Tárgytematika / Course Description

Mechanics for Engineers

GKNM_AMTA006

Tárgyfelelős neve / Teacher's name: dr. Antali Máté

Félév / Semester: 2023/24/2

Beszámolási forma / Assesment: Vizsga

Tárgy heti óraszáma / Teaching hours(week): 2/2/0

Tárgy féléves óraszáma / Teaching hours(sem.): 0/0/0

OKTATÁS CÉLJA / AIM OF THE COURSE

Introduction and generalization of the basic concepts and modeling questions of mechanics. Definition of force, moment and central line. Solving spatial static problems. Determination of internal forces of spatial beam structures and drawing of their internal force diagrams. Generalized state of strength of materials. Compound internal forces, sizing and verification of beams with spatial structures and loads. Determination of strain of beam structures. Writing the governing equations of elasticity. Description of motion of material points and rigid bodies. The basic laws of dynamics: linear and angular momentum theorems, energy theorem, theorem of mechanical work and their applications. Dynamic problems of compound structures. Excentric collisions of bodies. Characteristics of uneven running of rotors and elimination of their uneven running.

TANTÁRGY TARTALMA / DESCRIPTION

Week 1: **Force systems** as bound vector systems. Moment of force systems on a point and axis. Moment vector field. Force couple. Equivalent and equilibrium force systems. Criteria of equilibrium and equivalence. Substitution of force systems, central line. Conditions of equivalence and equilibrium.

Week 2: Reduction of force systems, resultant vector couple. Classification of force systems. Substitution and balancing of spatial force systems. The basic theorem of statics. Method of determination of the support force system of spatial beam structures.

Week 3: Methods of definition and determination of **internal forces**: reduction, balancing. Determination of internal forces of beam structures and supports with spatial structure and load. Equilibrium equations of beams: determination of internal force functions.

Week 4: Internal force diagrams of straight and curved lined supports and broken lined supports with planar and spatial loads. Drawing a bending moment diagram by integrating the shearing force diagram. Drawing internal force diagrams for straight and broken lined supports with spatial load.

Week 5: **Basic concepts of strength of materials.**State of strength of materials of elemental environment and a solid body.State of displacement, state of specific relative displacement, gradient tensor, state of strain, deformation tensor, rotation tensor, principal axes of strain, principal elongations. Internal force system, state of stress. Components and coordinates of the sterss vector..Determination and illustration of the stress coordinates. Definition and determination of principal stresses, and principal axes of stress.

Week 6: **Simple internal forces of beams.**Internal forces of axially loaded prismatic beams. Practical examples of axial loads. Torsion of a prismatic beam with circular and annular cross-sections. Pure bending of prismatic beams. Definition of straight and nonsymmetric bending. Curvature of the centerline, zero line.

Week 7: **Compound internal forces of beams.** Axial load and bending, axial load and torsion, nonsymmetric bending, shearing and bending. Shearing and bending of thin beams. Shearing center. Grashof's bending theory of curved planar beams. Strength sizing and verification of rod structures for stress peak and load capacity.

Week 8: **Work theorems of mechanics.** Mechanical work, strain energy. Castiglino's theorem and its application for the calculation of linear and angular displacements of statically determined support structures. Examples of calculation of linear and angular displacements of planar and spatial straight and curved beam structures.

Week 9: **Governing equations of elasticity.** Equilibrium equations and the symmetry of the stress tensor. Kinematic equations: the relationship between the displacement field and the strain field. Material equations: the relationship between strain and stress fields. Generalized Hooke's law for isotropic and orthotropic materials.

Week 10: **Kinematics of a point mass.** Determination of the characteristics of motion and relationships between them. Trajectory curve, hodograph, phoromomic curves. Properties of the velocity and acceleration function. Examples of describing the planar and spatial motion of a point mass. Kinematics of a rigid body. Determination of the states of displacement, velocity and acceleration; velocity diagram, acceleration diagram.

Week 11: Dynamics of point mass systems and rigid bodies. The linear momentum vector system, the inertia tensor of a rigid body. Principal axes of inertia, principal moments of inertia. Kinetic energy, power, mechanical work. **Basic laws of dynamics.** The linear and angular momentum theorems, the energy theorem and the mechanical work theorem.

Week 12: D'Alembert principle, definition of inertial force. Dynamics of the constrained motion of a point mass along straight and curved lines. Dynamics of constrained motion of a rigid body along a straight line. Translational and rolling motion of a rigid body and its rotational motion around a stationary axis.

Week 13: Determination of the acceleration and support force system of **compound one-degree-of-freedom structures**. Friction at rest and in motion, rope friction, pin friction.

Week 14: Rotational motion around a stationary axis, stability of the rotational motion, uneven movement of rotors, application of flywheel. Centric and eccentric collision of bodies.

SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESMENT'S METHOD

There will be two written midterm tests and one final written exam. The two midterm tests and the final exam will contain 80% calculating tasks and 20% theoretical tasks. The two midterm tests will take 50-50 minutes and in each midterm test students can score 20-20 points which will count into the final exam score. Students have to score at least 6 points out of 40 in the two midterm tests, otherwise you will not get the instructor's signature for the subject. If you did not score min. 6 points, you can complete it in the retake test last week of the semester. If students can not attend a midterm test due to a medical condition, certified by a doctor students can complete that test in the retake test but you must notify the instructor in advance. In the retake test you can gain the instructor's signature if you score at least 6 point from 20. Points obtained in the retake test will not be added to the sum of the points obtained from the two midterm tests or to the points of the final exam, they will be used only for the purpose of getting instructor's signature. If students did not score at least 6 point in the two midterm tests either in the retake test you will not get the instructor's signature and you are not allowed to participate in the final exam. The final exam will take 100 minutes and you can score max. 80 points. Student who perfoms well in the two midterm tests, this means who score min. 30 points from 40, could get a proposed final mark. This means if you score min. 30 point in the midterm tests you will not have to take the final exam.

Grading policy in the case of the proposed mark:

30 - 35	good (4)
36 - 40	excellent (5)

In exams students are not allowed to use smartphones, notes, books, smartwatches. Students must complete the exams on their own. In each exam studets have to identify themselfves with identity card or driving licence.

Grading Policy in the case of the final exam:

Score	Mark
under 48	fail (1)
48 - 61	pass (2)
62 - 75	satisfactory (3)
76 - 90	good (4)
91 - 120	excellent (5)

KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL

AJÁNLOTT IRODALOM / RECOMMENDED MATERIAL

Gross-Hauger's book series

• Gross, D. et. al.: Engineering Mechanics 1 – Statics, 2nd edition, Springer, 2013
• Gross, D. et. al.: Engineering Mechanics 2 – Mechanics of Materials, Springer, 2011
• Gross, D. et. al.: Engineering Mechanics 3 – Dynamics, 2nd edition, Springer, 2011

Hibbeler's book series

• Hibbeler, R. C.: Statics, 14th edition, Pearson, 2016
• Hibbeler, R. C.: Mechanics of Materials, 9th edition, Pearson, 2014
• Hibbeler, R. C.: Dynamics, 14th edition, Pearson, 2015