



Försättsblad Prov Original

Kurskod	Provkod	Tentamensdatum
E L O 4 1 A	T 2 0 1	2 0 1 8 - 0 8 - 3 0
Kursnamn	Elektronik AV, Sensorer och instrumentering	
Provnamn	Teori del 2: Skriftlig tentamen	
Ort	Sundsvall	
Termin	H18	
Ämne	Elektronik	



Mittuniversitetet
MID SWEDEN UNIVERSITY

Sensors and Instrumentation

Written re-examination on theory part 2, 3 hp
The 30th of August, 2018

All answers to the questions and solutions to the mathematical problems should be written in an “easy to read and easy to follow” fashion. Mention and motivate, if you make an assumption. Try to be precise and coherent in formulating your answers. Irrelevant and/or unnecessarily long text might cost you points. Figures and plots, if needed, should be drawn with proper labels, units and axes.

- Calculators are allowed.
- Only printed dictionary books are allowed, NOT the electronic ones.
- Time: 5 hours.
- Maximum points: 60.
- Minimum points to pass: 30.

Grading scale:

Points	Grade
54 - 60	A
48 - 53.5	B
42 - 47.5	C
36 - 41.5	D
30 - 35.5	E
28.5 - 29.5	F _x
0 - 28	F

Good luck!
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Section A: $7 \times 6 = 42$ points

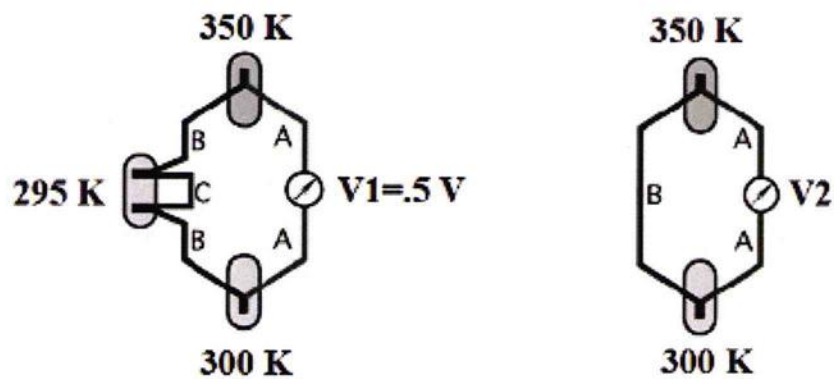
- (1) Surface processing methods, such as spin casting, vacuum deposition, sputtering, chemical vapor deposition and electroplating are used to deposit thin layers of films on substrate or semiconductor wafer. Describe **any three** of these methods.
- (2) Explain photolithography process step by step with necessary figures.
- (3) Briefly describe the working principle of three types of quantum detectors.
- (4) Explain split-wire and split-junction thermocouple circuits with necessary figures.
- (5) Design two sensors, one capacitive and one resistive, to sense humidity and moisture. How do your sensors function?
- (6) Answer to the following questions:
 - (a) Explain with physics, how the conductivity increases when a pressure sensitive film of piezoresistive ink is subjected to force?
 - (b) Describe the structure of a pressure sensitive piezoelectric cable. Where can it be useful?
- (7) How do these sensors work?
 - (a) Pressure sensor using Mercury.
 - (b) Breeze sensor using piezoelectric element.

Section B: 8 points

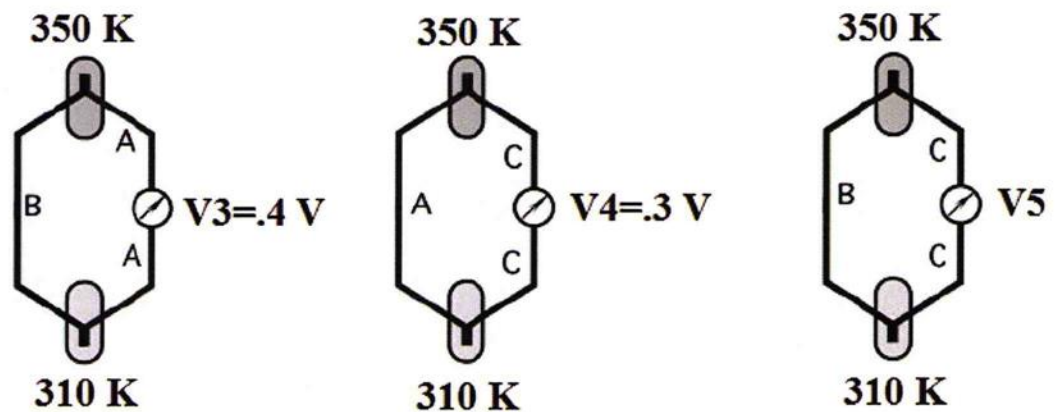
(1) Apply thermoelectric laws.

3 points

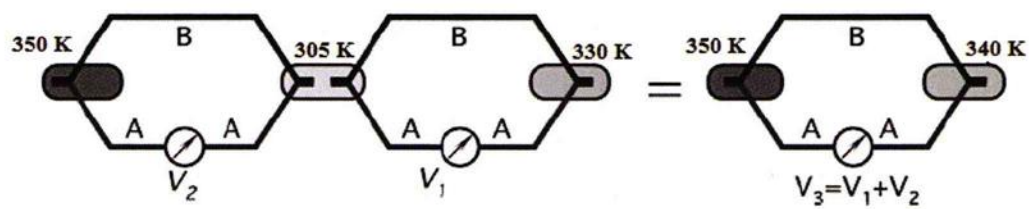
(a) Calculate V_2 .



(b) Calculate V_5 .

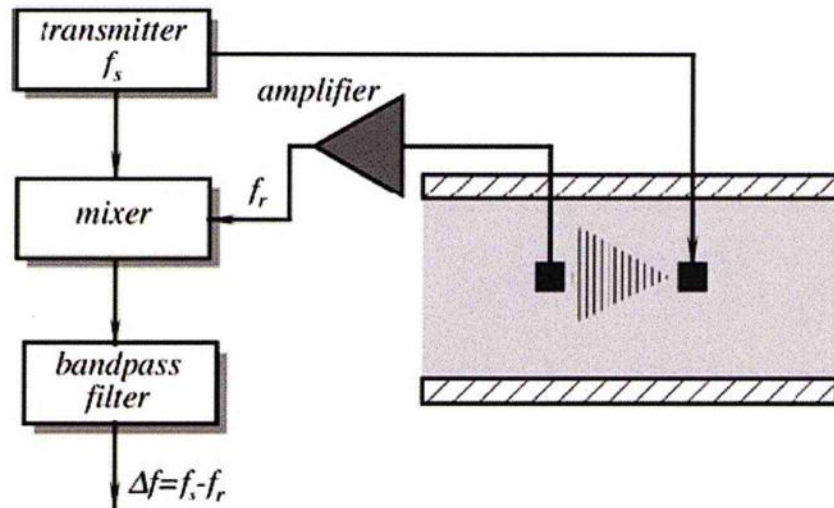


(c) What is wrong in the figure below?



- (2) A transmitter-receiver assembly is positioned inside a flowing stream. If $\Delta f = 0.3$ MHz, $f_r = 1.9$ MHz and the average fluid velocity $v = 100 \text{ ms}^{-1}$, estimate the velocity of sound in that medium in the given temperature.

3 points



Help:

$$\Delta f = f_s - f_r \approx \frac{2f_s v}{c}$$

- (3) What is earth's angular velocity?

2 points

Help:

A complete/full rotation is equal to 2π radians Angular velocity, $\omega = \frac{\phi}{t}$

Section C: $10 \times 1 = 10$ points

Write true or false for each statement below.

- (1) Silicon is the most abundant material on earth.
- (2) Isotropic etchant attacks the material being etched at the same rate in all directions.
- (3) The valence band corresponds to those electrons that are bound to specific lattice sites within a crystal.
- (4) Thermopile has nothing to do with thermocouples.
- (5) Every sensor, no matter the size or design, will disturb the measurement site.
- (6) Absolute humidity is the mass of water vapour per unit volume of wet gas.
- (7) In a linear velocity sensor with two double rings, the active coil produces an induced current.
- (8) In a Whispering Gallery Mode (WGM) resonator, the resonances are highly sensitive to changes of the microsphere.
- (9) 1 pascal is very high pressure.
- (10) The main idea in an ultrasonic flow sensor is the detection of frequency or phase shift caused by flowing medium.

I think it's much more interesting to live not knowing than to have answers which might be wrong.

– Richard P. Feynman