First mid-term examination on Ordinary Differential Equations

(Innopolis University, Spring semester 2020, BS-III)

Description

It is distance asynchronous individual written test to check that students understand and can apply main definitions, concepts and techniques covered in the lectures on weeks 1-3. According to the Syllabus, (https://moodle.innopolis.university/mod/resource/view.php?id=29351), the each mid-term and the final examination cost is 20 points each. Examination has one (parameterized) variant for all enrolled students with 2 obligatory (to attempt) tasks and 1 bonus task (for volunteers to enjoy a piece of theory – to be awarded by bonus points at the discretion of the lecturer). The timeline of the examination follows:

- Examination problems to be uploaded to Moodle by Saturday September 5, 2020.
- Individual solutions to be uploaded to Moodle for grading by Friday September 11, 2020.
- Submissions to be graded by Thursday September 17, 2020.

The main grading criterion for written test will be "proof of individual work" while computational errors will be treated as tiny mistakes (at most one-point deduction for each individual task).

Rules

1. "Proof of individual work" rule means that
   - students must upload individual solutions in two files: the source file (in one of 5 formats Word 2007 document .docx, Word document .doc, PowerPoint 2007 presentation .pptx, PowerPoint presentation .ppt without macros, or application/x-tex .tex with plain class) and the result of PDF-conversion of the source file (i.e. pdf file);
   - solutions must be well-structured and formatted, concise (each task – at most 4 slides with font 20pt or 2 pages with font 12pt) but detailed at least at level of lecture notes for week 2 (https://moodle.innopolis.university/mod/resource/view.php?id=40685).
2. Each submitted file should be named by student first name and surname (for example NikolayShilov.docx and NikolayShilov.pdf)
3. On the top of the front page of each submission should start with student first name and surname followed by birthdate (in the format $day.month.year$, for example $24.04.1961$).
4. Submissions with scanned or photo images of hand-written solutions will be discarded without consideration!

Tasks

Task 1 (10 points)

Characterize (in terms introduced in lectures for weeks 1-3) and solve (using methods introduced in lectures for weeks 1-3) equation $(day)x^2 + (month)y^2 + (year)xy\,y' = 0$. (I.e., you are asked to find (or progress/proceed as much as you can towards to) an explicit (it will be better) or an implicit form for the most general solution of the equation with *instantiated* values for parameters day, $month$, and $year$ – for example, the equation $24x^2 + 4y^2 + 1961xy\,y' = 0$ in case of the birthdate $24.04.1961$; the solution process must be explained!)

Task 2 (10 points)

Characterize (in terms introduced in lectures for weeks 1-3) and solve (using methods introduced in lectures for weeks 1-3) equation $dy - y(day + xy^{month})dx = 0$. (I.e., you are asked to find (or progress/proceed as much as you can towards to) an explicit (it will be better) or an implicit form for the most general solution of the equation with *instantiated* values for parameters day and $month$ – for example, the equation $dy - y(24 + xy^4)dx = 0$ in case of the birthdate $24.04.1961$; the solution process must be explained!)

Bonus Task (a piece of theory for volunteers)

Characterize (in terms introduced in lectures for weeks 1-3) the equation $(day)y'' + (month)y = 0$ (with *instantiated* values for parameters day and $month$ – for example, the equation $24y'' + 4y = 0$ in case of the birthdate $24.04.1961$). Using your knowledge from Real Analysis (BS-I), prove or refute that $y = C_1 \sin\left(\sqrt{\frac{month}{day}}x\right) + C_2 \cos\left(\sqrt{\frac{month}{day}}x\right)$ is the most general solution of the equation.