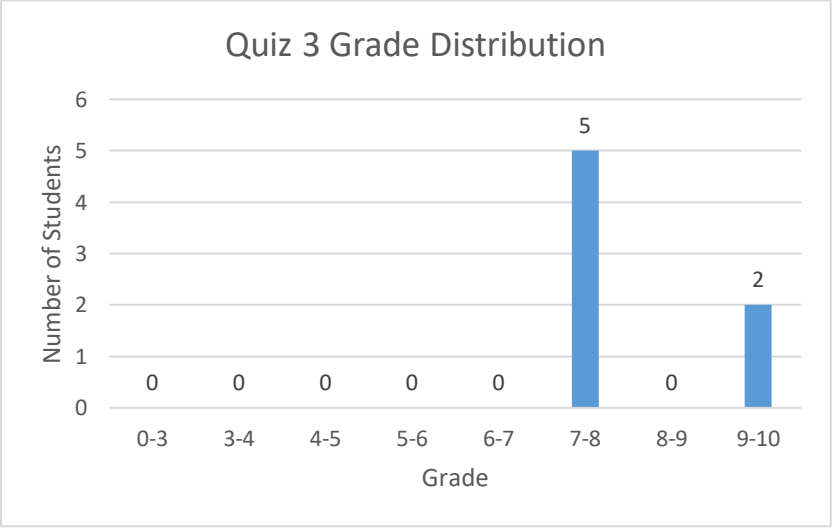
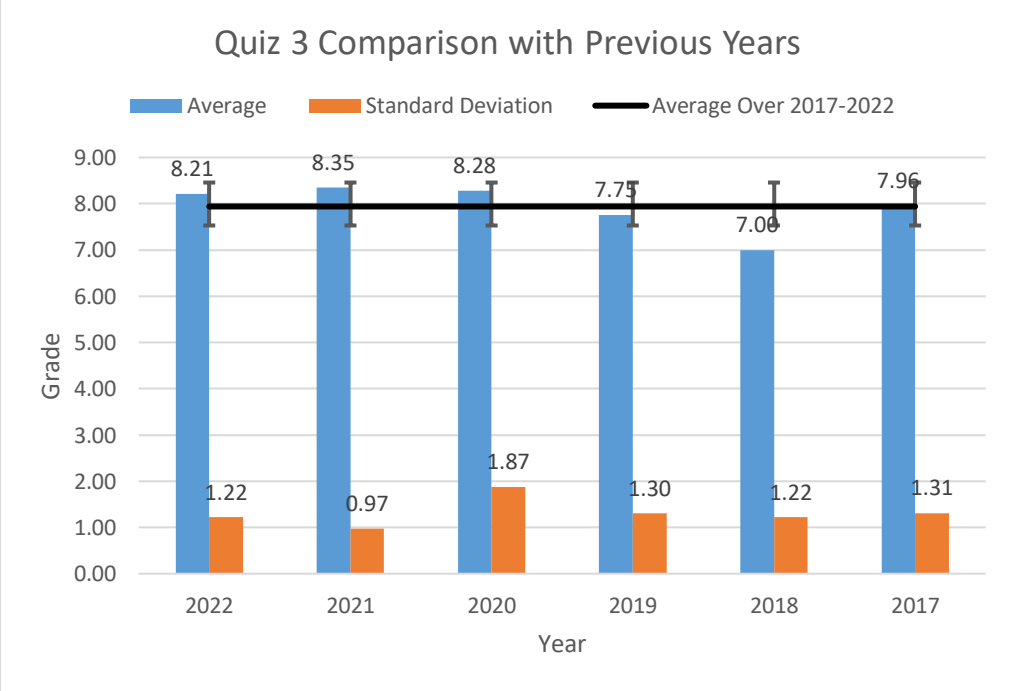
Quiz 3 Report

9/23/2022

1. Summary

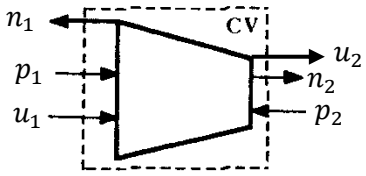
Total number of students	7
Attended	7
Missed	0
Average grade	8.21
Standard deviation of grades	1.22





2. Comments

- Five students had problem determining the sign of the momentum fluxes at inlet/outlet of the control volume.



$$\sum \boldsymbol{F} = \frac{d}{dt}\left(\int_{CV} \boldsymbol{V}\rho dV\right) + \int_{CS} \boldsymbol{V}\rho(\boldsymbol{V_r}\cdot\boldsymbol{n})dA$$

Assuming fixed control volume, $\boldsymbol{V_r} = \boldsymbol{V}$, constant density and zero acceleration

$$\sum \boldsymbol{F} = \int_{CS} \boldsymbol{V}\rho(\boldsymbol{V}\cdot\boldsymbol{n})dA$$

Assuming V and ρ uniform over A_1 and A_2 and projecting in the x-direction:

$$\sum F_x = \int_{CS} u\rho(\boldsymbol{V}\cdot\boldsymbol{n})dA = u_2\rho(\boldsymbol{V_2}\cdot\boldsymbol{n_2})A_2 + u_1\rho(\boldsymbol{V_1}\cdot\boldsymbol{n_1})A_1$$

The negative sign does not come from the discretization of the integral over A_1 and A_2, but from the dot product between the velocity and the normal to the section:

$$(\boldsymbol{V_1}\cdot\boldsymbol{n_1}) = -u_1$$

$$(\boldsymbol{V_2}\cdot\boldsymbol{n_2}) = u_2$$

Therefore:

$$\sum F_x = -F_{bolts,x} + p_{1,gage}A_1 = u_2\rho u_2 A_2 - u_1\rho u_1 A_1 = \dot{m}(u_2 - u_1)$$

Please, make sure to understand this key concept for the momentum equation.