7.1

(a) Transistor parameters are

$$r_\pi = \frac{\beta_0}{g_m} = 200 \times 52 = 10.4 \text{ k}\Omega$$

$$\tau_T = \frac{1}{2\pi f_T} = 318 \text{ ps}$$

$$C_\pi + C_\mu = g_m \tau_T = \frac{1}{52} \times 318 = 6.12 \text{ pF}$$

$$\therefore C_\pi = 6.1 - 0.3 = 5.8 \text{ pF}$$

$$C_M = (1 + g_m R_L) C_\mu$$

$$= (1 + \frac{3000}{52}) \times 0.3 = 17.6 \text{ pF}$$

In (7.12) and (7.9)

$$f_{-3dB} = \frac{1}{2\pi} \frac{5000 + 300 + 10400}{(5000 + 300) \times 10400} \frac{10^{12}}{5.8 + 17.6} \text{ Hz}$$

$$= 1.94 \text{ MHz}$$

(b) From (7.27)

$$P_2 = -\left(\frac{1}{R_L C_\mu} + \frac{1}{R C_\pi} + \frac{1}{R_L C_\pi} + \omega_T \right)$$

$$R = (R_S + r_b) \,/\!/\, r_\pi$$

$$= 5300 \| 10400 = 3511 \,\Omega$$

$$\therefore P_2 = -\left(\frac{10^{12}}{3000 \times 0.3} + \frac{10^{12}}{3511 \times 5.8} + \frac{10^{12}}{3000 \times 5.8} \right.$$

$$\left. + 2\pi \times 500 \times 10^6 \right)$$

$$= -(11.1 + 0.49 + 0.57 + 31.4) \times 10^8 \text{ rad/sec}$$

$$= -43.6 \times 10^8 \text{ rad/sec}$$

$$= -693 \text{ MHz}$$

```
COMMON EMITTER GAIN STAGE
VCC 1 0 5V
RL 1 2 3K
Q1 2 3 0 NPN
RS 4 3 5K
VI 4 0 0.7696 AC
.TF V(2) VI
.PLOT AC VDB(2)
.PLOT AC VP(2)
.AC DEC 10 100K 1GIG
.MODEL NPN NPN IS=1E-16A BF=200
+ RB=300 CJC=0.3PF CJS=0 TF=302PS
* ASSUME CJE SMALL COMPARED TO CB
.OPTIONS NOPAGE NOMOD
.WIDTH OUT=80
.OPTIONS SPICE
.OP
.END
```

****** OPERATING POINT INFORMATION   TNOM= 27.000 TEMP= 27.000

+0:1   = 5.000E+00 0:2   = 3.497E+00 0:3   = 7.571E-01
+0:4   = 7.696E-01

**** BIPOLAR JUNCTION TRANSISTORS

ELEMENT	0:Q1
MODEL	0:NPN
IB	2.504E-06
IC	5.009E-04
VBE	7.571E-01
VCE	3.497E+00
VBC	-2.740E+00
VS	-3.497E+00
POWER	1.754E-03
BETAD	2.000E+02
GM	1.937E-02
RPI	1.032E+04
RX	3.000E+02
RO	2.741E+16
CPI	5.849E-12
CMU	1.806E-13
CBX	0.
CCS	0.
BETAAC	2.000E+02
FT	5.112E+08

**** SMALL-SIGNAL TRANSFER CHARACTERISTICS

V(2)/VI		= -3.839E+01
INPUT RESISTANCE AT	VI	= 1.562E+04
OUTPUT RESISTANCE AT V(2)		= 3.000E+03

****** AC ANALYSIS   TNOM= 27.000 TEMP= 27.000

```
   FREQ      VDB(2)
  (A    )   -4.000E+01    -2.000E+01      0.       2.000E+01    4.000E+01
           +------------+------------+------------+------------+
1.000E+05  3.16E+01 +------------+------------+------------+------------+A----+
1.258E+05  3.16E+01 +     +      +      +      +      +      -     +A    +
1.584E+05  3.16E+01 +     +      +      +      +      +      +     +A    +
1.995E+05  3.16E+01 +     +      +      +      +      +      +     +A    +
2.511E+05  3.16E+01 +     +      +      +      +      +      +     +A    +
3.162E+05  3.16E+01 +     +      +      +      +      +      +     +A    +
3.981E+05  3.15E+01 +     +      +      +      +      +      +     +A    +
5.011E+05  3.15E+01 +     +      +      +      +      +      +     +A    +
6.309E+05  3.14E+01 +     +      +      +      +      +      +     +A    +
7.943E+05  3.13E+01 +     +      +      +      +      +      +     +A    +
1.000E+06  3.11E+01 +------------+------------+------------+------------+A----+
1.258E+06  3.08E+01 +     +      +      +      +      +      +     +A    +
1.584E+06  3.04E+01 +     +      +      +      +      +      +      A    +
1.995E+06  2.98E+01 +     +      +      +      +      +      +      A    +
2.511E+06  2.90E+01 +     +      +      +      +      +      +      A*   +
3.162E+06  2.80E+01 +     +      +      +      +      +      +      A*   +
3.981E+06  2.67E+01 +     +      +      +      +      +      +     A +   +
5.011E+06  2.52E+01 +     +      +      +      +      +      +    A +   +
6.309E+06  2.36E+01 +     +      +      +      +      +      +  A +   +
7.943E+06  2.19E+01 +     +      +      +      +      +     +A    +
1.000E+07  2.01E+01 +------------+------------+------------+------A-----+
1.258E+07  1.82E+01 +     +      +      +      +      +      A*    +
1.584E+07  1.62E+01 +     +      +      +      +     A +    +
1.995E+07  1.43E+01 +     +      +      +      +    A +    +
2.511E+07  1.23E+01 +     +      +      +      +   A +    +
3.162E+07  1.03E+01 +     +      +      +      A   +    +
3.981E+07  8.39E+00 +     +      +      +     A*    +
5.011E+07  6.39E+00 +     +      +      + A    +
6.309E+07  4.38E+00 +     +      +      + A    +
7.943E+07  2.37E+00 +     +      +      +A     +
1.000E+08  3.56E-01 +------------+------------+------A+------------+
1.258E+08 -1.67E+00 +     +      +      + A+    +
1.584E+08 -3.73E+00 +     +      +     + A +    +
1.995E+08 -5.82E+00 +     +      +      + A+    +
2.511E+08 -7.95E+00 +     +      +     +A    +
3.162E+08 -1.01E+01 +     +      +     A    +
3.981E+08 -1.24E+01 +     +     A*    +
5.011E+08 -1.49E+01 +     +    A +    +
6.309E+08 -1.75E+01 +     + A +    +
7.943E+08 -2.03E+01 +     A +    +
1.000E+09 -2.34E+01 +------------+A+------------+------------+------------+
           +            +            +            +            +
```

```
   FREQ      VP(2)
  (A    )     0.          5.000E+01    1.000E+02    1.500E+02    2.000E+02
           +------------+------------+------------+------------+
1.000E+05  1.77E+02 +------------+------------+------------+------------+A----+
1.258E+05  1.77E+02 +     +      +      +      +      +      +     +A    +
1.584E+05  1.76E+02 +     +      +      +      +      +      +      A    +
1.995E+05  1.75E+02 +     +      +      +      +      +      +      A    +
2.511E+05  1.74E+02 +     +      +      +      +      +      +      A    +
3.162E+05  1.73E+02 +     +      +      +      +      +      +      A    +
3.981E+05  1.71E+02 +     +      +      +      +      +     A+    +
5.011E+05  1.69E+02 +     +      +      +      +      +     A +    +
6.309E+05  1.67E+02 +     +      +      +      +      +     A +    +
7.943E+05  1.63E+02 +     +      +      +      +      +    A +    +
1.000E+06  1.59E+02 +------------+------------+------------+----A+------+
1.258E+06  1.55E+02 +     +      +      +      +      -A    +
1.584E+06  1.49E+02 +     +      +      +      +     A    +
1.995E+06  1.43E+02 +     +      +      +      +    A +    +
2.511E+06  1.37E+02 +     +      +      +      + A +    +
3.162E+06  1.30E+02 +     +      +      +      +A    +
3.981E+06  1.24E+02 +     +      +      +     A    +
5.011E+06  1.18E+02 +     +      +      +    A +    +
6.309E+06  1.13E+02 +     +      +      +  A +    +
7.943E+06  1.08E+02 +     +      +      +A    +
1.000E+07  1.04E+02 +------------+------------+------A-----+------------+
1.258E+07  1.01E+02 +     +      +      +A    +
1.584E+07  9.86E+01 +     +      +      A    +
1.995E+07  9.63E+01 +     +      +     A+    +
2.511E+07  9.44E+01 +     +      +     A +    +
3.162E+07  9.26E+01 +     +      +    A +    +
3.981E+07  9.10E+01 +     +      +    A +    +
5.011E+07  8.95E+01 +     +      +   A +    +
6.309E+07  8.79E+01 +     +      +   A +    +
7.943E+07  8.62E+01 +     +      + A +    +
1.000E+08  8.44E+01 +------------+------A-----+------------+------------+
1.258E+08  8.22E+01 +     +      + - A    +
1.584E+08  7.97E+01 +     +      +  -A    +
1.995E+08  7.66E+01 +     +      +  A    +
2.511E+08  7.30E+01 +     +      + A*    +
3.162E+08  6.86E+01 +     +     A +    +
3.981E+08  6.35E+01 +     +    A +    +
5.011E+08  5.76E+01 +     +   +A +    +
6.309E+08  5.10E+01 +     +   A +    +
7.943E+08  4.39E+01 +     + A +    +
1.000E+09  3.66E-01 +------------+A---+------------+------------+------------+
           +            +            +            +            +
```

7.2

$$g_m = \sqrt{2k_n' \frac{W}{L} I_D} = \sqrt{2 \times 60 \times 10^{-6} \times \frac{100}{2 - 2 \times 0.2 - 0} \times 500 \times 10^{-6}}$$

$$= 1.9 \times 10^{-3} \, A/V$$

$$A_v = -g_m R_L = -1.9 \times 10^{-3} \times 5 \times 10^{3} = -9.5$$

$$C_{gs} = \frac{2}{3} W L_{eff} C_{ox} + W L_d C_{ox}$$

$$= \frac{2}{3} \, 100 \times 1.6 \times 0.7 + 100 \times 0.2 \times 0.7$$

$$= 89 fF$$

$$C_{gd} = W L_d C_{ox} = 100 \times 0.2 \times 0.7 = 14 fF$$

(a) Use the Miller effect.

$$|P_1| = \frac{1}{R_s [C_{gs} + C_{gd}(1 - A_v)]}$$

$$= \frac{1}{10k [89 + 14(1 + 9.5)] \times 10^{-15}}$$

$$= \frac{1}{2.4 \times 10^{-9}} = 4.2 \times 10^{8} \, rad/s$$

$$f_{-3dB} = \frac{|P_1|}{2\pi} = 67 MHz$$

(b) Do not use the Miller effect to calculate the second pole.

From Eq. (7.26),

$$|P_2| = \frac{1}{|P_1|} \frac{1}{R_L R_s C_{gd} C_{gs}}$$

$$= \frac{1}{4.2 \times 10^{8}} \frac{1}{5k \times 10k \times 14 f \times 89 f}$$

$$= 3.8 \times 10^{10} \, rad/s$$

It is equivalent to 6.1 GHz.

```
COMMON SOURCE AMPLIFIER
VDD 1 0 5
VI 2 0 DC 1.216 AC 1
RS 2 3 10K
RL 1 4 5K
M1 4 3 0 0 CMOSN W=100U L=2U
* COX'=0.7FF/UM**2=EOX/TOX => TOX=500 ANGSTROMS
.MODEL CMOSN NMOS LEVEL=1 LAMBDA=0 VTO=0.7 KP=60U LD=0.2U TOX=500E-10
.OPTIONS NOMOD
.AC DEC 10 1MEG 10G
.PLOT AC VM(4)
.WIDTH OUT=80
.OPTIONS SPICE
.END


****** OPERATING POINT INFORMATION        TNOM= 27.000 TEMP= 27.000

+0:1     = 5.000E+00 0:2     = 1.216E+00 0:3     = 1.216E+00
+0:4     = 2.503E+00

**** MOSFETS

SUBCKT
ELEMENT   0:M1
MODEL     0:CMOSN
 ID       4.992E-04
 IBS      0.
 IBD      -2.504E-14
 VGS      1.216E+00
 VDS      2.503E+00
 VBS      0.
 VTH      7.000E-01
 VDSAT    5.160E-01
 BETA     3.750E-03
 GAM EFF  0.
 GM       1.935E-03
 GDS      0.
 GMB      0.
 CDTOT    1.418E-14
 CGTOT    1.050E-13
 CSTOT    8.748E-14
 CBTOT    3.349E-15
 CGS      8.748E-14
 CGD      1.418E-14

****** AC ANALYSIS                    TNOM= 27.000 TEMP= 27.000

    FREQ      VM(4)
(X        )   1.000E-02   1.000E-01   1.000E+00   9.999E+00   9.999E+01
              +           +           +           +           +
1.000E+06 9.67E+00-+------+------+------+------+------A------+------+-
1.258E+06 9.67E+00 +      +      +      +      +      A      +      +
1.584E+06 9.67E+00 +      +      +      +      +      A      +      +
1.995E+06 9.67E+00 +      +      +      +      +      A      +      +
2.511E+06 9.66E+00 +      +      +      +      +      A      +      +
3.162E+06 9.66E+00 +      +      +      +      +      A      +      +
3.981E+06 9.65E+00 +      +      +      +      +      A      +      +
5.011E+06 9.64E+00 +      +      +      +      +      A      +      +
6.309E+06 9.62E+00 +      +      +      +      +      A      +      +
7.943E+06 9.60E+00 +      +      +      +      +      A      +      +
1.000E+07 9.56E+00-+------+------+------+------+------A------+------+-
1.258E+07 9.49E+00 +      +      +      +      +      A      +      +
1.584E+07 9.39E+00 +      +      +      +      +      A      +      +
1.995E+07 9.24E+00 +      +      +      +      +      A      +      +
2.511E+07 9.01E+00 +      +      +      +      +      A+     +      +
3.162E+07 8.68E+00 +      +      +      +      +      A+     +      +
3.981E+07 8.23E+00 +      +      +      +      +      A+     +      +
5.011E+07 7.64E+00 +      +      +      +      +      A +    +      +
6.309E+07 6.91E+00 +      +      +      +      +      A +    +      +
7.943E+07 6.09E+00 +      +      +      +      +     A +     +      +
1.000E+08 5.24E+00-+------+------+------+------+-----A------+------+-
1.258E+08 4.41E+00 +      +      +      +      +A     +      +      +
1.584E+08 3.64E+00 +      +      +      +     +A     +      +      +
1.995E+08 2.97E+00 +      +      +      +     A      +      +      +
2.511E+08 2.40E+00 +      +      +      +    A +      +      +      +
3.162E+08 1.93E+00 +      +      +      +   A  +      +      +      +
3.981E+08 1.54E+00 +      +      +      + A    +      +      +      +
5.011E+08 1.23E+00 +      +      +      +A     +      +      +      +
6.309E+08 9.79E-01 +      +      +      A      +      +      +      +
7.943E+08 7.77E-01 +      +      +    A +      +      +      +      +
1.000E+09 6.15E-01-+------+------+---A--+------+------+------+------+-
1.258E+09 4.86E-01 +      +      + A    +      +      +      +      +
1.584E+09 3.82E-01 +      +     +A     +      +      +      +      +
1.995E+09 2.98E-01 +      +      A      +      +      +      +      +
2.511E+09 2.33E-01 +      +    A +      +      +      +      +      +
3.162E+09 1.77E-01 +      + A    +      +      +      +      +      +
3.981E+09 1.33E-01 +      A      +      +      +      +      +      +
5.011E+09 9.87E-02 +     A      +      +      +      +      +      +
6.309E+09 7.16E-02 +   A +      +      +      +      +      +      +
7.943E+09 5.09E-02 +  A  +      +      +      +      +      +      +
1.000E+10 3.58E-02-+------+A-----+------+------+------+------+------+-
              +           +           +           +           +
```

7.8

$$\frac{v_o}{v_i} = \frac{g_m R_E + \frac{R_E}{r_\pi}}{1 + g_m R_E + \frac{R_b + R_E}{r_\pi}} \cdot \frac{1 - \frac{s}{z_1}}{1 - \frac{s}{P_1}}$$

$$= \frac{\frac{0.3}{26} \times 4000 + \frac{4000}{50} \cdot \frac{0.3}{26}}{1 + \frac{0.3}{26} \times 4000 + \frac{4450}{50} \cdot \frac{0.3}{26}} \cdot \frac{1 - \frac{j\omega}{z_1}}{1 - \frac{j\omega}{P_1}}$$

$$= 0.977 \frac{1 - j\frac{\omega}{z_1}}{1 - j\frac{\omega}{P_1}}$$

$$z_1 = -\frac{g_m}{C_\pi} = -\omega_T = -2\pi \times 4 \times 10^6$$
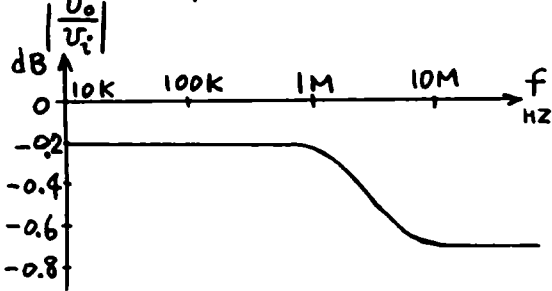$$= -25.1 \times 10^6 \text{ rad/sec}$$

$$P_1 = -\frac{1}{C_\pi R_1}$$

$$R_1 = r_\pi \| \frac{R_b + R_E}{1 + g_m R_E} = \frac{50 \times 26}{0.3} \| \frac{450 + 4000}{1 + \frac{0.3 \times 4000}{26}}$$
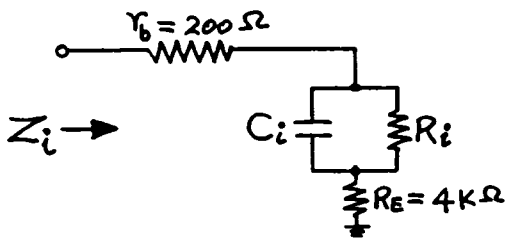$$= 4333 \| 94.4 = 92.4\,\Omega$$

$$C_\pi = \frac{g_m}{\omega_T} = \frac{0.3}{26} \cdot \frac{1}{2\pi \times 4 \times 10^6} = 459\,pF$$

$$\therefore P_1 = -\frac{10^{12}}{459 \times 92.4} = -23.6 \times 10^6 \text{ rad/sec}$$

7.9

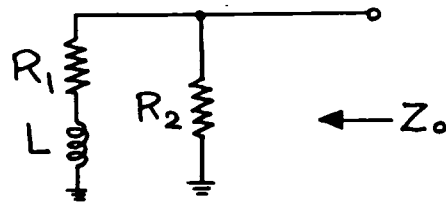
$$C_i = \frac{C_\pi}{1 + g_m R_E} = \frac{459}{1 + \frac{0.3 \times 4000}{26}} = 9.73\,pF$$

$$R_i = (1 + g_m R_E) r_\pi = \left(1 + \frac{0.3 \times 4000}{26}\right) \times \frac{50 \times 26}{0.3}$$
$$= 204\,K\Omega$$

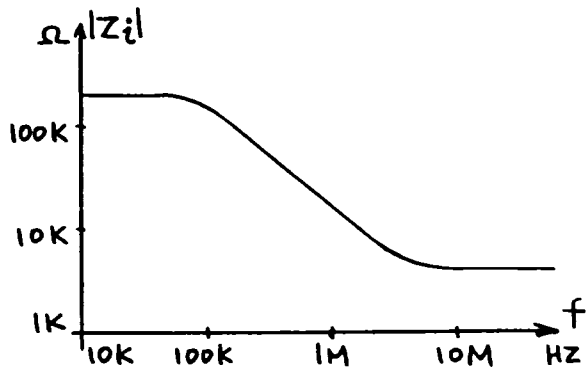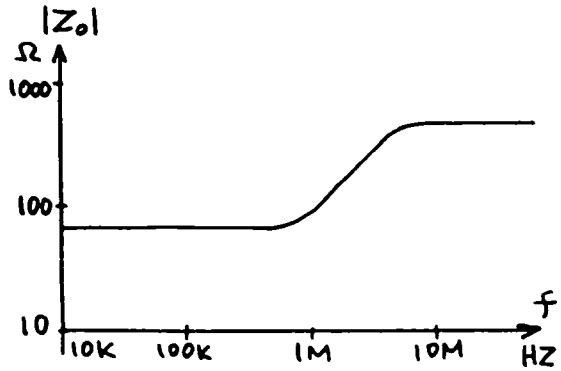$$Z_i = 4.2\,K\Omega + 204\,K\Omega \| \frac{1}{j\omega C_i}$$

$$R_1 = \frac{1}{g_m} + \frac{R_b}{\beta_o} = \frac{26}{0.3} + \frac{450}{50} = 95.7\,\Omega$$

$$R_2 = R_b = 450\,\Omega$$

$$L = C_\pi r_\pi \frac{R_b}{\beta_o} = 459 \times \frac{50 \times 26}{0.3} \times \frac{450}{50} \times 10^{-12}$$
$$= 17.9\,\mu H$$

```
PNP EMITTER FOLLOWER, REISTIVE LOAD
* DC VO=0V, 300UA*4K=1.2V=VCC
VCC 1 0 1.2V
VEE 2 0 -1.2V
RE 1 5 4K
Q1 2 4 5 PNP
RS 3 4 250
RLOAD 5 0 1K
VBIAS 3 6 -0.745V AC
VPULSE 6 0 PULSE 0V 1MV 1NS 0NS 0NS 100NS
.TRAN 0.25NS 10NS
.PLOT TRAN V(5)
.MODEL PNP PNP IS=1E-16A BF=50
+ RB=200 CJE=0 CJC=0 CJS=0 TF=39.8NS
.OPTIONS NOPAGE NOMOD
.WIDTH OUT=80
.OPTIONS SPICE
.OP
.END
```

****** OPERATING POINT INFORMATION   TNOM= 27.000 TEMP= 27.000

```
+0:1   = 1.200E+00 0:2   =-1.200E+00 0:3   =-7.450E-01
+0:4   =-7.435E-01 0:5   = 1.819E-04 0:6   = 0.
```

**** BIPOLAR JUNCTION TRANSISTORS

ELEMENT	0:Q1
MODEL	0:PNP
IB	-5.878E-06
IC	-2.939E-04
VBE	-7.437E-01
VCE	-1.200E+00
VBC	4.565E-01
VS	7.424E-01
POWER	3.571E-04
BETAD	5.000E+01
GM	1.136E-02
RPI	4.400E+03
RX	2.000E+02
RO	4.576E+15
CPI	4.522E-10
CMU	0.
CBX	0.
CCS	0.
BETAAC	5.000E+01
FT	3.998E+06

****** TRANSIENT ANALYSIS   TNOM= 27.000 TEMP= 27.000

```
     TIME    V(5)
(A      )   -5.000E-04   0.        5.000E-04   1.000E-03   1.500E-03
                          +         +           +           +
  0.        1.82E-04-+-------+-------+----A-+-------+-------+-
  2.500E-10 1.82E-04 +       +     A +       +       +       +
  5.000E-10 1.82E-04 +       +     A +       +       +       +
  7.500E-10 1.82E-04 +       +     A +       +       +       +
  1.000E-09 1.82E-04 +       +     A +       +       +       +
  1.250E-09 8.23E-04 +       +       +     A +       +       +
  1.500E-09 8.24E-04 +       +       +     A +       +       +
  1.750E-09 8.25E-04 +       +       +     A +       +       +
  2.000E-09 8.26E-04 +       +       +     A +       +       +
  2.250E-09 8.27E-04 +       +       +     A +       +       +
  2.500E-09 8.28E-04-+-------+-------+-------A-+-------+-----+-
  2.750E-09 8.29E-04 +       +       +     A +       +       +
  3.000E-09 8.31E-04 +       +       +     A +       +       +
  3.250E-09 8.32E-04 +       +       +     A +       +       +
  3.500E-09 8.33E-04 +       +       +     A +       +       +
  3.750E-09 8.34E-04 +       +       +     A +       +       +
  4.000E-09 8.35E-04 +       +       +     A +       +       +
  4.250E-09 8.36E-04 +       +       +     A +       +       +
  4.500E-09 8.37E-04 +       +       +     A +       +       +
  4.750E-09 8.38E-04 +       +       +     A +       +       +
  5.000E-09 8.39E-04-+-------+-------+-------A-+-------+-----+-
  5.250E-09 8.40E-04 +       +       +       + A +       +
  5.500E-09 8.42E-04 +       +       +       + A +       +
  5.750E-09 8.43E-04 +       +       +       + A +       +
  6.000E-09 8.44E-04 +       +       +       + A +       +
  6.250E-09 8.45E-04 +       +       +       + A +       +
  6.500E-09 8.46E-04 +       +       +       + A +       +
  6.750E-09 8.47E-04 +       +       +       + A +       +
  7.000E-09 8.48E-04 +       +       +       + A +       +
  7.250E-09 8.49E-04 +       +       +       + A +       +
  7.500E-09 8.50E-04-+-------+-------+-------+-A-+-------+-
  7.750E-09 8.51E-04 +       +       +       + A +       +
                          +         +           +           +
```

*****
PNP EMITTER FOLLOWER, CAPACITIVE LOAD

```
VCC 1 0 1.2V
VEE 2 0 -1.2V
IEE 1 5 300UA
Q1 2 4 5 PNP
RS 3 4 250
CLOAD 5 0 400PF
VBIAS 3 6 -0.745V AC
VPULSE 6 0 PULSE 0V 1MV 1NS 0NS 0NS 1300NS
.TRAN 20NS 800NS
```

```
.PLOT TRAN V(5)
.MODEL PNP PNP IS=1E-16A BF=50
+ RB=200 CJE=0 CJC=0 CJS=0 TF=39.8NS
.OPTIONS NOPAGE NOMOD
.WIDTH OUT=80
.OPTIONS SPICE
.OP
.END
```

**** BIPOLAR JUNCTION TRANSISTORS

ELEMENT	0:Q1
MODEL	0:PNP
IB	-5.882E-06
IC	-2.941E-04
VBE	-7.437E-01
VCE	-1.200E+00
VBC	4.565E-01
VS	7.424E-01
POWER	3.574E-04
BETAD	5.000E+01
GM	1.137E-02
RPI	4.396E+03
RX	2.000E+02
RO	4.576E+15
CPI	4.526E-10
CMU	0.
CBX	0.
CCS	0.
BETAAC	5.000E+01
FT	3.998E+06

****** TRANSIENT ANALYSIS   TNOM= 27.000 TEMP= 27.000

```
     TIME    V(5)
(A      )   0.        5.000E-04   1.000E-03   1.500E-03   2.000E-03
                       +          +           +           +
  0.        2.03E-04-+-----A----+-------+-------+-------+-------+-
  2.000E-08 2.59E-04 +     A    +       +       +       +       +
  4.000E-08 3.94E-04 +     + A  +       +       +       +       +
  6.000E-08 5.42E-04 +     +   +A       +       +       +       +
  8.000E-08 6.95E-04 +     +   + A +    +       +       +       +
  1.000E-07 8.44E-04 +     +   +   + A  +       +       +       +
  1.200E-07 9.81E-04 +     +   +   +   A+       +       +       +
  1.400E-07 1.10E-03 +     +   +   +   + A +    +       +       +
  1.600E-07 1.21E-03 +     +   +   +   +   A+   +       +       +
  1.800E-07 1.29E-03 +     +   +   +   +   +A   +       +       +
  2.000E-07 1.35E-03-+-----+---+---+---+---+-A---+-------+-----+-
  2.200E-07 1.39E-03 +     +   +   +   +   + A + +       +       +
  2.400E-07 1.42E-03 +     +   +   +   +   + A + +       +       +
  2.600E-07 1.43E-03 +     +   +   +   +   + A + +       +       +
  2.800E-07 1.42E-03 +     +   +   +   +   + A + +       +       +
  3.000E-07 1.41E-03 +     +   +   +   +   + A + +       +       +
  3.200E-07 1.39E-03 +     +   +   +   +   + A + +       +       +
  3.400E-07 1.36E-03 +     +   +   +   +   + A + +       +       +
  3.600E-07 1.33E-03 +     +   +   +   +   + A + +       +       +
  3.800E-07 1.30E-03 +     +   +   +   +   +A   +       +       +
  4.000E-07 1.27E-03-+-----+---+---+---+---+A----+-------+-----+-
  4.200E-07 1.24E-03 +     +   +   +   +   A +   +       +       +
  4.400E-07 1.22E-03 +     +   +   +   +   A+    +       +       +
  4.600E-07 1.20E-03 +     +   +   +   +   A+    +       +       +
  4.800E-07 1.18E-03 +     +   +   +   +  A -    +       +       +
  5.000E-07 1.17E-03 +     +   +   +   +  A +    +       +       +
  5.200E-07 1.16E-03 +     +   +   +   +  A +    +       +       +
  5.400E-07 1.16E-03 +     +   +   +   +  A -    +       +       +
  5.600E-07 1.16E-03 +     +   +   +   +  A +    +       +       +
  5.800E-07 1.16E-03 +     +   +   +   +  A +    +       +       +
  6.000E-07 1.16E-03-+-----+---+---+---+--A--+---+-------+-----+-
  6.200E-07 1.17E-03 +     +   +   +   +  A -    +       +       +
  6.400E-07 1.17E-03 +     +   +   +   +  A -    +       +       +
  6.600E-07 1.18E-03 +     +   +   +   +  A -    +       +       +
  6.800E-07 1.19E-03 +     +   +   +   +  A -    +       +       +
  7.000E-07 1.19E-03 +     +   +   +   +  A -    +       +       +
  7.200E-07 1.20E-03 +     +   +   +   +  A-     +       +       +
  7.400E-07 1.20E-03 +     +   +   +   +  A-     +       +       +
  7.600E-07 1.20E-03 +     +   +   +   -  A+     +       +       +
  7.800E-07 1.21E-03 +     +   +   +   +  A+     +       +       +
  8.000E-07 1.21E-03-+-----+---+---+---+---A-----+-------+-----+-
                       +          +           +           +
```

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CAPACITIVE LOAD RESULTS IN SOME PEAKING [V(5) JUMPS BY > 1MV]