number	Scheme	Marks
6.	(a) Det $\mathbf{A} = 3(u-3) - (u-5) - (3-5) = 2u - 2 \quad [= 2(u-1)]$ (*)	M1 A1 (2)
	(b) Cofactors $\begin{pmatrix} u-3 & 5-u & -2 \\ -(u+3) & 3u+5 & -4 \\ 2 & -4 & 2 \end{pmatrix}$ (– 1 A mark for each term wrong)	M1 A3
	$\mathbf{A}^{-1} = \dfrac{1}{2(u-1)}\begin{pmatrix} u-3 & -(u+3) & 2 \\ 5-u & 3u+5 & -4 \\ -2 & -4 & 2 \end{pmatrix}$	M1 A1 ft (6)
	(c) $\begin{pmatrix} a \\ b \\ c \end{pmatrix} = \mathbf{A}^{-1}\begin{pmatrix} 3 \\ 1 \\ 6 \end{pmatrix}$, Using $u = 6$: $\dfrac{1}{10}\begin{pmatrix} 3 & -9 & 2 \\ -1 & 23 & -4 \\ -2 & -4 & 2 \end{pmatrix}\begin{pmatrix} 3 \\ 1 \\ 6 \end{pmatrix} = \dfrac{1}{10}\begin{pmatrix} 12 \\ -4 \\ 2 \end{pmatrix}$	M1
	$a = \dfrac{6}{5}, \quad b = -\dfrac{2}{5} \quad c = \dfrac{1}{5}$ (One correct A1, other 2 correct A1)	A1, A1 (3)
	[Algebraic approach: Finding one value M1 A1, other two A1]	**[11]**

((*) indicates final line is given on the paper; awrt = anything which rounds to; ft = follow-through mark)

Question number	Scheme	Marks
7.	(a) Normal to plane is $(-\mathbf{i} + 5\mathbf{j} + 3\mathbf{k})$	B1
	Equation of plane: $\mathbf{r} \,.\, (-\mathbf{i} + 5\mathbf{j} + 3\mathbf{k}) = (\mathbf{i} + 2\mathbf{j} - \mathbf{k}) \,.\, (-\mathbf{i} + 5\mathbf{j} + 3\mathbf{k})$	M1
	$\Rightarrow \quad -x + 5y + 3z = -1 + 10 - 3 = 6$ or equivalent (*)	M1 A1 (4)
	[If vector equation of plane is by-passed, then B1 M2 A1]	
	(b) $\frac{1}{\sqrt{35}}$	B1
	$\lvert 6 - (\mathbf{i} + 2\mathbf{j} + 2\mathbf{k}) \,.\, (-\mathbf{i} + 5\mathbf{j} + 3\mathbf{k}) \rvert$	M1 A1
	or $\lvert \overrightarrow{PQ} \,.\, (-\mathbf{i} + 5\mathbf{j} + 3\mathbf{k}) \rvert = \lvert 3\mathbf{k} \,.\, (-\mathbf{i} + 5\mathbf{j} + 3\mathbf{k}) \rvert$	
	Distance = $\frac{9}{\sqrt{35}}$ or a.w.r.t 1.52	A1 (4)
	(c) Direction of one line in plane = $(-\mathbf{i} + 5\mathbf{j} + 3\mathbf{k})$	M1
	Direction of another line in plane = $(3\mathbf{i} - 2\mathbf{k}) - (\mathbf{i} + 2\mathbf{j} + 2\mathbf{k})$	M1
	$\Rightarrow \mathbf{r} = (\mathbf{i} + 2\mathbf{j} + 2\mathbf{k}) + s(-\mathbf{i} + 5\mathbf{j} + 3\mathbf{k}) + t(2\mathbf{i} - 2\mathbf{j} - 4\mathbf{k})$	M1 A1 (4)
	or $(3\mathbf{i} - 2\mathbf{k}) + s(-\mathbf{i} + 5\mathbf{j} + 3\mathbf{k}) + t(2\mathbf{i} - 2\mathbf{j} - 4\mathbf{k})$	**[12]**

((*) indicates final line is given on the paper)

Question number	Scheme	Marks
8.	(a) $x_0 = 0,\ y_0 = 1, \left(\frac{dy}{dx}\right)_0 = 0 - 1 = -1$	B1
	$y_1 - y_0 = 0.05(-1) \Rightarrow y_1 = 1 - 0.05 = 0.95$	M1 A1ft
	$x_1 = 0.05,\ y_1 = 0.95, \left(\frac{\mathrm{d}y}{\mathrm{d}x}\right)_1 = 0.05^2 - 0.95^2$ $(= -0.9)$	A1 ft
	$y_2 - y_1 = 0.05(-0.9) \Rightarrow y_2 = 0.95 - 0.045 = 0.905$ (A1 is c.s.o.)	M1 A1 (6)
	(b) $\frac{dy}{dx} = x^2 - y^2 \Rightarrow \frac{d^2y}{dx^2} = 2x - 2y\frac{dy}{dx}$	M1 A1
	$\Rightarrow \frac{d^3y}{dx^3} = 2 - 2y\frac{d^2y}{dx^2} - 2\left(\frac{dy}{dx}\right)^2$ allow at this stage	M1 A1 (4)
	(c) [$y_{x=0} = 1, \left(\frac{dy}{dx}\right)_{x=0} = -1,$] $\left(\frac{d^2y}{dx^2}\right)_{x=0} = 0 - 2(1)(-1) = 2$	B1
	$\left(\frac{d^3y}{dx^3}\right)_{x=0} = 2 - 2(-1)^2 - 2(1)(2) = -4$	B1
	Maclaurin: $y = 1 - x + x^2 - \frac{2}{3}x^3$	M1 A1 (4)
	[Alternative (c) $y = 1 + a_1x + a_2x^2 + a_3x^3$	[14]
	$\Rightarrow x^2 - (1 + a_1x + a_2x^2 + a_3x^3)^2 = a_1 + 2a_2x + 3a_3x^2$ B1	
	Compare coeffs $\Rightarrow a_1 = -1;\ a_2 = 1,\ a_3 = -\frac{2}{3}$. B1; M1 A1]	

((*) indicates final line is given on the paper; cso = correct solution only; ft = follow-through mark)