Exam: Sensors and Microsystems Electronics, AY 2018-2019 **June 11, 2019, Morning**

NAME:

Important: Fill out your full name and hand in this sheet together with your preparation.

1. Driving LEDs using a boost converter

2. Discuss: Thermistors

3. Problem:
   A horizontal tube with a circular cross section and an inner diameter of 10 cm contains a narrow section ('venturi') with an inner diameter of 5 cm. Water of 4 °C is flowing through this tube. The static pressure at a long distance before the venturi is 1.8×10^5 Pa; at the venturi the pressure has dropped to 1.5×10^5 Pa.
   Calculate the flow rate of the water that flows through the tube. Express the result in liters per

Exam: Sensors and Microsystems Electronics, AY 2021-2022 June 28, 2022, Afternoon

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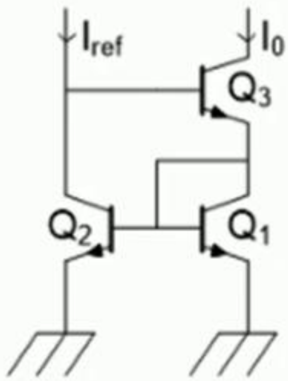
- A microsystem consumes:
  - on average 1.3 mA at 1.3 V
  - with periodic energy bursts.

If the device should work for at least 5 days continuously and there is a space restriction, which type of energy supply would you recommend for the device? Please elaborate your answer.

- Calculate for the adjacent circuit the relationship between I_0 and I_{ref}. Q_1, Q_2 and Q_3 are identical with the same β. How is this circuit called?



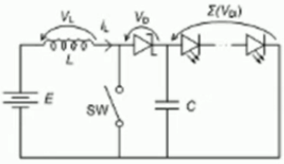
- Problem:
  Consider a typical "NTC" (thermistor with a negative temperature coefficient). The characteristic of such a sensor is given by:

$$R_s = R_0 e^{\frac{B}{T}}$$

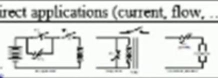
With T the absolute temperature in Kelvin.
Linearize the sensor by adding a parallel resistor R_p, chosen in such a way that the inflection

re sheets:

BOOST converter for LED driving

	**Weight**										
Schematic	4										
$E<\Sigma V_{Di}$ (e.g. battery powered)	1										
Cases sw=closed and open	1										
$V_L=L\,di_L/dt$	1										
i(t) for $t<T_{on}$ $i_L = i_L(0)+\frac{E}{L}t$	2										
i(t) for $T_{on}<t<T$ $i_L = i_L(T_{on})+\frac{1}{L}\int_{T_{on}}^{t}(E-V_D-\sum V_{Di})dt$	2										
Assume V_{Di} indep. i_L → const. in integral	1										
$i_L = i_L(T_{on})+(t-T_{on})(E-V_D-\sum V_{Di})$	1										
Steady-state condition $i_L(T)=i_L(0)$	1										
$(V_D+\sum V_{Di}-E)(T-T_{on})=ET_{on}$	1										
Duty cycle $D=T_{on}/T$. $\sum V_{Di}=E\frac{1}{1-D}-V_D$	2										
Figure current (t) 	1										
Efficiency: losses regulator; sense R; series resistance of L; series resistance of Mosfet; voltage drop V_D	2										
Typical overall efficiency 80-85%	1										
Other relevant info (bonus)	1										

Discuss: Thermistors

	Weight										
Based on semiconductors	1										
Symbol PTC, NTC (non-linear)	2										
Low doping: # charge carriers rises with T	1										
High doping: metallic: R rises with T	1										
$R_T = R_0 e^{B\left(\frac{1}{T}-\frac{1}{T_0}\right)} = Ae^{\frac{B}{T}}$	2										
Meaning of R_0, A, B	1										
B T-dept. + bad reproducibility	1										
Effective TCR (n/lin) $\alpha = \frac{dR_T/dT}{R_T} = -\frac{B}{T^2}$	1										
PTC: 2 types	1										
Posistors (ceramic)	1										
Silistors (doped Si)	1										
Posistors: abrupt; Curie temp.	1										
Silistors: smooth f^{on}: $R_T = R_{25}\left(\frac{T}{298.15\,K}\right)^{2.3}$	1										
Thermistors less stable than RTD; Artificial/accelerated aging.	1										
Sensitive, high resistance values (>> wires)	1										
Small, cheap	2										
Indirect applications (current, flow, …)	1										
Eg.: 	3										
Other relevant info (eg. "Thermally	1										