ASSIGNMENT

Consider the BJT amplifier circuit shown in Figure 5 and perform the following:

1. Hand calculation to find the medium frequency gain and the upper and lower 3dB points. Assume $v_s = 10\text{mV}$, $\beta_F = 100$, $C_\pi = 1\text{pF}$, $C_\mu = 3\text{pF}$.
2. Using the default parameters of the BJT, write a SPICE program to plot the gain-frequency characteristic. From the SPICE output file, calculate the medium frequency gain and the upper and lower 3dB points.
3. Repeat step 2 using $\beta_F = 100$, $I_S = 10^{-15}$, $r_b = 100\Omega$, $V_A = 150\text{V}$, $C\pi = 1\text{pF}$, $C_\mu = 3\text{pF}$ and $\tau_F = 0.2\text{ns}$.
4. Compare between the results obtained using hand calculations and SPICE simulations.
5. Comment on your results.

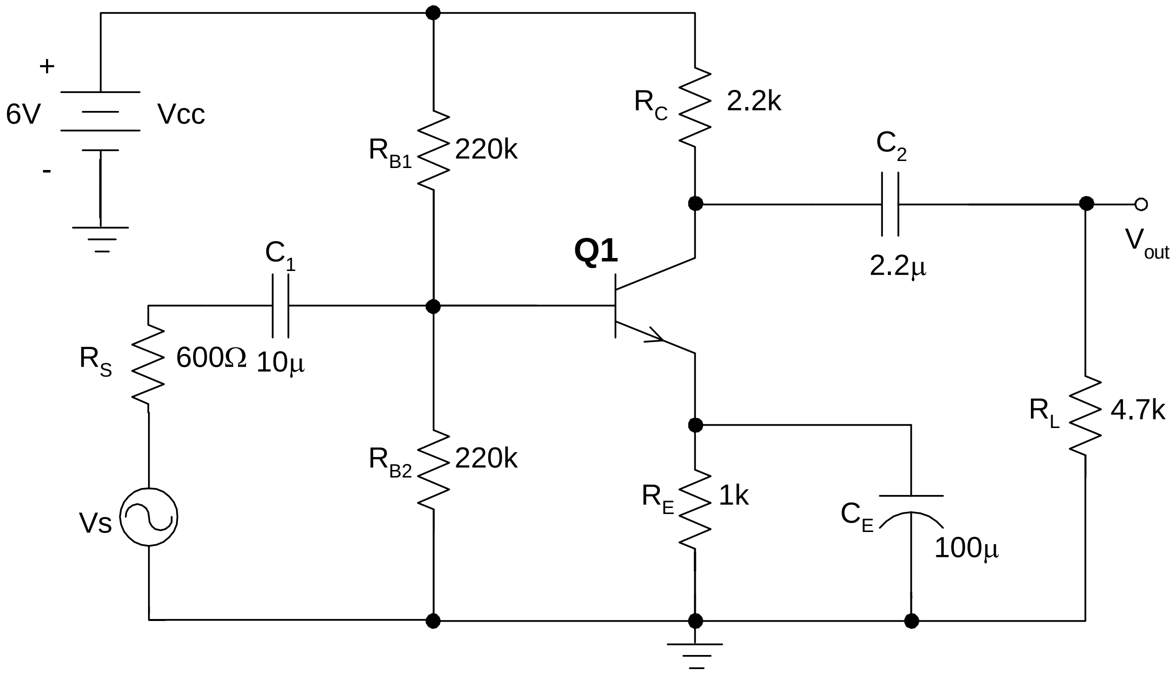

Figure 5

TABLE 1: DETAILED DIODE MODEL PARAMETERS

D Diode

D<name><+node><-node><model name>[area]

Model	Parameters	Default	Units
IS	saturation current	1E-14	A
N	emission coefficient	1	
RS	parasitic resistance	0	ohm
CJO	zero-bias *pn* capacitance	0	farad
VJ	*pn* potential	1	volt
M	*pn* grading coefficient	0.5	
FC	forward-bias depletion capacitance coefficient	0.5	
TT	transit time	0	S
BV	reverse breakdown voltage	infinite	volts
IBV	reverse breakdown current	1E-10	A
EG	bandgap voltage (barrier height)	1.11	eV
XTI	IS temperature exponent	3	
KF	flicker noise coefficient	0	
AF	flicker noise exponent	1	

TABLE 2: DETAILED JFET MODEL PARAMETERS

J Junction FET

J<name><drain node><gate node><source node><model name>[area]

Model	Description	Default	Units
VTO	threshold voltage	-2.0	volts
BETA	transconductance coefficient	1E-4	A/V^2
LAMBDA	channel-length modulation	0	$volt^{-1}$
RD	drain ohmic resistance	0	ohm
RS	source ohmic resistance	0	ohm
IS	gate *pn* saturation current	1E-14	ampere
PB	gate *pn* potential	1	volt
CGD	gate-drain zero-bias *pn* capacitance	0	farad
CGS	gate-source zero-bias *pn* capacitance	0	farad
FC	foward-bias depletion capacitance coefficient	0.5	

TABLE 3: DETAILED BJT MODEL PARAMETERS

Q Bipolar Transistor

Q<name><collector node><base node><emitter node><[substrate node]
<model name>[area value]

Model	Parameters	Default	Units
IS	*pn* saturation current	lE-16	A
BF	ideal maximum forward beta	100	
NF	forward current emission coefficient	1	
VAF (VA)	forward Early voltage	infinite	V
IKF (IK)	corner for fwd beta high-cur roll off	infinite	A
ISE (C2)	base-emitter leakage saturation current	0	A
NE	base-emitter leakage emission coefficient	1.5	
BR	ideal maximum reverse beta	1	
NR	reverse current emission coefficient	1	
VAR (VB)	reverse Early voltage	infinite	V
IKR	corner for rev beta hi-cur roll off	infinite	A
ISC (C4)	base-collector leakage saturation current	0	A
NC	base-collector leakage emission coefficient	2.0	
RB	zero-bias (maximum) base resistance	0	ohm
RBM	minimum base resistance	RB	ohm
RE	emitter ohmic resistance	0	ohm
RC	collector ohmic resistance	0	ohm
CJE	base-emitter zero-bias *pn* capacitance	0	F
VJE (PE)	base-emitter built-in potential	0.75	V
MJE (ME)	base-emitter *pn* grading factor	0.33	
CJC	base-collector zero-bias pn capacitance	0	F
VJC (PC)	base-collector built-in potential	0.75	V
MJC (MC)	base-collector *pn* grading factor	0.33	
XCJC	fraction of C_{bc} connected into R_b	1	
CJS (CCS)	collector-substrate zero-bias pn capacitance	0	F
VJS (PS)	collector-substrate built-in potential	0.75	
MJS (MS)	collector-substrate pn grading factor	0	
FC	forward-bias depletion capacitor coefficient	0.5	
TF	ideal forward transit time	0	s
XTF	transit time bias dependence coefficient	0	
VTF	transit time dependency on Vbc	infinite	V
ITF	transit time dependency on Ic	0	A
PTF	excess phase @ 1/ $(2\pi TF)$ Hz	0	°C
TR	ideal reverse transit time	0	s
EG	bandgap voltage (barrier height)	1.11	eV
XTB	forward and reverse beta temp coefficient	0	
XTI(PT)	IS temperature effect exponent	3	
KF	flicker noise coefficient	0	
AF	flicker noise exponent	1	

TABLE 4: DETAILED MOSFET MODEL PARAMETERS

M MOSFET

M<name><drain node><gate node><source node><bulk/substrate node>
<model name>[L=<value>][W=<value>][AD=<value>][AS=<value>]

Model	Description	Default	Units
LEVEL	model type(l, 2, or 3)	1	
L	channel length	DEFL	meter
W	channel width	DEFW	meter
LD	lateral diffusion (length)	0	meter
WD	lateral diffusion (width)	0	meter
VTO	zero-bias threshold voltage	0	volt
KP	transconductance	2E-5	A/V^2
GAMMA	bulk threshold parameter	0	volt$^{1/2}$
PHI	surface potential	0.6	volt
LAMBDA	channel-length. modulation (LEVEL 1 or 2)	0	volt^{-1}
RD	drain ohmic resistance	0	ohm
RS	source ohmic resistance	0	ohm
RG	gate ohmic resistance	0	ohm
RB	bulk ohmic resistance	0	ohm
RDS	drain-source shunt resistance	infinite	ohms
RSH	drain-source diff. sheet res.	0	ohm/sq.
IS	bulk pn saturation current	1E-14	A
JS	bulk pn sat. current/area	0	A/m^2
PB	bulk pn potential	0.8	volt
CBD	bulk-drain zero-bias pn cap.	0	farad
CBS	bulk-source zero-bias pn cap.	0	farad
CJ	bulk pn zero-bias bot. cap./area	0	F/m^2
CJSW	bulk pn zero-bias perimeter cap./length	0	F/m
MJ	bulk *pn* bottom grading coefficient	0.5	
MJSW	bulk pn sidewall grading coefficient	0.33	
FC	bulk pn forward bias capacitance coefficient	0.5	
CGSO	gate-source overlap capacitance/channel width	0	F/m
CGDO	gate-drain overlap capacitance/channel width	0	F/m
CGBO	gate-bulk overlap capacitance/channel length	0	F/m
NSUB	substrate doping density	0	cm^{-3}
NSS	surface state density	0	cm^{-2}
NFS	fast surface state density	0	cm^{-2}
TOX	oxide thickness	infinite	meter
TPG	gate material type; +1 = opposite of substrate;	+1	
	-1 = same as substrate; 0 = aluminum		
XJ	metallurgical junction depth	0	meter
UO	surface mobility	600	cm^2/Vs
UCRIT	mobility degradation critical field (LEYEL=2)	IE4	V/cm
UEXP	mobility degradation exponent (LEVEL=2)	0	
UTRA	(not used) mobility degradation transverse field coefficient		
VMAX	maximum drift velocity	0	m/s
NEFF	channel charge coefficient (LEVEL=2)	1	
XQC	fraction of channel charge attributed to drain	1	
DELTA	width effect on threshold	0	
THETA	mobility modulation (LEVEL=3)	0	volt^{-1}
ETA	static feedback (LEVEL=3)	0	
KAPPA	saturation field factor (LEVEL=3)	0.2	
KF	flicker noise coefficient	0	
AF	flicker noise exponent	1	