

۱- $r \sin^2 u = r \sin u - 1 \Rightarrow r \sin^2 u + r \sin u - r = 0 \Rightarrow (r \sin u + 1)(\sin u - 1) = 0$ (الف)
 $\sin u = -\frac{1}{r}$ / $\sin u = 1 \Rightarrow \sin u = \sin \frac{\pi}{2} \Rightarrow u = \frac{k\pi}{r} + \frac{\pi}{2}$
 $u = \frac{k\pi}{r} + \frac{\pi}{2}$

$r \cos^2 u - 1 + \cos u - r = 0 \Rightarrow \cos^2 u + \cos u - r = 0 \Rightarrow (\cos u + r)(\cos u - r) = 0$
 $\cos u = -\frac{1}{r}$ / $\cos u = 1 \Rightarrow \cos u = \cos \frac{\pi}{2} \Rightarrow u = \frac{k\pi}{r}$

(الف) $(\sin^2 u - \cos^2 u)(\sin^2 u + \cos^2 u) = \sin^2 u \Rightarrow -\cos^2 u = r \sin^2 u \cos^2 u$
 $-\cos^2 u = 0 \Rightarrow \cos u = 0 \Rightarrow u = \frac{k\pi}{r} + \frac{\pi}{2}$

$\begin{cases} \cos^2 u = 0 \Rightarrow u = \frac{k\pi}{r} + \frac{\pi}{2} \rightarrow u = \frac{k\pi}{r} + \frac{\pi}{2} \\ \sin^2 u = -\frac{1}{r} \Rightarrow \sin u = -\frac{1}{\sqrt{r}} \rightarrow u = \frac{k\pi}{r} + \frac{\pi}{2} \end{cases}$

$r \cos^2 u - 1 + r \sin^2 u = 0 \Rightarrow \cos^2 u + \sin^2 u = 0 \Rightarrow \cos^2 u = -\sin^2 u$
 $\rightarrow u = \frac{k\pi}{r} + \frac{\pi}{2} \rightarrow u = \frac{k\pi}{r} + \frac{\pi}{2}$

$\frac{\cos u}{\sin u} (r \cos u + 1) = \frac{1}{\sin u} \Rightarrow r \cos^2 u + \cos u - 1 = 0$ (الف)
 $\cos u = 1 \Rightarrow u = \frac{k\pi}{r}$
 $\cos u = -\frac{1}{r} \Rightarrow u = \frac{k\pi}{r} + \frac{\pi}{2}$

$r \sin^2 u + \cos^2 u - \sin u \cos u = r \sin^2 u + r \cos^2 u \Rightarrow \cos^2 u + \cos u \sin u = 0$
 $\Rightarrow \cos u (\cos u + \sin u) = 0 \Rightarrow \begin{cases} \cos u = 0 \rightarrow u = \frac{k\pi}{r} + \frac{\pi}{2} \\ \cos u = -\sin u \rightarrow u = \frac{k\pi}{r} - \frac{\pi}{2} \end{cases}$

$\cos(\frac{\pi}{r} + u) \cos(\frac{\pi}{r} - u) = \frac{1}{r} \Rightarrow \cos(\frac{\pi}{r} + u) \sin(\frac{\pi}{r} + u) = \frac{1}{r} \Rightarrow \sin(\frac{\pi}{r} + u) = \frac{1}{r}$ (الف)
 $\rightarrow \cos u = \frac{1}{r} = \cos \frac{\pi}{r} \rightarrow \begin{cases} u = \frac{k\pi}{r} + \frac{\pi}{r} \rightarrow u = \frac{k\pi}{r} + \frac{\pi}{r} \\ u = \frac{k\pi}{r} - \frac{\pi}{r} \rightarrow u = \frac{k\pi}{r} - \frac{\pi}{r} \end{cases}$

$\cos(\frac{\pi}{r} - u) = \cos(\frac{\pi}{r} + u) \Rightarrow \frac{\pi}{r} - u = \frac{\pi}{r} + u \Rightarrow u = 0$
 $\vee u = \frac{\pi}{r} = \frac{k\pi}{r} - \frac{\pi}{r} \rightarrow u = \frac{k\pi}{r} - \frac{\pi}{r}$

$\frac{r \sin^2 u \cos^2 u + \sin^2 u}{\sin^2 u} = 1 \Rightarrow r \cos^2 u + 1 = 1 \Rightarrow r \cos^2 u = 0$

$\cos u = 0 \rightarrow u = \frac{k\pi}{r} + \frac{\pi}{2}$
 $\sin u \neq 0 \rightarrow u \neq \frac{k\pi}{r}$

$\frac{\sin \frac{u}{r}}{1 + \cos \frac{u}{r}} = \frac{1}{\sin \frac{u}{r}} + \cot \frac{u}{r} \Rightarrow \frac{\sin \frac{u}{r}}{1 + \cos \frac{u}{r}} = \frac{\cos \frac{u}{r} + 1}{\sin \frac{u}{r}} \Rightarrow \frac{\sin \frac{u}{r}}{1 + \cos \frac{u}{r}} = \frac{\cos \frac{u}{r} + 1}{\sin \frac{u}{r}}$ $\Rightarrow \sin^2 \frac{u}{r} = \cos^2 \frac{u}{r} + 2 \cos \frac{u}{r} + 1 \Rightarrow \cancel{\sin^2 \frac{u}{r}} - \cos^2 \frac{u}{r} - 2 \cos \frac{u}{r} - 1 = 0 \Rightarrow$ $X - 2 \cos \frac{u}{r} = 1 \Rightarrow \cos \frac{u}{r} = 0 \Rightarrow \cos \frac{u}{r} = 0 \Rightarrow \frac{u}{r} = k\pi + \frac{\pi}{2}$ $\Rightarrow u = r(k\pi + \frac{\pi}{2})$	6
$\cos^2 u - \sin^2 u \cos^2 u = 1 \Rightarrow -\sin^2 u \cos^2 u = \sin^2 u \Rightarrow -\cos^2 u = 1$ $\Rightarrow \sin^2 u (1 + \cos^2 u) = 0 \Rightarrow \sin u = 0$ $\Rightarrow u = k\pi \rightarrow 0, \pi, 2\pi$ $\cos^2 u = -1 \Rightarrow r u = r k\pi + \pi \Rightarrow u = \frac{r k\pi}{r} + \frac{\pi}{r} \Rightarrow u = \frac{\pi}{r}, \pi$ جواب: $\frac{\pi}{r}, \pi$	7
$\tan\left(\frac{\pi}{2} - u\right) = \tan u \Rightarrow \frac{\pi}{2} - u = k\pi + u \Rightarrow u = \frac{\pi}{4} - k\pi$ $\Rightarrow u = \frac{\pi}{4} - \frac{k\pi}{2}$	8
$\sqrt{1 + \sin^2 u} = \sqrt{2} \cos u \Rightarrow \sqrt{2} \cos u = \sqrt{1 + \sin^2 u}$ $\Rightarrow u = \pi \Rightarrow u = 0 \Rightarrow \cos u = k\pi + \frac{\pi}{r}$ جواب: $\frac{\pi}{r}$	9
$\sin^2 u - \cos^2 u = 1 \Rightarrow \cos^2 u = -1 \Rightarrow \cos u = \pm i \Rightarrow u = k\pi + \frac{\pi}{2}$ $r u = r k\pi + \frac{\pi}{2} \Rightarrow u = \frac{r k\pi}{r} + \frac{\pi}{2r}$ جواب: $\frac{\pi}{r}, \frac{\pi}{2r}$ نفاذ مری / انسان کی $h = 0 \rightarrow \frac{\pi}{r}$ ✓ $h = \pi \rightarrow 1$ X $h = \frac{\pi}{2} \rightarrow 1$ X $h = \frac{3\pi}{2} \rightarrow -1$ ✓	10