

1. Are the following statements true (T) or false (F)? Every correct answer gives you +1 p and every wrong one -1 p. An empty answer is worth 0 p.
- An application-specific processor can be implemented using any of the integrated circuit technologies: VLSI, ASIC, or FPGA \_\_\_\_\_
  - The response times of real-time systems are always as fast as possible \_\_\_\_\_
  - Reactive systems are always also embedded systems \_\_\_\_\_
  - A typical benefit of a custom integrated circuit (VLSI) compared to a corresponding field-programmable gate array (FPGA) is its clearly lower power consumption \_\_\_\_\_
  - Moore's law was proposed right after the end of World War II in 1945 \_\_\_\_\_
  - In the recent years, the productivity of integrated circuit designers has grown slower than the complexity of leading-edge circuits \_\_\_\_\_
2. Two inductive sensors are placed consecutively below the surface of a one-way street. Those sensors recognize when a pair of car's wheels arrives on the top of a sensor. The distance between sensors is 1000 mm. An embedded system is connected to those sensors and it computes the speed of bypassing cars with the aid of a 16-bit up counter (the counter can be started, stopped and reset by software). Select a suitable *clock frequency* for the counter when the lowest measured speed is 10 km/h; explain your selection.
3. Illustrate with a short sequence of assembly-language instructions the benefits of Harvard architecture compared to the traditional von Neumann (Princeton) architecture.
4. The following table shows a comparison of the characteristics of different memory types. Fill in the missing data (grey boxes) to make the table complete.

Type	Volatile	Writeable	Erase size	Max erase cycles	Cost per byte	Speed
DRAM	Yes	Yes	Byte	g)	Moderate	Moderate
EEPROM	No	Yes	e)	Limited (consult datasheet)	Expensive	k)
EPROM	No	Yes, with a device programmer	f)	Limited (consult datasheet)	Moderate	Fast
Flash	a)	Yes	Sector	h)	Moderate	Fast to read, slow to erase/write
Mask ROM	No	c)	-	-	i)	Fast
NVRAM	No	d)	Byte	Unlimited	j)	Fast
OTP-ROM	No	Once, with a device programmer	-	-	Moderate	l)
SRAM	b)	Yes	Byte	Unlimited	Expensive	Fast

5. Your embedded system has an 8-bit microprocessor, which has a 16-bit address bus. In addition, you have a 32-Kbyte ROM chip and an 8-Kbyte RAM chip. You want to locate the ROM chip right in the beginning of the address space (begins from the hexadecimal address 0000) and the RAM chip right after the ROM chip. Both memory chips have a single /CS selection line, which is controlled by an 8 x 2 OTP-ROM chip. What are you going to program into the contents of the OTP-ROM, and how are you going to connect it to the microprocessor and the memory chips?