EE 234
EXPERIMENT # 6
BJT (Bipolar Junction Transistor) Characteristics

OBJECTIVE:

- **To test the BJT transistor and identify its type and its three terminal leads.**
- **To study experimentally the static characteristics of forward and reverse biased 3904(plastic), 3906(plastic), & BC107 (metal) BJT transistors.**
- **To understand how to analysis practically the DC (V_C, V_B, V_E) and DC (I_C, I_B, I_E)**
- **To understand the Transistor modes of operations.**

EQUIPMENT:

Breadboard /DMM /Avometer /FG /CRO/Curve Tracer / BJT transistors: 3904 (plastic), 3906 (plastic), & BC107 (metal).

PART (A): Testing BJT Type (NPN or PNP):

Procedure:

- **To test the BJT type & identify its leads three terminals (Base, Emitter or Collector), we use the Avoimeter by the following procedure and filling the table below:**

1- **We connect the (positive) lead of the Avometer with the mid lead terminals (Base $_2$) of the transistor and the other the (negative) lead of the Avometer to one end terminals (Emitter $_1$ or Collector $_3$) of the transistor.**

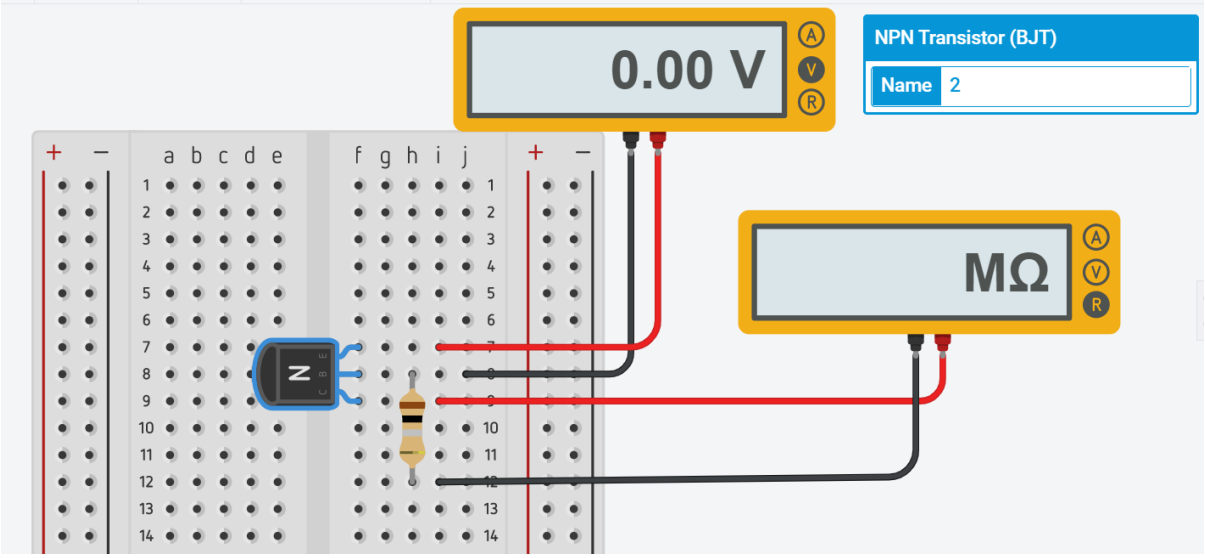
2- **Measure resistance R and V, if we have large reading and zero voltage, we need to connect the (negative) lead of the Avometer with the mid lead terminals (Base $_2$).**

3- **Measure resistance R and V, if we have small reading and ~ 0.8 V, then:**
check the polarity of the Avometer that connect the (Base $_2$) terminal of the transistor (if its positive then its NPN transistor) & (if its negative then its PNP transistor).

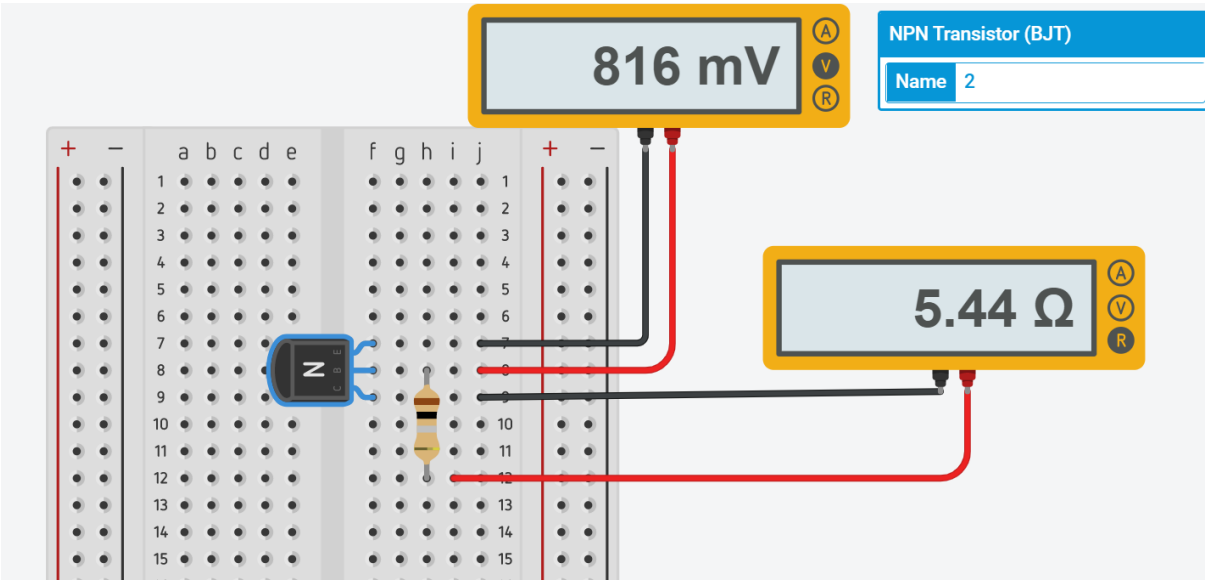
Type	BC107 (metal)	3904(plastic)	3906(plastic)
NPN or PNP			


2N
3904
3831
B

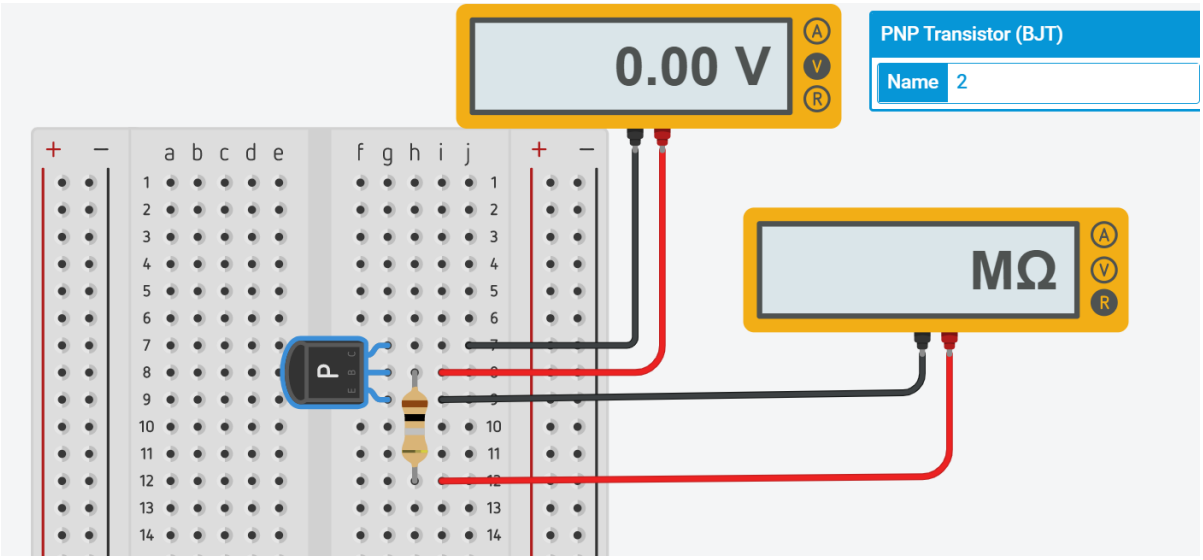

2N
3906
3831
B



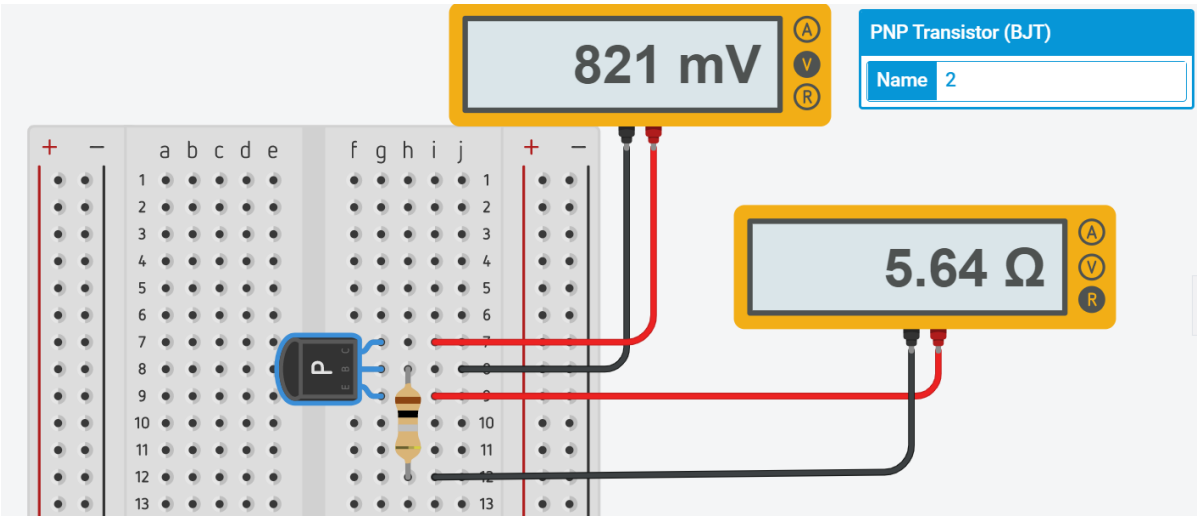
NPN for large reading



NPN for small reading



PNP for large reading



PNP for small reading

PART (B): The BJT Characteristics:
Procedure:

- **Using the curve tracer in the lab room, we will obtain a curve between I_C & V_{CE} at different steps I_B of for the output characteristic of the BJT transistor & find h parameters values practically from the slope of the curve using the following formulas:**
- **$h_{fe}=B_{AC}$ $= \Delta I_C / \Delta I_B \mid V_{CE}$ =constant =…. > $\alpha_{AC} = B_{AC}/(B_{AC}+1)$ =……<1**
- **h_{oe}= 1/ro $= \Delta I_C / \Delta V_{CE} \mid I_B$ =constant =….. > ro =…….Ω.**
- **Note: $h_{ie} = r\pi = \Delta V_{BE} / \Delta I_B \mid V_{CE}$ =constant =…. Ω. Will be obtained by the input characteristic of the BJT transistor using the curve submit by Engineer.**

PART (C): Dc analysis of the BJT circuit:

Find VC, VB, VE, and the mode of operation for both figures 1 & 2 circuits below for VBB= -5V, 2.5V and 10 V. Also, Find the mode of operation for each VBB. Set the analysis to bias points. Summarized all the values in the tables below.

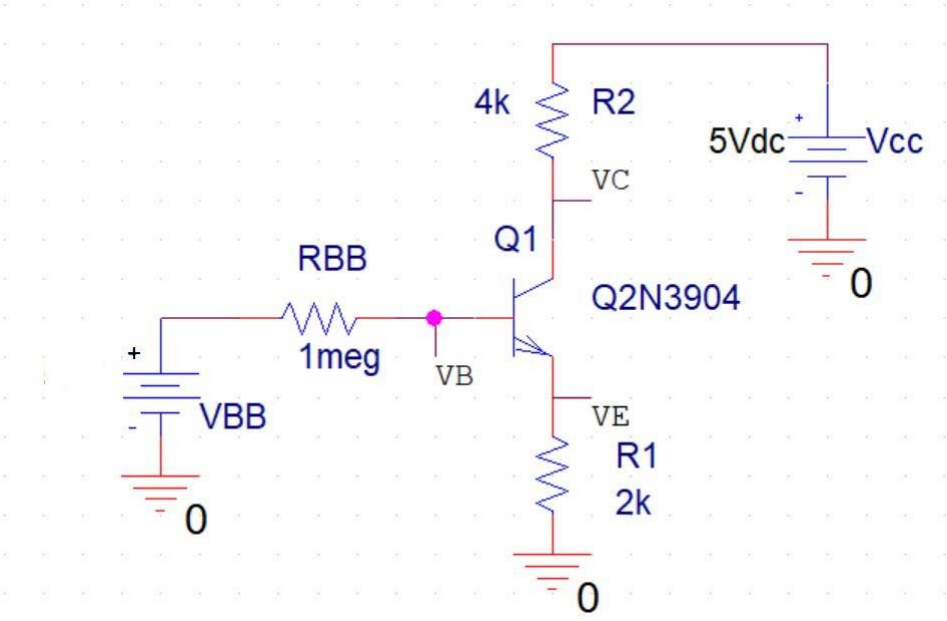


Fig.1

VBB	VC	VB	VE	Mode of operation	Justify your answer
-5V					
2.5V					
10V					

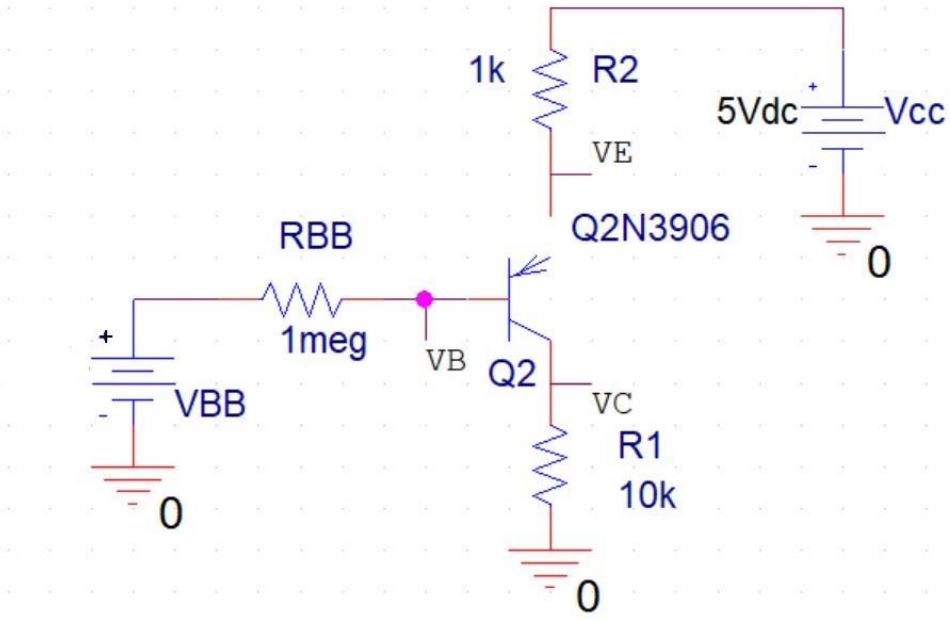


Fig.2

VBB	VC	VB	VE	Mode of operation	Justify your answer
-5V					
2.5V					
10V					

Pre-Spice analysis: (10 points)

1- **Simulate both figures 1 & 2 circuits using spice OrCAD and show your output simulations.**
2- **Find VC, VB, VE for both figures 1 & 2 circuits for VBB= -5V, 2.5V and 10V. Set the analysis to bias points. Summarized all the values in tables.**

Discussion:

1- **For all three BJT transistors used in the lab find (B_{AC}, α_{AC}, ro) parameters using curve tracer?**

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Data sheet

Part (A):

Type	3904(plastic)	3906(plastic)	BC107 (metal)
NPN or PNP			

Part (B):

Calculation using the curves of the curve tracer in the appendix for BJTs characteristics.

Part (C):

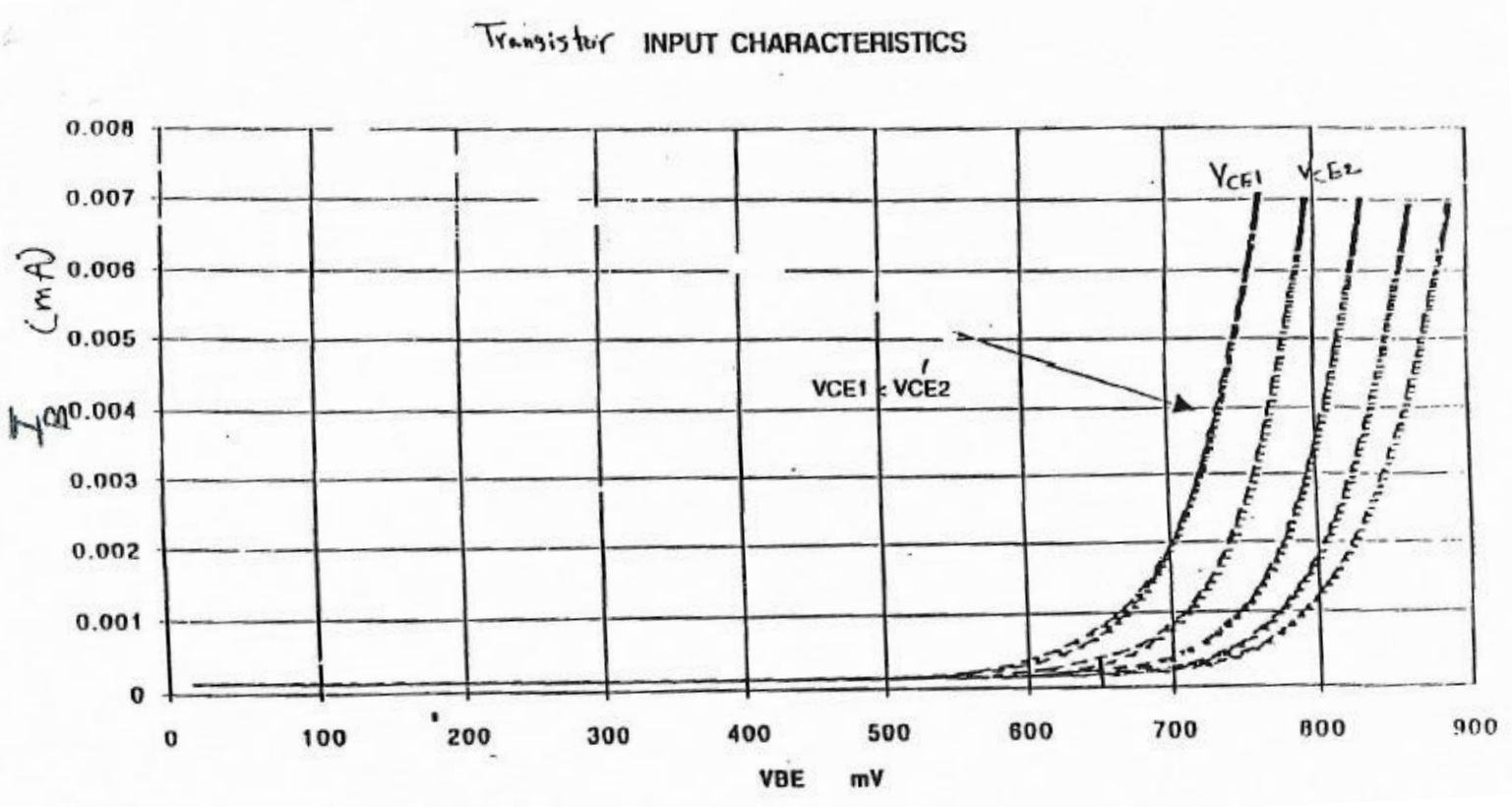
VBB	VC	VB	VE	Mode of operation	Justify your answer
-5V					
2.5V					
10V					

Fig.1

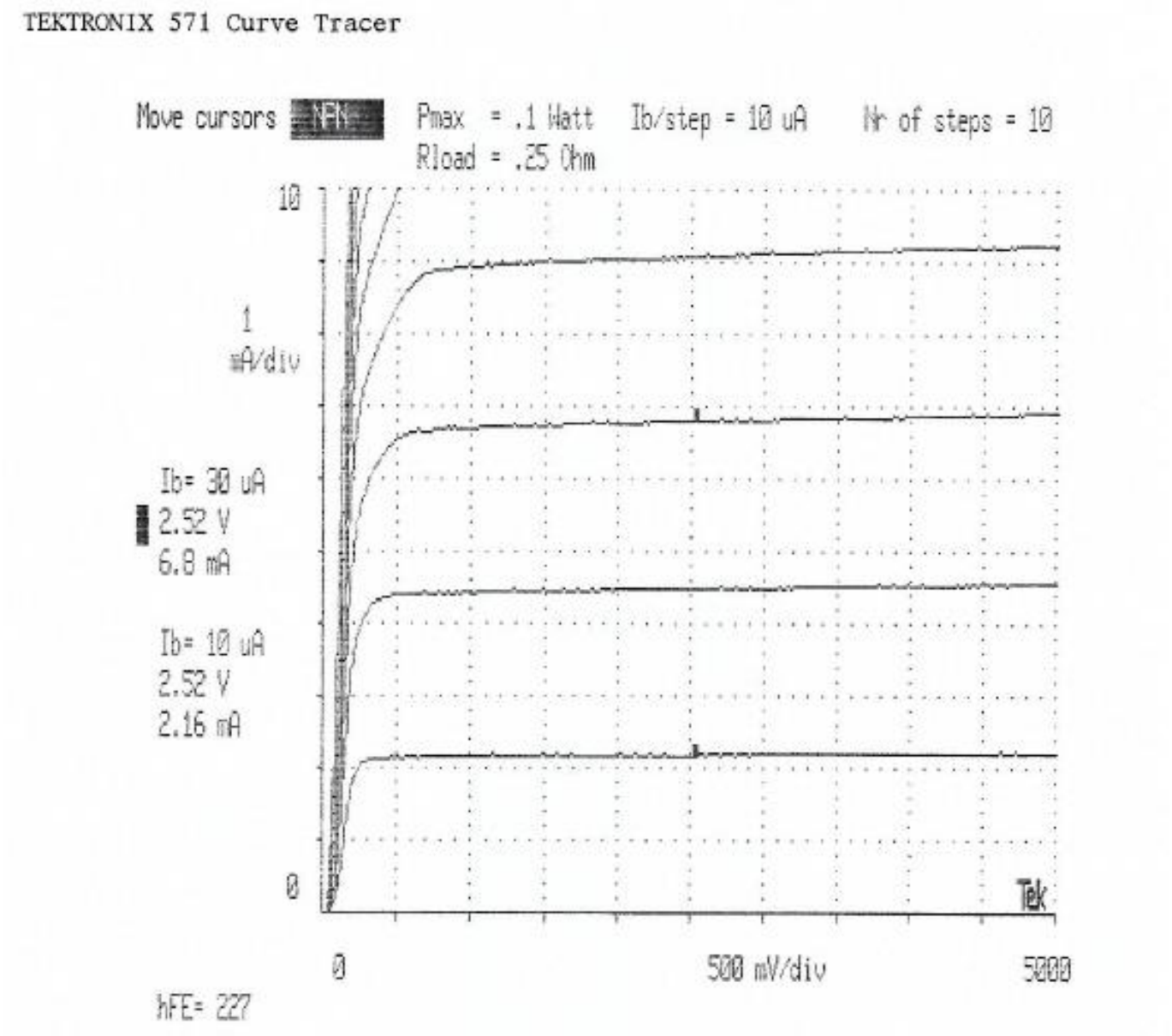
VBB	VC	VB	VE	Mode of operation	Justify your answer
-5V					
2.5V					
10V					

Fig.2

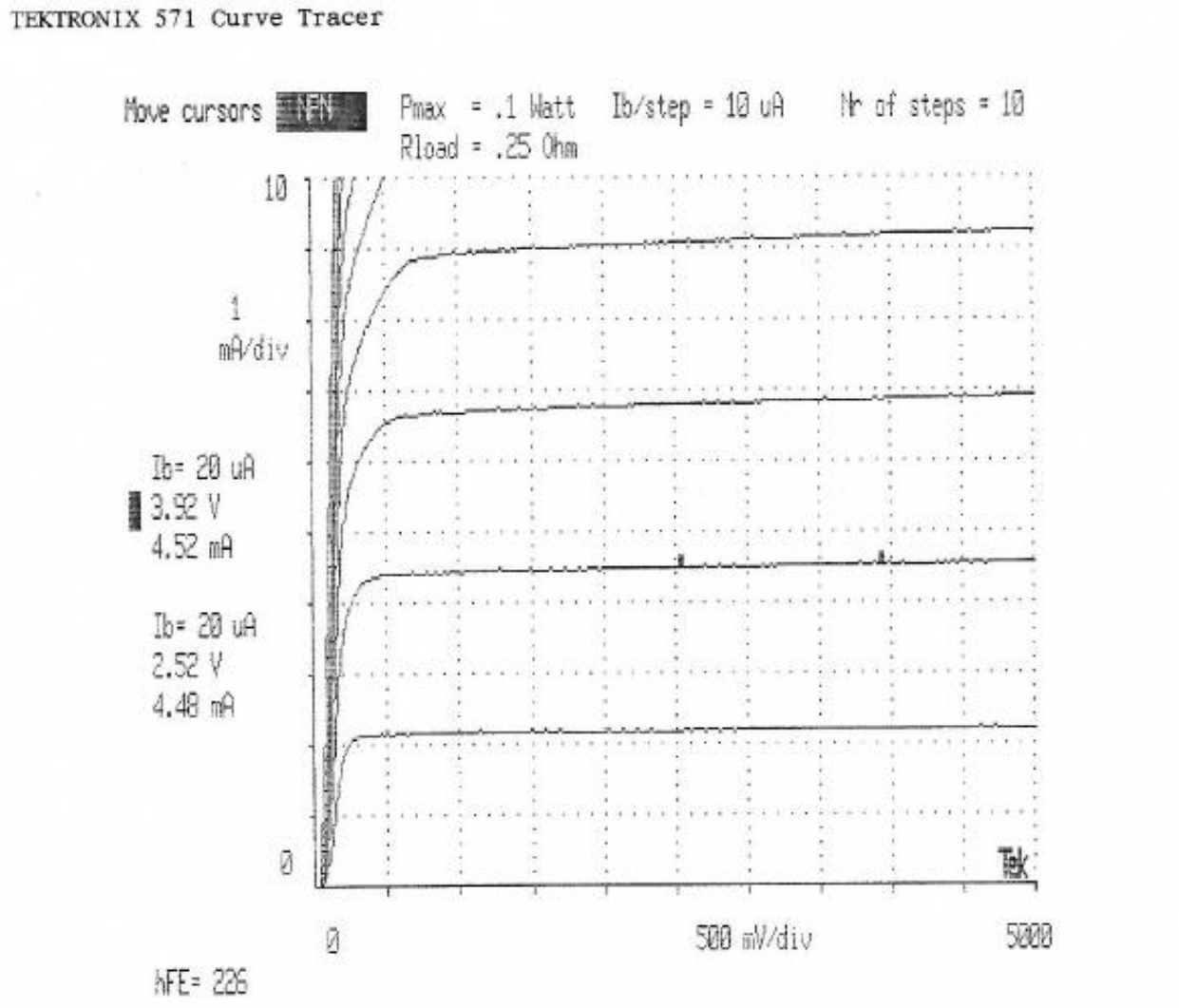
Appendix for BJTs characteristics (curve tracer prints out part B):



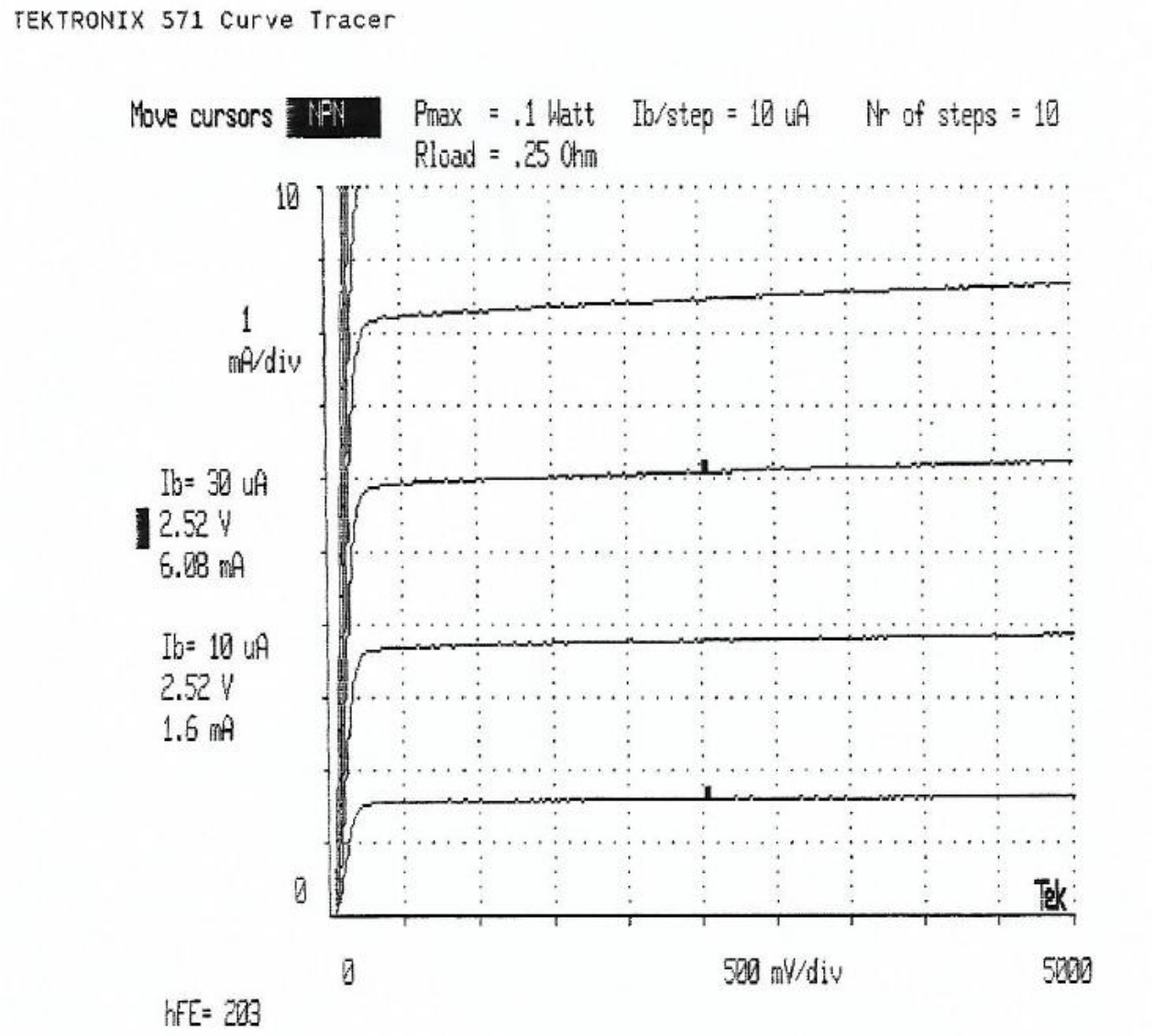
BC 107


TEKTRONIX 571 Curve Tracer
Move cursors
Pmax = .1 Watt
Ib/step = 10 uA
Nr of steps = 10
Rload = .25 Ohm
10
1
mA/div
Ib= 30 uA
2.52 V
6.8 mA
Ib= 10 uA
2.52 V
2.16 mA
0
Tek
0
500 mV/div
5000
hFE= 227

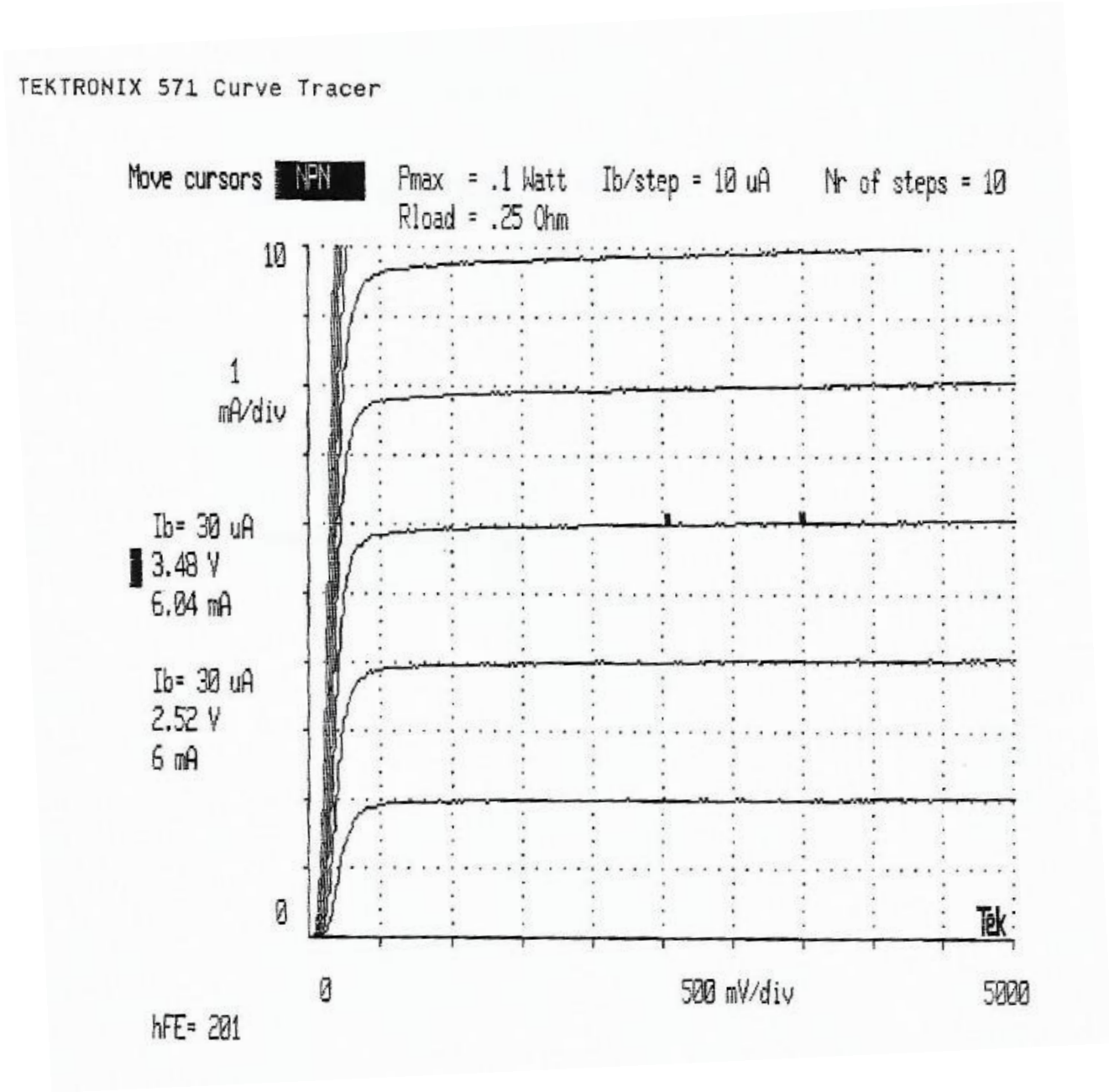
BC 107


TEKTRONIX 571 Curve Tracer
Move cursors
Pmax = .1 Watt
Ib/step = 10 uA
Nr of steps = 10
Rload = .25 Ohm
10
1
mA/div
Ib= 20 uA
3.92 V
4.52 mA
Ib= 20 uA
2.52 V
4.48 mA
0
0
500 mV/div
5000
hFE= 225
Screen copy (since power up) #2

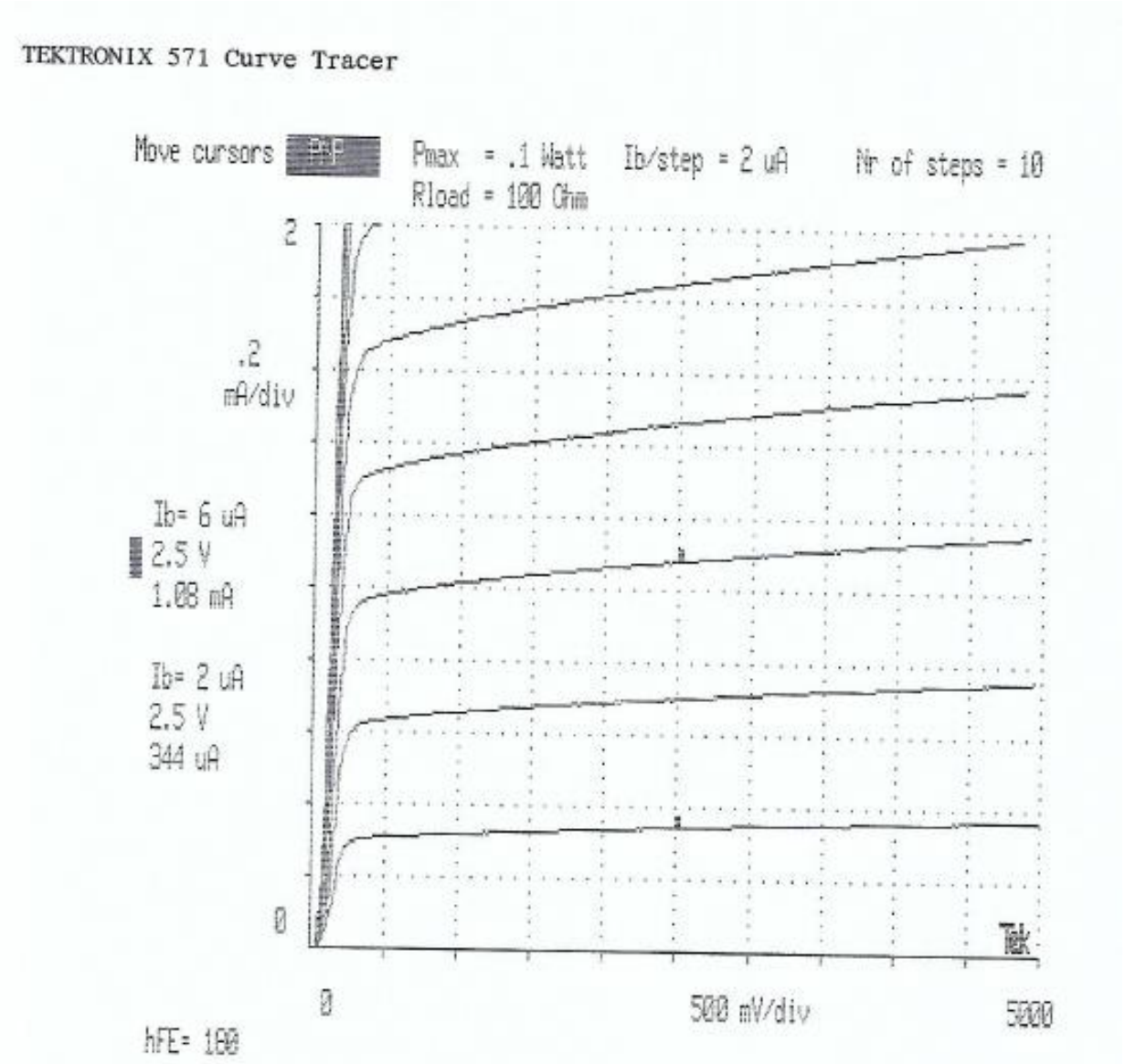
3904


TEKTRONIX 571 Curve Tracer
Move cursors
NPN
Pmax = .1 Watt
Rload = .25 Ohm
Ib/step = 10 uA
Nr of steps = 10
10
1
mA/div
Ib= 30 uA
2.52 V
6.08 mA
Ib= 10 uA
2.52 V
1.6 mA
0
Tek
0
500 mV/div
5000
hFE= 203

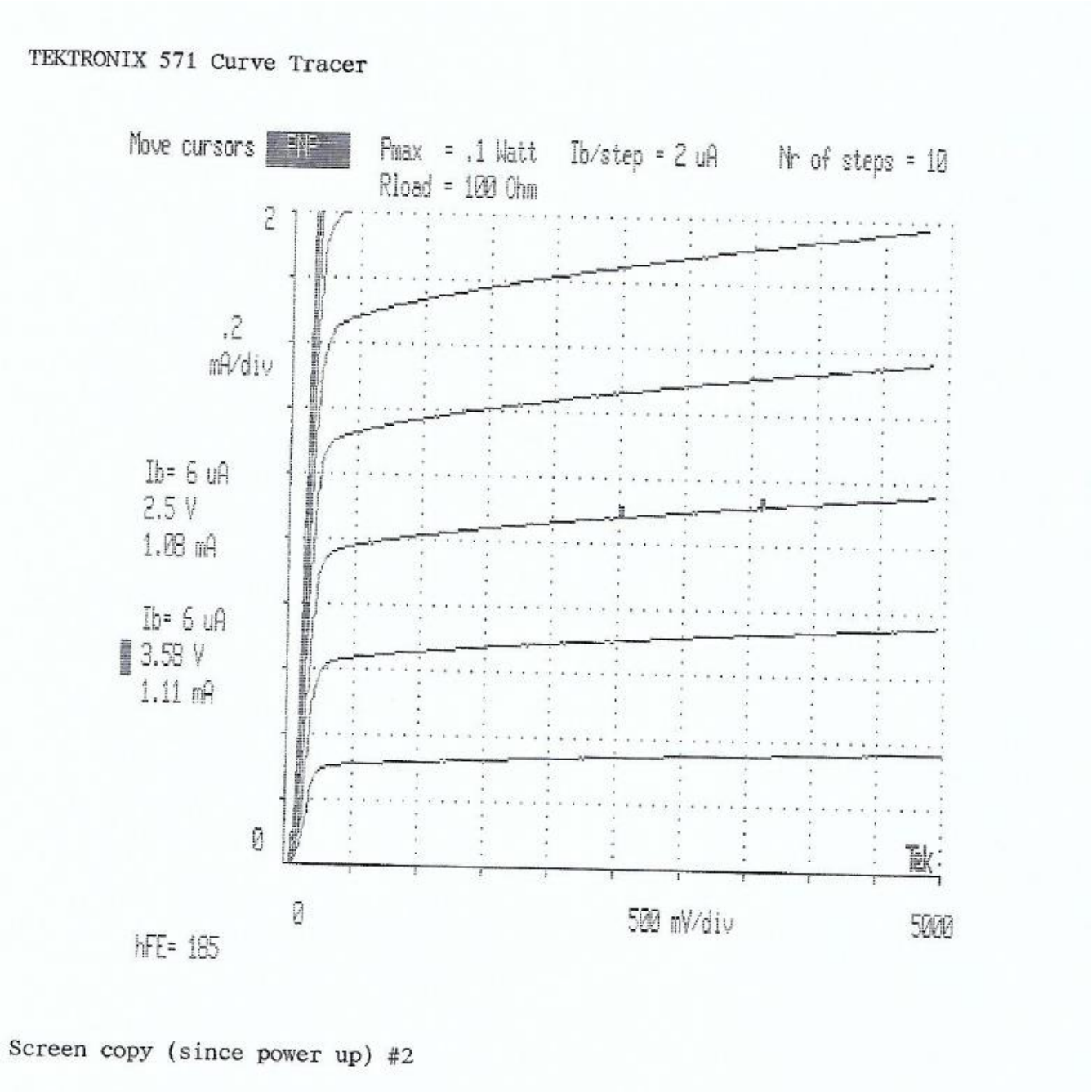
3904


TEKTRONIX 571 Curve Tracer
Move cursors
NPN
Pmax = .1 Watt
Ib/step = 10 uA
Nr of steps = 10
Rload = .25 Ohm
10
1
mA/div
Ib= 30 uA
3.48 V
6.04 mA
Ib= 30 uA
2.52 V
6 mA
0
Tek
0
500 mV/div
5000
hFE= 201

3906


TEKTRONIX 571 Curve Tracer
Move cursors
PNP
Pmax = .1 Watt
Rload = 100 Ohm
Ib/step = 2 uA
Nr of steps = 10
2
.2
mA/div
Ib= 6 uA
2.5 V
1.08 mA
Ib= 2 uA
2.5 V
344 uA
0
0
500 mV/div
5000
hFE= 180
Tek
Screen copy (since power up) #1

3906


TEKTRONIX 571 Curve Tracer
Move cursors
Pmax = .1 Watt
Ib/step = 2 uA
Nr of steps = 10
Rload = 100 Ohm
2
.2
mA/div
Ib= 6 uA
2.5 V
1.08 mA
Ib= 6 uA
3.58 V
1.11 mA
0
0
500 mV/div
5000
hFE= 185
Tek
Screen copy (since power up) #2