1. Curve C is given by the polar equation $r = \sqrt{1+\sin 2\theta}$, $\theta \in [0, \pi/2]$.

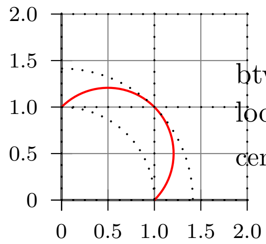
(a)(5) Write it into a rectangular equation:

Clearly, $1 \le r^2 \le 2$ in the 1st quadrant.

$$\begin{aligned} r^2 &= 1 + 2\sin\theta\cos\theta \text{ (+1)} \\ r^4 &= r^2 + 2r\cos\theta r\sin\theta \text{ (+1)} \\ (x^2+y^2)^2 &= (x^2+y^2) + 2xy \text{ (+1)} \\ x^2+y^2 &= |x+y| \text{ (+1)} \end{aligned}$$

$(x-\frac{1}{2})^2 + (y-\frac{1}{2})^2 = \frac{1}{2}$ or ~~$(x+\frac{1}{2})^2 + (y+\frac{1}{2})^2 = \frac{1}{2}$~~ (+1)

(b)(3) Sketch C:



btw $r=1$ & $r=\sqrt{2}$ (+1)

looks like a circle of radius $\frac{1}{\sqrt{2}}$ (+1)

centered at $(\frac{1}{2}, \frac{1}{2})$ (+1)

(c)(4) Compute the area enclosed by C in the 1st quadrant:

$$\begin{aligned} \text{Area} &= \int_0^{\pi/2} \tfrac{1}{2}(1+\sin 2\theta)\,d\theta \text{ (+1)} \\ &= \int_0^{\pi/2} d\theta/2 + \int_0^{\pi} \sin t\,dt/4 \\ &= \pi/4 \text{ (+1)} + 1/2 \text{ (+2)} \end{aligned}$$

(d)(4) Compute the arc length of C:

$$\frac{dr}{d\theta}^2 + r^2 = \left(\frac{\cos 2\theta}{\sqrt{1+\sin 2\theta}}\right)^2 \text{(+1)} + 1 + \sin 2\theta$$

$$= \frac{\cos^2 2\theta + 1 + 2\sin 2\theta + \sin^2 2\theta}{1+\sin 2\theta} \text{ (+1)} = 2 \text{ (+1)},$$

$$\text{Arc length} = \int_0^{\pi/2} \sqrt{2}\,d\theta = \pi/\sqrt{2} \text{ (+1)}$$

2.(8) $P(2,-2,1)$, $Q(3,-1,2)$, $R(3,-1,1)$. Find the equation of the plane containing $\triangle PQR$ and the area of $\triangle PQR$.

$$\overrightarrow{PQ} \times \overrightarrow{RQ} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & 1 \\ 0 & 0 & 1 \end{vmatrix} \begin{matrix}\text{(+1)}\\ \text{(+1)}\end{matrix} = (1,-1,0) \text{ (+2)}$$, parallel to plane's normal,

$\triangle$ area $= \|(1,-1,0)\|/2 = 1/\sqrt{2}$, (+2) $\big((x,y,z)-(2,-2,1)\big) \bullet (1,-1,0) = 0$, i.e. $x - y = 4$. (+2)

(Tidy up your work above. Anything written below does not count.)