Deggendorf University of Applied Sciences
Faculty of Electrical Engineering and Media Technology

# Master-Program of Electrical Engineering and Information Technology

# Sample Problems for Preparation of the Admission Test

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The following collection of problems and test questions shall give applicants opportunity to make themselves familiar with the **contents** and **level** of the admission test for the Master-Program of Electrical Engineering and Information Technology at Deggendorf University of Applied Sciences.
The problems also represent the range of basic subjects which are considered elementary, prerequisite knowledge to participate successfully in the Master-Program.

## 1) Basics of Computer Science

1.1) What must be the width of the address bus if an address range of 4 GByte has to be addressed?

1.2) In the C programming language a variable declaration char reserves 1 byte for an integer number. Negative numbers are coded using 2 complement. Give
a) the smallest and biggest negative number and
b) the biggest and smallest positive number
in decimal, binary and hexa-decimal form.

First bit for sign. 0 means +, 1 means -

1.3) Have a look at the following lines of code. Convert the for loop in a do while loop:

```
int i = 0;
int j;
for (i = 0; i < 10; i++)
{
   j = i * 2;
   cout << j << endl;
}
```

## 2) Microelectronics and Technology of Integrated Circuits and Systems

2.1) Why do we use energy band diagrams to describe the energetic states of carriers in semiconductors? Explain the differences to the Bohr model!

2.2) Explain the expressions “drift current” and “diffusion current”!

2.3) Sketch the simplified band diagram of a metal, a semiconductor and an insulator!

2.4) Explain the Fermi probability distribution function!

2.5) The “Continuity Equations” describes changes in carrier concentrations with time. Explain the meaning of the expression $\frac{\partial p}{dt} = -\frac{1}{q}\nabla J_p + G - R$ for a given small volume within actual semiconductors!

2.6) Sketch the energy band diagram for a pn-junction diode at equilibrium, at forward bias and at reverse bias!

2.7) Explain the carrier concentrations in Emitter, Base and Collector of a npn-bipolar junction transistor (BJT) operated in the normal active region!

2.8) Explain the “Early-Voltage” of a BJT!

2.9) Sketch a simplified small signal equivalent circuit for a BJT!

2.10) Sketch the $I_C$ vs. $V_{CE}$ characteristics of a BJT!

2.11) Sketch the $I_D$ vs. $V_{DS}$ characteristics of an n-channel MOSFET!

2.12) What are the differences in respect to non-linearity between the characteristics depicted in 2.10 and 2.11 ?

2.13) At high currents and voltages, characteristics 2.10 and 2.11 show some similarities. Do you know any effect in a MOSFET corresponding to the “Early-Effect” in BJTs?

## 3) Circuitry

3.1) Sketch the schematics of amplifier circuits with BJT in common Emitter (without feedback), common Collector and common Base configuration.
Indicate the small signal voltage gain and the small signal input resistance of these amplifiers.

3.2) Which feedback configurations do you know for common Emitter amplifiers?

3.3) Explain principle and schematic of a CMOS current mirror. In which way is the ratio of the currents defined.

## 4) Electromagentic Field Theory

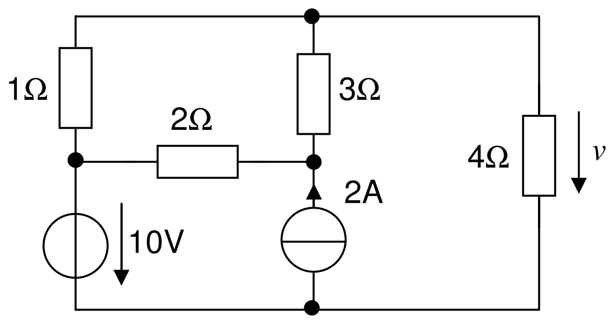
4.1) A test charge of $10^{-6}$C is placed halfway between a charge of $5 \cdot 10^{-6}$C and a charge of $3 \cdot 10^{-6}$C that are 20 cm apart. Find the magnitude and direction of the force on the test charge.

4.2 a) Two parallel wires 10 cm apart carry currents in the same direction of 8 A. What is the magnetic field halfway between them? Why is this so?
4.2 b)Two parallel wires 10 cm apart carry currents in opposite directions of 8 A. Calculate the magnetic field halfway between them?

4.3 a) A square wire loop 8 cm on a side is perpendicular to a magnetic field of $5 \cdot 10^{-3}$T.
4.3 b) Calculate the magnetic flux through the loop?
4.3 c) The field drops to 0 in 0.1s. Calculate the average emf which is induced in the loop during this period of time?

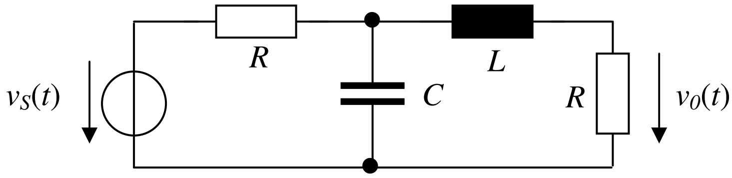
## 5) Basics of Electrical Engineering

5.1) DC Circuit Analysis
Find voltage $v$ in the given DC circuit.



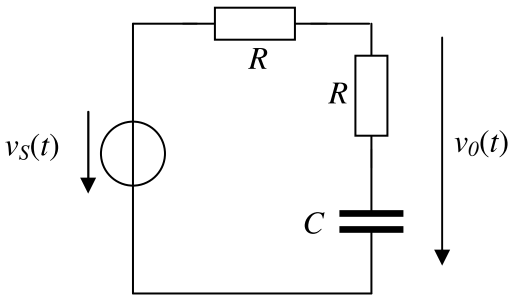

5.2) Sinusodial Steady-State Analysis
Compute $v_0(t)$ in the given circuit.

Take into account that $R = \omega L = \frac{1}{\omega C}$ and therefore $\omega = \frac{1}{\sqrt{LC}}$ and $R = \sqrt{\frac{L}{C}}$. The voltage source is $v_S(t) = \hat{v} \cdot \sin \omega t$.

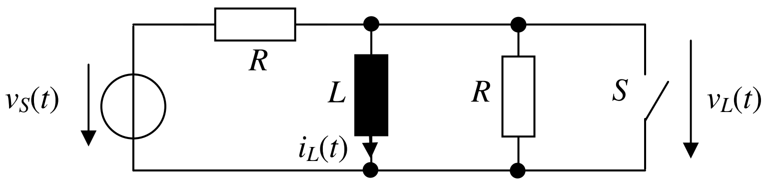


5.3) Bode plot

Determine the frequency response (Bode plot) of the transfer function $T(j\omega) = \frac{\underline{v}_0}{\underline{v}_S}$.




5.4) Transient Analysis
Consider the given RL circuit.




The voltage source $v_S(t)$ has a voltage step at t=0 from 0V to $\hat{v}$. The initial condition is $i_L(0)=0$. The switch $S$ is ideal. So its on resistance is zero and the off resistance is infinite. The switch $S$ is closed at time $t = \frac{L}{R}$ and open before.

Calculate and sketch the voltage $v_L(t)$ and the current $i_L(t)$.