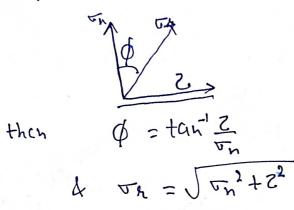
## COMPOUND OTRESSES & OTRAINS

Wilos

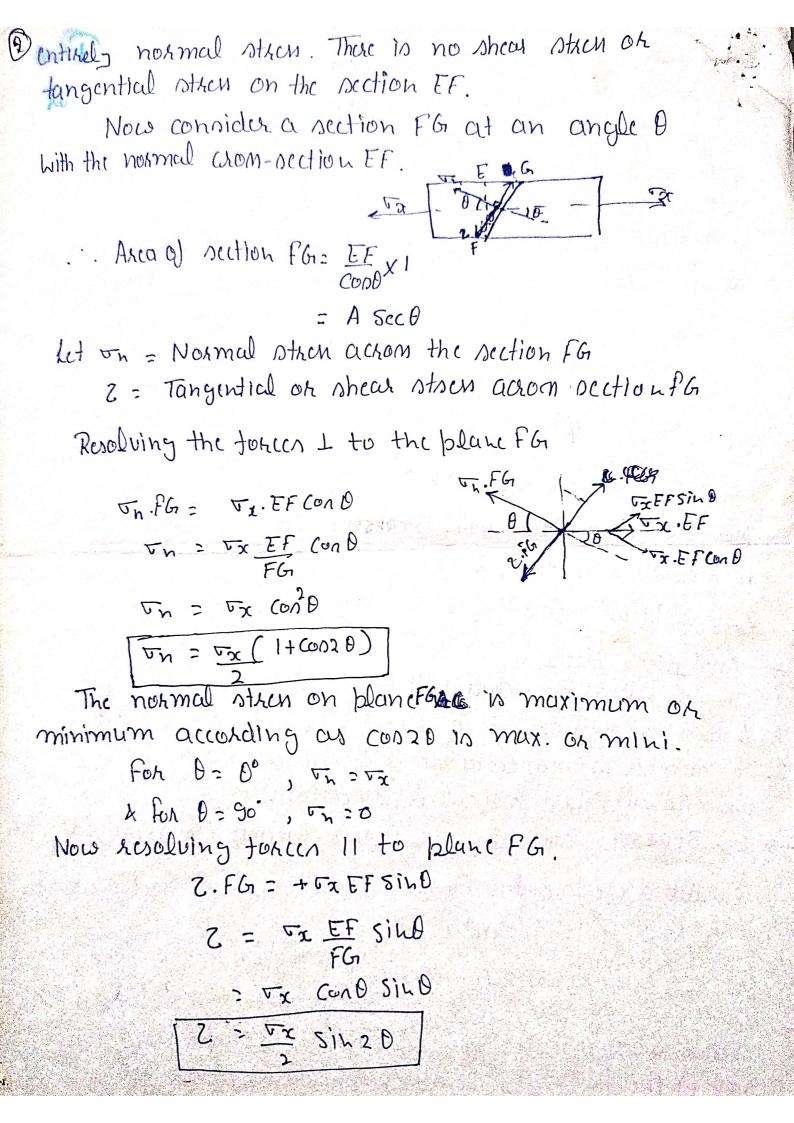
In many engincering problem, both direct (tensile of compressive) & shear stresses are brought in to play k the resultant stress across any section will be neither normal nor tangential to the plane. It on is the resultant stress making an angle of with the normal to the plane on which it acts



- 2. Graphical method
- \* Analytical Method The following two cases will be considered.
- 1. A member subjected to a direct stren in one plane.
- ?. The member is subjected to like direct strend in two mutually berbendicular directions

-> L. STRESSES ON OBLIQUE PLANE UNDER UNIAXIAL LOADING

Consider a rectangular member of uniform cross-sectional Let  $\nabla x = Axial Others acting P < The Bi The Bi The P$ area A k of unit thickness. Consider a crom-section EF which is I to the line of action of the fonce P. The stress on the section EF is



Resultant stach  $\sigma_{R} = \sqrt{\sigma_{R}^{2} + 2^{2}}$ 

$$= \frac{\nabla_{\mathcal{X}}}{2} \left[ \left( 1 + (002\theta)^{2} + 5ih^{2}2\theta \right)^{2} \right]$$
$$= \nabla_{\mathcal{X}} \left[ \frac{1 + (002\theta)}{2} \right]^{1/2} = \nabla_{\mathcal{X}} (00\theta)$$

32.

目的

If the resultant stren makes an angle  $\phi$  with normal stren then,

$$tan\phi = \frac{2}{5n} = \frac{520}{5x} \frac{\sin \theta}{\sqrt{2}} \frac{(\cos \theta)^2}{9}$$

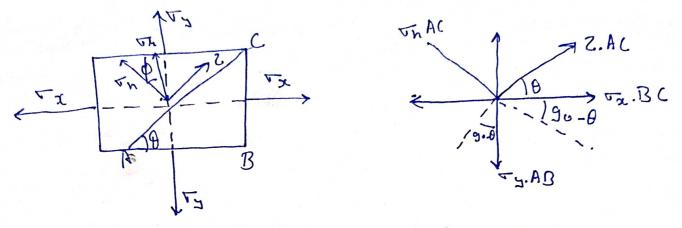
$$= tan\theta$$

$$\therefore \phi = \theta$$
Now, Shew Athen  $Z = \frac{52}{2} \frac{5\ln 2\theta}{2}$ 
Z is max when  $\frac{5\ln 2\theta}{2}$  is max. If.  
 $5\ln 2\theta = \pm 1$ 

$$2\theta = 50^{\circ} \frac{\cosh 270^{\circ}}{\theta = 45^{\circ} \frac{1}{25}}$$

$$\therefore \frac{2max = \frac{52}{2}}{2}$$

Tractore tox a state of uniaxial strue the max. tangential strue occurs along planes, the normal to which make angle of 45° & 135° with the direction of the load. <u>Conclusion</u> :- If a material is such that its shear strength is law than half of its tensile strength, then the material will tail by shear. 2. STESSES ON AN OBLIQUE PLANE UNDER BIAXIAL LOADING (a) Like strency - Consider a body under the action of biaxial strency on k or . Let Ac be the oblique plane inclined at an angle D with the plane AB which is 11 to the line of action of or . Let on k 2 be



the normal & shear streng on plane AC. Now, By resolution the tokes I to plane Ac Vn XAC = Vx. BC. Sind + Vy . AB. Cond Un = UX · BC · Sin0 + Uz · AB · Con0 = voc Sin'0 + vo con'0  $= \nabla_{\mathbf{x}} \left( 1 - (\omega n 2\theta) + \nabla_{\mathbf{x}} \left( 1 + (\omega n 2\theta) \right) \right)$  $\overline{\nabla n} = \overline{\nabla x + \overline{\nabla y}} + \left(\overline{\nabla y - \overline{\nabla x}}\right) \cos 2\theta$ Similarly, by Accoluling the forces 11 to plane AC, ZXAC = - TX. BC CONO + TZ. AB SIND Z = - Fx. BK COND + FJ AB SILD = - Tx SIND (OND + Ty COND SIND

$$= (\underline{\nabla}_{3} - \underline{\nabla}_{3}) \operatorname{Sind}(\underline{\sigma}_{10})$$

$$\boxed{2 = \frac{1}{2} (\underline{\nabla}_{3} - \underline{\nabla}_{3}) \operatorname{Sin20}}$$

The shear show is may, when 
$$\theta = 45^{\circ} k$$
  
The shear show is may, when  $\theta = 45^{\circ} k$   
The max, value is  
 $E_{max} = \frac{1}{2} \left( \frac{e_{3}}{5} - e_{3} \right)$   
At  $\theta = 45$ , the value of nonmed state is,  
 $\nabla_{n} = \frac{\nabla_{3} + \overline{\nabla_{3}}}{2}$   
RESULTANT STRESS  $\nabla_{A} = \sqrt{\nabla_{n}^{2} + 2^{2}}$   
 $= \left[ \left( \frac{e_{3} + e_{3}}{2} + \frac{\overline{\nabla_{3}} - \overline{\nabla_{3}}}{2} \left( \cos^{2}\theta \right)^{2} + \left( \frac{\overline{\nabla_{3}} - \overline{\nabla_{3}}}{2} \right)^{2} \sin^{2}2\theta \right]^{\frac{1}{2}}$   
 $= \left[ \left( \frac{e_{3} + e_{3}}{2} \right)^{2} \left( \cos^{2}\theta + 2 \right) \cdot \frac{\nabla_{3} + \overline{\nabla_{3}}}{2} \cdot \frac{\nabla_{3} - \overline{\nabla_{3}}}{2} \right] \left( \cos^{2}\theta + 5ix^{2}\theta \right)^{\frac{1}{2}}$   
 $= \left[ \left( \frac{\overline{\nabla_{3}} + e_{3}}{2} \right)^{2} \left( \cos^{2}\theta + 2 \right) \cdot \frac{\nabla_{3} + e_{3}}{2} \cdot \frac{\overline{\nabla_{3}} - \overline{\nabla_{3}}}{2} \right] \left( \cos^{2}\theta + 5ix^{2}\theta \right)^{\frac{1}{2}}$   
 $= \left[ \left( \frac{\overline{\nabla_{3}} + e_{3}}{2} \right)^{2} \left( \frac{\overline{\nabla_{3}} - \overline{\nabla_{3}}}{2} \right) \left( \frac{\overline{\nabla_{3}} - \overline{\nabla_{3}$ 

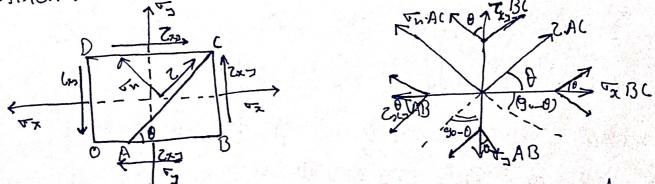
(b) W. Onlike strener: - let use be tensile & oz compressive.

Take tensile as the Comprariive as the

$$-: \nabla n = \nabla_{x} Sih^{2} \theta - \nabla_{y} (un^{2} \theta)$$
  
=  $\frac{1}{2} (\nabla_{x} - \nabla_{y}) := \frac{1}{2} (\nabla_{y} + \nabla_{y}) (un 2\theta)$   
&  $Z = -\frac{1}{2} (\nabla_{y} + \nabla_{y}) Sih 2\theta$   
&  $Zme_{x} = \frac{1}{2} (\nabla_{x} + \nabla_{y})$ 

20 BIAXIAL STRESSES COMBINED WITH SHEAR STRESSES

Consider a rectangular body OBCD of unit thickness subjected to direct stress  $\overline{z_2} & \overline{z_3} & shear stress \overline{z_2}$ . Let AC be the oblique plane making an angle O with the  $\overline{z_2}$  stress.



Let vn & z be the normal & shear stren respectively acting on the plane AC

Now by resolving all the functs along the direction of  $\nabla n$ , we get  $\nabla_{r}AC + 2z_{2}BC \cos\theta - \nabla_{x}BC \sin\theta - \nabla_{y}AB \cos\theta + 2z_{2}AB \sin\theta = 0$   $\Rightarrow \quad \nabla_{n} = \nabla_{x} \frac{BC}{AC} \sin\theta + \frac{\Gamma_{3}}{AB} \frac{AB}{AC} \cos\theta - \frac{Cx_{3}BC}{AC} \frac{Cm\theta}{AC} - \frac{Cx_{3}AB}{AC} \sin\theta$   $\Rightarrow \quad \nabla_{n} = \nabla_{x} \frac{BC}{AC} \sin\theta + \frac{\Gamma_{3}}{AB} \cos\theta - \frac{Cx_{3}BC}{AC} \cos\theta$  $= \nabla_{x} (1 - \frac{Cm^{2}\theta}{2}) + \nabla_{y} (1 + \frac{Cm^{2}\theta}{2}) - \frac{Zz_{3}}{2} \sin 2\theta$ 

$$\frac{1}{|T_{n}|^{2}} = \frac{1}{12} (\frac{1}{2} + \frac{1}{22}) + \frac{1}{12} (\frac{1}{23} - \frac{1}{22}) (\omega_{12} \partial \theta - 2\lambda_{12} Sin2\theta)$$
Now Ansolving all the token 11 to blane AC  

$$\frac{1}{2} = \frac{1}{2} \frac{1}{2} (\frac{1}{23} - \frac{1}{23}) AB = \frac{1}{2} AC = \frac{1}{2} AB = \frac{1}{2} AB = \frac{1}{2} AC = \frac{1}{2} AB = \frac{1}{2} AC = \frac{1}{2} AC = \frac{1}{2} AB = \frac{1}{2} AB = \frac{1}{2} AC =$$

The keo values of 20 g differ by 180° y  
hence two values c) 0 differing by 90°.  
Note: - Comparing eqn. (1) k(2)  
tan 20 = 
$$-\frac{\sigma_{3}-\sigma_{3}}{2\tau_{3}} = -\frac{1}{tan 0}$$
.  
 $\Rightarrow tan 20 = -\cot 20$ ,  
 $\Rightarrow tan 20 = -\cot 20$ ,  
 $\Rightarrow tan 20 = tan 90+20$ ,  
 $\Rightarrow 0 = 0 +5° + 0$ ,  
 $\Rightarrow 0 = 0 +5° + 0$ ,  
 $\Rightarrow -\frac{1}{2} \frac{(\sigma_{3}-\sigma_{3})(\sigma_{3}-\sigma_{3})}{2\sqrt{(s_{3}-\sigma_{3})^{2}+t^{2}s_{3}}} \frac{1}{\sqrt{(s_{3}-\sigma_{3})^{2}+t^{2}s_{3}}} \frac{1}{\sqrt{(s_{3}-\sigma_{3})^{2$ 

## PRINCIPAL STESSES & PRINCIPAL PLANES

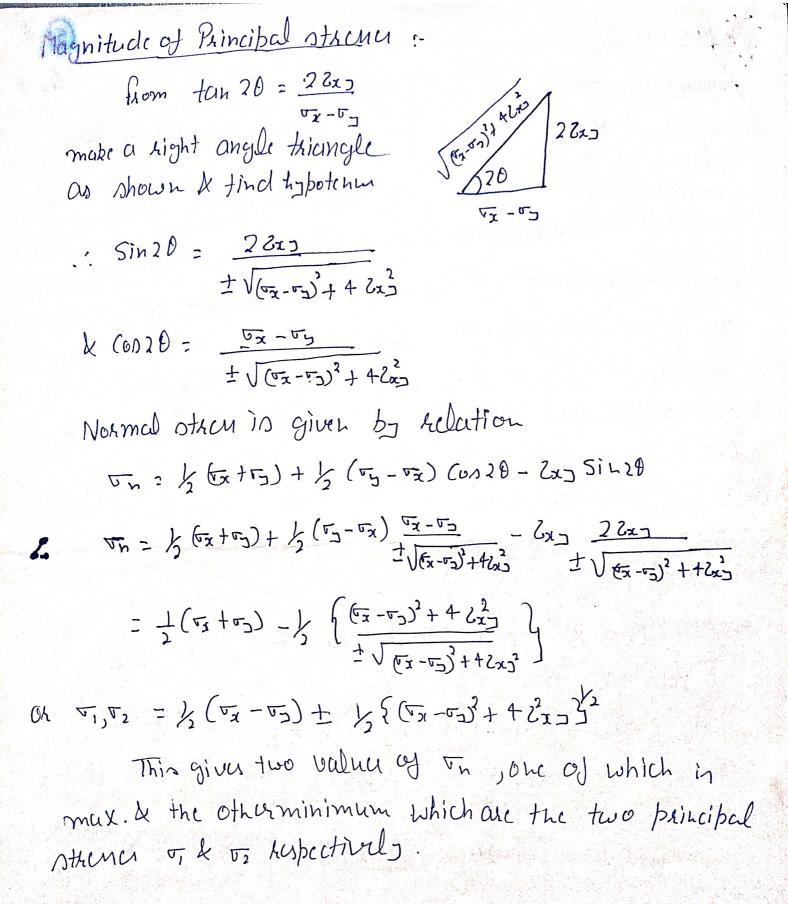
PRINCIPAL PLANES: With in a stacked body at any boint, there always exist three mutually perpendicular planes on each of which the resultant strew is a normal strew. There is no shear strew. There mutually perpendicular planes are called principal planes.
PRINCIPAL STRESSES: - The resultant normal strews acting on the principal planes are called principal strews. In the case of two dimensional problems, one, of the principal strew is zero & out of other two, one is the greatest & the other is the least atree.
Position of principal planes:-

strear strent, in call of blaxial strand combined is

Put 
$$Z = 0$$
  
 $\frac{1}{2} (\overline{v_3} - \overline{v_x}) \sin 2\theta + 2xy (0.020 = 0)$   
 $\Rightarrow \qquad \frac{5 \sin 2\theta}{C \cos 2\theta} = -\frac{2Cxy}{\overline{v_3} - \overline{v_x}}$   
 $\Rightarrow \qquad \frac{1}{2} \tan 2\theta = \frac{2Cxy}{\overline{v_3} - \overline{v_x}}$ 

7. = K (vy - vx) Sin20 + 2xy (0020

This gives two values of 20 differing by 180° 4 hence two values of 0 differing by 90°, ic the principal planes are two planes at hight angle.



MOHR'S CIRCLE :-

It is a graphical method of tinding normal, tangentia & resultant strenes on an oblique plane. Mohn's circle will be drawn ton the following

Carci: (i) A body subjected to two mutually perpendicular principal tensile strenes of unequal intensities.

(ii) A body subjected to two mutually perpendicular principal strener which are unequal & unlike (ic., one is tensile & other is comprehive)

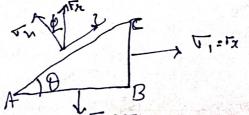
(iii) A body subjected to two mutually I principal struck accompained by a simple shear stren.

I canclix-

Let of = Major tenile other (or principal stren)

vy = Minoh tensile stren(oninprincipal stren)

on the principal plane BC & AB. The stren circle will be developed to find the stress components on any blanc AC which makes angle & with AB.



METHOD TO MAKE MOMP'S CIRCLE .

Marbold PL= JI= TO JT, UN JJT PM= 52= Ty

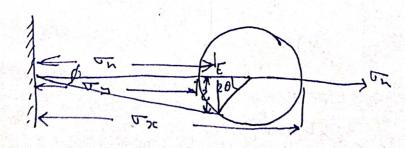
ON LM as diameter describe a circle ?antre O.

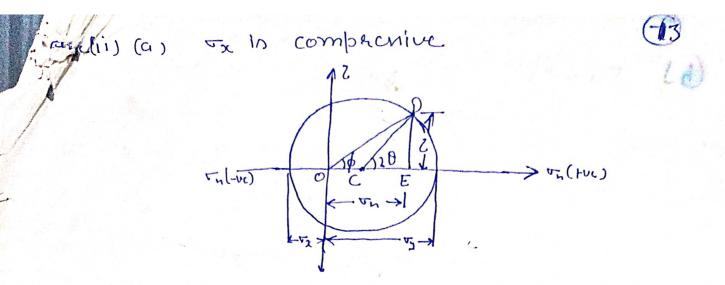
Then the hading OL Represents' the plane of VI (BC), & OM 'represents' the plane of Ta(AB). Plane AC is obtained by

circle is notated through 20 in the same direction, the radius OR is obtained which will give be shown to represent the plane AC.

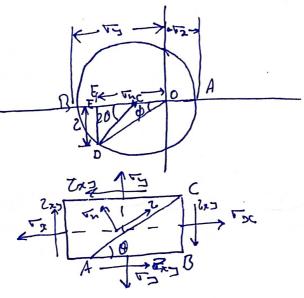
Phace RN  $\perp$  PM Then PN = PO + ON =  $\frac{1}{2}(\overline{v_1} + \overline{v_2}) + \frac{1}{2}(\overline{v_2} - \overline{v_1})(vo2\theta)$ =  $\overline{v_1}(1 - (vo2\theta)) + \overline{v_2}(1 + (vo2\theta))$ =  $\overline{v_1} \sin^2\theta + \overline{v_2}(vo2\theta)$ =  $\overline{v_1}, \text{ the normal stren component on AC.}$ K RN =  $\frac{1}{2}(\overline{v_2} - \overline{v_1})\sin 2\theta$ =  $\overline{c}, \text{ the sheat stren component on AC.}$ Also the resultand stren  $\overline{v_1} = \sqrt{\overline{v_1}^2 + U^2}$ k its inclination to the normal of the plane in given by  $d = \langle RPN \rangle$ .

Other care :- Ux> 53

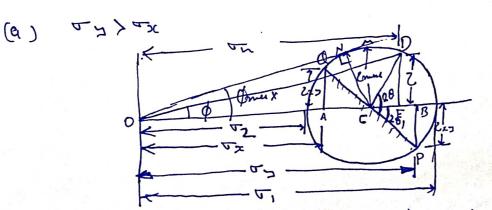




(b) on in compachive



Carc(iii)

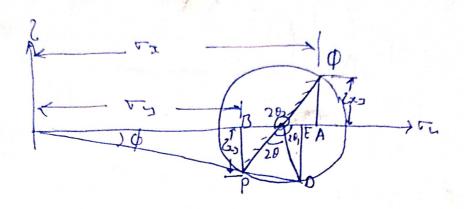


Mapof OA= TX, OB= TS, & take AQ=BP= 2xJ -> Join PQ.

-> with ( as centre & CP as radius draw the circle. -> Draw(PCD = 20

+ Draw DELAB & Join OD.

Then  $OE = \nabla n$ , DE = 2,  $OD = \nabla n$ ,  $dG = \nabla_1$ , LOO(= q) $OF = \nabla_2$ , LPCG = 201, LPCF = 202, LNOF = q (b) v z < ~ >(



stander and the wayboar it



MOHR'S CIRCLE :-

It is a graphical method of finding normal, tangential & resultant stren on an oblique plane.

Mohr's circle will be drawn for following cases generally:

(1) A body subjected to two mutually perpendicular principal tensile struce of emequal intensities.
(ii) A body subjected to two mutually perpendicular principal structure which are unequal & unlike (i.e. One in tensile & other is compressive)
(iii) A body subjected to two metually perpendicular principal structure accompained by simple shear structure.

<u>Carecis</u>: - A body in subjected to two mutually berbendicular principal tensile structure of unequal intensitients of alike . 12 het,  $\overline{v_2} = Major tensile structure of$ on two, principal structure ofon two, principal structure ofoh timmum principal structure0 = Angle made by oblique plane withminor tinsile structure.

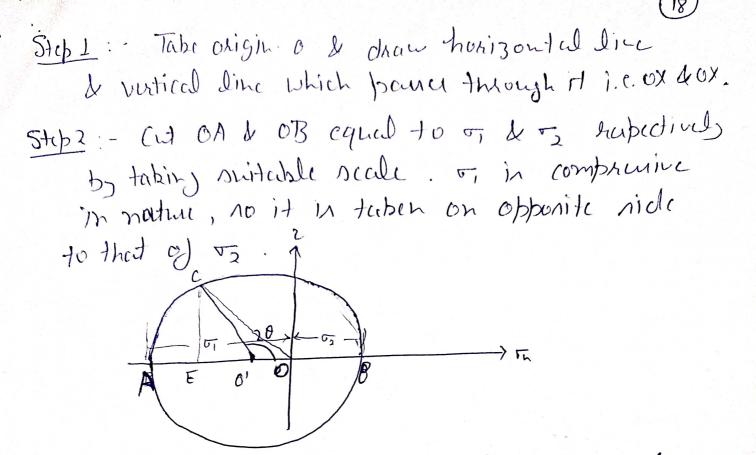
To findout

Normal stren on oblight plane = Th Shear stran on oblique plane = 2 Resultand strucy on & 2 = Th Resultant angle of The with Th = \$ Maix shear stren = Zomax Max. resultant angle = Amery How to make Mohr's circle of stren with given data & to find out struct on oblightplane Step 1: - Take origin O & draw horizontal line & vertical line to which barrer through it j.e. OX & OY. NOTE: All shear streng taken on vertical line & direct struct on horizontal line. Step 2: - Cut OA & OB equal to T, & 52 respectively by taking suitable scale. 2%

(10)

Stip 3: - Binect AB at O'K tabe O' an centre & O'A an radiu, draw circle

Step4. - At andre O', draw on inclined line at an angle of 20 which cuts the circle at point C Step 5: Through boint C, draw a perpendicular line to the hosizontal line which cuts it at point E. Alno join OC. Step 6: - Now, Meanne OC, OENCE. Thue are aquivaluit to va, va, t 2 rapedively Step 7 - Manne 200B, O'c (radius of circle) also. LCOB ~ p O'C ~ Zmax Stip8, - For finding out Pmax, draw a line from O', which in tangential to the circle cut Ciscle at F. 2FOB ~ Pmax (an(1)) A body is subjected to two mutually porpendicular principal strand which are unequal & unlike.  $\overline{\nabla}_{1} = Complemine other$   $\overline{\nabla}_{2} = Complemine other$   $\overline{\nabla}_{2} = Tensile other$  D = Angle of abline 10 D = Complemine otherGiven 0 = Angle a) obliger plane 15 To Hind out Normal stran on oblight plane, m Shear stress on oblight plane, 2 Resultant AtACM of The & 2 Angle of obliquity of resultant string



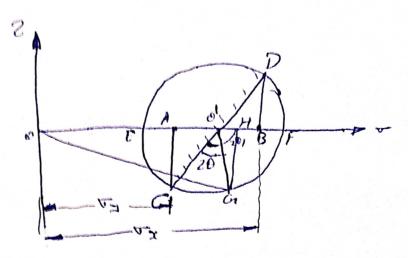
- Step 3 : Binect AB at d' & tabe d' an centre & d'A as radius, draw a circle.
- <u>Step 4</u>: At centre o', draw an inclined line at an angle of 20 which cut the circle at point C.
- Step 5: Through point (, draw a perpendicular Dine to the horizontal line which cuts it at point E. Also join OC.

Step 6: - Now, meanure OC, OE, CE & LCOA Thur are equivalent to v7, v7, 2 & Q hubectively Convert there in to strem by multiplying with anomed real.

A body in subjected to two mituelly Care (in) perpendicular principal struct accompained by simple shear stren Vi JANZ (a) "2) "2 Giver :-Vy= Major tensile stran 7 - Minor tenrile strug Zx> = Shear Atres ß O = Angle maide of E A by oblique "Islanc K " 521 & with minor tensile struct To find out :-Maximum & Minimum Principal stacueije. VT & 52 Winection of plane of vikoz i.e. D, Dz i.e. Principal Hann Maximum she car stren i.e. Zoner Direction of planes of maximum shear stren ic. of + 04 Normal stren on oblight plane i.e. Th Shear stren on oblight plane i.e. 2 Resultant strong on b 2 i.c. on Resultand angle of the ton i.c. \$ Sol. Step ! 1. Make off OA-Tx, OB-Ty Oh Ox line 2. Also take AC & BD in opposite direction equivalent to zxy 3. Join CD which cuts the hostizontal line at 0's

<ul> <li>(1) With o' as crudne &amp; o'c as hadim, draws chile which cuts the horizoutal Dire at E &amp; F.</li> <li>5. Ohnus an angle of 20 with CD as base line &amp; o' as and i.e. 2600 = 20.</li> <li>6. Ohnus perpendicular from point G on or other line which add it at H. Join o a line the or of the or o</li></ul>	
Chile which cut the horizoutal line at E & F. 5. Oknus an angle of 20 with CD an base line & O' an andre i.e. 26,0'D = 20. 6. Okans papendicular from point G on ox boose line which and the Join OG of one 7. Now measure OE & OF, which equivalent to $\nabla_2 & \nabla_1$ . Meanie 2BO'D ~ 20, & Os = 0,445 $O_2 = 0,190^\circ$ $D4 = 0,2445^\circ$ Nouve GH, OG, OH, 2Gool which are Chuivelent to 2, $\nabla n$ , $\nabla n & A & Aubechidy Censure it boy multiplying by anymed neale. (b) \nabla_2 \times \nabla_3Given:-\nabla_3. High trule otherT_3. High trule otherD_2 = 0,190° D_1 and T_1 while there with might thereT_3. High trule otherT_3. High trule otherD_2 = 0,190° D_1 and T_2 and T_3T_4 and T_4 and T_4 and T_4 and T_4 and T_4 and T_5 and T_5.T_5. High trule otherT_5 and T_7 and T_8 and T_$	
at F & F. 5. Quanto an angle of 20 with CD as base line & O' as an angle of 20 with CD as base line & O' as an angle i.e. 260D = 20. 6. Quanto perfecticular from point Gi on ox board line which add it at H. Join OG also 7. Now measure OF & OF, which equivalent to $\overline{r_2} \wedge \overline{r_1}$ . Meane 280'D $\sim 20$ , & $0_3 = 0.145^5$ $0_2 = 0.190^\circ$ $04 = 0.2445^\circ$ Meane GH, OG, OH, 2600' which are Cynivelent to 2, $\overline{r_1}$ , $\overline{r_n} \wedge \phi$ subsectively Cenvert it tory multiplying by assumed scale. (b) $\overline{r_2} \times \overline{r_3}$ Given: $\overline{r_3}$ . Migor tenide stars $\overline{r_5}$ . Migor tenide stars $\overline{r_5}$ . Shear Athen $\overline{P} = Angle meide by oblighte fleure with meiger tenide Athen To third at \cdot - May & Min. Principed attenue ie. \overline{r_1 \times r_2}Quantion of plate of \overline{r_1 \times r_3} is. \overline{P_1 \times P_2}$	,
<ul> <li>5. Okaus an angle of 20 with CD as base line &amp; O' as cendre i.e. 26,0D=20.</li> <li>6. Okaus perpendicular from point G on on ox base line which add it at H. Join o G also</li> <li>7. Now measure OE &amp; OF, which equivalent to \$\overline{\sigma}_2 &amp; \overline{\sigma}_1.</li> <li>7. Now measure OE &amp; OF, which equivalent to \$\overline{\sigma}_2 &amp; \overline{\sigma}_1.</li> <li>7. Now measure OE &amp; OF, which equivalent to \$\overline{\sigma}_2 &amp; \overline{\sigma}_1.</li> <li>7. Now measure OE &amp; OF, which equivalent to \$\overline{\sigma}_2 &amp; \overline{\sigma}_1.</li> <li>7. Now measure OE &amp; OF, which equivalent to \$\overline{\sigma}_2 &amp; \overline{\sigma}_1.</li> <li>7. Now measure OE &amp; OF, which equivalent to \$\overline{\sigma}_2 &amp; \overline{\sigma}_1.</li> <li>7. Now measure OE &amp; OF, which equivalent to \$\overline{\sigma}_2 &amp; \overline{\sigma}_1.</li> <li>7. Now measure OE &amp; OH, a line of \$\overline{\sigma}_2 &amp; \overline{\sigma}_2.</li> <li>7. Now measure OE &amp; OH, a line if \$\overline{\sigma}_2 &amp; \overline{\sigma}_2.</li> <li>7. Measure 2 BO' D \$\sigma 2 &amp; \overline{\sigma}_2.</li> <li>7. Measure 2 BO' D \$\sigma 2 &amp; \overline{\sigma}_2.</li> <li>7. Measure 2 BO' D \$\sigma 2 &amp; \overline{\sigma}_2.</li> <li>7. Measure 2 &amp; \overline{\sigma}_2.</li> <li>7. Measure 3 &amp; \overline{\sigma}_2.</li> <li>7. A \$\overline{\sigma}_2 &amp; \overline{\sigma}_2.</li> <li>8. A \$\overline{\sigma}_2 &amp; \overline{\sigma}_2.</li> <li>8. A \$\overline{\sigma}_2.</li> <li>8. A \$\overline{\sigma}_2.</li> <li>9. A \$\</li></ul>	
<ul> <li>&amp; O' ar cerdre i.c. 26,0'D = 20.</li> <li>6. Oraces performational promission point an one of the which added the point of an oracle.</li> <li>7. Now measure OE &amp; OF, which equivalent to \$\nabla_2\$ &amp; \$\nabla_1\$.</li> <li>Morrise 2BO' D \$\sigma 20, \$\mathcal{k}\$ \$\mathcal{O}_2\$ = \$\mathcal{O}_1 + 90^{\circ}\$ \$\mathcal{D}_2\$ \$\math</li></ul>	
<ul> <li>6. Φλαιθ þerþendiceðar from þoint Gron ox bærð line which (ida it at H. Join 0 Gradro</li> <li>7. Now meanne 0E &amp; OF, ashich equivedent to ∇<sub>2</sub> &amp; ∇<sub>1</sub>.</li> <li>Menne ∠BO'D ~ 20, &amp; 03: 0,145 02 = 0,190° 04 = 02+45°</li> <li>Monne GrH, OG, OH, ∠GOO' which are Cynivelent to Z, ∇π, σπ &amp; Ø Aubectindy Cenvert it toy multiplying by assumed reade.</li> <li>(b) σ<sub>2</sub> &gt; σ<sub>3</sub></li> <li>Griven: ∇<sub>2</sub>: hight tenile stære 5: Hight tenile stære To finde at i - Has. &amp; Hin. Principed otherur ie. T &amp; 52 Otherton of place of TK To 1. K OL</li> </ul>	지 않는 것은 것은 데이지 않는 것 같아요. 그는 것 같아요. 그는 것은 것 같아요. 것
Ox boox line which (which it at H. Join 06, also 7. Now measure OE & OF, which equivalent to $\overline{\nabla}_2 & \overline{\nabla}_1$ . Measure 2 BO'D ~ 20, & $\overline{O}_3 = \overline{O}_1 + 45^{\circ}$ $\overline{O}_2 = \overline{O}_1 + 90^{\circ}$ $\overline{O}_4 = \overline{O}_2 + 45^{\circ}$ Measure G.H., OG, OH, LGOOI which are Cynivalent to 2, $\overline{\nabla}_1$ , $\overline{\nabla}_1 & d$ $\overline{D}$ Aufsectively Convert it toy multiplying by ansmed reale. (b) $\overline{\nabla}_2 > \overline{\nabla}_3$ Given:- $\overline{\nabla}_3 = Hight trulle other \overline{\nabla}_5 = Hight trulle other \overline{\nabla}_5 = Shear Ather \overline{O} = Angle made by oblighte former vith major tengle Ather To find out - Hay. & Hin. Principal Atherna ie. \overline{\nabla}_1 & \overline{O}_3.$	방향을 생겨 사람들 모두 가격을 열 한 것 때 문화 관계가 많은 것이다. 그는 것이라는 것은 것은 것이 가지 않는 것 같아. 것이 없는 것이 없는 것을 했다.
to v <sub>2</sub> k v <sub>1</sub> . Meanue ∠BOD ~ 20, k 0 <sub>3</sub> : 0,+45 0 <sub>2</sub> = 0,+90° 04 = 02+45° Meanue GiH, OG, OH, LGOOU which are Cquivalent to Z, vn, vn k φ Aubechidy Cenvent it tog multiplying by anomed reale. (b) v <sub>2</sub> > v <sub>3</sub> Given:- v <sub>3</sub> : Higor tenide other S= Minor tenide other 0 = Angle meide by oblighte plane with meigen tenide Athen <u>To tind out</u> - Hay. & Min. Phineipal otherwarie ie. vidoz Quartino of plane of vizo 10. 0, k 02	그는 그는 아파 아파 그는 것 같은 것 같아요. 그는 것은 것 같아요. 그는 것 같아요. 그 그는 것 같아요. 그는 그는 것 그는 그는 것 ? 그는 그는 것 ? 그는 그는 것 ? 그는 그는 그는 그는 그는 그는 요. 그는 그는 그는 그는 그는
to v <sub>2</sub> & v <sub>1</sub> . Menue ∠BOD ~ 20, & O <sub>3</sub> : 0,+45 O <sub>2</sub> = 0,+90° 04 = 02+45° Menue GiH, OG, OH, LGOO' which are Cquivalent to Z, vn, vn & Ø Aubschiedy Cenvent it toy multiplying by anomed neale. (b) v <sub>2</sub> > v <sub>3</sub> Given:- v <sub>3</sub> : high tenile stren v <sub>5</sub> : high tenile stren Can tenile stren Direction of place of the major tenile Atrin <u>To tind out</u> - Har. & Hin. Principal streng ic. v & 0.2 Other of the of	7. Now measure OE & OF, which equivalent
θ <sub>2</sub> = θ <sub>1</sub> +90° θ4 = θ <sub>2</sub> +45° Manue GiH, OG, OH, LGOOI which are Cquivalent to Z, Th, Th & Ø Aufsectively Convert it tong multiplying by assumed reale. (b) σ <sub>2</sub> > σ <sub>3</sub> Given:- T <sub>2</sub> : Hajor teniele other T <sub>3</sub> = Minor teniele other B = Angle meide by oblique plane with mayor teniele Atum To find out :- Hay. & Hin. Principal attenue ie. T. doz Question of plane of TK T3 1.8. 9, K θ <sub>2</sub>	지 같아요. 그는 것 같아요. 그는 그는 것 같아요. 그 그는 요. 그는 것 같아요. 그는 것 같아요. 그는 것 같아요. 그는 그는 요. 그는 것 같아요. 그는 것 같아요. 그는 그는 것 같아요. 그는 것 ? 그는 것 같아요. 그는 것 같아요. 그는
Monne GrH, OG, OH, LGOU which are Cynivalent to Z, Tr, Tr & Ø Ampectialy Convert it tory multiplying by animed reals. (b) J2 > J2 Given:- Tr = Migor tenile stren To = Mone made by oblique plane with migor tenile Aten To find out : - May. & Min. Principal atrance ie. Tr & J2 (Direction of plane of TK To 10. B, K B2	Manue 200 D ~ 20, & 03: 0,+45"
Monne GiH, OG, OH, LGOO' which are Cynivalent to Z, Vr, vn & Ø subjectively Convert it tory multiplying by assumed reale. (b) J2 > 05 Given:- Vz: Major tenile stren Tz = Minor tenile stren D:= Angle maide by oblighte plane with major tenile Atra To find out :- May. & Min. Principal atrance ie. vr & 02 Other of plane of vr & 0, k B2	
Cynivalent to Z, Th, Th & O hubectively Convert it tory multiplying by assumed reale. (b) $\sigma_x > \sigma_y$ Given:- $\overline{\sigma_x} = Hajor tenile other\overline{\sigma_x} = Major tenile other\overline{\sigma_x} = Shear otherD = Angle maide by oblighte belance with major tenileotherTo the out :- Hay & Hin. Principal otherwar i.e. \overline{\sigma_x} = M\sigma_y$	Manue Git, OG, OH, LGOO' which are
Convert it toy multiplying by anumed reale. (b) $\sigma_{2} > \sigma_{3}$ Given:- $\overline{\sigma_{x}} = Higor tenile other \overline{\sigma_{5}} = Minor tenile other \overline{\sigma_{5}} = Shear Athen \theta = Angle meide by oblique plane with migor tenile Athen To tind out - Hay & Min. Phincipal Athenue i.e. \overline{\sigma_{5}} d\sigma_{2}$	Cynivalent to Z, Th, Th & P rupectively
5 = Minor times und Exs = Shear Athen θ = Angle maide by oblighte followe with might tengle Athen To tind out - Hay & Min. Principal Athenne i.e. v. doz Quection of plane of v. k. θ. K. θ. K. θ.	Convert it toy multiplying by assumed reale.
5 = Minor times und Exs = Shear Athen θ = Angle maide by oblighte followe with might tengle Athen To tind out - Hay & Min. Principal Athenne i.e. v. doz Quection of plane of v. k. θ. K. θ. K. θ.	(b) $\sigma_{\chi} > \sigma_{\chi}$
5 = Minor times und Exs = Shear Athen θ = Angle maide by oblighte followe with might tengle Athen To tind out - Hay & Min. Principal Athenne i.e. v. doz Quection of plane of v. k. θ. K. θ. K. θ.	273A VIX
5 = Minor turner Exs = Shear Athen 0 = Angle maide by oblighte followe with might tengle Athen To tind out - Har. & Min. Phincipal Athenne i.e. v. doz Ωtrection of plane of T & v2 1.e. 0, K 02	Given:-
5 = Minor turner Exs = Shear Athen 0 = Angle maide by oblighte followe with might tengle Athen To tind out - Har. & Min. Phincipal Athenne i.e. v. doz Ωtrection of plane of T & v2 1.e. 0, K 02	Vz = Major tenile stren A VV5
0 = Angle maide by oblighte facture conn mayor Atren To find out : - Hay. & Min. Principed Atrene i.e. v. doz Direction of plane of v. k v. 18. 0, k 02	T3 = Minor Timber
To find out : - May & Min. Principal Atran i.e. v. 652 Direction of plane of v. & J. R. O. K O2	Exy: shear minde by oblighte blanc with mayor tenile
To find out : - May. & Min. Thincipal Athan I.C. VT & 52 Direction of place of TX 53 1.S. D. K D2	A 14 AA
WIRECTION Of Treasure of the 2	This hat the Have & Him. Principal Atrance LC. TT & 52
duit Thear Athen Li, court	WIRECTION of Izean of 1 n 2
	dux man stren LC, come t

Dividion of planer of mus obtain other ic. Oz & O4 Normal return on ablique plane ic. The Shear stress on ablique plane ic. Z. Resultant stren of vid Z ic. The Resultant angle of vid Vin 1c. of Sit.



D. Houp off 0A-05, OB-05 on horizontal Dine by assuming suitable scale.

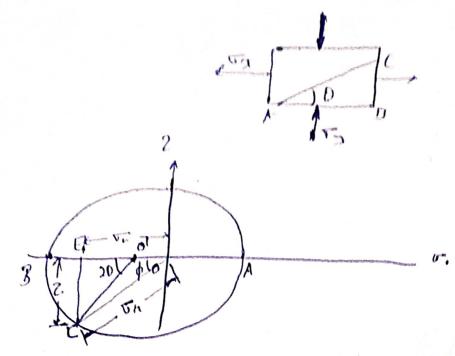
(2) Also take AC & BD in opposite direction oquivalent to Zas.

Note: - Ac in downward direction & BD in upward direction where as in previous care. Ac was in upward direction & BD in downward direction.

(3) Join CD which and the hurizontal line at 0'.
(4) With 0' as centre & O'C as heading, draw circle which and the hurizontal line at E & F.
(5) Draw an angle of 20 with CD as bare line & O' as centre ic. 260'C = 20 in anticlochrine direction.

(6). Draw perpendicular from point G on or line which and it at H. Join Obr also. D Now meanine OE & OF, which equivalent to 5. 4 57 Meanue LBO'C=20,  $\theta_1 = 2 \frac{B \theta' c}{2}$  &  $\theta_3 = \theta_1 + 45^\circ$ 04 = 0,+45° Measure GH, OG, OH, ZGOO' which are equivalent to Z, T, The & Auspectively. Convertit by multiplying by assumed scale. OTHER GASES (1) USLUX, when a body in subjected to two mutually perpendicular strater ouls C ID Sol. 720(101

(ii.) of in companying, when a body in pubjected to two minuly perpendicular manually

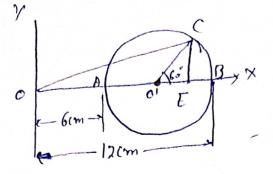


Problem 1.10.

The principal tensile strenger at a point across two mutually perpendicular planes are  $120 N/mm^2$  &  $60N/mm^2$ . Octamine the normal, tangential & heseltant strenger on a plane indired at 30° to the axis of the minor principal stress by Hohr's circle method. Sol. - Given Hajor principal strenger =  $120 N/mm^2$  (tensile) Hinor principal strenger =  $60 N/mm^2$  (tensile) Angle of oblique plane with the axis of of minor principal stress,  $0 = 30^{\circ}$  $1^{\frac{1}{2} - 120 N/mm^2}$ 

> Let u assume a scale  $1 \text{ cm} = 10 \text{ N/mm}^2$  $\frac{1}{2} = \frac{120 \text{ N/mm}^2}{12 \text{ cm}}$

Mohr's circle is drawn as:



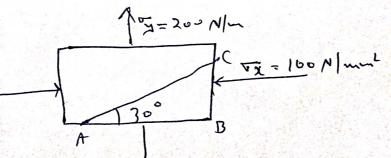
1. Take origin of & draw vertical line or & hurizouted line OX. 2. Take OA-TX-6cm & OB-Ty-112cm J. Bind AB at o' & with AB on diameter, draw circle. 4. At centre O', draw an inclined line with engle 20=60 which cuts the circle at point C. 5. WHEN CELOX & Join OC also 6. Measure OC, OE, CE & LCOB By Measurements: hength  $\mathcal{A} O E = 10.5 \text{ cm}$  &  $\angle C O E = \phi =$ CE = 2.60 CmOC = 10.82 cm . Normal Atru, vn = OEX Acale = 10.5× 10 = 105 N/mm2 Ano Tangential of shear Atru, 2 = CEX scale = 2.6 × 10 = 26 N/mm Ars 6 Republicant strung, 07 = 10.82 × 10 = 108.2 N/mmt P\_ Problem 1.11

The principal place at a point in a bar are 2001/mm? (tensile) & 100 N/mm? (comparative). Actumine the scrubtant strue in magnitude & direction on a plane inclined at 30° to the axis of the minor principal strue (on to the plane of major principal strue i.e. major principal plane). Also detomine the maximum intensity of shear strue in a maturial at that point.

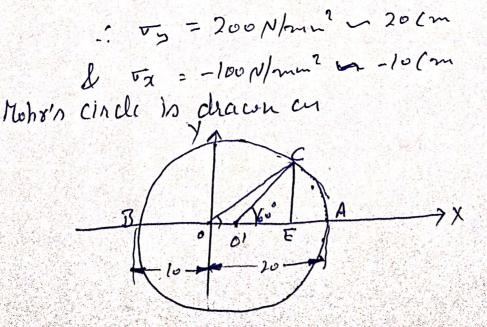
(25)

Jol. Griven Major Principal Atren,  $\overline{v_{3}} = 200 N/mm^{2} (teniele)$ Minor Principal Atren,  $\overline{v_{3}} = 100 N/mm^{2} (comp.)$ 1.C. -100 N/mm<sup>2</sup>

Angle of oblique plane with the axis of minor principal stren, D = 30°

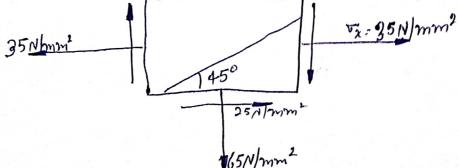


Let manne a scale 1cm ~ 10 N/m~?

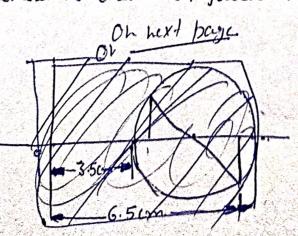


hoblem 1.12

At a catain point in a strained maderial the Intensities of strands on two planes at hight angle to each other our 35N/mm? & 65N/mm? both tensile. They are accompanied by a shear strang magnitude 25N/mm?. Using Mohr's circle method, detamine the normal, tangenticed by shear other of Accultant strand accorn the oblight plane when a resultant strand accorn the oblight plane when a find the location of principal planes & evaluate the principal strands also. 03=65N/mm<sup>2</sup>



het us assume a scale  $1cm - 10N/mm^2$   $\therefore v_x = 35N/mm^2 - 3.5cm$   $v_y = 65N/mm^2 - 6.5cm$   $2x_5 = 25N/mm^2 - 2.5cm$ Mohr's circle is drawn ay follows:



1. 0

- 1. Mark off OAmong 3. Send OBmong 6. Sem on publicated
- 2. Also take AC- 2xy-2.5 cm & BD-2x3-2.5cm in opposite direction.
- 3. Join CD which cuin the horizonical Dire at O'.
- 4. With O' as centre & o'c as reading, draw circle Which cuts the horizontal line at E& F.
- 5. Grave an angle of 20=00° with CD on bare line in anticlocomise direction i.e. LGO'D = 20=60°
- 6. Draw GHL OX & join OG also.

0G1 = 7.65 cm

7. Nous measure, OE GOF, GH, OG, OH, LGOO', LBOD

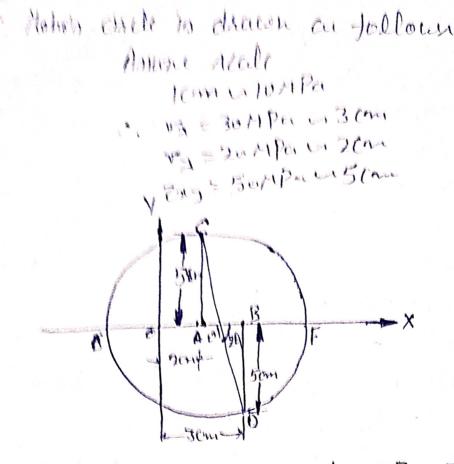
By measurements, Length OE = 2.08 cm OF = 7.9 cm OH = 7.5 cm GH = 1.5 cm GH = 1.5 cm  $CBO'D = 25.39^{\circ}$   $CGOO' = 0 = 11.3^{\circ}$ O'G = 5.83 cm

Normal strent,  $\overline{Tn} = OH \times \text{scale}$ = 7.5 × 10 = 75 N/mm<sup>2</sup> Am Streat strent, Z = GH × scale = 1.5 × 10 = 15N/mm<sup>2</sup> Am

Resultand Alem, 
$$\overline{v_{h}} = \frac{1}{1600} \frac{1}{90} 64 \times \text{Scale}$$
  
 $= 7.65 \times 10^{\circ}$   
 $= 76.5 \text{ N/mm^{2}} \text{ Am}$   
Hax. Principal Adam,  $\overline{v_{1}} = 0 \text{ Ex Scale} = 70 \times 10^{\circ} = 75 \text{ Almm^{1}}$   
Min. Principal Adam,  $\overline{v_{3}} = 0 \text{ Ex Scale} = 208 \times 10^{\circ} = 20.8 \text{ Almm^{1}}$   
 $LBO'D = 2D, = 25.39$   
 $\therefore \text{ Obsection of bain cidal blane } D_{1} = \frac{25.39}{2}$   
 $= 12.69^{\circ} \text{ Am}$   
 $Pole (1)$  on of bain cidal blane  $D_{2} = 12.69^{\circ} \text{ Am}$   
 $Pole (1)$  on of bain cidal blane  $D_{2} = 12.69^{\circ} \text{ Am}$   
 $Pole (1)$  on  $V_{2} = 30 \text{ MPa}$  is  $v_{3} = 20 \text{ MPa}$  both tensile.  
 $Pole (1)$  of  $\overline{v_{2}} = 30 \text{ MPa}$  is  $\sigma_{3} = 20 \text{ MPa}$  both tensile.  
 $Pole (1)$  or  $\sigma_{3}$  bis cide (1) is the plane of some of  $\sigma_{3}$  and  $\sigma_{3} = 20 \text{ MPa}$   
 $Pole (2)$  bin cide  $\sigma_{3}$  because of  $\sigma_{3}$  and  $\sigma_{3} = 20 \text{ MPa}$  both tensile.  
 $Pole (2)$  bin cide  $\sigma_{3}$  because  $\sigma_{3}$  and  $\sigma_{3} = 20 \text{ MPa}$  both tensile.  
 $Pole (2)$  bin cide  $\sigma_{3}$  both  $\sigma_{3} = 20 \text{ MPa}$  both tensile.  
 $Pole (2)$  bin cide  $\sigma_{3}$  because  $\sigma_{3} = 20 \text{ MPa}$  both tensile.  
 $Pole (2)$  bin (2) bin (2)  $Pole (1)$  bin (2)  $Pole (2)$  bin (2)  $Po$ 

NOTE: Although, this is the care Tx >03, but 2x3 in given in opposite direction, no we have to take Zay tiket upward & then in downward direction

Sol



1. Mark off OA - 1 - 20m & OB - 1 - 30m on horizontal line OX.

2. Also take AC-223-5cm & BD-223-5cm. in opposite direction.

3. Join CD which cuts the hodizontal Dine at 0! 4. With 0' as centre & 0'C as radius, draw the challe which cuts the hodizontal line at EKF. 5. Now measure OE, OF, LBO'D, 0'C

By Measurement

$$\begin{array}{rcl} hery 11 & OE = -2.5 cm & LBO'D = 84^{\circ} \\ OF = 7.5 cm \\ O'C = 5 cm \end{array}$$

Mini phincipal strue, 0== OEXEL=-2:50-XScale = -25 MPa Aini Max Phincipal strue, 0== OFXED12:5X Scale Am

5; = 7.5×10MPy of chil internets = 75 MPachanthan Max, Shear MACH, Zmux = O'CY Scale = SX loripu = 50 MPa Am LBO'D = 20, = 84 : Angle of principal planer Di= 42° & Dz = 42°+90 = 132° Am & Direction of plane of Max. Ohear Atten 03 = 42 + 45° = 87° Am & 24=132+45 =177° Am SOME MORE PROBLEMS

31)

10 MPh

Notioned stated  $\overline{v_n} = \overline{v_3} \sin^2 \theta + \overline{v_5} (\cos^2 \theta - 2\cos \sin^2 \theta + \cos^2 \theta +$  139)

Shear Athen prom

$$Z = (v_{3} - v_{3}) \operatorname{Sind}. \operatorname{Cond} + 2z_{3}(\operatorname{Cond} - \operatorname{Sind})$$
  
= (10-20) Sin 30° × (on 30° + 5(con' 30 - Sin 30)  
= -10×  $\frac{1}{2}$ ×  $\frac{\sqrt{2}}{2}$  + 5  $(\frac{2}{4} - \frac{1}{4})$ 

= -4.43+2.5

=-1.93MPa

Negative nigh shown that direction of the ahear strum in opposite.

Problem 1.15: - The state of stren at a point in a maturial is given by two mutually perpendicular ntruer as 2017Pa & 1017Pa & a shear stren 2517Pa. Deturnine the direction & magnitude of principal strence in the maturial. Also locate the plance of maximum shearing stren & calculate the normal & shearing stren & calculate the normal & shearing strence on three plance. Solution: Given Ta = 2011Pa Ta = 1011Pa

. The principal strance are 「、「、「=」(「+「」) ナメん(「-「」)++2233 -1 (20+10)+ 1 (20-10)+ 4(25) 32 = 15 - 1 (100 + 2500) 2 = 15 ± 25.5 = 40.5, -10.5 MPa Am The Rincipal planer are given by  $\frac{1}{\sqrt{10}} = \frac{2}{\sqrt{10}} = \frac{2}{\sqrt{10}} = \frac{2}{\sqrt{10}} = \frac{5}{\sqrt{10}} =$ · 20 = 78.66° D, = 78.66 = 39.33° Am Donce of maximum shear Atrenare given 62  $tan 20 = -\frac{\sqrt{x}-\sqrt{5}}{270}$  $=-\left(\frac{20-10}{2\times 25}\right)=-\frac{10}{50}=-0.2$ · 20 - -11.34 Dz = -5.67° Am & Da = -95-67° An Now, in the direction of vx, the angle of inclination of shear stren plane in -5.67° - · · Ø = -5.67°

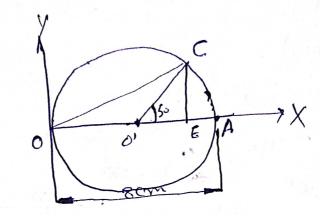
(Notional Attach on Altas Attach Blanc (D=-567)  

$$\overline{v_n} = \frac{1}{2}(\overline{v_2}+\overline{v_5}) + \frac{1}{2}(\overline{v_5}-\overline{v_3})(0,000 - 23_5) = 20$$
  
 $= \frac{1}{2}(0,0+0) + \frac{1}{2}(10-20)(0,0)(5x-5.67) - 25(5) + (2x5.67)$   
 $= 15 - 5 \times 0.98 + 25 \times 0.197$   
 $= 15 - 4.9 + 4.925$   
 $= 15.02 MPa$  Alm.  
Shear Attach on Altach Blanc.  
 $2merr = -\frac{1}{2}(\overline{v_5}-\overline{v_3})(5) + 20 + 23_5(0,020)$   
 $= -\frac{1}{2}5 \times 0.157 + 25 \times 0.38$   
 $= 0.58 + 24.5$   
 $= 25.48 MPa$  Alm.  
Reblem 1.15 Find the phincipal Attach for  
the Attach Of Attach Mark Attach  
 $\frac{26007Pa}{10007Pa}$   
Solution: - Given  $\overline{v_3} = 100 MPa$   
 $\overline{v_3} = 50 MPa$   
Rincipal Attach  $.\overline{v_{1,2}} = -\frac{1}{2}(\overline{v_3}-\overline{v_3}) + \frac{1}{2}(\overline{v_3}-\overline{v_3})^2 + 47.63^2$   
 $= -\frac{1}{2}(100-0) + \frac{1}{2}(100-0)^2 + 47.63^2$   
 $= -\frac{1}{2}(100-0) + \frac{1}{2}(100-0)^2 + 47.63^2$   
 $= 50 + 70.71$   
 $\therefore \overline{v_1} = 50 + 70.71 = 120.71 MPa Am$ 

(33)  
Refer HL - Octumine normal orther & tangential  
Ahan on a 25° inclined plane in a sheeined  
material which in subjected to gottpa tensile star  
a shown in tip by analytical &  
graphical method.  
Solution - Analytical Method  

$$\theta = 25^{\circ}$$
  
Since Named other in given by  
 $Tm = \frac{V_{2}+\sigma_{2}}{2} + \frac{v_{2}-\sigma_{2}}{2} \cos 2\theta$   
 $= \frac{goto}{2} + \frac{go.o}{2} \cos 2\theta$   
 $= \frac{goto}{2} + \frac{go.o}{2} \cos 2\theta$   
 $z = \frac{1}{2}(\sigma_{2} - \sigma_{2}) \sin 2\theta$   
 $= \frac{1}{2}(\sigma_{2} - \sigma_{2}) \sin 2\theta$   
 $= \frac{1}{2}(so-0) \sin 0x2s^{2}$   
 $= 30.64 HPa Am$   
Graphical Method (Moho'n Cincle)  
Int anume a Scale  
HPa i Com  
1. Tabe origin 0 k draw writed line of k  
horizontal line ox.

 Take OA noz 8cm on boxizontal axin,
 Binect OA at O' & with o'A on radiu draw Gircle.



4. At centre 0', draw an angle of 50° which Cut the circle at point C. 5. Draw CELOX & Join OC also 6. Meanine OR, CE, OE By Measurements henjth OE = 6.5 cm CE = 3: 1 Cm lot application The second Contract Normal Atren, 5n = OEX Scale = 6.5 × 10 MPa-= 65 MPa Am & Shear Atra, 2 -2CE X Scal = 3.1 × 10 mPan = 31 MPa Am

(31) . , HIGHLIGHTS 1. Analytical & Graphical methods are med for finding the other on an oblight nections 9. When a member in subjected to direct strenger in one plane i.e. under initiatiel loading, then the Atkener on an oblight plane ( which is indired at an angle of O) are given by Normal strue,  $\overline{v_n} = \frac{\overline{v_n}}{2} (1+(c_n)20)$ Shew stren, 2 = 52 Sin 20 Rendtant strun, The = Tou con 0 Max. shear Aten, Enux = 50 3. For a state of unicial stress the maximum tangential stren occurs along planer, the normal to which make an angle of 45°. & 135° with the direction of the load ..... 4. When a member is subjected to two dike direct stremen in two mutually perpendicularity directions, then the struction an oblight plane inclined on angle of 0 with the axis of minor stron (on with the plane of major strong are given by . [ (a soft !! -Normal Athen, Jn= 52+53 + (55-52) Con20 Shewi Athen, 2 = 1 (5-5) Sin20 Resultant Athen, 57 = [= (5+5)++ (5-5)(0020]2

38 5. The angle made by the resultant stren with the normal of the oblight plane 9+ in is known an angle of obliquits denoted by P tand = 2 = Jun + 55 col D 6. When a member is subjected to two clinect struct in two mutually papendicular directions, tooletoerother accompanied by a nhear stren (223) then struce on oblight plane inclined at an angle of I with the axin of minor strue, an given by Normal strue, on = + (05+ vz) + 5-12 (0020 - 2x35120 Tangential Athen, 2 = + (5-5x) sin 20 + 2xy Con 20 7. The plance, which have no shear stran, are known on principal planer 8. The strener, acting on principal plance, are phown an phincipal strand. 9. The position of Phincipal planer in given by tan 20 = 22x2 Max. & min. Principal strawargiven 155 16.  $\nabla_{1_{1}}\nabla_{2_{2}} = \frac{1}{2}(\nabla_{2} - \nabla_{3}) \pm \frac{1}{2}(\nabla_{2} - \nabla_{3})^{2} + 42x_{3}^{2} + \frac{1}{2}$ Mux. Nhear other given by 11.  $2m_{1}x = \frac{1}{2} \sqrt{(\sigma_{y} - \sigma_{x})^{2} + 42x^{2}} (1) (1)$ - 1 (51-52)

(39). 12. The plane of max shear sham in given by +an20 = 03-07 = - (07-53) & (ondition? 2200 2200) \$ (200) The plane of max shear stren are inclined at 45° to the plane of max. shear stren. 13. Mohr's Circle is a graphical method of finding normal, tangential & resultant structur on an oblight plane. 14. In Mohs's Circle, on vertical axis, we take shear strenes & on horizontel axis, we take, direct Otherner. 1311 (A) THEORITICAL QUESTIONS 1. Define the tollowing termine all moldent Car Rincipal Plance in di unie ai sinstance o

(b) Principal Straw a principal of the philosophies (c) (c) (obliquity minorated by the principal (c))

2. Show that maximum shear stray in a body subjected to unicivial tension or compression is half the value of applied others.

3. Drive expression job the normal strent, tangential strent, & the resultant strent on an oblique plane when the body in subjected to direct strend in two methods perpendicular direction.

A 12 20 3 1 2 3 5 1 1 1 1

(2) A rectangular body in subjected to direct A rectangular body in subjected to directions accompanied by a shear stren. Prove that the normal stren & the shear stren on an oblique plane inclined at an angle B with the plane of major direct strent, ere given by

2 Z = 53-53 SIN29 - Zzz (0128) 5. A body is subjected to direct stresses in two instrally perpendicular directions accompanied by a shear stren. Draw Mohro's circle of strener.

6. A body is subjected to direct strend in two mutually perpendicular direction. How will you deturning graphically the resultant Atren on an oblight plane when: (a) The string are unequal & white (b) The string are unequal & white (b) The string are unequal & like (B) NOMERICAL PROBLEMS

Zincy 2 - 50 N/mm2\_

2. A steel plate is subjected to tensile Atrener of DooMPa & IsomPa at higher angle to each other. Othermine the normal & tengential Atrener on a plane inclined at 60° to the 200 MPa strue. Also find the plane on which the hesultant streen the maximum obliquity.

[ALS: - 07 = 187.50Pa, 2 =-21.65MPa, 0 = 40°+3']

3. At a point within a body subjected to two mutually pupendicular direction, the strend are 100N/mmi (tenside) & 75N/mmi (tenside), Each of the above struce, is accompanied by a shear stren of 75N/mm?. Determine the normal, shear & resultant strend on anoplique plane inclined at an angle of 45° with the axis of minor tensile stru [50150N/ 1, Z=25 N/mm, Tr 152.07 N/mi) Solve this problem graphically also. 4. Using Mohr's circle method, determine graphically the magnitude & direction of the planer, principal stan for the member shown in fight shars 20 MW/m2 08 (ii) 20 W/m Dorw/me will 3 (i)PARS - CALLER COTIN) IONN/2

(4-2)5. An elemented cube is subjected to terride Attend of 60 N/min & 20N/min active on two mitually perpendicular plana accompanied by a shear strand 20N/mont "On these planes. Where the Moho's circle of strence determine the magnitude & direction of Principal strener & also the greatest shear stren & parition direction of greater shown blance  $LAm = 68.01 N / mm^2, = 211.72, 0 = 25.5, 0 = 1125^{\circ}$ 2mux=28.28N/m² D3=70 5°, 942157.5° J 6. Determine graphically the magnitude & direction of Phincipal strand for the elements show in A 20MM/m2 Ellerridge Fig. porphi 1 12 million (in) of 6 20min/mil bod A (i) 2011/14 (ii) 2011/14 (iii) 2011/14 (iii) 2001/14 (iii) 2001/14 (iii) 2011/14 (iii) Am:-(3) ~, = 5.61 MA/m², 5=-35.61 MN/m², 1000 , 5.61 MN/m² Mac.  $\theta_{1} = -37.58^{\circ}, \ \theta_{2} = 57.02^{\circ}$ (11) 0,=30MN/m2, 0,=-20 MN/m2  $D_1 = -53.13^\circ$ ,  $D_2 = 36.87^\circ$ 7. Using Mohr's Circle method, determine the normed & tangential attance actom oblight blare check the construct and sticely. Advin the sophimic and sticely. Advin the sophimic of 2 105/21ml 22 15 N/mul

(43)

8. A hectangular block of maderical in subjected to a temile stress of loon/hund on one plane & a tensile strue of SavInut on a plane at night angles, together with shew strengs of box/mind on the face Find ! (i) The direction of principal planer, (ii) The magnitude of principal strenes (11) Magnitude of the greatest shear stren (Am(1)0,33°41' 02=123°41 sprend we also while (i) vi= 140 N/mil, v2 = 10 N/mil und 7 Till Ener = 65 N/m withit b mardesdelling of E QUARD (AN L OX J JOIN CLARD) F Mois meanur, OF YOF, GH, OG, OH, ZGCC', ZBOB Atamericanone d Length OF 208 cm 2 80'0 : 25 39' 600'- \$ 165' OF - Paim 011:75Cm C62 5-83 6mm GH: 1-5 Cm OGA - T.ES COM

Manual alkan, en oblig acto - This is a second to - This is the state of the state of the second of the - This is a second of the second of

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117