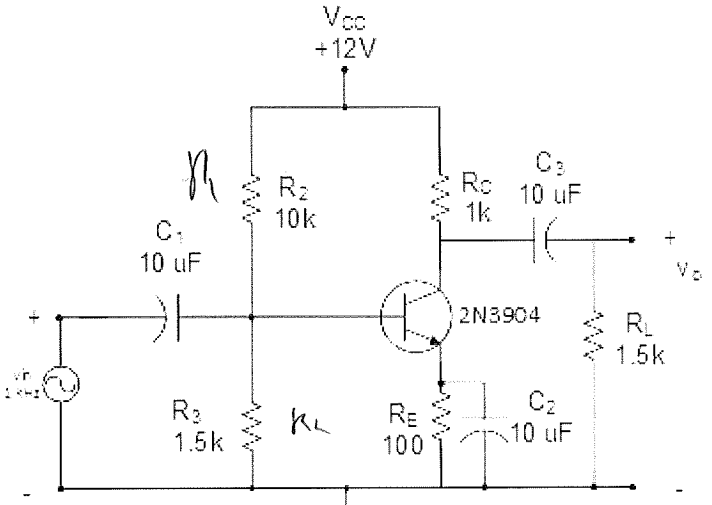
(1)

Union College
ECE248
Lab 07 Solution

See page 370 in the text book




Case 1 MSS

Find the value of $R_3$ for MSS

a) find $I_{CQ}$ and $V_{CEQ}$

$$I_{CQ} = \frac{V_{CC}}{R_{ac} + R_{dc}} \qquad R_{ac} = R_C \,||\, R_L$$

$$R_{ac} = 1k \,||\, 1.5k = 600\,\Omega$$

$$R_{dc} = R_C + R_E = 1k + 100\,\Omega = 1.1k\,\Omega$$

$$I_{CQ} = \frac{12}{1.1k + .6k} = 7.06\,mA$$

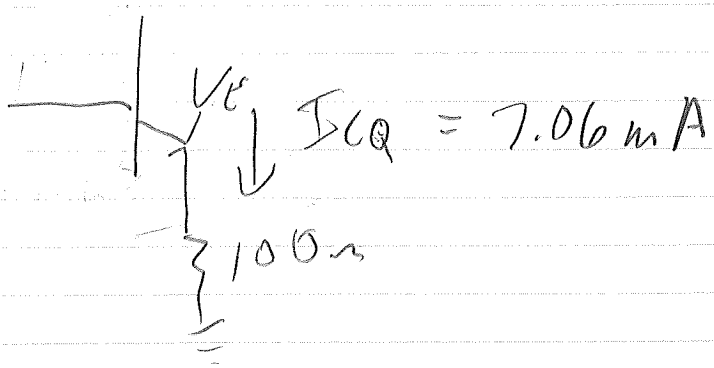
$$V_{CEQ} = V_{CC} - I_{CQ}(R_C + R_E) = 12 - (7.06(1+.1)) = 4.3V$$

(2)

b) Find value for $R_3$

"Thevenize" voltage divider

Find $V_{BB}$




$V_E = (7.06\,mA)(100\,\Omega) = .706\,V$

$V_{BB} = V_E + 0.7 = 1.406$

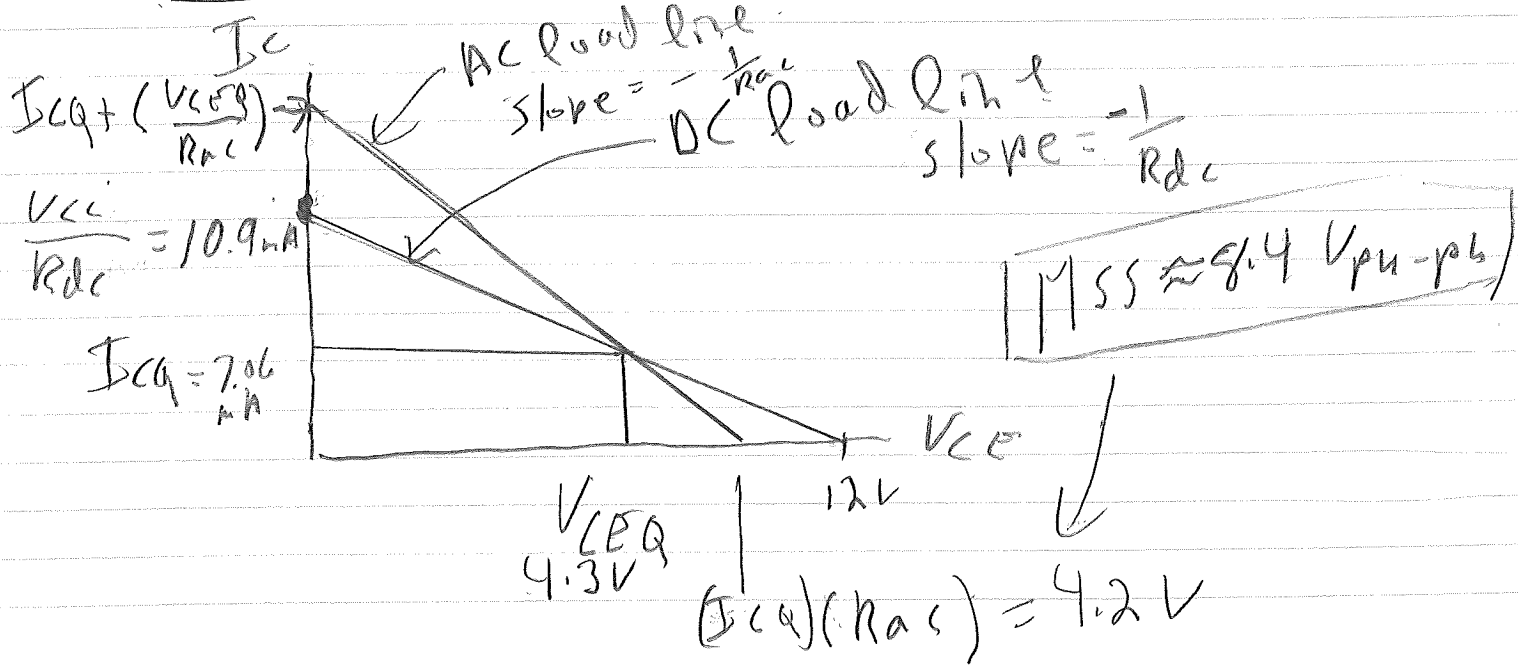
Find $R_3$ to give 1.406 V

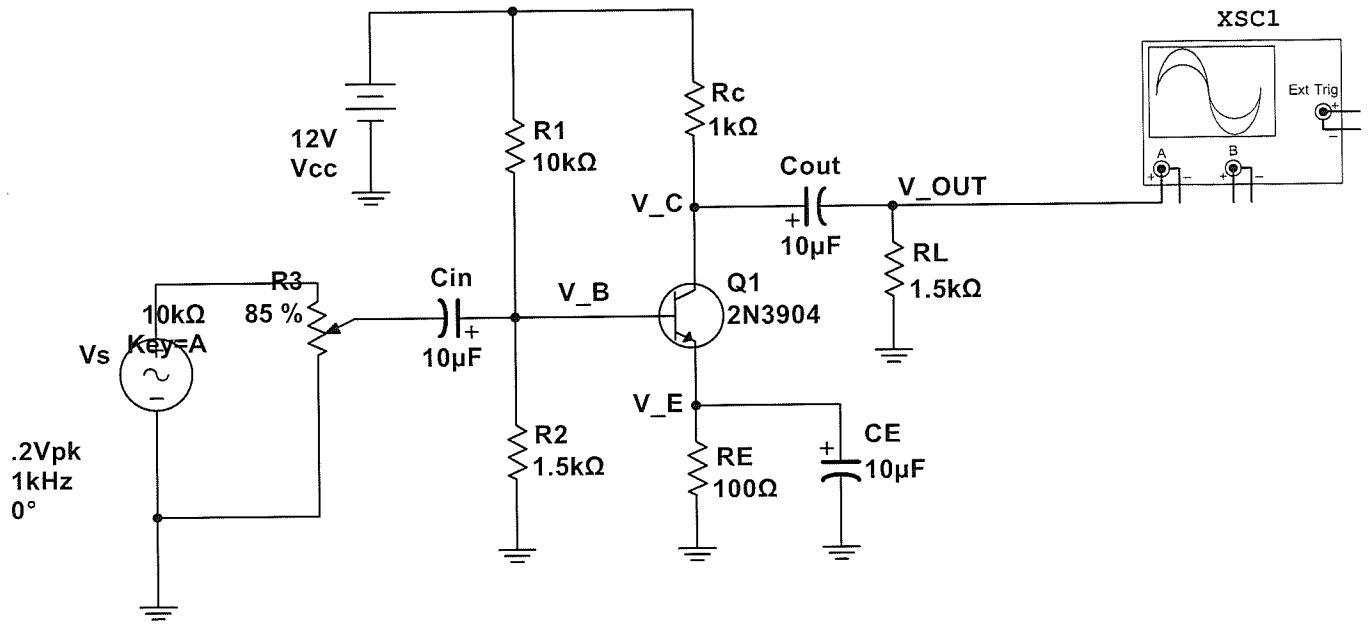
$$1.406 = \frac{12 R_3}{R_3 + 10k}$$

$$\boxed{R_3 = 1.335\,k\Omega}$$

nearest 5% value = $\boxed{1.5\,k\Omega}$

∴ Draw load line




12V
Vcc
R1
10kΩ
Rc
1kΩ
XSC1
Ext Trig
A
B
Cout
10µF
V_C
V_OUT
RL
1.5kΩ
R3
10kΩ
85 %
Key=A
Vs
.2Vpk
1kHz
0°
Cin
10µF
V_B
Q1
2N3904
V_E
R2
1.5kΩ
RE
100Ω
CE
10µF

# LoadLinesR3_1.5k

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## DC Operating Point Analysis

| | Variable | Operating point value |
|---|---|---|
| 1 | V(v_b) | 1.50363 |
| 2 | V(v_c) | 4.21784 |
| 3 | V(v_c)-V(v_e) | 3.43491 |
| 4 | V(v_e) | 782.93716 m |
| 5 | I(Q1[IB]) | 47.21579 u |
| 6 | I(Q1[IC]) | 7.78216 m |
| 7 | I(Q1[IE]) | -7.82937 m |

← designed for $V_{CEQ} = 4.3V$

← designed for $I_{CQ} = 7.06mA$

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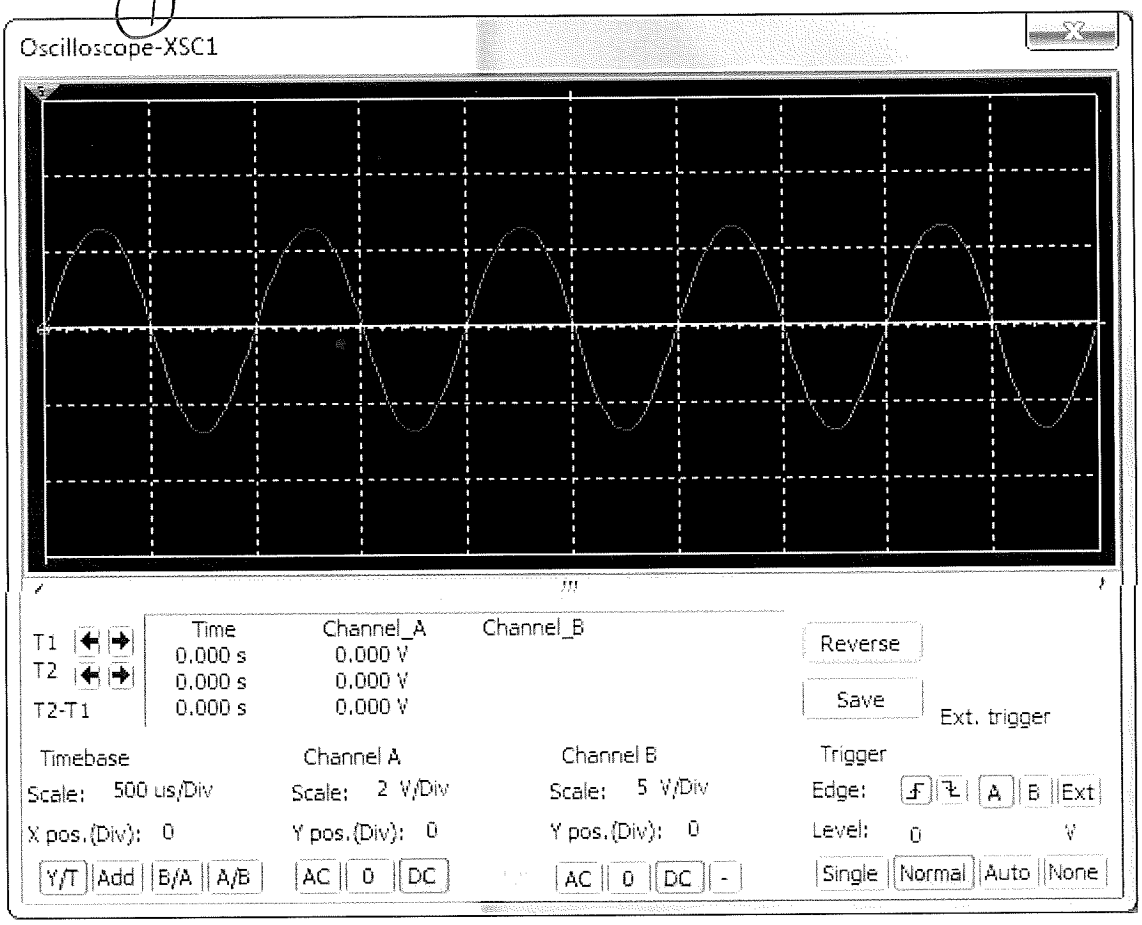
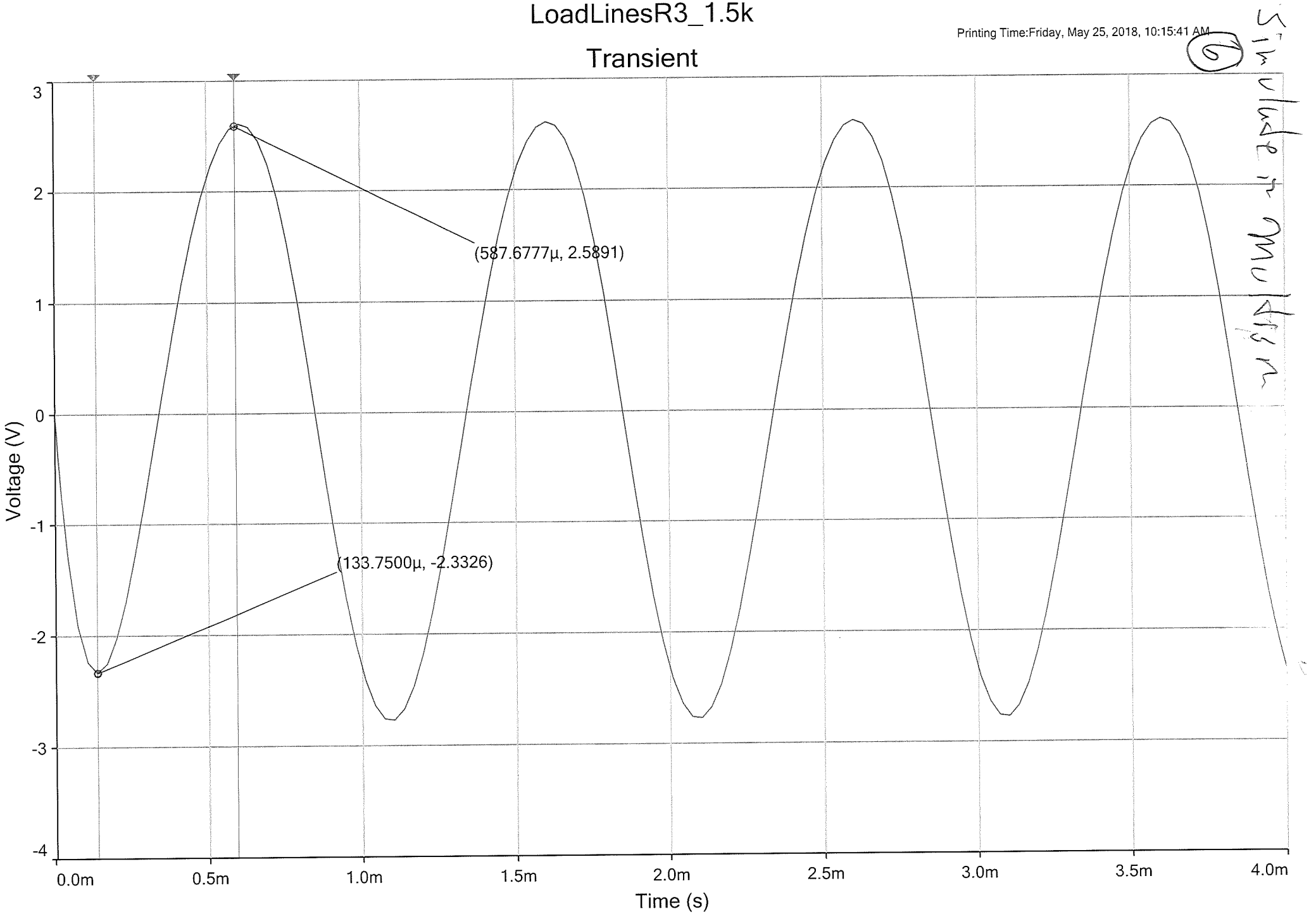
Simulate in Multisim




Simulate in Multisim



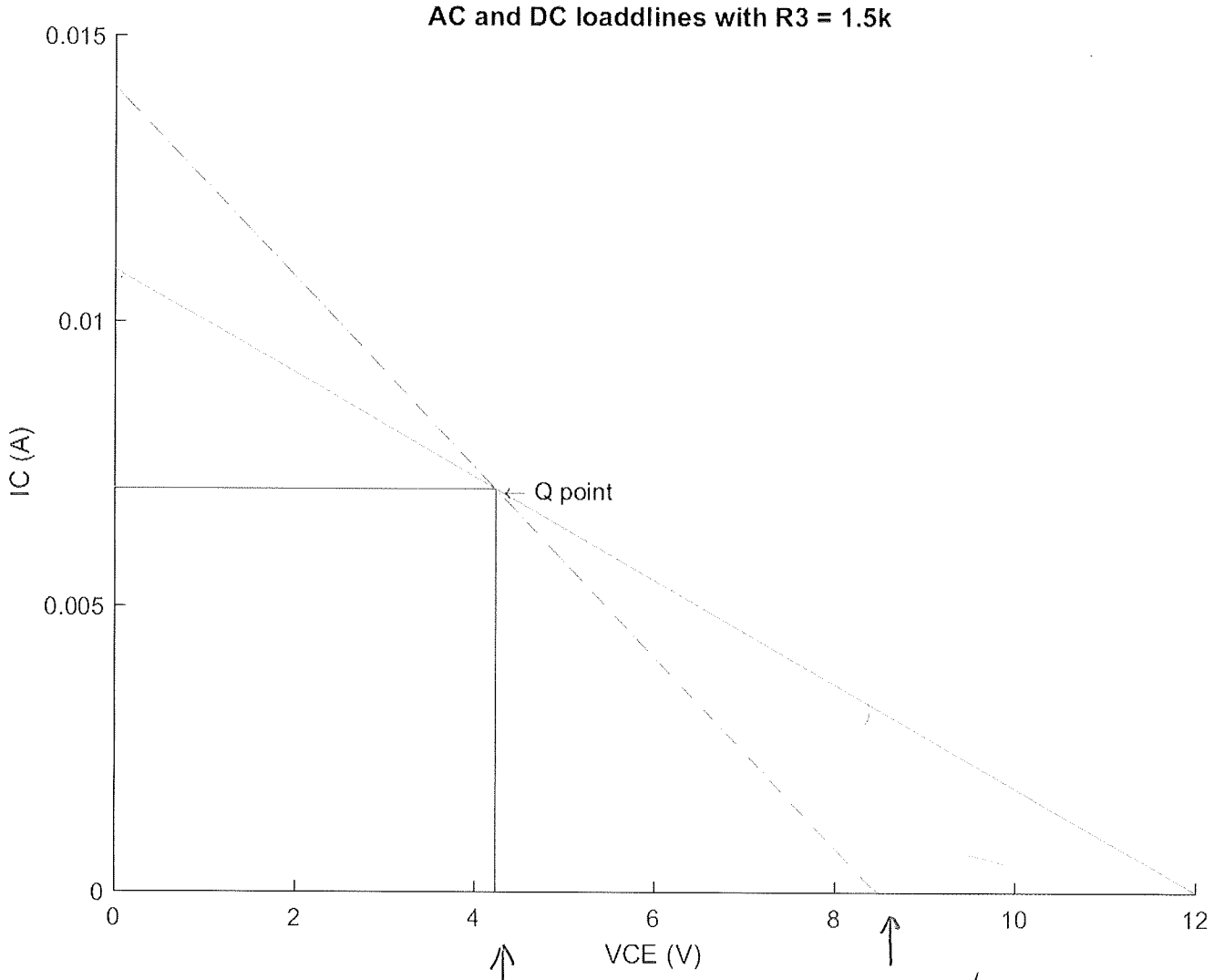

| | x1 | y1 | x2 | y2 | dx | dy | dy/dx | 1/dx |
|---|---|---|---|---|---|---|---|---|
| V(v_out): | 587.6777µ | 2.5891 | 133.7500µ | -2.3326 | -453.9277µ | -4.9217 | 10.8424k | -2.2030k |

```
% Generate the DC and AC load lines for R3 = 1.5k
% this will give the MSS

clear
clf



k = 10^3;
VCC = 12;
RC = 1*k;
RE = 100;
RL = 1.5*k;
RDC = RC + RE
Rac = (RC*RL)/(RC + RL)


% calculate ICQ for MSS

ICQ = VCC/(Rac +RDC)
VCEQ = VCC -  (ICQ*(RC + RE))

Vpk = ICQ * Rac


x = 0:.1: VCC;
ydc = (-1/RDC)*x + (VCC/RDC);

yac = (-1/Rac)*x + (ICQ + (VCEQ/Rac));

for i = 1: length(yac)
   if yac(i) <= 0
     yac(i) = 0;
    end
end

hold

plot(x,ydc, x, yac)

plot([0, VCEQ], [ICQ, ICQ] , 'r')

plot([VCEQ, VCEQ] , [ICQ,0],'r')

Qpt = ' \leftarrow Q point';
text(VCEQ, ICQ, Qpt)
grid
xlabel('VCE (V)')
ylabel('IC (A)')
title(' AC and DC loaddlines with R3 = 1.5k')
hold off
```

Use Matlab to plot Theoretical Load Lines

(8)

matlab

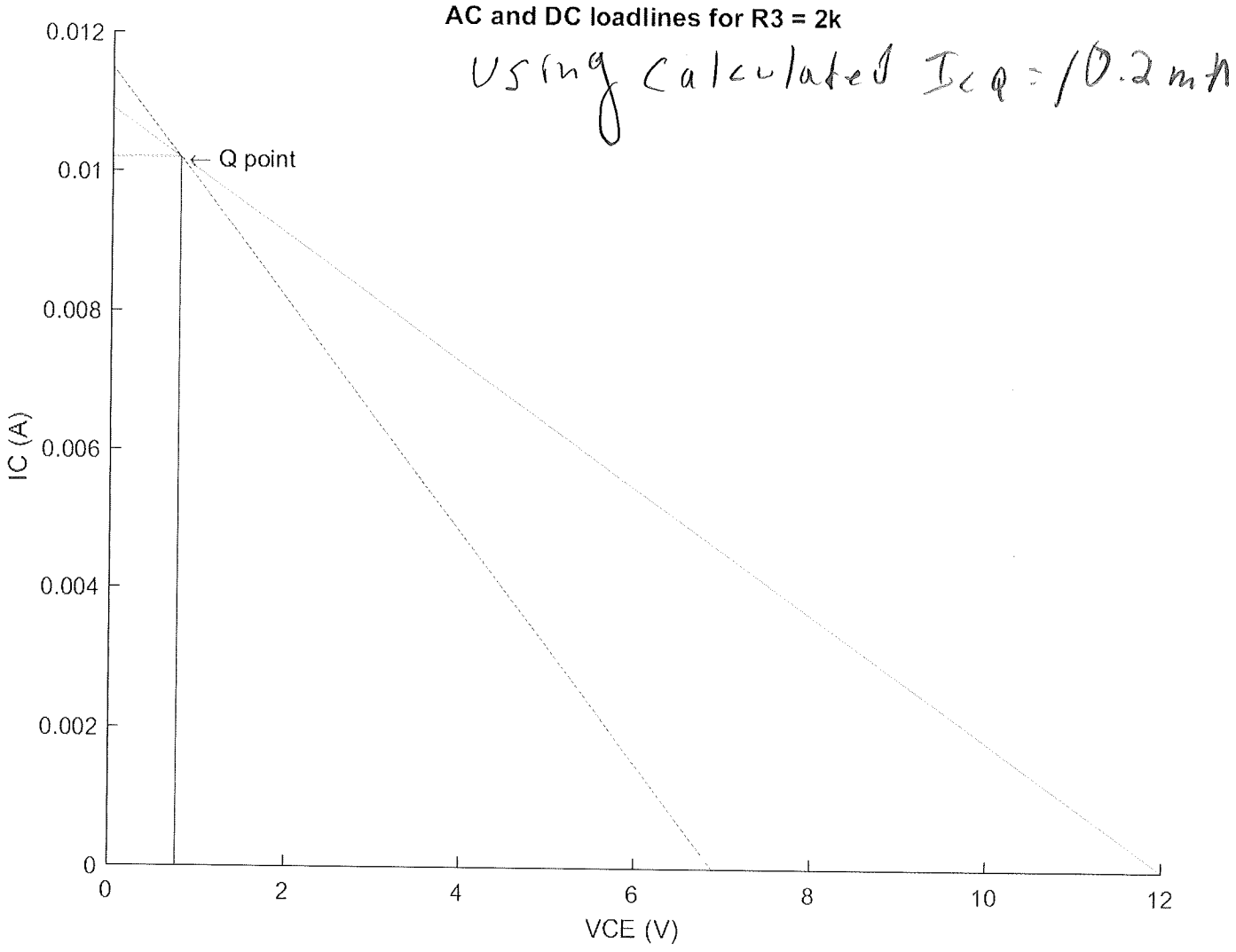



4.225V

8.4V

↑ ← 4.165V → ↑

absolute max Vss = 8.33 pk-pk


AC and DC loadlines for R3 = 2k
Using Calculated $I_{CQ} = 10.2\,mA$
Q point
0.012
0.01
0.008
0.006
0.004
0.002
0
IC (A)
0
2
4
6
8
10
12
VCE (V)