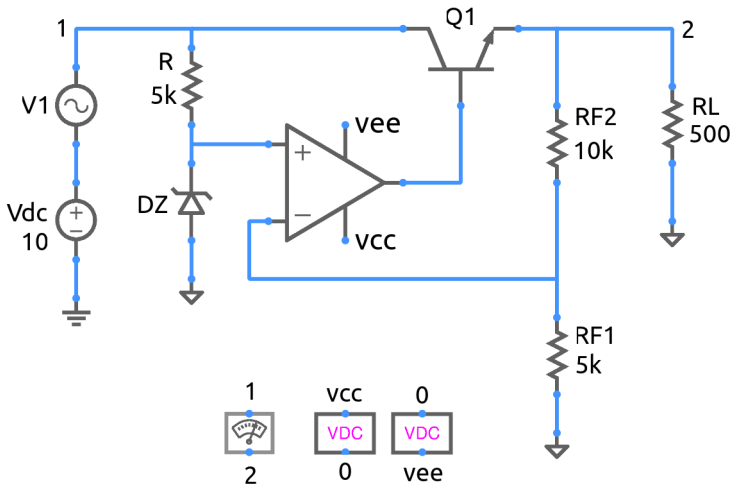
## opamp_regulator_2.sqproj




Ref: Millman and Grabel, Microelectronics

Shown in the figure is an Op Amp based regulated power supply. The resistor $R$ provides a bias current to the Zener which serves as a reference voltage $V_R = 2.9\,\text{V}$. The BJT operates as an emitter follower with a gain of approximately 1. Since the gain of the Op Amp is large, we have

$$V_- \approx V_+ = V_R. \tag{1}$$

Also, since the input current of the Op Amp is negligibly small, we have

$$V_- = V_o \frac{R_{F1}}{R_{F1} + R_{F2}}. \tag{2}$$

Using the above two equations, we get

$$V_o = V_R \frac{R_{F1} + R_{F2}}{R_{F1}}. \tag{3}$$

The voltage difference $V_i - V_o$ appears as $V_{CE}$ of the transistor. Note that the Op Amp has to only supply the base current of the transistor which is much smaller than the load current.

## Exercise Set

1. Calculate the output voltage for the parameters specified in the circuit diagram. Run the simulation, and verify that the output voltage is regulated.

2. Change the load resistance value to $100\,\Omega$ and check whether the output voltage remains the same.

3. In addition to the output voltage, plot $I_C$, $I_B$, and $V_{CE}$ versus time. How does the Op Amp output current compare with the load current?

## References


1. J. Millman and A. Grabel, *Microelectronics,* McGraw-Hill, 1988.

2. A. S. Sedra, K. C. Smith, and A. .N. Chandorkar, *Microelectronic Circuits*, Oxford University Press, 2004.