Intended learning outcome	Having passed the course, the student shall be able to
1 Bandstructure	describe the electronic band structure for insulators, semiconductors and metals qualitatively
2 Concentrations	use the concepts electron- and hole-concentration, bandgap and mobility for calculations of current-voltage relations in semiconductor components
3 Electrostatics	analyse and calculate the internal electrostatics (charges, electric field and potential) in semiconductor components based on pn- and MOS-structures
4 Operation principles	describe the function and the application areas for the pn-diode, the MOS-transistor and common types of memory cells and some kind of semiconductor sensor
5 Circuits	describe the basic properties for CMOS-inverters and how these are used to implement integrated circuits
6 Sustainability	give an account of the most important sustainability aspects in production of modern microelectronics

The intended learning outcomes are examined according to this matrix

Nummer & beskrivning	TENA (summative)	LABA (summative & formative)	SEMA (formative)	Other
1 Bandstructure	Yes		Yes	
2 Concentrations	Yes	Partly	Yes	
3 Electrostatics	Yes	Partly	Yes	
4 Operation principles	Yes	Partly	Yes	
5 Circuits	Yes		Yes	
6 Sustainability				In class

Weighting of grades

If the student has achieved more than grade E on any part of the examination the grade will be calculated as an average. This average will be based on the subset of tasks, where the complete range E-A applies. Tasks that are only graded pass (E) are not considered in the average.

E-nivåkriterier (pass criteria at E-level)

ILO	E-level criterion
1 Bandstructure	The student should be able to draw band diagrams, both in equilibrium, and under applied bias. The band diagrams should represent both known conditions and types of devices. The student should draw the band diagram so that the operation of the device becomes correct in principle.
2 Concentrations	The student should be able to use the exponential relation between applied potential (or Fermi level) and the carrier concentration in a well-known case. The student should be able to account for which modern physics (solid state, statistical mechanics, and quantum mechanics) that is needed to formulate the semiconductor theory.
3 Electrostatics	The student should be able to calculate surface- or channel-concentrations of carriers in the MOS-system for different applied bias cases.
4 Operation principles	The student should be able to explicitly show the operation principle for diodes and transistors through IV-diagrams or expressions. Focus should be on the use of these devices in their respective application areas.
5 Circuits	The student should be able to explain the design and operation principle for the CMOS inverter
6 Sustainability	The student should be able discuss cleanroom wafer fabrication of silicon based integrated circuits with respect to material supply and energy usage

Criteria for higher levels C and A

ILO	C and/or A-level criterion
1 Bandstructure	The student should be able to draw band diagrams, both in equilibrium, and under applied bias. The band diagrams should represent both known conditions and types of devices. The student should draw the band diagram so that the operation of the device becomes correct. Polarities, barrier, alignment etc must be chosen and described correctly, when several similar cases exist. The student must not confuse different devices. In that case the criterion is not fulfilled, even if the band diagram in itself is correct.
2 Concentrations	The student should be able to use the exponential relation between applied potential (or Fermi level) and the carrier concentration in more than one well-known case. The student should be able to use modern physics (see above) for specific semiconductor calculations.
3 Electrostatics	The student should be able to calculate surface- or channel-concentrations of carriers in the MOS-system for different applied bias cases. In addition, the student should be able to calculate the threshold voltage numerically and state the assumptions and equations that are needed.
4 Operation principles	The student should be able to explicitly show more advanced properties of CMOS inverters and memory types. These properties should be related to the operation principle of the devices that are used as building blocks.
5 Circuits	The student should be able to generalize the CMOS inverter to different logic gates with two inputs. The student should be able to relate the following concepts to each other: power delay product, clock speed, supply voltage, static and dynamic power.
6 Sustainability	N/A graded as pass level only i.e. at E level not part of final grade average