Kathmandu University
Department of Electrical and Electronics Engineering
ANALOG ELECTRONICS LABORATORY WORK

EXPERIMENT 9: Application of Current Mirror and Active Loads

Objectives: To bias a common emitter amplifier using current mirror
To understand the concept of active loads in an amplifier

Materials and Equipment:
Resistors: 15KΩ [2], Capacitor: 220µF [1], Transistor: 2N3904 [3], 2N3906 [2]
Oscilloscope Probes: 3, Multi-Meter, Breadboard

Theory:
When an amplifier is biased in a proper way faithful amplification can be achieved. For the amplifier in fig.1, biasing will be stable when the emitter current is fixed. Here we have fixed the emitter current of Q3 by using a NPN current mirror. The reference current of Q1 is the mirrored current in Q2 and is given by (1).

$$I_{Mirrored} = I_{REF} = \frac{10 - 0.8 + 10}{15\text{K}} \approx 1.28\text{mA} \quad (1)$$

This equation is valid as long as both the transistors (Q1 and Q2) are in the active region of operation. The potential across collector of Q2 should always be higher then that of its base potential so that collector diode of Q2 is always reversed biased and the transistor does not enter into saturation.

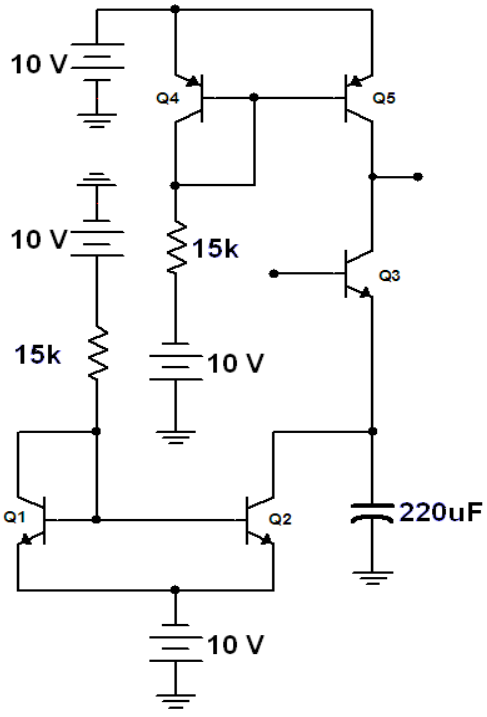

Fig1: IC amplifier

Here the collector load resistor R_C is absent instead active load is used to increase the gain. The gain of this type of structure is very high since the resistance seen by collector of Q3 is the resistance of a current source i.e. output resistance of Q5 which is typically in the range of hundreds of kilo ohms. The reference current of Q4 is the mirrored current in Q5 and is given by (2).

$$I_{Mirrored} = I_{REF} = \frac{10 - 0.8 + 10}{15\text{K}} \approx 1.28\text{mA} \quad (2)$$

This equation is valid as long as both the transistors (Q4 and Q5) are in the active region of operation. The potential across collector of Q5 should always be lower then that of its base potential so that collector diode of Q5 is always reversed biased and the transistor does not enter into saturation.
Note that the '*Beta'* of the transistors used in the current mirror should be perfectly matched otherwise the current mirror action will not be valid.

Procedure

1. Generate NPN current mirror as shown in fig 1.
2. Check the collector current of Q1. (*Don't use multimeter to measure the current, instead use the voltage drop across 15K resistor to estimate the current).*
3. Check the collector current of Q2 for different collector potential.
4. Generate PNP current mirror as shown in fig 1.
5. Check the collector current of Q4.
6. Check the collector current of Q5 for different collector potential.
7. Connect the circuit as shown in fig 1.
8. Apply small signal across the base of Q3. (*Sine, 1 kHz, 30dB attenuation, 1mV).* Monitor the output across the collector of Q3.
9. Calculate the gain of the amplifier.

Exercise

- Simulate the circuit in Multisim.
- Compare software simulated result and the result obtained from hardware.