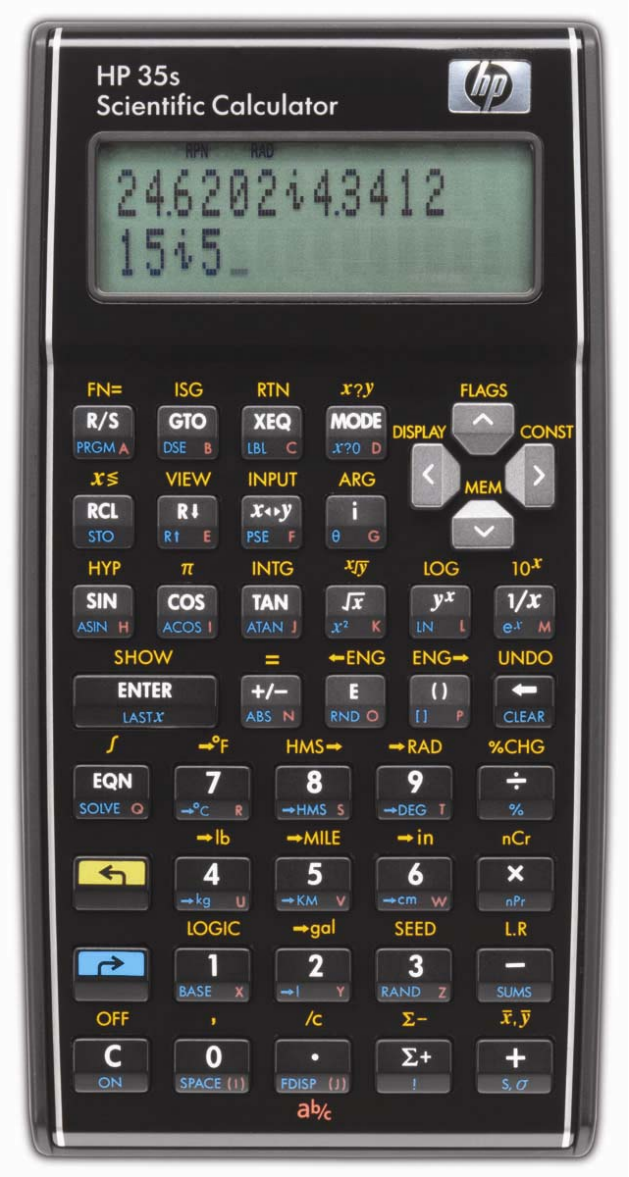
hp calculators



HP 35s Applications in Mechanical Engineering

Applications in mechanical engineering

Practice solving problems in mechanical engineering

- Application 1: Stress on an element (Mohr circle)

Applications in mechanical engineering

This training aid will illustrate the application of the HP 35s calculator to several problems arising in mechanical engineering. These examples are far from exhaustive, but do indicate the incredible flexibility of the HP 35s calculator.

Practice solving problems in mechanical engineering

Application 1: Stress on an element (Mohr circle)

The Mohr circle equations convert an arbitrary stress configuration to principal stresses, maximum shear stress, and rotation angle. It is then possible to calculate the state of stress for an arbitrary orientation θ'.

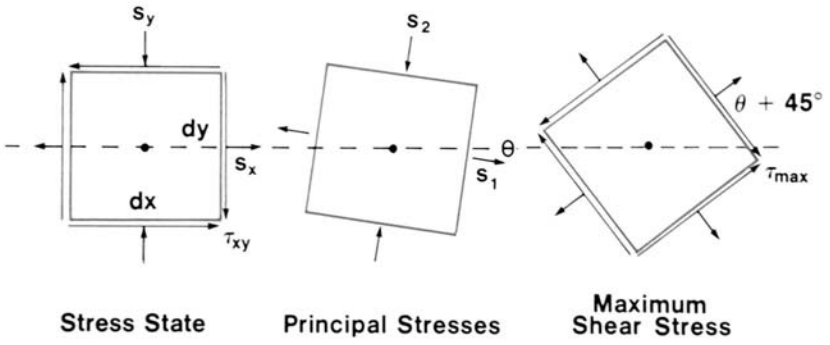


Figure 1

The Mohr circle formulas are shown below, where s is the normal stress, τ is the shear stress, s_x is the stress in the x direction for Mohr circle input, s_y is the stress in the y direction for Mohr circle input, τ_{xy} is the shear stress on the element for the Mohr circle input, s_1 and s_2 are the principal stresses, θ is the rotation angle, and τ_{max} is the maximum shear stress. Note that θ is the angle of rotation from the specified axis to the principal axis, and so should be thought of as a negative angle. This is opposite to the normal Mohr circle convention.

Maximum shear stress $$\tau_{max} = \sqrt{\left(\frac{s_x - s_y}{2}\right)^2 + \tau_{xy}^2}$$ Figure 2

Principal stress $$s_1 = \frac{s_x + s_y}{2} + \tau_{max}$$ Figure 3

Principal stress $$s_2 = \frac{s_x + s_y}{2} - \tau_{max}$$ Figure 4

Rotation angle $$\theta = \frac{1}{2}\tan^{-1}\left(\frac{2\tau_{xy}}{s_x - s_y}\right)$$ Figure 5

Example: If s_x = 25,000 psi, s_y = -5,000 psi, and τ_{xy} = 4,000 psi, compute the principal stresses, the angle of rotation θ, and the maximum shear stress.

Solution: Solve for the maximum shear stress, τ_{max}.

In RPN mode: 2 5 0 0 0 ENTER 5 0 0 0 +/- − 2 ÷ ↗ x^2 4 0 0 0 ↗ x^2 + $\sqrt{x}$ ↗ STO T

In algebraic mode: $\sqrt{x}$ ↗ x^2 ( ) 2 5 0 0 0 − 5 0 0 0 +/- › ÷ 2 › + ↗ x^2 4 0 0 0 ENTER ↗ STO T

Figure 6

Solve for the principal stress, s_1.

In RPN mode: 2 5 0 0 0 ENTER 5 0 0 0 +/- + 2 ÷ RCL T +

In algebraic mode: ( ) 2 5 0 0 0 + 5 0 0 0 +/- › ÷ 2 + RCL T ENTER

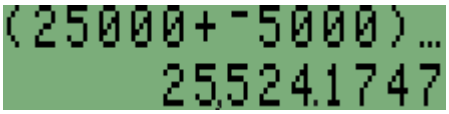


Figure 7

Solve for the principal stress, s_2.

In RPN mode: 2 5 0 0 0 ENTER 5 0 0 0 +/- + 2 ÷ RCL T −

In algebraic mode: ( ) 2 5 0 0 0 + 5 0 0 0 +/- › ÷ 2 − RCL T ENTER

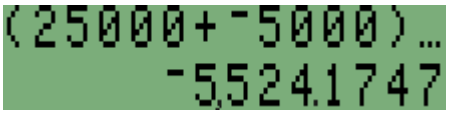


Figure 8

Solve for the rotation angle, θ.

In RPN mode: 2 ENTER 4 0 0 0 × 2 5 0 0 0 ENTER 5 0 0 0 +/- − ÷ ↗ ATAN 2 ÷

In algebraic mode: ↗ ATAN 2 × 4 0 0 0 ÷ ( ) 2 5 0 0 0 − 5 0 0 0 +/- › › ÷ 2 ENTER

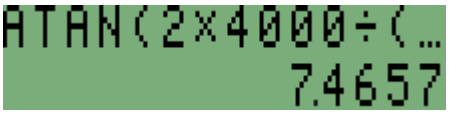


Figure 9

Answer: The principal stresses, s_1 and s_2, are 25,524 psi and -5,524 psi. The angle of rotation, θ, is 7.4657 degrees. The maximum shear stress is 15,524 psi.