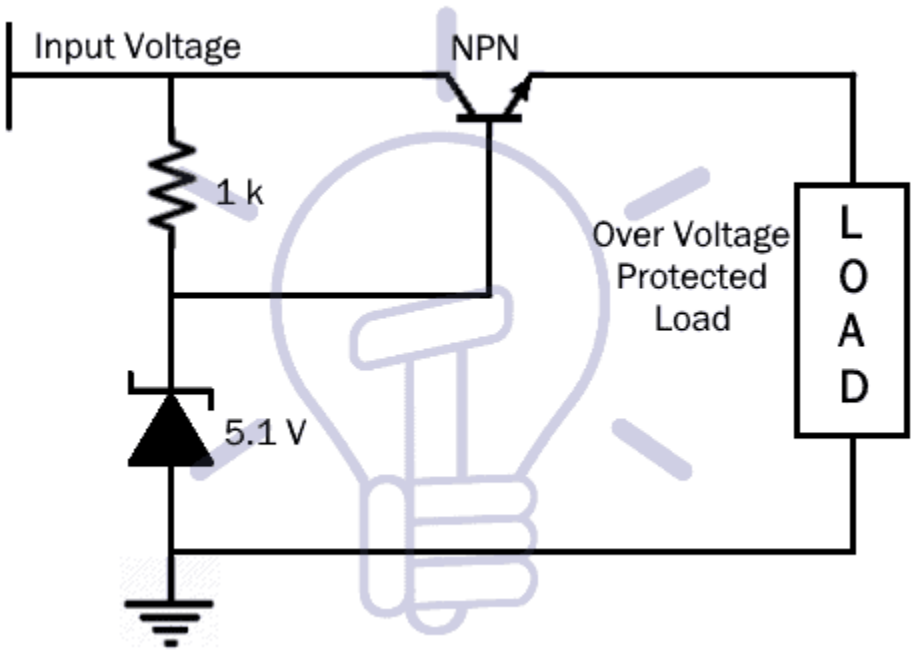
Over protection circuit
Using
pnp & npn transistors

1.npn circuit:

This is one of the two configurations of overvoltage protection circuits using Zener diode. This circuit not only protects the load side circuit but also regulates the input supply voltage to maintain a steady voltage.



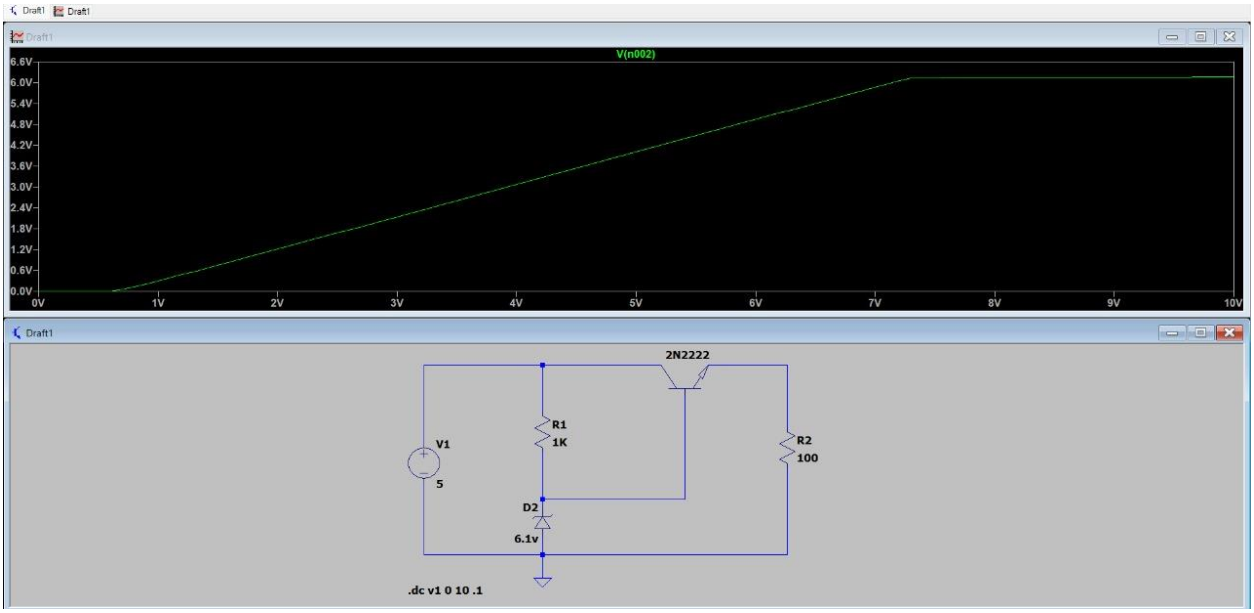
The idea of this circuit is we set a threshold voltage by choosing the suitable Zener diode with a breakdown voltage slightly more than the normal load voltage required so for example if the required load voltage is 5 V we choose a Zener diode with a breakdown voltage slightly more than 5 V for example we select 5.1v

After that we connect the Zener , npn and resistor in the following sequence

In normal condition that input voltage is equal than or below the threshold voltage the Zener doesn't conduct so the transistor base current will be set to high so transistor will be turned ON and conduct current to the load normally

But if the input voltage exceeded the Zener breakdown voltage at this point the Zener will conduct and maintain a constand voltage Vz and the npn will be forward and conduct to the load without exceeding the limit

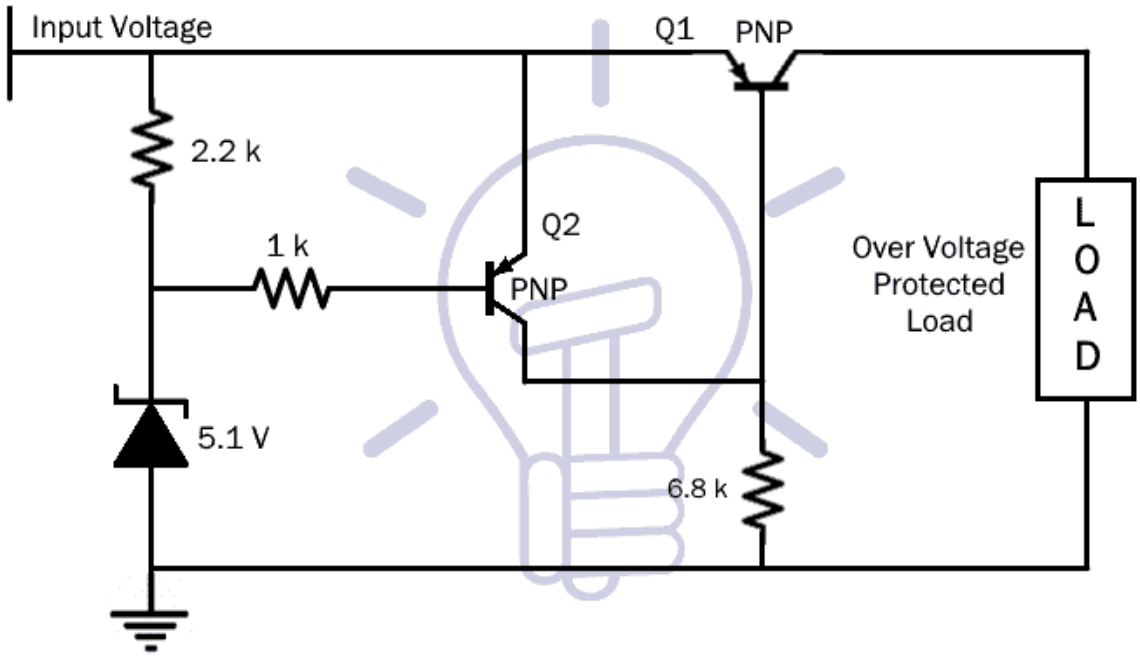
The simulation result and circuit diagram :



2.pnp circuit :

This configuration is a bit complex and behave a bit differently

So the circuit look like this



When the base voltage is lower than the emitter voltage

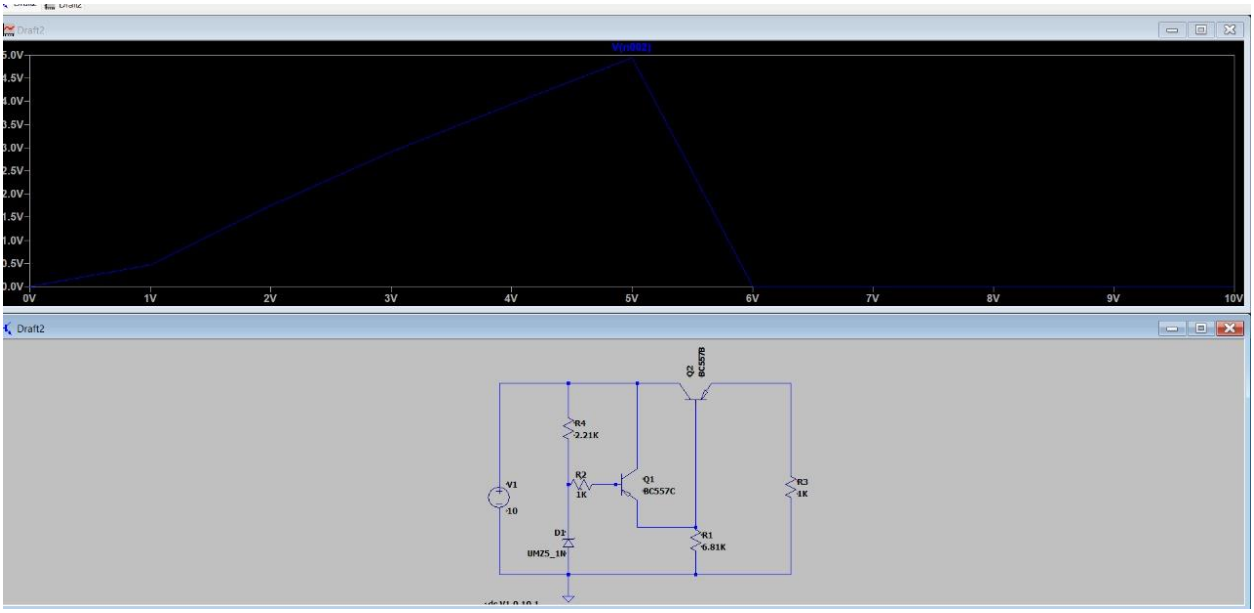
the base-emitter junction is forward-biased.

The transistor turns on, allowing current to flow from the emitter to the collector. Current also flows through the load.

When the base voltage is close to or higher than the emitter voltage, the base-emitter junction is not forward-biased.

The transistor turns off, stopping current flow from the emitter to the collector. No current flows through the load.

The simulation result and circuit diagram :



The difference between the two circuits

NPN: Turns ON when the base voltage is sufficiently higher than the emitter voltage; turns OFF when base voltage drops below the threshold.

PNP: Turns ON when the base voltage is sufficiently lower than the emitter voltage; turns OFF when the base voltage rises towards the emitter voltage.

Another difference is that npn maintains the threshold voltage once the input voltage exceeds but the pnp drops the voltages to zero after input voltage exceeds

Pnp advantages:

.**High-Side Protection**: PNP transistors are well-suited for high-side protection circuits where you need to control the voltage to the load by switching the high side of the circuit.

.**Simplicity in Certain Configurations**: For circuits where the load is referenced to a high voltage, PNP transistors can simplify the design as they switch the high side directly.

Npn advantages:

.Common Ground Reference: NPN transistors work well with a common ground reference, which is often simpler for circuits where the control signal is referenced to ground.

.Easier Integration with Logic Circuits: NPN transistors can interface easily with digital logic circuits that use ground as a reference point.