Final exam questions

Subject group name: **Thermal Physics**

Neptun code: ZVEGEENNWTP

Credit points: 3

Subject in this subject group:

- **Thermal Physics** (BMEGEENNWTP)

Program: Mechanical Engineering Modelling MSc (2N-MW0-2019)

Specialization(s): Thermal engineering

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You can check the current subject forms at the Educational Portal of the Faculty of Mechanical Engineering.

https://oktatas.gpk.bme.hu/

Always check the for updates at edu.gpk.bme.hu before preparing for the exam, especially if the subject group contains at least one subject from your final semester!

Valid from 01 September 2021

Dr. Róbert KOVÁCS
assistant professor

I. Fourier heat conduction
   1. Please, present the background of heat conduction based on Fourier's law.
   2. Derive the Fourier heat equation and explain the thermophysical quantities appearing in the equation.
   3. Please, present the possible initial and boundary conditions.

II. Generalized heat conduction
   1. What is the motivation to seek other heat conduction models?
   2. What is the background of the Maxwell-Cattaneo-Vernotte equation?
   3. How this extension modifies the characteristics of temperature profiles?

III. Boundary conditions
   1. What sort of boundary conditions are applied to the Fourier heat equation?
   2. Please, present the meaning of contact boundary condition with thermal resistance.
   3. How the contact boundary condition can be applied for friction?

IV. Thermophysical quantities
   1. What thermophysical quantities do appear in the Fourier heat equation?
   2. How the temperature dependence of the thermophysical quantities modify the Fourier heat equation?
   3. What method do you know to solve the non-linear heat equation?
   4. How is it possible to measure the temperature dependence of the thermophysical quantities?

V. Finite difference method
   1. What is the background of finite differences?
   2. Please, describe the most used approximations for the first derivative. What is the essential difference between them?
   3. Please, present the application of finite differences on the example of Fourier heat equation.
   4. Please, explain the Crank-Nicolson method.

VI. Control volume method
   1. Please, explain the background of the control volume approach.
   2. Please, present is application on the example of Fourier heat equation.
   3. Please, show how the convection boundary condition can be realized with the control volume method.
   4. What is the stability condition of such schemes?

VII. Measurement of thermophysical quantities I.
   1. Please, present the most important aspects and requirements of measurement methods.
   2. Schematically present the principle of Differential Scanning Calorimetry. Which thermophysical quantity can be measured?
   3. Please, present the measurement methods for temperature-dependent parameters.

VIII. Measurement of thermophysical quantities I.
   1. Please, explain the measurement methods for thermal conductivity. What are the essential aspects of such measurements? Is it possible to use transient methods?
   2. Please, present the background of thermal diffusivity measurements. Is it possible to use steady-state experiments to measure the thermal diffusivity?

IX. Inverse heat conduction
   1. Please, explain the difference between direct and inverse problems.
   2. What can be the unknowns in inverse problems?
   3. What techniques do you know to solve an inverse heat conduction problem?