

## Topics for program Microelectronics (MPA-MEL)

PN junction in equilibrium, empty junction area, diffusion voltage. Barrier and diffusion capacity of PN junction. PN transition in forward direction and reverse direction. Ampere-volt characteristic of PN junction. PN junction breakdowns. Inverse diode. Tunnel diode. Other types of transitions; metal-semiconductor junction.

Semiconductor diode. Ampere-volt characteristic of a semiconductor diode. Diode in forward direction and reverse direction. Stabilizing diode. Diode as rectifier, reference voltage source, switch, controlled resistance.

Bipolar transistor (BT). Bipolar transistor structure, principle of operation. Ampere-volt characteristics of BT in connection with a common emitter (SE). Normal and inverse BT mode. BT saturation and reverse mode.

Bipolar transistor (BT). Dependences of BT characteristic parameters on working conditions. The first and second breakthrough of the BT structure. Nonlinear BT models. BT linear models; h-parameters; y-parameters. Giacoletti model BT, cut-off frequency BT.

Bipolar transistor. Basic circuits with transistors. Setting the operating point. Principle of transistor amplifier. Class A amplifier, SE, SB, SC connections; current and voltage amplification; input and output resistance. BT as a switch, dynamic properties of a BT switch.

Unipolar transistors. J-FET, MOSFET, MESFET; structure, principle of activity. Linear (active) mode, saturation mode. Ampere-volt characteristics. Unipolar transistor as current source, amplifier, switch and controlled resistor. Linearized FET models.

Feedback - types, Black's relation, influence of feedback on amplifier parameters.

Operational amplifier VFA - properties, basic connection as a linear amplifier.

Frequency filters: division by shape and by approximation of frequency characteristic, by realization. Active frequency filters "continuous-time" and with switched capacitors: principle and examples of connection of 2nd order filters.

RC oscillators for integrated realizations: feedback principle, example of realization, function of circuit for stabilization of oscillation amplitude.

Simple current mirror (SCM), scheme and principle. Small signal parameters and properties. The main advantages and disadvantages of SCM. Cascade and Wilson current mirror. Scheme and principles. Differences from a SCM.

Single-stage MOS amplifier, connection with common "source". Principle and behavior in the field of low, medium and high frequencies. Explain the principle of active load. Differential degree. Principle, use. Basic principles of differential stage layout.

Simple transconductance operational amplifier (OTA). What is transconductance? OTA - block structure, principle. Small signal properties, compensation.

Basic logic cell - CMOS inverter. Scheme, principle and properties of structure. Basic static logic gates (NAND, NOR, XOR). Principle of assembling logic function circuits using serial-parallel connections of MOS transistors. What is AOI logic and what are its advantages?

Hazards in digital circuits. What is hazard. Where hazards occur. Elimination options. Give examples of when hazard may be accepted and when not.

Combinational logic circuits. Description of combinational logic circuits in VHDL language. Decoder, encoder, multiplexer, digital comparator and more.

Arithmetic operations in digital circuits. Addition, subtraction, multiplication, BCD adder, binary complement and more.

Sequential logic circuits. Description of sequential logic circuits in VHDL language. Different types of counters, shift registers and more. Describe in detail the use of processes in VHDL.

## **Evaluation of the entrance exam**

The entrance examination consists of two parts which take place in one day. The first part is a written exam, which takes place in the morning. The second part is an oral exam, which takes place in the afternoon. The second part of the entrance examination can only be submitted by candidates who successfully complete the first part of the test, i.e. they will receive a higher number of points than the set minimum score.

The first part of the entrance examination – the written exam, lasts 75 minutes. The maximum number of points that can be obtained is 100. The exam consists of 10 questions selected from two thematic areas which are listed above. The subject areas and their content are determined by the Board of Study Programs. The assignment of questions will be made by the academic staff so that the difficulty of each question is equivalent. These assignments are kept strictly secret until they are unsealed. The assignment and writing of the written exam is in English.

The written work of the first part of the entrance examination is evaluated immediately after its completion. The authorized employee guarantees the correctness of the evaluation. The results of the first round are available to the applicants on the BUT website at (<https://www.vutbr.cz/eprihlaska/en/>) after entering the application password.

The second part of the entrance examination - the oral exam, takes approximately 30 minutes. Taking part is conditional upon successfully completing the first part of the examination. A commission consisting of internal members (academic staff of FEEC BUT) and external members (external academic staff even from abroad and specialists from the industry) is appointed for the oral part of the examination. The maximum number of points that can be obtained is 30. The exam consists of three theoretical questions and takes the

form of a professional discussion with the candidate. It focuses on the topics specified in par. 3. The oral exam is in English. Candidates are expected to have a good command of English when communicating with members of the Commission.

The result of the oral test is evaluated immediately after its termination. The authorized employee guarantees the correctness of the evaluation. The results of the second round are again available to applicants on the BUT website at (<https://www.vutbr.cz/eprihlaska/en/>) after entering the application password.