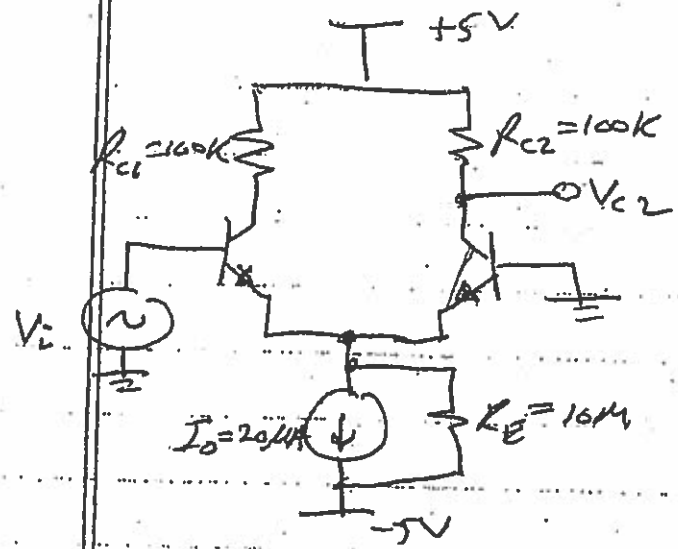
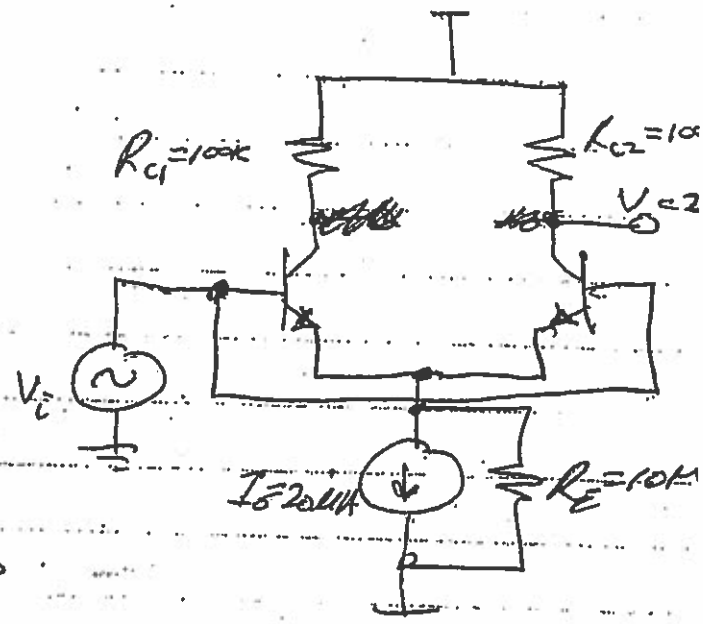
EE352 HW1 Solutions

(1-) SEOM-Case "D-88 Config"



SEOM Case "CM Config"



$\beta = 100$

$R_B = 0$

$g_m = \frac{I_Q/2}{V_T/2} = 4mA/V$

$r_\pi = \frac{\beta}{g_m} = 250K$

From your Class Notes:

$A_{cm} = -\frac{\alpha R_C}{2R_E} \approx -.005$

$A_d = \frac{g_m}{2} R_C = 20$

$R_{icm} = R_E(1+\beta) = 1010M$

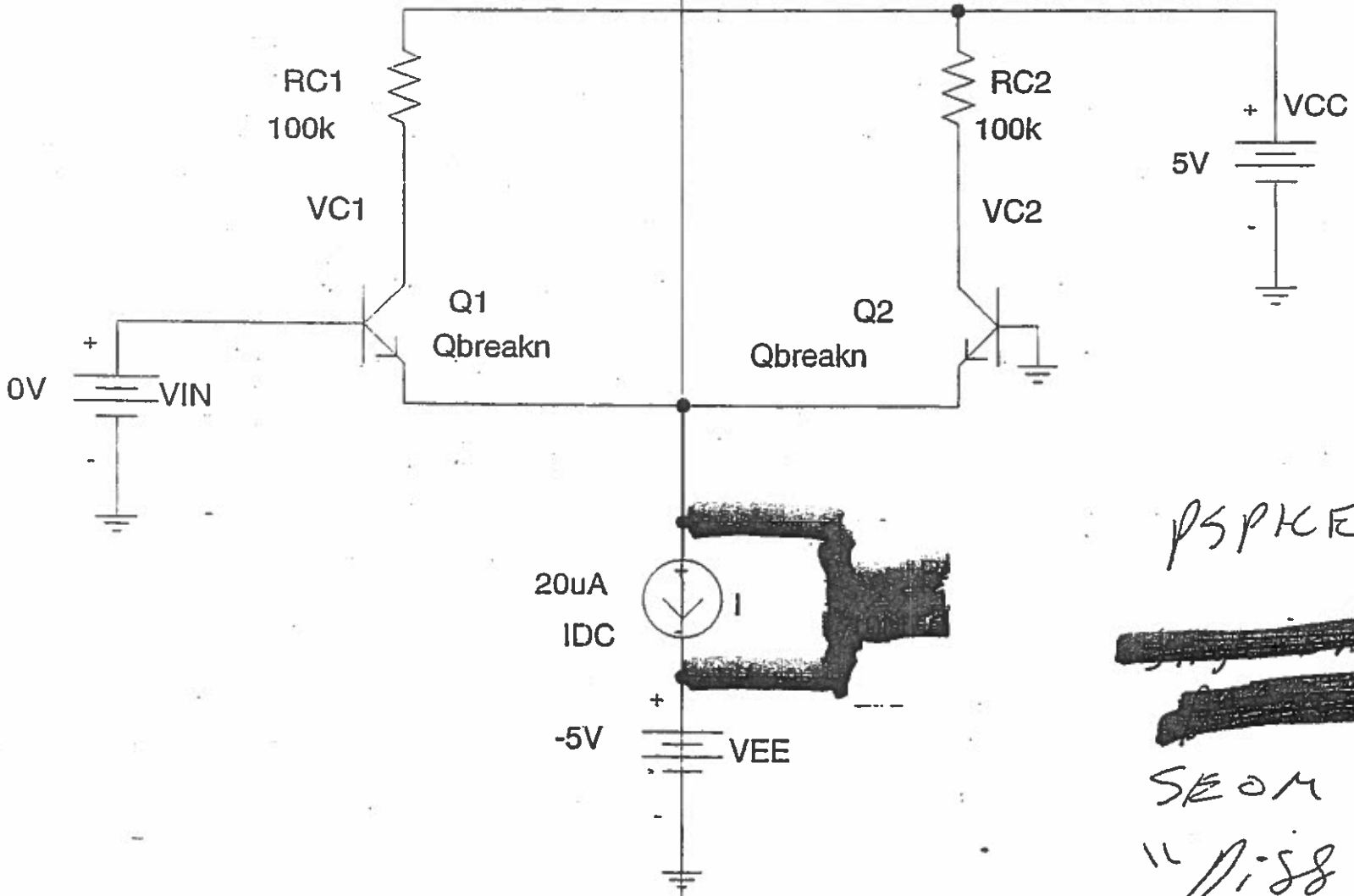
$R_{id} = 2r_\pi = 500K$

$R_{ocm} = R_C = 100K$

$R_{od} = R_C = 100K$

$CMRR = 20\log\left|\frac{A_d}{A_{cm}}\right| = 72dB$

(2) See PSPICE output files



PSPICE Schematic

[redacted]

SEOM case

"Dip8 config"

```
 ****     CIRCUIT DESCRIPTION
******************************************************************************
* Schematics Version 9.1 - Web Update 1
* Mon Jan 21 10:50:56 2019
** Analysis setup **
.TF V([VC2]) V_VIN
.OP
.LIB hw1.lib"
V_VCC          $N_0001 0 5V
V_VIN          $N_0002 0 0V
V_VEE          $N_0003 0 -5V
Q_Q1          VC1 $N_0002 VE Qbreakn
R_RC1          VC1 $N_0001  100k
R_RC2          VC2 $N_0001  100k
I_I           VE $N_0003 DC 20uA
Q_Q2           VC2 0 VE Qbreakn
.probe
.END

 ****     BJT MODEL PARAMETERS
               Qbreakn
               NPN
          BF   100

 ****   SMALL SIGNAL BIAS SOLUTION   TEMPERATURE =   27.000 DEG C
******************************************************************************
NODE   VOLTAGE  NODE   VOLTAGE     NODE    VOLTAGE     NODE   VOLTAGE
(VE)     -.6548  (VC1)     4.0099  (VC2)     4.0099
($N_0001) 5.0000    ($N_0002)     0.0000  ($N_0003)    -5.0000

**** BIPOLAR JUNCTION TRANSISTORS
NAME           Q_Q1          Q_Q2
MODEL          Qbreakn       Qbreakn
IB             9.90E-08      9.90E-08
IC             9.90E-06      9.90E-06
VBE            6.55E-01      6.55E-01
VBC           -4.01E+00     -4.01E+00
VCE            4.66E+00      4.66E+00
BETADC         1.00E+02      1.00E+02
GM             3.83E-04      3.83E-04
RPI            2.61E+05      2.61E+05
RO             1.00E+12      1.00E+12

 ****     SMALL-SIGNAL CHARACTERISTICS
      V(VC2)/V_VIN = 1.914E+01
      INPUT RESISTANCE AT V_VIN = 5.225E+05
      OUTPUT RESISTANCE AT V(VC2) = 1.000E+05
```

PSPICE

xxx.out file

SEOM Case "Diff Config"

← Hand = 10μA

← Hand = 0.4mA/V

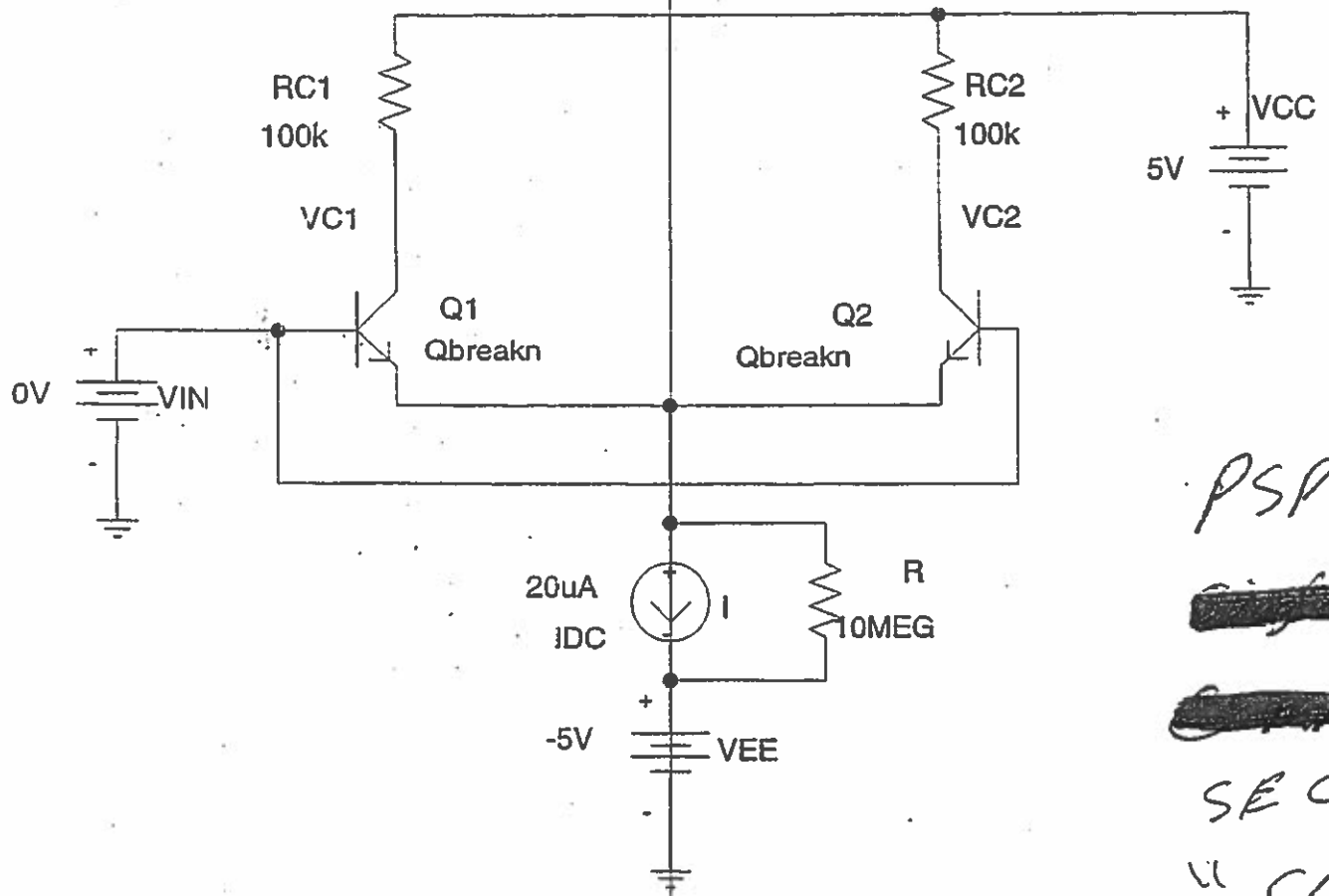
← Hand = 250kΩ

If and A_d = 20 v/v

← Hand R_{id} = 500kΩ

← Hand R_{od} = 100kΩ

All values compare favorably!!



PSPICE Schematic

[redacted]

SE OM case

"CM Config"

```
****     CIRCUIT DESCRIPTION
******************************************************************************
* Schematics Version 6.2 - April 1995
* Fri Jan 28 11:01:52 2000
** Analysis setup **
.TF V([VC2]) V_VIN
.OP
.LIB hw1.lib
R_RC1          VC1 $N_0001  100k
R_RC2          VC2 $N_0001  100k
V_VCC          $N_0001 0 5V
I_I          $N_0002 $N_0003 DC 20uA
V_VIN          $N_0004 0 0V
V_VEE          $N_0003 0 -5V
R_R          $N_0003 $N_0002  10MEG
Q_Q1          VC1 $N_0004 $N_0002 QbreakN
Q_Q2          VC2 $N_0004 $N_0002 QbreakN
.probe
.END
```

PSPICE

xxx.out file

SEdit Case "CM config"

```
****     BJT MODEL PARAMETERS
******************************************************************************
               QbreakN
               NPN
          BF   100
          RB     0

****     SMALL SIGNAL BIAS SOLUTION       TEMPERATURE =   27.000 DEG C
******************************************************************************
 NODE   VOLTAGE     NODE   VOLTAGE     NODE   VOLTAGE     NODE   VOLTAGE
(  VC1)    3.9884  (  VC2)    3.9884  ($N_0001)    5.0000
($N_0002)    -.6554                  ($N_0003)   -5.0000
($N_0004)    0.0000

**** BIPOLAR JUNCTION TRANSISTORS
NAME            Q_Q1          Q_Q2
MODEL           QbreakN       QbreakN
IB              1.01E-07      1.01E-07
IC              1.01E-05      1.01E-05
VBE             6.55E-01      6.55E-01
VBC            -3.99E+00     -3.99E+00
VCE             4.64E+00      4.64E+00
BETADC          1.00E+02      1.00E+02
GM              3.91E-04      3.91E-04
RPI             2.56E+05      2.56E+05
RX              0.00E+00      0.00E+00
RO              1.00E+12      1.00E+12
CBE             0.00E+00      0.00E+00
CBC             0.00E+00      0.00E+00
CBX             0.00E+00      0.00E+00
CJS             0.00E+00      0.00E+00
BETAAC          1.00E+02      1.00E+02
FT              6.22E+15      6.22E+15

****     SMALL-SIGNAL CHARACTERISTICS
     V(VC2)/V_VIN =  -4.950E-03
     INPUT RESISTANCE AT V_VIN =  1.008E+09
     OUTPUT RESISTANCE AT V(VC2) =  1.000E+05
```

IC: Hand = 10 uA ✓

GM: Hand = 0.4mA/V ✓

RPI: Hand = 250 kΩ ✓

Acm: Hand = −.005 V/V ✓

Ricm: Hand = 1010 MΩ ✓

Rocm: Hand = 100K ✓

All values compare favorably!!

CMRR = $20\log\left|\frac{Ad}{Acm}\right| = 71.9$ dB ✓