Q: Derive the transfer function of the P, I, and D controllers in slide 28 (show the procedures of your derivations).

A: The derivation will be done in 3 parts

* For the **P**roportion:

Using KCL at the junction:

Thus:

Indicating the proportional gain being

* For the **I**ntegration:

Using KCL at the minus pin of the Op Amp:

Apply the character of a capacitor:

Thus:

Indicating the integration time being

* For the **D**erivation:

With functions as a low-pass filter, the high frequency component is rolled off.

Using KVL from input to the minus pin of Op Amp:

Since no current flow into the Op Amp, using KVL from the minus pin to output:

Thus:

Where functions at a differential gain limiter, and the differentiation time being.