

DEPARTMENT OF ELECTRICAL ENGINEERING

Spice simulation of Transistors

All semiconductor devices are specified by using *two command* lines. The first statement defines the *element* and the second one is the *model* statement.

The syntax for the model statement is:

```
.MODEL MODName Type (parameter values)
```

MODName is the name of the model for the device.. The Type refers to the type of device and can be any of the following:

NPN: npn bipolar transistor

PNP: pnp bipolar transistor

NMOS: nmos transistor

PMOS: pmos transistor

The parameter values specify the device characteristics as explained below.

Bipolar transistors

Element:

```
Qname C B E BJT_modelName
```

The bipolar transistor's name has to start with a Q

Model statement:

```
.MODEL BJT_modName NPN (BF=val IS=val VAF=val)
```

in which BF is the β , IS is the saturation current and VAF is the Early voltage. If no values are specified, the default values are assumed ($\beta=100$; $IS=1e-16A$, and $VAF=infinite$).

MOSFETS

Element:

```
Mname D G S B ModName L= W=
```

The MOS transistor's name has to start with a M

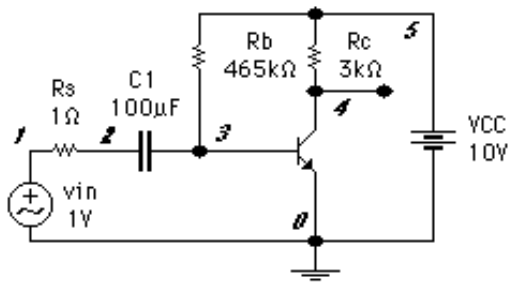
Model statement:

```
.MODEL ModName NMOS (KP= VT0= lambda= gamma=)
```

in which $KP=uCox$. The default values are $KP=20uA/V^2$; and the rest is equal to 0.

Example of a NPN Transistor Amplifier

Consider the circuit of the figure below. We are interested in finding the DC voltages and current, as well as the voltage gain and the input resistance seen by the input source.



*** Example of a NPN transistor

```
vin 1 0 ac 1
```

```
rs 1 2 1
```

```
c1 2 3 100uf
```

```
rb 5 3 465k
```

```
rc 5 4 3k
```

```
vcc 5 0 dc 10
```

```
q1 4 3 0 npn-trans
```

```
.model npn-trans npn (is=2e-15 bf=100 vaf=200)
```

```
*calculation of the operating point and small signal parameters
```

```
.op
```

```
*calculation of the small signal gain
```

```
.ac dec 10 100 10k
```

```
.plot ac vm(4)
```

```
* calculations of the small signal input conductance (i/v)
```

```
.plot ac im(vin)
```

```
.end
```

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