MISKOLCI EGYETEM
Gépészmérnöki és Informatikai Kar
Műszaki Mechanikai Intézet
3515 Miskolc - Egyetemváros

2nd September 2024

MM/67/2024.

NOTICE

Requirements of the subject **STRENGTH OF MATERIALS** (GEMET268M)
in the fall semester of academic year 2024/2025

This subject is a compulsory course. The most important information concerning the subject is given below under various keywords.

OBJECTIVES

The main objective of this course is to provide the student with an introduction to the theory of elasticity, finite element modelling and plasticity. Our further aim is to present the fundamental concepts and methodologies, then apply them to the solutions of engineering problems. There are two formal lectures and a practical class during the 14-week term-time. The location of the classes might change, but if this is the case the students will be informed about the new location in time.

SCHEDULE

Week 1 Basics of elasticity, mathematical preliminaries and indicial notation. The general boundary value problem of linear elasticity.

Week 2 Kinematics of deformation, strain measures. Seth-Hill family of generalized strain tensors. Green-Lagrange strain tensor and kinematic equation. Infinitesimal deformations. Strain measurement methods.

Week 3 Stress state and Cauchy's hypothesis. Stress vector and its components, the Cauchy stress tensor. First and second Piola-Kirchhoff stress tensors. Equilibrium equation and Cauchy's equation of motion. Residual stresses and stress measurement methods. Constitutive equations, basic definitions. Strain energy density and generalized Hooke's law. Thermoelastic effect and hydrostatic stress state. Engineering notation and different types of material anisotropy. Material nonlinearities.

Week 4-5 Solution approaches for the general boundary value problem of linear elasticity. Boundary conditions, basic principles and nonlinear problems. Primal and dual systems, compatibility equation. Navier equation and Beltrami-Mitchell equation. Thermodynamic principles and heat conduction. Helmholtz free energy.

Week 6 Design for strength. Eigenvalue problems and basic definitions of design and analysis. Strain energy, isotropic and deviatoric decomposition. Von Mises and Tresca theories.

Week 7 Two-dimensional formulation: plane strain, plane stress, generalized plane stress, axisymmetric problems. Structural elements and models: Kirchhoff and Reissner-Mindlin plate theories, basic beam theories.

Week 8 Analytical solutions of rotating cylindrical bodies, such as shafts, pipes and tubes. Desing and analysis of cylindrical and spherical pressure vessels.

Week 9 Basics of variational approach. Principle of minimum potential energy and principle of virtual work. Ritz method. Matrix formalism of the boundary value problem.

Week 10 Basics of finite element modelling. Displacement based FE method: interpolation, equations, potential energy, stiffness matrix, solvers and convergence. Truss element.

Weeks 11-13	Isoparametric quadrilateral elements, isoparametric mapping, Jacobi matrix and Gauss quadrature. Examples. Other element types and element selection. Introduction to Abaqus CAE FE software.
Week 14	Basics of plasticity, elastoplastic truss structures and beam problems. Summary.

GETTING THE SIGNATURE

Students are requested to learn the materials of the lectures and practical classes in a satisfactory manners. For the sake of effective and systematic work **regular attendance at the classes is compulsory**.

Two midterm exams are to be taken during the semester. The maximum attainable score in a 45 minute long midterm exam is 40. The maximum total score is 80, the minimum score for the signature is 32 (40%).

The midterm exams are to be held on week 6 and 12. Students who do not achieve the minimum prescribed, have to take a **make up exam** on week 14. This exam lasts for 45 minutes, the total score is 40 and the passing score is 16 (40%).

If a student does not achieve the minimum prescribed, he/she won't get a signature in the term-time. One can **make up for the signature** at the beginning of the examination period (during the first two weeks of the examination period), however the conditions are harder: the performance should be at least 50% (passing score 20).

TAKING THE FINAL EXAM

There is a final examination at the end of the semester, which is a 45 minute long written test. The maximum score of the test is 40. The course is graded on a five grade scale: excellent (5), good (4), fair (3), pass (2) and fail (1). The mark given to a student depends on the performance provided in the final exam:

Score	0-19	20-23	24-27	28-31	32-
Mark	fail	pass	fair	good	excellent

To reward regular work, one quarter of the score above 32 points achieved in the term-time is added to the total score of the final exam.

TEXTBOOKS

1. Sadd M. H.: *Elasticity: Theory, Applications and Numerics*. Third edition, Academic Press, 2014.
2. Reddy J. N.: *Energy Principles and Variational Methods in Applied Mechanics*, 3rd Edition, John Wiley and Sons, Inc., 2017.
3. Bathe K. J.: *Finite Element Procedures*. Prentice Hall, Pearson Education, 2007.

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