# Test-Sheet

Dear applicant!

We recommend that you try to solve the following five sample problems in order to test yourself. Only if you understand the given questions, we encourage you to proceed to step two.

Remember: The results **do not** have any influence on your application!

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## 1. Electromagnetic Theory

The electrostatic field *E(r)* is described by an electrostatic potential *V(r)* via the equation:

$$\vec{E}(\vec{r}) = -\operatorname{grad} V(\vec{r})$$

Which field equation for *E* is solved by this expression ?

a) $\vec{E} = \vec{0}$

b) $\operatorname{rot} \vec{E} = \vec{0}$

c) $\operatorname{div} \vec{E} = 0$

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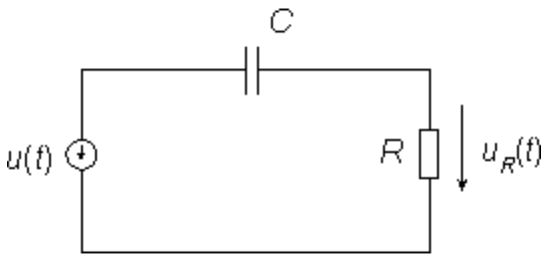
## 2. System and Network Theory




Above a simple network consisting of an ideal voltage source, a linear time-invariant resistor and a linear time-invariant capacitor is given.

By choosing *u(t)* as the input and $u_R(t)$ as the output a simple system is defined.

What are the transfer function *H(s)* and zero state step response *S(t)* of the system ?

a) $H(s) = \dfrac{\frac{1}{sC}}{R + \frac{1}{sC}}$, $S(t) = \begin{cases} 0, & t < 0 \\ 1 - e^{-\frac{t}{RC}}, & t > 0 \end{cases}$

b) $H(s) = \dfrac{R}{R + \frac{1}{sC}}$, $S(t) = \begin{cases} 0, & t < 0 \\ 1 - e^{-\frac{t}{RC}}, & t > 0 \end{cases}$

c) $H(s) = \dfrac{R}{R + \frac{1}{sC}}$, $S(t) = \begin{cases} 0, & t < 0 \\ e^{-\frac{t}{RC}}, & t > 0 \end{cases}$

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# 3. Feedback Control

Consider the ***feedback control loop***


where *R(s)* and *G(s)* are the rational transfer functions of controller and plant respectively. It is assumed that no pole-zero cancellations occur in *R(s)G(s)*.

Please answer the following two questions (multiple answers are possible):

**1.** The *closed-loop* system is stable...

| | TRUE |
|---|---|
| If *R(s)* and *G(s)* both are stable | ☐ |
| If the zeros of *1+R(s)G(s)* all have negative real parts | ☐ |
| If the poles of *1+R(s)G(s)* all have negative real parts | ☐ |

If the impulse response of the closed-loop system tends toward zero as time goes infinity ☐

**2.** The *transfer function* of the closed-loop system (describing the relation between reference
signal *r* and control output signal *y*) is...

TRUE

$$G_{ry}(s) = \frac{1}{1 + R(s)G(s)}$$ ☐

$$G_{ry}(s) = \frac{R(s)G(s)}{1 + R(s)G(s)}$$ ☐

$$G_{ry}(s) = \frac{G(s)}{1 + R(s)G(s)}$$ ☐

$$G_{ry}(s) = \frac{1 + R(s)G(s)}{R(s)G(s)}$$ ☐

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# 4. Probability Theory and Communication Networks

The response time for a query made in a communication network is assumed to be a negative
exponentially distributed random variable with a mean of *T* seconds.
The probability density function for this variable is given by *f(t) = (1/T)exp(-t/T)*.
Its cumulative distribution function is given by *F(t) = 1 - exp(-t/T)*.

What is the propability that a particular response time exceeds the value *2T seconds* ?

a) (1/T)exp(-2) ○
b) 1 - exp(-2) ○
c) exp(-2) ○

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# 5. Programming

A segment out of a C program is given below:

```
int result (int k)
 {
  if (k<=1) return 1;
  else return k*result(k-1);
 }
```

What would be the value assigned to the expression: *result(4)-result(-4)* ?

a) 0

b) 23

c) 24