Problem:

A silty soil has drained Mohr-Coulomb strength parameters $c=50\text{kPa}$ and $\phi_D = 30^\circ$. A sample of this soil has been reconsolidated under the same stresses it experienced in the field: $\sigma_u = 200\text{kPa}; \sigma_h = 160\text{kPa}$. The pore pressure in the sample after it is fully consolidated under these stresses is 100 kPa. A drained strength test in the triaxial cell is then performed to shear failure: During the test, pore pressure is kept constant while $\sigma_u$ is increased and $\sigma_h$ is decreased simultaneously by half the amount (i.e. $\Delta \sigma_h = -1$ when $\Delta \sigma_u = +2$).

i. Using Mohr’s circle, find an expression relating the principal effective stresses $\sigma'_1$ and $\sigma'_3$ at failure.

ii. What are the total principal stresses $\sigma_1$ and $\sigma_3$ at failure?

iii. What is the orientation of the plane on which shear failure occurs, and what are the effective stresses on that plane?