

Mockup Exam

Study Course: EL BSc / SE BSc

Examination Part: EL 5 / SE 5 2907 Sensor, Actuator, Networks

Examiner: Prof. Dr.-Ing. Budelmann

Allowed aids: Two double-sided DIN-A4 pages with handwritten notes, non-programmable calculator.

Points: 40

Duration: 60 minutes (the regular exam is 120 minutes)

Please write legibly and full sentences! If you need additional space, use the back of the pages.

Date: _____

Family Name: _____

First Name: _____

Student No.: _____

Signature (Student)

FOR INTERNAL USE ONLY:

					Transfer Points
Question Number	Tick Questions Attempted	Points	Question Number	Tick Questions attempted	
1		4			
2		2			
3		4			
4		4			
5		2			
6		6			
7		5			
8		4			
9		5			
10		2			
11		2			
SUM			TOTAL		

Graded by		Checked by

Final Grade

Regular grading key.	yes
Adjusted grading key. (Please add the adjusted grading key to the exam-results)	

Points:

Question 1: Determine the measurement range and the maximum measurement error of the device from the right picture.

Measurement range:
60 – 400 A

Measurement error:
 $1.5\% \cdot 400A = 6A$

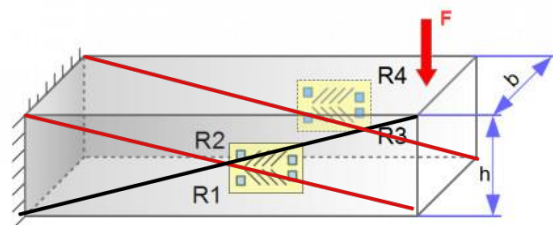


___/4

Question 2: Which one of the following answers is correct for the following strain gauge setup (for a positive force F)?

___/2

- R1 and R3 are positively stretched.
- R2 and R4 are positively stretched.
- R1 and R2 are positively stretched.
- R1 and R4 are positively stretched.



Student No.: _____

Question 3: You are measuring a resistance and the displayed value on your Fluke 177 is 500kΩ. What is the maximum measurement error? ____/4

Models 175, 177 & 179
Users Manual

Function	Range ¹	Resolution	Accuracy ± ([% of Reading] + [Counts])		
			Model 175	Model 177	Model 179
AC Volts ^{2,3}	600.0 mV 6.000 V 60.00 V 600.0 V 1000 V	0.1 mV 0.001 V 0.01 V 0.1 V 1 V	1.0 % + 3 (45 Hz to 500 Hz) 2.0 % + 3 (500 Hz to 1 kHz)	1.0 % + 3 (45 Hz to 500 Hz) 2.0 % + 3 (500 Hz to 1 kHz)	1.0 % + 3 (45 Hz to 500 Hz) 2.0 % + 3 (500 Hz to 1 kHz)
DC mV	600.0 mV	0.1 mV	0.15 % + 2	0.09 % + 2	0.09 % + 2
DC Volts	6.000 V 60.00 V 600.0 V 1000 V	0.001 V 0.01 V 0.1 V 1 V	0.15 % + 2 0.15 % + 2	0.09 % + 2 0.15 % + 2	0.09 % + 2 0.15 % + 2
Continuity	600 Ω	1 Ω	Meter beeps at < 25 Ω, beeper turns off at > 250 Ω; detects opens or shorts of 250 μs or longer.		
Ohms	600.0 Ω 6.000 kΩ 60.00 kΩ 600.0 kΩ 6.000 MΩ 50.00 MΩ	0.1 Ω 0.001 kΩ 0.01 kΩ 0.1 kΩ 0.001 MΩ 0.01 MΩ	0.9 % + 2 0.9 % + 1 0.9 % + 1 0.9 % + 1 0.9 % + 1 1.5 % + 3	0.9 % + 2 0.9 % + 1 0.9 % + 1 0.9 % + 1 0.9 % + 1 1.5 % + 3	0.9 % + 2 0.9 % + 1 0.9 % + 1 0.9 % + 1 0.9 % + 1 1.5 % + 3
Diode test	2.400 V	0.001 V	1 % + 2		
Capacitance	1000 nF 10.00 μF 100.0 μF 9999 μF ⁴	1 nF 0.01 μF 0.1 μF 1 μF	1.2 % + 2 1.2 % + 2 1.2 % + 2 10 % typical	1.2 % + 2 1.2 % + 2 1.2 % + 2 10 % typical	1.2 % + 2 1.2 % + 2 1.2 % + 2 10 % typical
AC Amps ⁵ (True RMS) (45 Hz to 1 kHz)	60.00 mA 400.0 mA 6.000 A 10.00 A	0.01 mA 0.1 mA 0.001 A 0.01 A	1.5 % + 3	1.5 % + 3	1.5 % + 3

1. All AC voltage and AC current ranges are specified from 5 % of range to 100 % of range.
2. Crest factor of ≤ 3 at full scale up to 500 V, decreasing linearly to crest factor ≤ 1.5 at 1000 V.
3. For non-sinusoidal waveforms, add -(2% reading + 2% full scale) typical, for crest factors up to 3.
4. In the 9999 μF range for measurements to 1000 μF, the measurement accuracy is 1.2 % + 2 for all models.
5. Amps input burden voltage (typical): 400 mA input 2 mV/mA, 10 A input 37 mV/A.

Displayed value = 500 kΩ

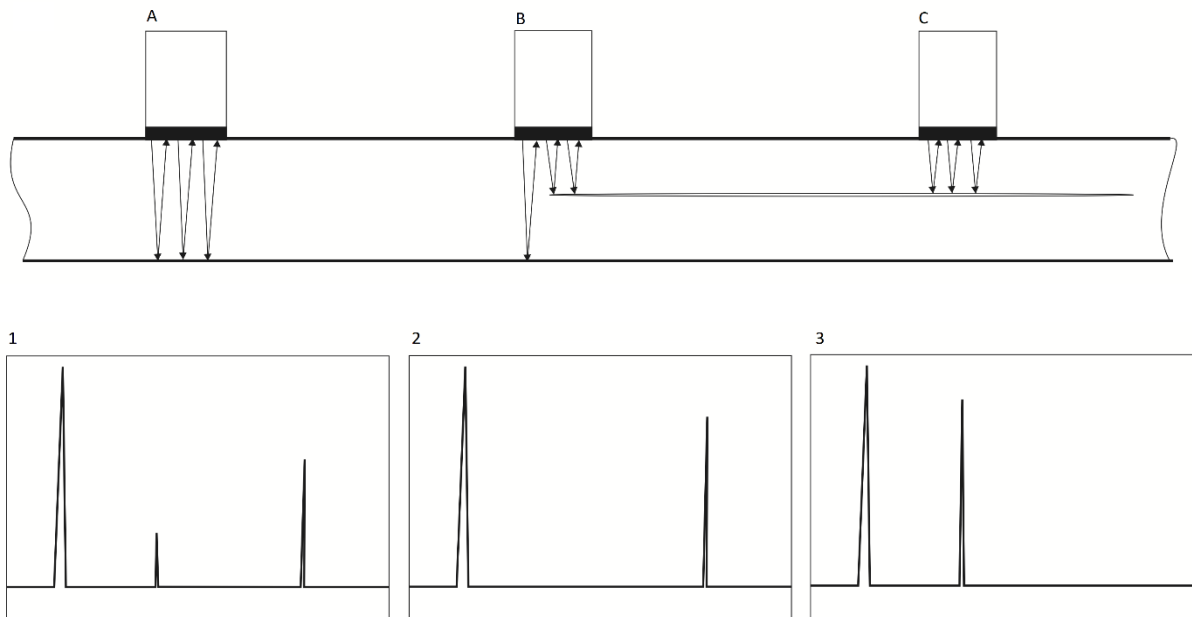
→ Range = 600.0 kΩ

→ Resolution = 0.1 kΩ

Maximum measurement error = ± (0.9% · 500.0 kΩ + 1 · 0.1 kΩ) = ± 4.6 kΩ

Student No.: _____

Question 4: You have three different setups for ultrasonic testing (A, B, and C). Select the correct signal outputs (1, 2, and 3) of the different setups. ____/4



A → 2 (Only an echo from the backwall, far away)

B → 1 (Echo from the first close defect, second echo from the backwall)

C → 3 (Only an echo from the defect, very close)

Question 5: You have a hydraulic press and a jack cylinder with a diameter of 20mm and a force of 150N. The working cylinder has a diameter of 100mm. What is the maximum working force, you can achieve? ____/2

$P = F / A$, pressure is identical in both cylinders.

$$F = 150 \text{ N} / (\pi \cdot (0.5 \cdot 20\text{mm})^2) \cdot (\pi \cdot (0.5 \cdot 100\text{mm})^2) = 3750 \text{ N}$$

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Question 6: Explain the working principle of a piezo actuator.

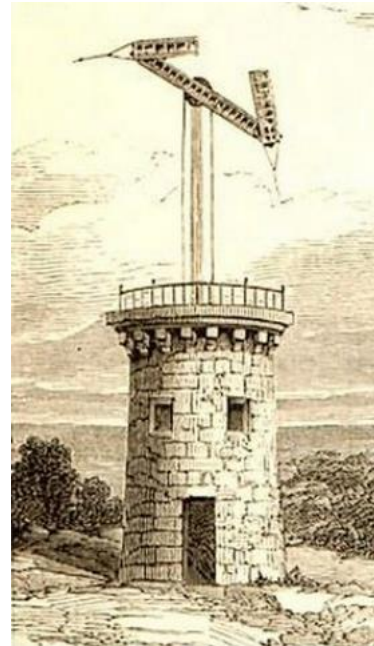
____/6

For example:

The piezoelectric effect results from a linear electromechanical interaction between the mechanical and electrical states in crystalline materials with no inversion symmetry. In an actuator, an applied electric field causes a change of the materials static dimension.

For a better explanation, also a drawing can be added (for example, crystal structure with and without the external electric field).

Question 7: In 1831, the First French Empire started to operate an optical telegraph system between Metz and Mainz. It could transmit administrative and military messages by optical signals over a distance of nearly 225 kilometers. The telegraph line comprised 22 telegraph stations, each furnished with a signal mast with three cable-operated arms. The center arm had four different positions whereas the two end arms had seven different positions each. In average, the operators needed two minutes to set the arms into a new position.



- a) How many bits per second can be transmitted? _____/3

Total number of different positions of the three arms: $7 \cdot 7 \cdot 4 = 196$ positions

This means, one symbol contains 7 bit and the operator needs 120s to realize a new setup.

Bitrate = $7 \text{ bit} / 120\text{s} \approx 0.0583 \text{ bit} / \text{s}$

- b) What is the end-to-end delay (from the first to the last station) for forwarding a message? _____/2

End-to-end means 21 transmissions (the last station one only has to read the message).

End-to-end delay: 42 minutes

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Question 8: Calculate the CRC checksum for the payload 11010011 by using the generator polynomial x^5+x^2+1 . ____/4

Generator polynomial in binary representation: 100101

Adding five zeros at the end of the payload (because it is a fifth order polynomial) and performing the polynomial division:

```
1101001100000
100101
0100011
 100101
 000110100
    100101
    01000100
      100101
      00011100
```

Result 1110

Question 9: Calculate the netmask, the first and last host address, the network address and the broadcast address using the IP address 153.213.11.213/27. ____/5

Netmask: 255.255.255.224

Network address: 153.213.11.192

First host address: 153.213.11.193

Last host address: 153.213.11.222

Broadcast address: 153.213.11.223

Student No.: _____

Question 10: Indicate the positions, where stuffing bits have to be added in the following CAN bus message and indicate the levels of the stuffing bits. ____/2

Complete CAN Data Frame																																																							
Data	Start of Frame		Arbitration Field								Control				Data								CRC Field (15 bits)															End of Frame																	
			11 bit identifier										Data length code		1 to 8 bytes								15 Bits															7 bits																	
	ID 10	ID 9	ID 8	ID 7	ID 6	ID 5	ID 4	ID 3	ID 2	ID 1	ID 0	RTR	IDE	Reserved	DL 3	DL 2	DL 1	DL 0	D 7	D 6	D 5	D 4	D 3	D 2	D 1	D 0	CRC14	CRC13	CRC12	CRC11	CRC10	CRC9	CRC8	CRC7	CRC6	CRC5	CRC4	CRC3	CRC2	CRC1	CRC0	CRC Delimiter	Ack slot bit	Ack delimiter	D 6	D 5	D 4	D 3	D 2	D 1	D 0				
0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1

ID7: 1

Reserved: 1

D3: 1

CRC2: 1

Question 11: What two problems can occur, when NRZ is used to encode data? ____/2

Baseline wander

Clockdrift / No selfsynchronization possible