MEC-E1070 Selection of Engineering Materials

Task 2: Multiple constraints

Instructions: Check the following questions and exercises. Read chapters 7 and 8 of the course textbook (4th edition).

Criterion: A good report on this task demonstrates a good understanding of:

- the concept of solutions that dominate others when there are multiple objectives, and trade-offs when there are multiple un-dominated solutions
- how to combine multiple material performance indices into a penalty function, using a trade-off parameter
- how to graphically represent this on a chart with multiple performance indices as axes, and
- how to express this as relative performance compared to a reference solution

Task 2.1: Sufficient stiffness is required from the frame structures used in various transportation vehicles. In addition, those frame structures should be as light as possible to minimize fuel consumption. On the other hand, the frame should also be as cost-efficient as possible.

The vehicle frame can be simplified as panels, or beams, or a combination of both. Different loading conditions can be possible, therefore you may have different answers from your peers. Hence, you need to **specify the situation for your own structure at the beginning**.

Find out the materials that meet your requirements. Choose **two** vehicles from the listed application table below. Explore suitable materials for each of your chosen vehicles with the corresponding exchange constants (α) provided in the table. In this case, each exchange constant represents the value of weight savings in that vehicle.

Note: Suitable indices for frame structures can be found in the textbook. **A step-by-step derivation must be included in your report**.

Hint: It is recommended to perform the material comparison by calculating the values of a *penalty function (Z)*. A graph of the results needed for this task can be drawn from the GRANTA EduPack by choosing the Z-function values as the Y-axis in *Advanced*-tools, and various material groups for the X-axis by leaving the attribute of X-axis empty or by using the *Trees*-tool. Draw these maps on **level 2**.

Application	Alpha [€/kg]
Passenger car	5
Truck	15
Commercial airplane	250
Fighter jet	750
Space shuttle	5000

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Task 2.2: Not so long ago, the most prevalent casing material for mobile phones and portable music players was ABS-plastic.

Draw a relative material property map following the example from the textbook: 8.6 "*Wafer-thin casings for must-have electronics"*.

Compare the casing materials from nowadays (e.g., aluminum, carbon fiber and glass) to ABS. **Describe** and **explain** your observations.

***Hint**:* In this task the casing material is approximated as a bent sheet structure, for which the limiting factor is stiffness. Alternative parameters that should be optimized are mass and wall thickness. Construct a relative material property map where the alternative materials are located in a WIN-LOSE – four-quadrant map. Place the reference material choice (ABS) so that its coordinates are (1,1). The relative material properties can be expressed using the following formula: $\frac{P(M_n)}{P(M_{nABS})}$. In your answer, use the material properties for ABS, which can be found from GRANTA EduPack, level 2 materials, or from the textbook appendices.

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