

# HW1

November 11, 2025

## 1 Homework 1

A cast aluminum 195-T6 exhibits  $S_{ut} = 248.220$  MPa,  $S_{uc} = 241.325$  MPa, and  $\varepsilon_f = 0.045$ . For the given state of plane stress, (a) using the Coulomb-Mohr theory, determine the factor of safety, (b) plot the failure locus and the load line, and estimate the factor of safety by graphical measurement

Problem Number	$\sigma_x$ (MPa)	$\sigma_y$ (MPa)	$\tau_{xy}$
5-26	103.425	-68.950	0
5-27	-103.425	68.950	0
5-28	82.74	0	-55.160
5-29	-68.950	-103.425	68.950
5-30	103.425	55.160	-55.160

Here is my solution for part A

For part (b), I choose Modified Mohr Failure Envelope (MSS):

```
[15]: import numpy as np
import matplotlib.pyplot as plt

#parameters
S_ut = 248.22 # ultimate tensile strength in MPa
S_uc = 241.325 # ultimate compressive strength in MPa

# define points
A = (S_ut, 0)
B = (0, -S_uc)
C = (-S_uc, -S_uc)
D = (-S_uc, 0)
E = (0, S_ut)
F = (S_ut, S_ut)
sigma_A = np.array([A[0], B[0], C[0], D[0], E[0], F[0], A[0]])
sigma_B = np.array([A[1], B[1], C[1], D[1], E[1], F[1], A[1]])

# 5 load cases
load_cases = [
    (103.425, -68.95),
    (68.95, -103.425),
    (110.32, -27.58),
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        (-15.106, -157.2595),
        (139.505, 19.0845)
    ]

    problem_labels = ["5-26", "5-27", "5-28", "5-29", "5-30"]
    # Create the plot
    plt.figure(figsize=(10, 10))

    # MSS
    plt.plot(sigma_A, sigma_B, 'b-', linewidth=2, label='Modified Mohr-Coulomb_
    ↪Criterion')

    #
    colors = ['red', 'green', 'orange', 'purple', 'brown']
    markers = ['o', 'o', 'o', 'o', 'o']

    for i, case in enumerate(load_cases):
        color = colors[i % len(colors)]
        marker = markers[i % len(markers)]

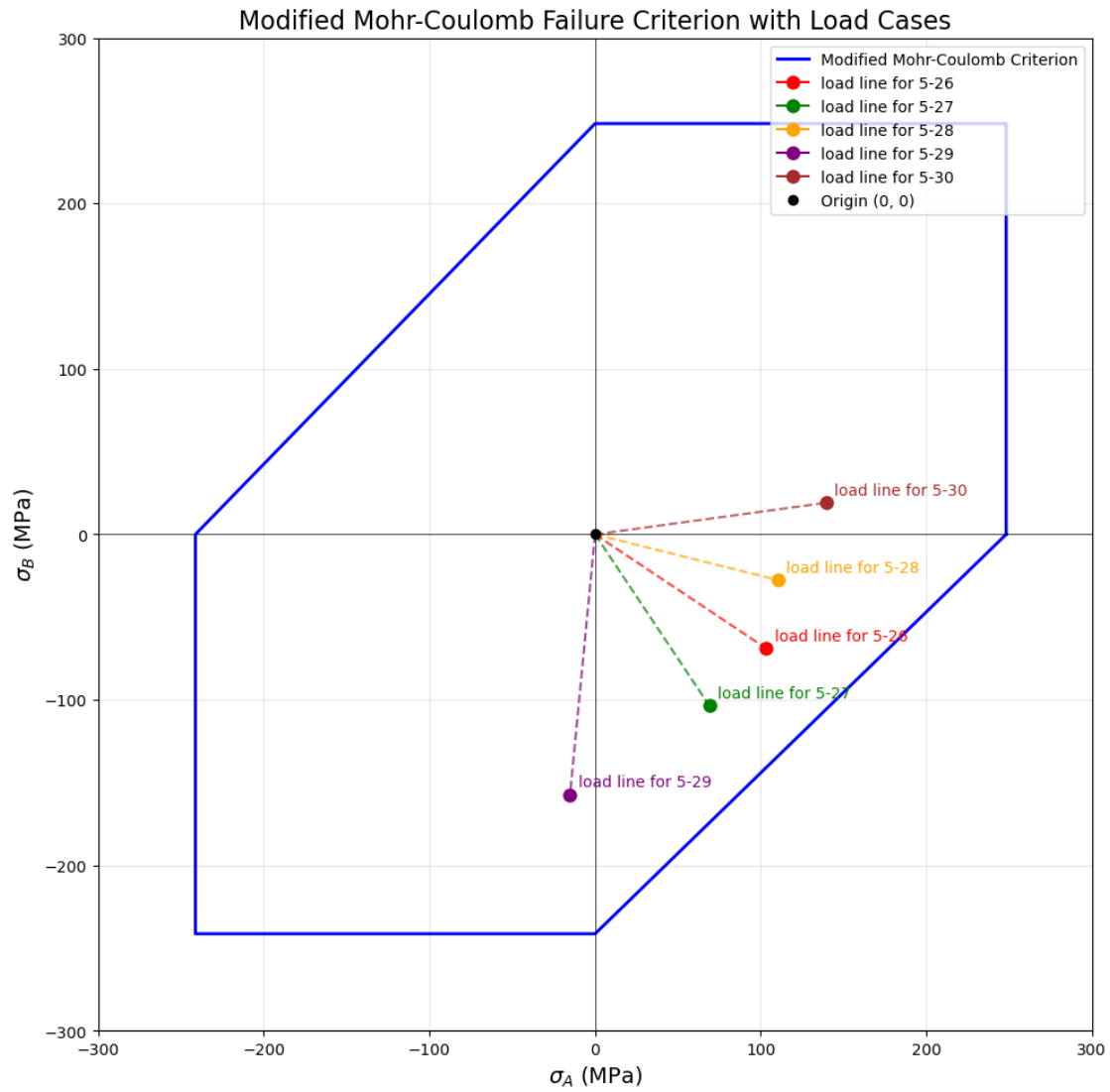
        plt.plot(case[0], case[1], marker=marker, color=color, markersize=8,
                  label=f'load line for {problem_labels[i]}')

        plt.plot([0, case[0]], [0, case[1]], color=color, linestyle='--',
        ↪linewidth=1.5, alpha=0.7)
        plt.text(case[0]+5, case[1]+5, f'load line for {problem_labels[i]}',
        ↪fontsize=10, color=color)

    plt.plot(0, 0, 'ko', markersize=6, label='Origin (0, 0)')
    plt.xlim(-300, 300)
    plt.ylim(-300, 300)
    plt.xlabel('$\sigma_A$ (MPa)', fontsize=14)
    plt.ylabel('$\sigma_B$ (MPa)', fontsize=14)
    plt.title('Modified Mohr-Coulomb Failure Criterion with Load Cases',
    ↪fontsize=16)
    plt.grid(True, alpha=0.3)
    plt.axhline(y=0, color='k', linewidth=0.5)
    plt.axvline(x=0, color='k', linewidth=0.5)
    plt.legend(loc='upper right', fontsize=10)
    plt.gca().set_aspect('equal', adjustable='box')

    plt.tight_layout()
    plt.show()

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