



## Final exam questions

Subject group name: **Fatigue and Fracture**

Neptun code: ZVEGEMTNWFF

Credit points: 3

Subject in this subject group:

- **Fatigue and Fracture** (BMEGEMTNWFF)

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

Specialization: Design and Technology

Responsible person:

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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](http://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**

*Imre Norbert Orbulov, PhD*

Full professor, lecturer

## **Fatigue and Fracture**

1. **Mechanisms of fracture.** Frenkel model, theoretical strength. Dislocations and dislocation theory. Plastic deformation of single and polycrystalline metals. Cottrell-Lomer barrier. Frank-Read sources.
2. **Fatigue.** Definition and mechanisms of fatigue failure. Modelling of real loadings. Stress concentration factor. Fatigue limit. Endurance limit.
3. **High cycle fatigue.** Measurement of the fatigue limit. Rotating-bending test. Evaluation of the tests, mathematical and statistical approach. Wöhler curve. Theory of cumulative damage.
4. **Safety diagrams.** Haigh diagram. Smith diagram. Design of the Smith diagram: (i) IIW method, (ii) two points method. Application of safety diagrams.
5. **Low cycle fatigue.** Measurement, stress – strain loops. Cyclic flow curve. Unified Wöhler curve. Design for fatigue. Strain life method.
6. **Fracture mechanics.** Design philosophy. Linear Elastic Fracture Mechanics. Griffith model. Critical stress and crack length for unstable crack propagation. Specific energy release rate. Stress intensity factor.
7. **Fracture toughness.** Measurement of plain-strain fracture toughness. Typical specimens. Sampling. Pre-fatigue. Test procedure. The evaluation of the test. Validation.
8. **Small scale yielding.** Size determination of the small plastic zone. Irwin's first order approximation. Determination of the plastic zone contour in plane stress and in plane strain conditions. Determination of the plastic zone surface.
9. **Elastic – plastic fracture mechanics.** J-integral. Determination of the critical value of J-integral: (i) measurement, (ii) evaluation and (iii) validation. Connection to the fracture toughness.
10. **Fatigue crack propagation.** Models and basic considerations. Kinetic diagram of fatigue crack propagation. Paris – Erdogan relationship. Forman relationship. Measurement of the material constants of Paris – Erdogan relationship. Estimation of the expected life-time.