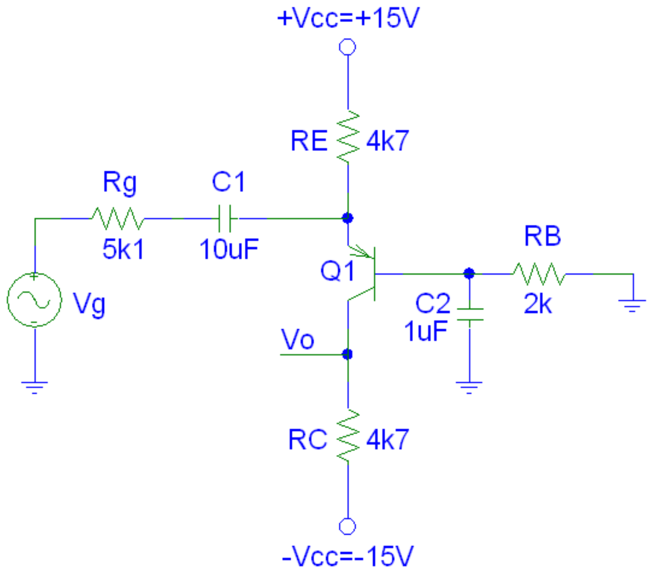
Time: 1 hour and 30 minutes

EXERCISE 1

Figure 1 shows a bias circuit of a BJT transistor used as a common base amplifier.



DATA:

$|V_{BE}| = 0.7$ V
$|V_{CE-sat}| = 0.2$ V
$\beta_F = \beta_0 = 300$
$r_0 \rightarrow \infty$
$V_T = 25$ mV

$R_B = 2K\Omega$
$R_E = R_C = 4.7K\Omega$
$R_g = 5.1\ K\Omega$
$C_1 = 10\ \mu F$
$C_2 = 1\ \mu F$

Figure 1

a) Obtain V_B, V_E e I_E (consider negligible I_B). Show that the approximation is right.

b) Calculate the bias point (I_{CQ}, V_{ECQ}). Which is the operating region? Justify the answer.

c) Draw the small-signal equivalent circuit valid for midrange frequency and calculate the small signal parameters of the BJT (g_m and r_π).

d) Draw the small-signal equivalent circuit valid for the low-frequency range.

EXERCISE 2

Figure 2 shows a transconductance amplifier with an accumulation N-channel MOSFET transistor (NMOS).

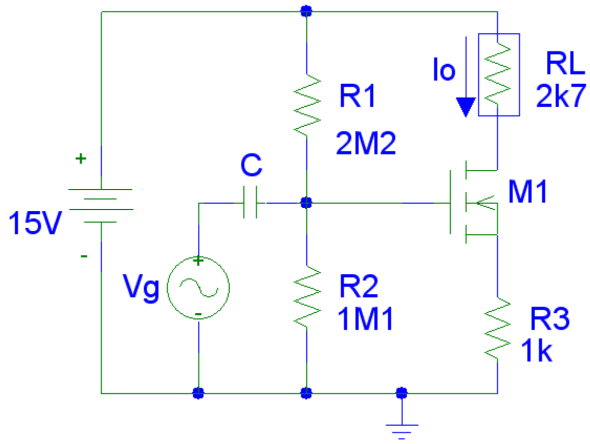


Figure 2

DATA:

MOSFET Transistor

$V_t = 1$ V

$K = 0.5$ mA/V^2

NOTA: $I_D = K\cdot(V_{GS}-V_t)^2$

$V_A = 100$ V

$C \rightarrow \infty$

a) Calculate the DC load current (RL).

b) Which is the operating region? Justify the answer. Plot the output characteristic of the transistor and the load line.

c) Calculate the small-signal parameters, draw the small signal equivalent circuit for midrange frequency and obtain the transconductance gain i_o/v_g.

d) Draw the small-signal equivalent circuit valid for the high-frequency range

EXERCISE 3

The circuit of Figure 3 is an AC coupled amplifier based on a JFET transistor.

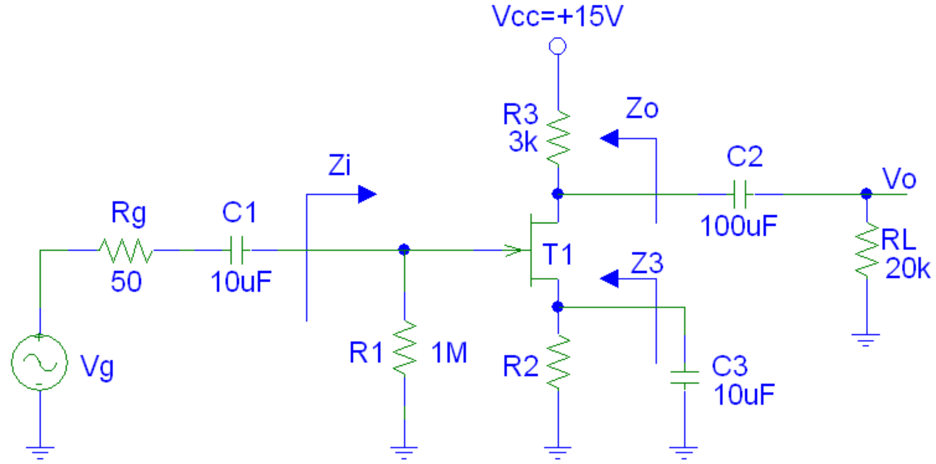


Figure 3

DATA:

I_{DQ} = 2.5 mA	Rg = 50 Ω	R1 = 1 MΩ	R3 = 3 KΩ	RL = 20 KΩ
I_{DSS} = 10 mA	V_p = -3 V	$r_{ds} \rightarrow \infty$	$I_D = I_{DSS} \cdot (1-V_{GS}/V_p)^2$	
C1 = 10 µF	C2 = 100 µF	C3 = 10 µF	Cgs = 2 pF	Cgd = 1 pF

a) Calculate R2 for a bias current I_{DQ} = 2.5 mA. Calculate the small-signal parameter g_m.

b) Draw the small-signal equivalent circuit valid for midrange.

c) Obtain the gain Vo/Vg and the impedances Zi and Zo.

d) Calculate the impedance Z_3 that is in parallel with C_3.

EXERCISE 4

The circuit of Figure 4 is a DC coupled multi-stage amplifier.

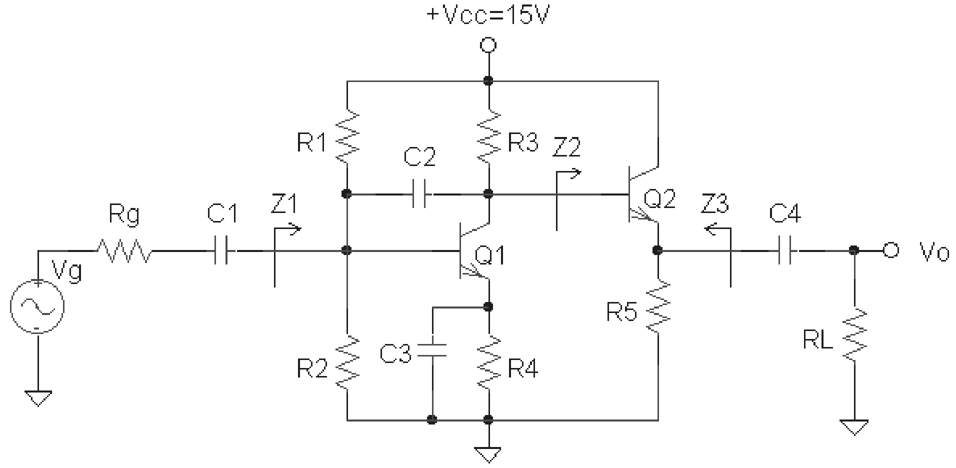


Figure 4

DATA:

Rg = 5 KΩ	C1, C3 → ∞	C2 = 2.5 pF	C4 = 20 μF	
R1 = 30 KΩ	R2 = 15 KΩ	R3 = 10KΩ	R4 = 8.8 KΩ	R5 = R_L = 4.7 KΩ
V_{BE} = 0.6 V	V_T = 25 mV	β = 200	$C\mu_1$ = 0.5 pF	$C\pi_1 = C\pi_2 = C\mu_2$ = 0 pF

a) Obtain the bias point of both transistors (I_{C1}, I_{C2}, V_{CE1}, V_{CE2}) and Vo DC value.

b) Draw the small-signal equivalent circuit for midrange frequency. Obtain the impedances Z1, Z2 and Z3.

c) Calculate the low cut-off frequency. Use the time constants method.

d) Calculate the high cut-off frequency. Explain each and any approximation.

e) Obtain the Bode plot approximately (amplitude and phase).
Midrange frequency gain (40 dB, -180º).