

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

«قال يا قوم أرأيتم إن كنتم على بينة من ربي ورزقني
منه رزقا حسنا وما أريد أن أخالفكم إلى ما أنهاكم عنه إن
أريد إلا الإصلاح ما استطعت وما توفيقي إلا بالله

عليه توكلت وإليه أنيب» صدق الله العظيم (آل عمران: 101)



College of Engineering
Mechanical Engineering Department



تصميم أجزاء ماكينات (١) – همك ٤١١

Design of Machine Elements –1 ME 411

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Mechanical Engineering Department



Design of Machine Elements-1

ME 411

Week No. 10 - Lect. No. 13&14

- Principal Stresses and Mohr's Circle
- Force Analysis and BMD in 2-D

الاسبوع العاشر

- تطبيقات على الاجهادات الرئيسية ودائرة مور
- تطبيقات على تحليل القوى في مستويين

-
- **Principal Stresses and Mohr's Circle**
 - **Practical Team work Drill**
 - **Force Analysis and BMD in 2-D**

General Equations for Plane Stress Transformation

Maximum or Principal Normal Stresses (σ_1 and σ_2)
and its angle ϕ_p

Maximum Shear Stress (τ_{\max}) and its angle ϕ_s

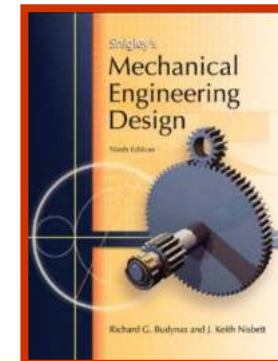
$$\sigma_1, \sigma_2 = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\tan 2\phi_s = -\frac{\sigma_x - \sigma_y}{2\tau_{xy}}$$

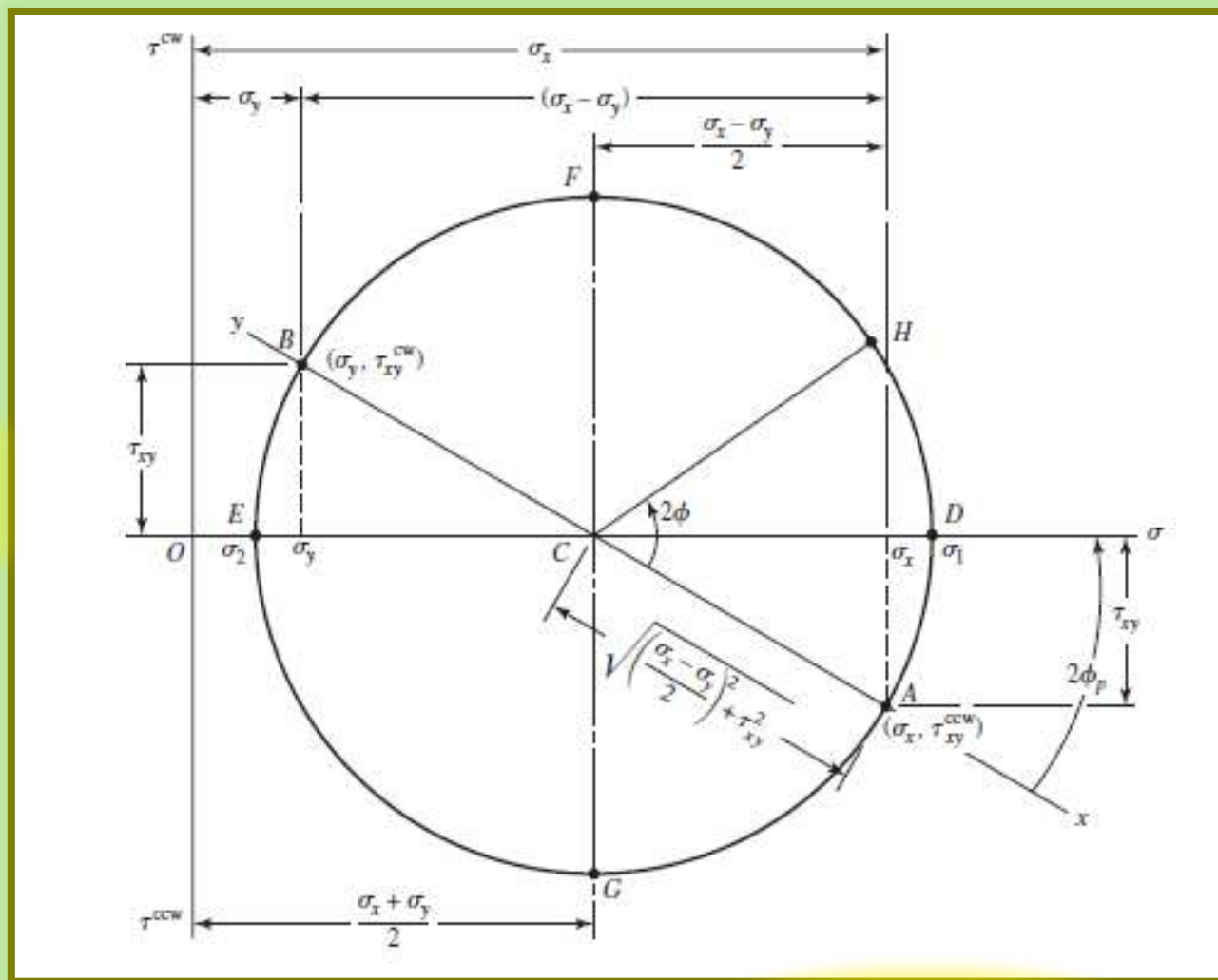
$$\tau_{\max} = \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\tan 2\phi_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$$

Mohr's Circle



Graphical Solution



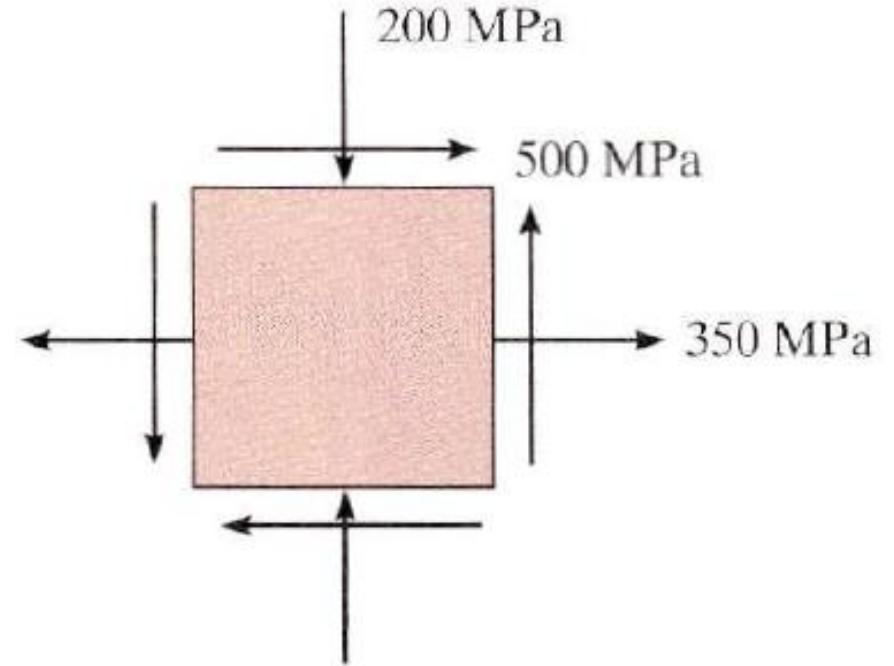
Mohr's Circle
كريستيان أوتو مور
بالألمانية:
Christian **Otto Mohr**)
أكتوبر ٢ - ١٨٣٥م - أكتوبر 8
(١٩١٨م)

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Drill (1)

Use Both Mohr's circle and Equations to determine:

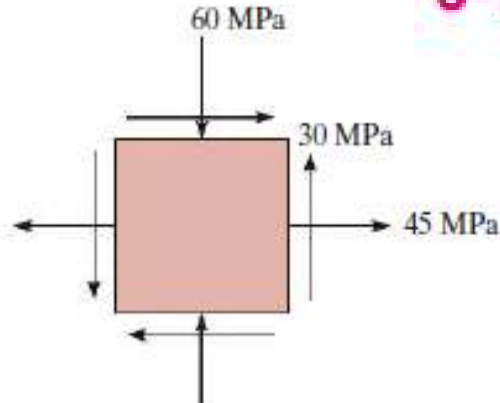
- The principal stress, and
- The maximum in-plane shear stress and average normal stress.
- Specify the orientation of the element in each case (Get angles?).



Drill (2) Team Work

3-15

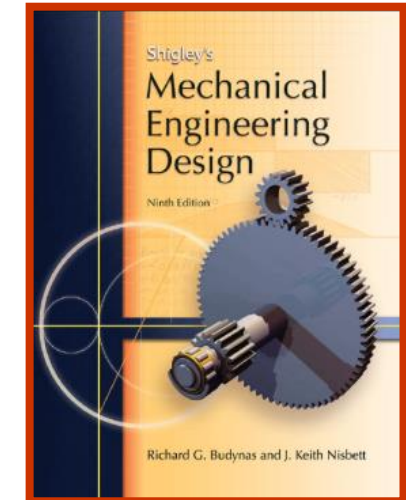
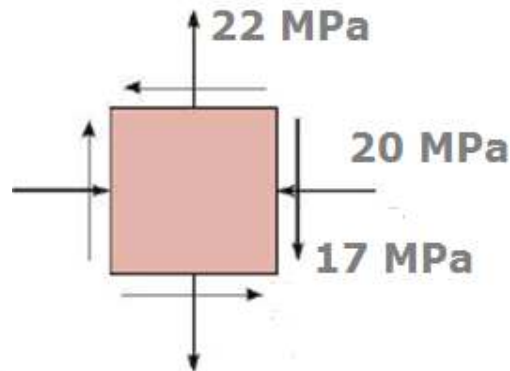
For each of the plane stress states listed below, draw a Mohr's circle diagram properly labeled, find the principal normal and shear stresses, and determine the angle from the x axis to σ_1 . Draw stress elements as in Fig. 3-11c and d and label all details.



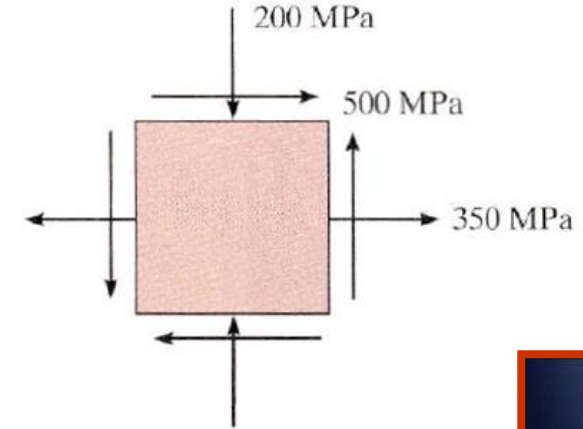
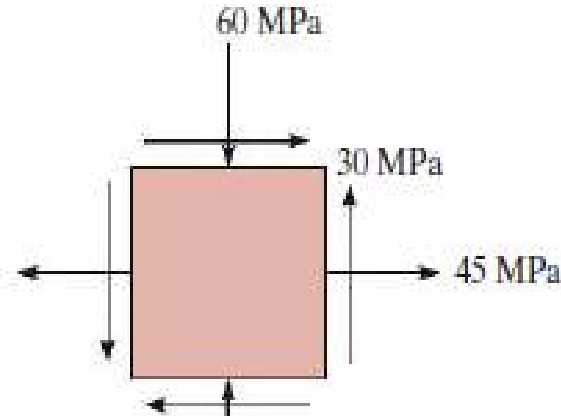
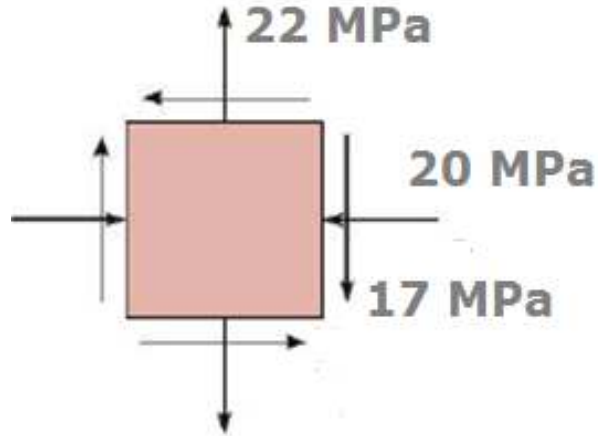
3-16

Repeat Prob. 3-15 for:

- (a) $\sigma_x = -8$ MPa, $\sigma_y = 7$ MPa, $\tau_{xy} = 6$ MPa cw
- (b) $\sigma_x = 9$ MPa, $\sigma_y = -6$ MPa, $\tau_{xy} = 3$ MPa cw
- (c) $\sigma_x = -4$ MPa, $\sigma_y = 12$ MPa, $\tau_{xy} = 7$ MPa ccw
- (d) $\sigma_x = 6$ MPa, $\sigma_y = -5$ MPa, $\tau_{xy} = 8$ MPa ccw



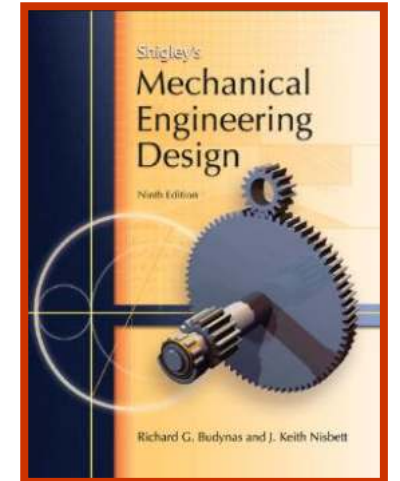
Assignment-1



3-16

Repeat Prob. 3-15 for:

- (a) $\sigma_x = -8 \text{ MPa}$, $\sigma_y = 7 \text{ MPa}$, $\tau_{xy} = 6 \text{ MPa}$ cw
- (b) $\sigma_x = 9 \text{ MPa}$, $\sigma_y = -6 \text{ MPa}$, $\tau_{xy} = 3 \text{ MPa}$ cw
- (c) $\sigma_x = -4 \text{ MPa}$, $\sigma_y = 12 \text{ MPa}$, $\tau_{xy} = 7 \text{ MPa}$ ccw
- (d) $\sigma_x = 6 \text{ MPa}$, $\sigma_y = -5 \text{ MPa}$, $\tau_{xy} = 8 \text{ MPa}$ ccw

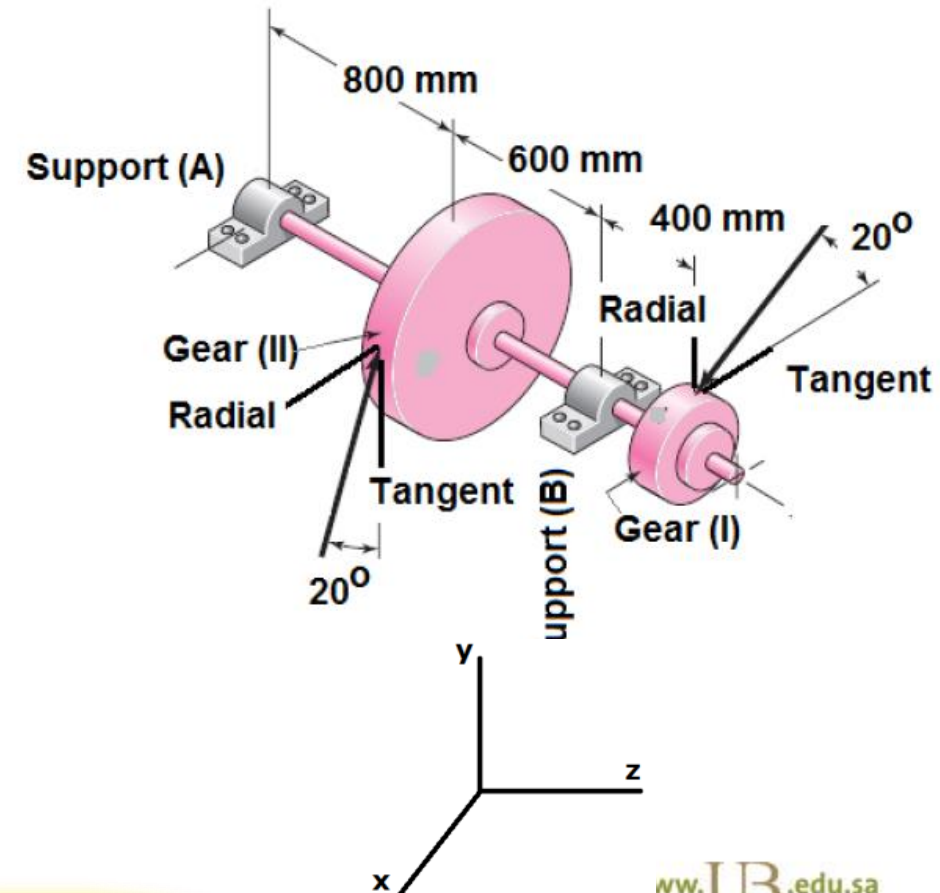


Assignment-2

Calculate the principal stresses and Maximum shear stress in (MPa) for the shown shaft of $d = 60$ mm at Gear I and $d = 75$ mm at Gear II.

Shaft Material AISI 1020 CD (Design Factor = 3)

Tangent component at gear I (F_I) = 2.5 kN,
 $D(I) = 250$ mm and $D(II) = 400$ mm



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

«يَوْمَ تَجِدُ كُلُّ نَفْسٍ مَا عَمِلَتْ مِنْ خَيْرٍ
مَحْضَرًا وَمَا عَمِلَتْ مِنْ سُوءٍ تَوَدُّ لَوْ أَنَّ بَيْنَهَا
وَبَيْنَهُ أَمَدًا بَعِيدًا وَيُحَذِّرُكُمُ اللَّهُ نَفْسَهُ وَاللَّهُ
رَعُوفٌ بِالْعِبَادِ» صدق الله العظيم

آل عمران