13/9/22	Tutorial	Planning	· · ·
assignment No	tes:	<b>V</b>	
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Convento	h` A		• • •
2) 100-65,	you are fall :	to assume circular helps is given by	<u>ц</u>
a param	etrization of	a certain form	) 
$\propto 6$	$t) = (a \cos t)$	, asmt, b).	
You can	then either	argue using Fund. Thm. of curves or solu	l
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Recall Def: Differential of a map: let  $f: U \subset \mathbb{R}^n \to \mathbb{R}^m$  be a differentiable map. Then the differential of fat pell,  $df_p: \mathbb{R}^n \to \mathbb{R}^n$ is defined as follows: let  $\alpha: (-2, 2) \rightarrow U$  be a smooth curve with  $\alpha(0) = p$ ,  $\alpha'(0) = W$ , then the curve  $\beta = Fo \alpha: (-2, 2) \rightarrow \mathbb{R}^m$ IS SMooth and we define defp by  $cf_{p}(w) = p(0).$ Note, when wrötten in the standend basis, §e,..., en 5, ofpische Jacobion matrix off at p. is. dFp(m). T pm · clfp Rn > Rm there are tangent spaces at p. f(p)

Recall Def (Regular Surface): NCR<sup>3</sup> is a regular surface if for each pEN, there is a while UCR<sup>3</sup> and an open set DCR<sup>2</sup> and a map X: D -> UNM S.t. 1) X is smooth 2) dx is full round: X =  $\frac{\partial X}{\partial u}$ , X =  $\frac{\partial Y}{\partial v}$  are linearly independent for any (4, v) eD (=> dXp is 1-1 for each pED) 3) X is a homeomorphism  $\mathbb{R}^3$  $(u_1,v_1)$  $(u_1,v_2)$  $(u_1,v_2)$  $(u_1,v_2)$ . Talk of (u,v) as the lacal coords of p if X(u,v)=p. Regulaivly condition (condition 2). avoid the following. P - no temgenot pleme here (regulanty conclotion) (homeomophism conclistion)

Ex 1: Hyperbolotel of 2 Sheets: -x2-y2+22=1. Show theat this
1 1 is a vegular surface and find a
pourmetrization.
Define $f(x,y,z) = -x^2 - y^2 + z^2 - 1$ .
Clearly the surface is the inverse image
$f^{-1}(0) = \xi(x,y,z) : -x^{2} - y^{2} + z^{2} = 1$
Clearly f:RI -> R is smooth, and
Ois a regular value of f since
af = -2r, af2y af = 2z. So VF vomishes only of (0,0,0
and (0,0,0) & f (0). So it is a regular surface.
Remote as 12+12+1=22, Taling 12=12+12 (10 K=rcosv)
Then we got $r^2 + 1 = z^2 = 1 = z^2 - r^2$ , $(1, y = rom v)$
Then by hypozodic trig identity cosh <sup>2</sup> u - sinh <sup>2</sup> u =1
we take Z= coshu, rasmiku, then we lieve
(x,y,z) = (sinhu cosv, sinhu sinv, coshu).
This is an annual of a regular of Fire Para the Lis disconnected
mis is an example of a regular surface mention disconnected
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$Ex2$ : $f(x,y,z) = z^2$ . Show $f^{-1}(0)$ is a negular surface.
$f'(0) = \{(x,y,z): 2^2 = 0\} <= \} \{z : Z = 0\}$
O is not a regular value of f smee
$\nabla f = (0, 0, 2z)$ , so $\nabla f$ vanishes when $z = 0$ , ie.
$0 \in f^{-1}(0)$
By above, f'(0) is the plane Z=0
Well show directly from the definition y
let $p \in f'(0)$ , then write $p = (u, v, 0)$ for some $u, v \in \mathbb{R}$ .
we here specified a param of f (0).
So X: $\mathbb{R}^2 \to f'(0)$ by X(u,v) = (u,v, 0).
· X is clearly surosth, a homeomorphism of R2 with P-1(0) = R2.
$dX = \left(\frac{\partial X_1}{\partial x_1}\right) = \left \frac{\partial X_1}{\partial x_1} - \frac{\partial X_1}{\partial x_1}\right  = \left[1 - 0\right]$
ON OK OK ON I
Lon ov j L j
L'Collimns are lin, molep.
So f (S) is a regimer surface.

Ex3: Cotenoid: (ccosh ~ cosu, ccosh ~ smu, v)  $ue(-\pi,\pi)$ , veR, c+o const. Is the surface quevolition dotancel by rotating the costenary u=ccosh c 1/ about the vertical. () u wrote the cotoneny as  $\alpha(v) = (0, ccoshy, v)$ Then rotating about the Z-axis, we have X(u,v) = (ccoshe cosu, ccoshe smu, v) Clearly X is smooth, we have vectricited domains of U, V so that X is homeomorphic. Finally, we have Xy= (sinhveosu, sinhvsinu, 1) Xu= (cosh\_sinu, cosh\_cosu, 0) which we can see are linearly independent. The catenaid is an example of a minimal surface (it is cally minimizes surface area (it is cally minimizes surface area functional  $\int dA$ (i) we can curve the area functional  $\int dA$ (i) mean curvesture identically  $0 \quad \overrightarrow{H} = \frac{1}{2\pi} \int_{-\infty}^{2\pi} |\widehat{H}(a) da = 0$ ).