Assiut University
Faculty of Engineering
Dept. of Electrical Engineering

E302-ELECTRONIC CIRCUITS (1)

First Term Final Exam
January 2015

3rd Year
Control and
Computers Section

Attempt all questions, full mark: 100 Points — **Time: 3 Hours**

Question #1: (20 Points)

Choose the right answer:

1) In a voltage-divider biased npn transistor, if the lower voltage-divider resistor (the one connected to ground) opens,

D

(A) the transistor is not affected
(B) the transistor may be driven into cutoff
(C) the collector current will decrease
(D) the transistor may be driven into saturation

2) A differential amplifier

D

(A) is used in op-amps
(B) has one input and one output
(C) has two outputs
(D) answers (A) and (C)

3) A MOSFET differs from a JFET mainly because

C

(A) of the power rating
(B) the MOSFET has two gates
(C) the JFET has a *pn* junction
(D) MOSFETs do not have a physical channel

4) The efficiency of a power amplifier is the ratio of the power delivered to the load to the

B

(A) input signal power
(B) power from the dc power supply
(C) power dissipated in the transistor
(D) power dissipated in the last stage

5) When operated in cutoff and saturation, the transistor acts like a

B

(A) linear amplifier
(B) switch
(C) variable capacitor
(D) variable resistor

6) In saturation, V_{CE} is

C

(A) 0.7 V
(B) equal to V_{CC}
(C) minimum
(D) maximum

7) A certain common-emitter amplifier has a voltage gain of 100. If the emitter bypass capacitor is removed,

B

(A) the circuit will become unstable
(B) the voltage gain will decrease
(C) the voltage gain will increase
(D) the Q-point will shift

8) A differential amplifier

D

(A) is used in op-amps
(B) has one input and one output
(C) has two outputs
(D) answers (a) and (c)

9) The peak current a class A power amplifier can deliver to a load depends on the

B

(A) maximum rating of the power supply
(B) quiescent current
(C) current in the bias resistors
(D) size of the heat sink

10) If the gate-to-source voltage in an n-channel E-MOSFET is made more positive, the drain current will

A

(A) increase
(B) remain unchanged
(C) decrease

Question #2: (10 Points)

a) A certain transistor has α_{DC}= 0.99. If the dc base current is 10 µA, determine r_e'.

$\beta = \alpha/(1-\alpha) = 99$
$I_E = (\beta + 1)I_B = 1$ mA
$r_e' = 25/I_E = 25\ \Omega$

b) A common-emitter amplifier is driving a load resistance R_L= 10 kΩ. If R_C = 2.2 kΩ, I_{CQ} = 2.5mA, β_{ac} = 75 and R_E is completely bypassed at the operating frequency. Find the voltage gain.

$r_e' = 25/I_E = 10\ \Omega$
$R_C' = 2.2//10 = 1.8$ KΩ
$A_v = -R_C'/r_e' = -180$

c) An n-channel JFET has I_{DSS} = 5 mA and $V_{GS(off)}$ = -8 V. What value of V_{GS} is required to set up a drain current of 2.25 mA.

$I_D = 5[1 - V_{GS}/(-8)]^2 = 2.25$

$V_{GS} = -2.63$ V

d) Each stage of a four-stage amplifier has a voltage gain of 15. Find the overall voltage gain in dBs.

A_v = 94.09 dBs

e) An n-channel E-MOSFET has $I_{D(on)}$ = 18 mA at V_{GS} = 4 V, and $V_{GS(th)}$ = 2.5 V. Find I_D when V_{GS} = 3.25 V.

$K = 8$ mA/V^2

$I_D = 4.5$ mA

Question #3: (10 Points)

The silicon npn transistor used in the swamped amplifier shown in Fig.3 has $\beta_{dc} = \beta_{ac} = 100$.

a) Find I_{CQ} and V_{CEQ}.

b) Find r_e'.

c) Find the voltage gain and input impedance of the amplifier.

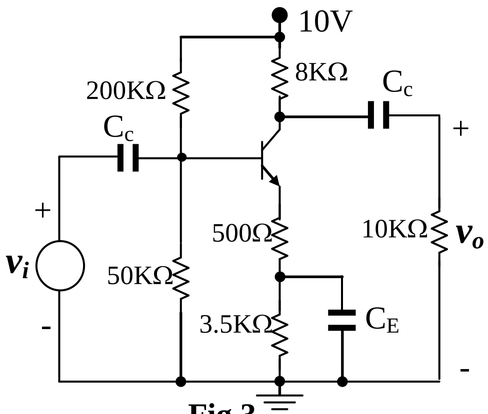


Fig.3

I_{CQ}= 0.295 mA	V_{CEQ}= 6.45 V	r_e'= 84.6 Ω
A_v= - 7.6	Z_{in}= 23.75 KΩ	

Question #4: (12 Points)

The silicon ***npn*** transistor used in the common base amplifier of Fig.4 has $\boldsymbol{\beta_{dc} = \beta_{ac}}$ =250.

a) Find $\boldsymbol{I_{CQ}}$ and $\boldsymbol{V_{CEQ}}$. (4 Points)

b) Find $\boldsymbol{r_e'}$. (2 Point)

c) Find the voltage gain, current gain and input impedance of the circuit. (6 Points)

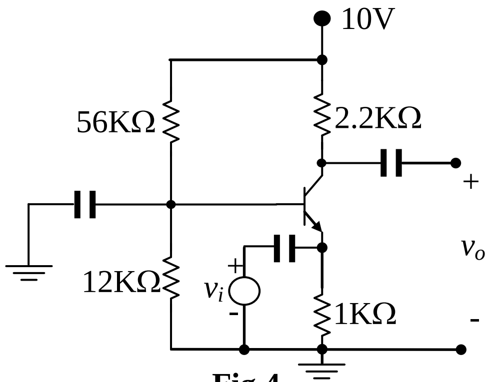


Fig.4

I_{CQ}= 1.02 mA	V_{CEQ}= 6.74 V	r_e'= 24.5 Ω
A_v= 89.8	A_i= 1	Z_{in}= 24.5 Ω

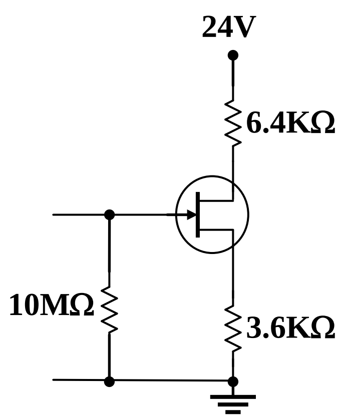
Question #5: (5 Points)

a) A certain JFET datasheet gives I_{DSS} = 10 mA and $V_{GS(off)}$ = -8 V. Determine the drain current for V_{GS} = -5 V. (2 Points)

b) The transistor is to operate at: V_{GSQ} = -5 V, V_{DSQ} = 10V. Draw a suitable circuit to bias this transistor giving suitable resistances values, assuming that V_{DD} =24 V (3 Points)

I_D= 1.41 mA

The Circuit Diagram



<u>Question #6</u>: (8 Points)

The class AB amplifier in Fig.6 is operating with a single power supply.

(a) Assuming the input voltage is 10 V peak-to-peak, determine the power delivered to the load resistor. (3 Points)

(b) What is the maximum power that could be delivered to the load resistor? (3 Points)

(c) Assume the power supply voltage is raised to 24 V. What is the new maximum power that could be delivered to the load resistor? (2 Points)

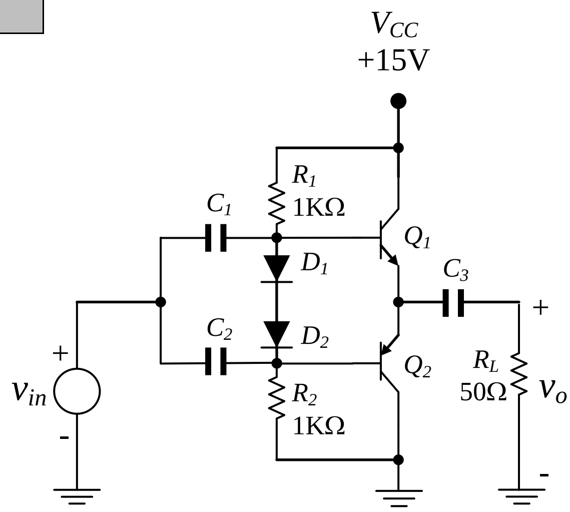


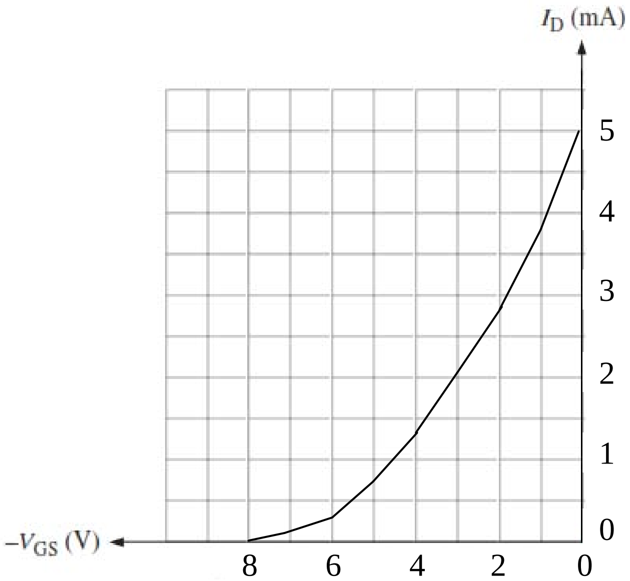
Fig.6

P_{LD} =	**0.25 W**	$P_{LD(max)}$ = For V_{CC}=15V	**0.5625 W**	$P_{LD(max)}$ = For V_{CC}=24V	**1.44 W**

<u>Question #7</u>: (8 Points)

The following parameters are obtained from a certain JFET datasheet: I_{DSS} = 5 mA and $V_{GS(off)}$ = - 8 V. Determine the values of I_D for each value of V_{GS} ranging from 0 V to -8 V in 1 V steps. Plot the transfer characteristic curve from these data.

V_{GS}/volts	0	-1	-2	-3	-4	-5	-6	-7	-8
I_D/mA	5	3.8	2.8	2	1.25	0.7	0.31	0.08	0



<u>Question #8</u>: (12 Points)

The E-MOSFET used in the common-source amplifier in Fig.8 has $I_{D(on)}$ = 200 mA at V_{GS} = 4 V and $V_{GS(th)}$ = 2 V.

a) Determine the operating point V_{GSQ}, I_{DQ} and V_{DSQ}. (6 Points)

b) Calculate the value of the transconductance g_m at the Q-point (2 Points)

c) Determine the voltage gain and input impedance of the amplifier. (4 Points)

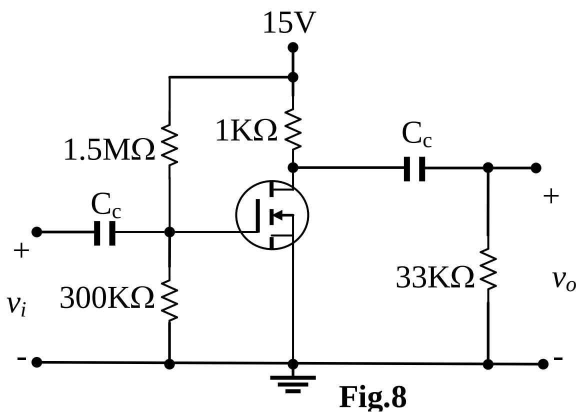


Fig.8

V_{GSQ}= 2.5 V	I_{DQ}= 12.5 mA	V_{DSQ} = 2.5 V
g_m= 50 mS	A_v= -48.5	Z_{in}= 250 KΩ

Question #9: (15 Points)

For the amplifier circuit of Fig.9, Determine the critical frequencies **(f_{L1}, f_{L2}, f_{L3})** associated with the low-frequency response, the critical frequencies **(f_{H1}, f_{H2})** associated with the high-frequency response.

$\beta_{dc} = \beta_{ac} = 100$, $h_{ie} = 900\Omega$, $r_e' = 9\Omega$, $C_{be} = 25pF$, $C_{bc} = 10pF$, $R_s = 600\Omega$, $R_1 = 68K\Omega$, $R_2 = 18K\Omega$, $R_E = 500\Omega$, $R_C = 1.8K\Omega$, $R_L = 1.8K\Omega$, $C_1 = 0.5\mu F$, $C_2 = 10\mu F$, $C_3 = 1\mu F$.

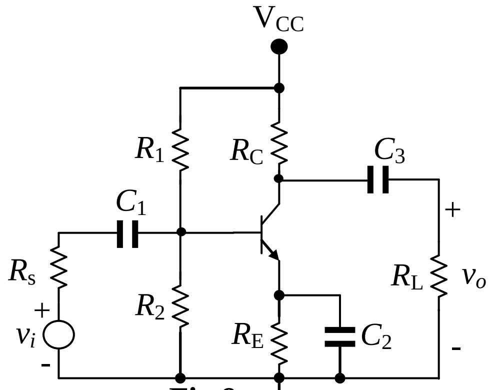


Fig.9

$C = C_1 = 0.5\ \mu F$ $R = (R_1 // R_2 // h_{ie}) + R_s = 1.446\ K\Omega$ $f_{L1} = \frac{10^6}{2\pi \times 0.5 \times 1446} = 220\ Hz$	f_{L1} = 220 Hz
$C = C_2 = 10\ \mu F$ $R = \{[(R_1 // R_2 // R_s) + h_{ie})]/ h_{fe}\} // R_E = 14.4\ \Omega$ $f_{L1} = \frac{10^6}{2\pi \times 10 \times 14.4} = 1112\ Hz$	f_{L2} = 1112 Hz
$C = C_3 = 1\ \mu F$ $R = (R_C + R_L) = 3.6\ K\Omega$ $f_{L1} = \frac{10^6}{2\pi \times 1 \times 3600} = 44\ Hz$	f_{L3} = 44 Hz
$C_{in} = C_{be} + (A_v + 1)\ C_{bc} = 1035\ pF$ $R_{in} = (R_1 // R_2 // h_{fe} // R_s) = 351\ \Omega$ $f_{L1} = \frac{10^{12}}{2\pi \times 1035 \times 351} = 438\ KHz$	f_{H1} = 438 KHz
$C_{in} \cong C_{bc} = 10\ pF$ $R_{out} = (R_C // R_L) = 900\ \Omega$ $f_{L1} = \frac{10^{12}}{2\pi \times 10 \times 900} = 17.7\ MHz$	f_{H2}= 17.7 MHz

****************** **Best Wishes, Prof. Magdy M. Doss** ******************