

# NBE-E4310 - Biomedical Ultrasonics

## EXERCISE 5 (40p)

**Independent/group work 21.3.2019 at 12-14; correct solutions 28.3.2019 at 12-14**

*Submission: Please submit your responses via MyCourses as one zip file containing your responses in pdf and Matlab format.*

*The deadline for submitting your Exercise 4 responses is at 11:00 AM on Mar 28, 2019.*

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### 1. Cavitation (11p)

Consider the differential equation proposed in the Exercise 4 task 1 and use same parameters.

- Calculate and plot the contribution of the pressure generated by the pulsating bubble to the total pressure field at a distance of  $15 \mu m$  from the centre of the bubble. Consider the bubble as a pulsating sphere source. (8p)
- Plot the amplitude spectrum of the total pressure signal. (3p)

### 2. Thermal Dose 1 (9p)

Calculate how long it takes to reach tissue damage ( $30 < TD_{43} < 240$ ) and tissue necrosis ( $TD_{43} > 240$ ) in the following cases:

- $T_1 = 42.5 \text{ }^\circ\text{C}$  (3p)
- $T_2 = 54 \text{ }^\circ\text{C}$  (3p)
- $T_3 = 80 \text{ }^\circ\text{C}$  (3p)

### 3. Thermal Dose 2 (10p)

Calculate how long it takes to reach tissue damage ( $30 < TD_{43} < 240$ ) and tissue necrosis ( $TD_{43} > 240$ ) in the following cases:

a)  $T_1(t) = 70 (1 - e^{-t/10})$  °C (5p)

b)  $T_2(t) = 55 (1 - e^{-t/15})$  °C (5p)

### 4. Biomedical applications (10p)

a) Define the parameters that should be used in order to achieve histotripsy at 1 MHz without inducing thermal damage in tissue. (5p)

b) Define the parameters that should be used in order to achieve thermal ablation at 1 MHz without inducing cavitation. (5p)