TECHNICAL UNIVERSITY OF SOFIA
DEPARTMENT OF ELECTRONICS

Questions for Exam Test in Semiconductor Elements

The questions are the same as in Laboratory test plus some extra questions, collared in yellow.

Basics of Semiconductors

1. An intrinsic semiconductor has: a) more electrons than holes; b) more holes than electrons; c) equal number of electrons and holes
2. A semiconductor with donor impurities has: a) more electrons than holes; b) more holes than electrons; c) equal number of electrons and holes
3. A semiconductor with acceptor impurities has: a) more electrons than holes; b) more holes than electrons; c) equal number of electrons and holes

PN Junction Diode

Compulsory questions

1. Draw the schematic of forward-biased diode. Show the polarity of voltage source (positive and negative terminal of the source) and the current direction.

2. Draw the schematic of reverse-biased diode. Show the polarity of voltage source (positive and negative terminal of the source) and the current direction.

3. Draw the VA characteristics of a Ge and Si diode (forward and reverse) in common coordinate system. Show the turn-on knee voltage value for both diodes and approximate values of reverse current.

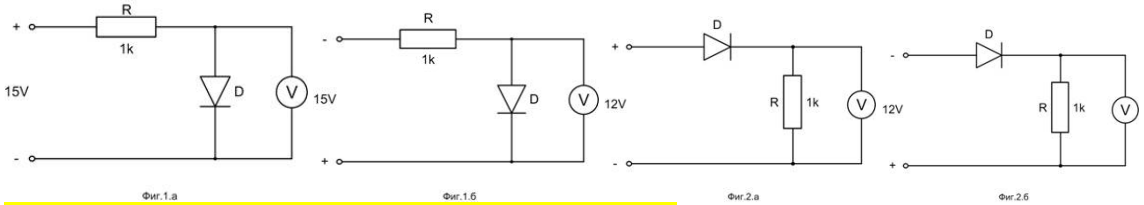
4. Draw the VA characteristic of a Si diode for two temperatures ($T_2>T_1$) in common coordinate system.

Practical questions

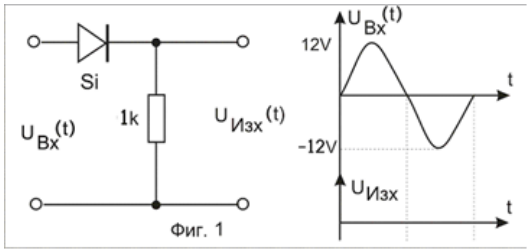
4. Draw the forward characteristic of a Si diode. Define dynamic resistance *r* and show how it is possible to determine it from the characteristic.

6. Draw the forward characteristic of a Si diode for two temperatures ($T_2>T_1$). Define the temperature coefficient of forward voltage TKU_F and show how it is possible to determine it from the forward characteristics.

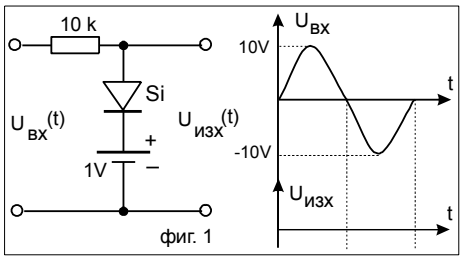
7. What is the voltmeter voltage for every one schematic if a diode is from Si? (or diode is from Ge?) Calculate the current through the circuit.



Draw the *ac* output voltage waveforms for the circuit in figure.



Draw the *ac* output voltage waveforms for the circuit in figure.



фиг. 1

Optional questions **NB:** there may be **more than one** correct answer**.**

8. When is reverse-biased, a Si diode: a) Has a high resistance; b) Has a low resistance; c) Act as an open switch; d) Act as closed switch; e) Conducts a large current; f) Has a turn-on of voltage of 0.7 V at room temperature; g) Has a turn-on of voltage of 0.4 V at room temperature.

9. When is forward-biased, a Si diode: a) Has a high resistance; b) Has a low resistance; c) Act as an open switch; d) Act as closed switch; e) Conducts a large current; f) Has a turn-on of voltage of 0.7 V at room temperature; g) Has a turn-on of voltage of 0.4 V at room temperature.

10. A reverse saturation current: a) is very small; b)increases when the temperature increases; c)is very large; d)increases when reverse voltage increases; e) does not affect by reverse voltage; f) does not affect by temperature.

11. In forward-biased Si diode: a) A turn-on of voltage is 0.7 V at room temperature; b) A turn-on of voltage is 0.4 V at room temperature; c) Forward voltage decreases with rising temperatures; d) Forward voltage increases with rising temperatures; e) Temperature dependence of forward voltage can be used for temperature compensation and temperature sensors.

12. A PN junction diode is used as: a) switch; b) amplifier; c) generator; d) rectifier; e) voltage regulator

Zener Diode

Compulsory questions

1. Draw the volt-ampere characteristics (forward and reverse) of a low voltage breakdown Zener diode for two temperatures ($T_2>T_1$) in common coordinate system.

2. Draw the volt-ampere characteristics (forward and reverse) of a high voltage breakdown Zener diode for two temperatures ($T_2>T_1$) in common coordinate system.

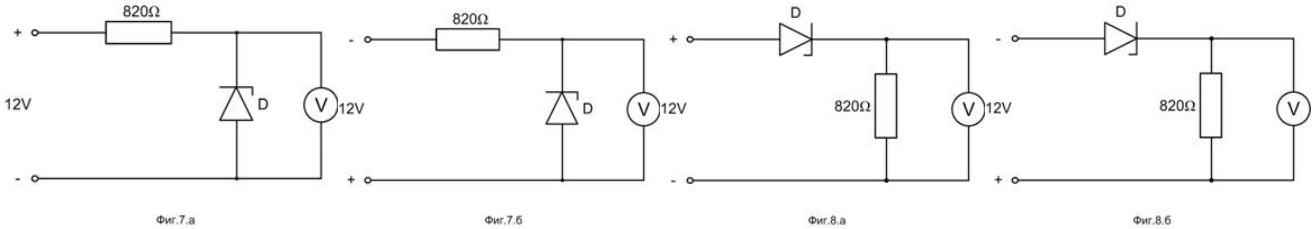
Practical questions

3. Draw the reverse characteristics of a low voltage breakdown Zener diode for two temperatures ($T_2>T_1$) in common coordinate system. Define the temperature coefficient of breakdown voltage TKU_Z and show how it is possible to determine it from the reverse characteristics. Which are the TKU_Z values – positive or negative?

4. Draw the reverse characteristics of a high voltage breakdown Zener diode for two temperatures ($T_2>T_1$) in common coordinate system. Define the temperature coefficient of breakdown voltage TKU_Z and show how it is possible to determine it from the reverse characteristics. Which are the TKU_Z values – positive or negative?

5. Draw the reverse characteristics of low and high voltage Zener diodes in common coordinate system. Define dynamic Zener resistance r_Z and show how it is possible to determine it from the characteristic. For which diode the r_Z is lower?

6. What is the voltmeter voltage for every one schematic if the Zener voltage of the Zener diod is U_Z = 9V?



Фиг.7.а Фиг.7.б Фиг.8.а Фиг.8.б

Optional questions **NB:** there may be **more than one** correct answer**.**

7. A Zener diode: a) operates mainly in the breakdown region; b) uses avalanche or Zener effect for its operation; c) is a constant-voltage device; d) acts like a battery in the breakdown region; e) is used in voltage regulators.

8. A Zener diode is used as: a) amplifier; b) generator; c) rectifier; d) voltage regulator

Light Emitting Diodes (LED)

Compulsory questions

1. Draw the volt-ampere characteristics of red and green LEDs in common coordinate system. Show the value of forward voltage for every one diode.

2. Draw the volt-ampere characteristics of infrared and blue LEDs in common coordinate system. Show the value of forward voltage for every one diode.

3. Draw the volt-ampere characteristics of red and yellow LEDs in common coordinate system. Show the value of forward voltage for every one diode.

Practical questions

5. Draw the schematic of forward biased LED diode. Calculate the current in a circuit (just formula).

5. Draw the schematic of forward biased LED diode. Calculate the current limiting resistor (just formula).

Optional questions **NB:** there may be **more than one** correct answer**.**

LED diodes: a) convert electrical energy in a light; b) convert light energy in the electrical energy; c) emit light when they are forward biased; d) emit light when they are reverse-biased.

LEDs are used for: a) remote control; b) illuminating devices; c) indicators; d) rectifiers.

Bipolar Junction Transistor

Compulsory questions

Draw a symbol of NPN bipolar transistor. Mention the names of electrodes.

Draw a symbol of PNP bipolar transistor. Mention the names of electrodes.

1. Draw a circuit with common-base (CB) connection of an NPN transistor in active mode. Show the polarities of the voltages and the direction of currents.

2. Draw a circuit with common-base (CE) connection of an NPN transistor in active mode. Show the polarities of the voltages and the direction of currents.

3. Draw the output VA characteristic of bipolar transistor in common base connection – $I_C = f(U_{CB})|I_E$=const .

4. Draw the output VA characteristic of bipolar transistor in common emitter connection – $I_C = f(U_{CE})|I_B$=const .

5. Draw the input VA characteristic of bipolar transistor in common base connection – $I_E = f(U_{EB})|U_{CB}$=const .

6. Draw the input VA characteristic of bipolar transistor in common emitter connection – $I_B = f(U_{BE})|U_{CE}$=const .

Practical questions

7. Define relationship between transistor currents in CE connection.

8. What is the collector current I_C of the bipolar transistor in common emitter connection if I_B = 40 μA and current gain β = 250. What is the value of emitter current I_E?

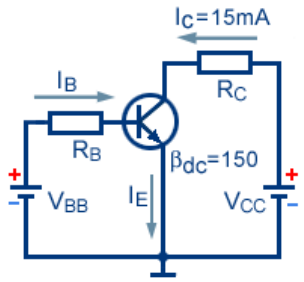
9. What is the current gain β of the bipolar transistor in CE connection if I_C = 10 mA, and I_B = 50 μA. What is the value of emitter current?

10. What is the current gain β of the bipolar transistor in common emitter connection if collector current I_C = 10 mA, and base current I_B = 50 μA. What is the value of emitter current I_E?

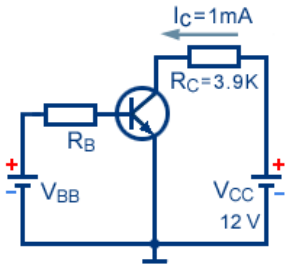
11. Define relationship between transistor currents in CB connection.

12. Calculate the collector current I_C of the bipolar transistor in common base (CB) connection if emitter current is I_E = 1 mA and α_{dc} = 0.98. Calculate the base current I_B.

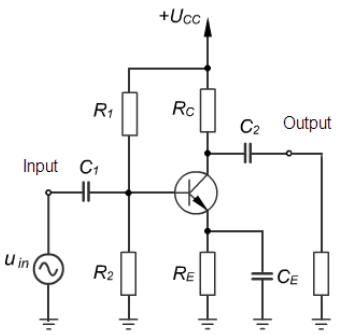
What is a transistor connection (CB or CE) in figure? What is emitter current I_E of transistor in figure?

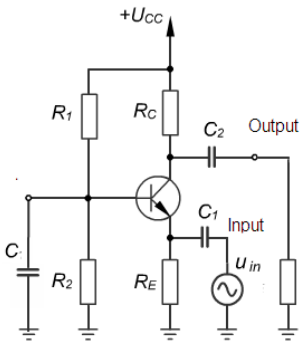


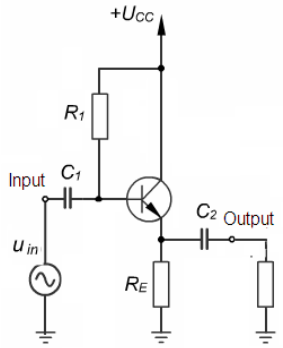
What is colector-emitter voltage U_{CE} for transistor in figure?



What is a transistor connection (CB, CE or CC) in every figure?







Optional questions **NB:** there may be **more than one** correct answer**.**

14. In active mode a bipolar transistor has: a) Forward biased emitter junction and reverse biased collector junction; b) forward biased emitter and collector junctions; c) reverse biased emitter and collector junction; d) reverse biased emitter junction and forward biased collector junction.

15. In cut-off mode a bipolar transistor has: a) emitter junction forward based and collector junction reverse biased; b) both junctions reverse biased; c) both junctions forward based.

16. In saturation mode a bipolar transistor has: a) emitter junction forward based and collector junction reverse biased; b) b4oth junctions reverse biased; c) both junctions forward based (2 marks).

17. A bipolar junction transistor: a) is a voltage controlled device; b) is a current controlled device; c) uses only majority carriers; d) uses both

Metal Oxide Semiconductor (MOS) Transistor

Compulsory questions

Draw the symbol of an *N*-channel enhancement-mode MOSFET. Mention the names of electrodes.

Draw the symbol of an *N*-channel deepletion-mode MOSFET. Mention the names of electrodes.

Draw the symbol of an *P*-channel enhancement-mode MOSFET. Mention the names of electrodes.

Draw the symbol of an P-channel deepletion-mode MOSFET. Mention the names of electrodes.

1. Draw the output VA characteristics of an N-channel enhancement-mode MOSFET $-I_D = f(U_{DS})/U_{GS}$=const. Show the polarity of the gate voltage in any curve, so that transistor is conducting .

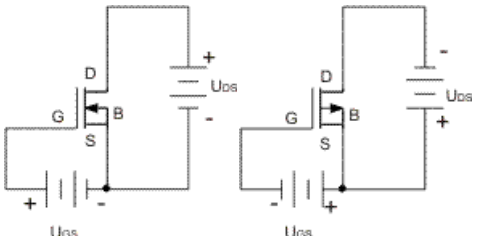
2. Draw the transfer characteristics of an *N*-channel enhancement-mode MOSFET I_D=f(U_{GS})/ U_{DS} = const. Show the values of the parameter (U_{DS} = const).

Practical questions

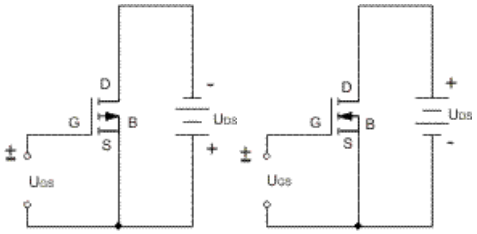
3. Define the dynamic output resistance of MOS transistor and show how it is possible to determine it from output characteristics.

4. Define the transconductance of MOS transistor and show how it is possible to determine it from transfer characteristic.

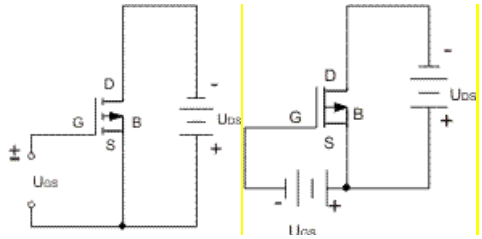
What is the correct schematic of depletion-mode *P*-channel MOSFET? /(or of depletion-mode *N*-channel MOSFET?)



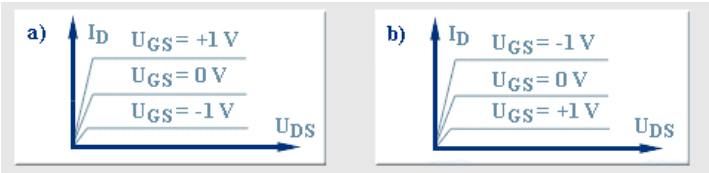
What is the correct schematic of an enhancement mode *P*-channel MOSFET? /(or of an enhancement- mode *N*-channel MOSFET?)



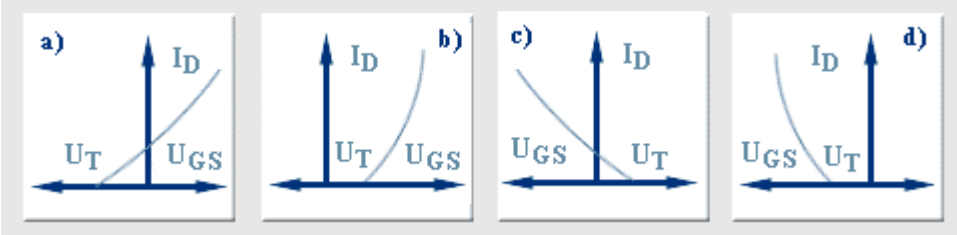
What is the correct schematic of a depletion- mode *P*-channel MOSFET?/(or of an enhancement-mode *P*-channel MOSFET?)



What is the correct output characteristic for *P*-channel depletion-mode MOSFET? /(or for *N*-channel depletion-mode MOSFET?



Match the transfer characteristics in figure to corresponding MOSFET type



Enhancement – mode N-channel MOSFET

Enhancement – mode P-channel MOSFET

Depletion-mode N-channel MOSFET

Depletion-mode P-channel MOSFET

Optional questions NB: **there may be** more than one **correct answer.**

5. What is the polarity of threshold voltage of an *N*-channel enhancement-mode MOSFET? a) Positive; b) Negative; c) Zero

What is the polarity of threshold voltage of a *P*-channel enhancement-mode MOSFET? a) Positive; b) Negative; c) Zero

What is the polarity of threshold voltage of a *N*-channel depletion-mode MOSFET? a) Positive; b) Negative; c) Zero

What is the polarity of threshold voltage of a *P*-channel depletion-mode MOSFET? a) Positive; b) Negative; c) Zero

6. A MOSFET: a) is a voltage controlled device; b) is a current controlled device; c) has a very high input resistance; d) uses only majority carriers; e) has an insulator under the gate.

The depletion-mode MOSFET works: a) in depletion-mode only; b)in enhancement-mode only; c)in both enhancement- and depletion- mode; d)with positive and negative input signals.

The enhancement-mode MOSFET works: a) in depletion-mode only; b)in enhancement-mode only; c)in both enhancement- and depletion- mode; d)with positive and negative input signals.

Integrated Circuit

1. Integrated circuits are characterized by: a) Reliability; b) Low power dissipation; c) Low weight and volume; d) High degree of integration

2. CMOS integrated circuits: a) have low power consumption; b) contain both NMOS and PMOS transistors; c) need insulation between PMOS and NMOS devices; d) provide higher level of integration than NMOS ICs.