1. Show in Mohr stress space the Mohr's circles representing the following states of stress: (1.5 mark)

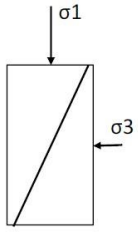
(a) Uniaxial compression

(b) Uniaxial tension

(c) Hydrostatic compression

2. Repeat Q1 in principal stress space (σ3 as x axis, σ1 as y axis) by showing points representing the states of stress. (1 mark)

3. Principal stresses are applied to a rock specimen, as illustrated below: (2.5 marks)



This rock fails along a plane, as indicated above, orientated 25° with respect to the σ1 direction. The magnitudes of σ1 and σ3 when failure occurs are 150 MPa and 5 MPa, respectively.

(a) Calculate using the stress transformation equations, the normal and shear stresses acting on this plane at failure.

(b) Calculate the magnitude of the maximum shear stress in this specimen; what is the orientation of the plane which contains this maximum shear stress relative to the σ1 direction? What is the magnitude of the normal stress acting on the plane containing the maximum shear stress?

(c) Why does the rock not fail along the plane with the maximum shear stress?

4. A specimen is tested in a triaxial apparatus and is subject to a confining pressure of 5 MPa. The specimen fails when the axial stress reaches 120 MPa. The failure plane is at 25° to the direction of the major principal stress. (2 marks)

(a) Calculate the stresses on the failure plane.

(b) Assuming the rock obeys a linear Mohr-Coulomb strength criterion, determine the friction angle.

5. A dry, intact, rock has a Mohr failure envelope given by $\tau r = \sigma \tan 33° + 6$ [MPa]. Joints in this rock have a shear strength given by $\tau j = \sigma \tan 30°$. A specimen of this rock is tested in a triaxial apparatus with the joint oriented at an angle of 30° to the major principal stress direction, with a confining pressure of 4 MPa. (3 marks)

(a) Will failure occur by sliding on the joint or by fracture through the solid?

(b) What is the magnitude of the major principal stress at failure?

(c) The confining pressure is now increased to 8 MPa and the major principal stress is kept constant at the value calculated in above. Water is injected into the specimen. At what water pressure will failure again occur?

(d) Show all the Mohr circles, properly labelled, for all the above calculations in Mohr stress space.