COURSE SYLLABUS AND COURSE REQUIREMENTS
ACADEMIC YEAR 2022/2023 SEMESTER 1

Course title	*Biomechanics*
Course Code	*MSM606ANEG*
Hours/Week: le/pr/lab	2/2/0
Credits	4
Degree Programme	Biomedical Engineering MSc
Study Mode	Full time
Requirements	Exam
Teaching Period	Autumn
Prerequisites	None
Department(s)	Department of Mechanical Engineering
Course Director	David Csonka
Teaching Staff	David Csonka

COURSE DESCRIPTION

Basic knowledge necessary for performing calculations in the field of statics and stress analysis. Types of force systems, calculating resultant forces, equilibrium. Loads, load diagrams in beams. Cases of friction. Moment of inertia of planar shapes. Basics of stress analysis. Determination of stresses from fundamental and complex loads of bars. Basic knowledge about the biomechanics of the human musculoskeletal system.

SYLLABUS

1. GOALS AND OBJECTIVES

By the end of the course students will be able to:

- Analyze forces and find out the resultant forces in two dimensions.
- Differentiate between various types of supports and draw free-body-diagram.
- Compute the reaction force, internal forces and bending moment at a specific point on a simple structure.
- Draw bending moment and shear force diagram of simple structures.
- Strength check of beams and structures by calculating stresses.
- Apply problem solving strategies.

2. COURSE CONTENT

	TOPICS
LECTURE	1. *Essential basic terms and concepts.* 2. *Brief history of biomechanics.* 3. *Forces in line and plane, addition of force vectors in a Euclidean space, force vector components.* 4. *Force systems, resultant forces, equilibrium.* 5. *Introducing moment, parallel forces.* 6. *Breaking down forces into three components.* 7. *Equilization with multiple forces in a plane.* 8. *General force systems, finding resultant force and moment.* 9. *Types of constraints, degrees of freedom.* 10. *Introducing internal forces and load diagrams.* 11. *Load and moment diagrams on cantilever and two-post supported beams.* 12. *Friction.* 13. *Rope and belt friction.* 14. *Rolling resistance.* 15. *Cross - sectional characteristics of supporting structures.* 16. *Center of gravity concept.* 17. *Center of gravity of lines and planes.*

18. *Moment of inertia.*
19. *Centroid of body parts.*
20. *The concept and representation of tension.*
21. *Uniaxial stress and deformation state (Hooke's law).*
22. *Central tension and pressure.*
23. *Pure shear.*
24. *Pure twist.*
25. *Pure straight bending.*
26. *Unidirectional complex loads.*
27. *Inclined bending.*
28. *Simultaneous bending and shearing.*
29. *Eccentric tension.*
30. *Simultaneous bending and twisting.*
31. *Centrally pressed slender structures.*
32. *The differential equation of the axis of an elastic beam.*
33. *Euler's elastic buckling.*
34. *Tetmajer's plastic buckling.*
35. *Buckling of bones.*
36. *Mechanics of the musculoskeletal system.*
37. *Biomechanics and material properties of bones.*
38. *Responses of tissues to forces.*
39. *Viscoelasticity.*
40. *Biomechanics of the passive muscle-tendon unit (MTU).*
41. *Biomechanics of ligaments.*
42. *The biochemistry of muslces.*
43. *The mechanical characteristics of muscles.*
44. *Force-velocity-length-time relationships.*
45. *Biomechanics of walking.*
46. *Walking disorders.*
47. *Assistive devices.*

PRACTICE

1. *Addition of force vector components.*
2. *Finding out the resultant force in an intersecting force system.*
3. *Calculating moments.*
4. *Equilization problems.*
5. *Complex force system problems.*
6. *Calculating reaction forces and moments with various supports.*
7. *Calculating reaction forces and moments on simple beams and drawing load diagrams.*
8. *Balancing problems with various forms of friction.*
9. *Center of gravity of planar shapes.*
10. *Determination of inertia of planar shapes for centers of gravity.*
11. *Introducing stress calculation.*
12. *Checking the strength of the beam for central tension and pressure*
13. *Calculating stresses from load diagrams, pure shear, twist and bending.*
14. *Stress check problems for unidirectional complex loads.*
15. *Shear coupled with bending.*
16. *Sizing of bent and sheared supports.*
17. *Check for buckling.*

DETAILED SYLLABUS AND COURSE SCHEDULE

LECTURE

week	**Topic**	**Compulsory reading;**	**Required tasks**	**Completion date, due date**
1.	Essential basic terms and concepts. Brief history of biomechanics. Forces in line and plane, addition of force vectors in a Euclidean space, force vector components. Force systems, resultant forces, equilibrium.	Vector Chapters 1.2; 2.1; 2.2 and 2.3		
2.	Introducing moment, parallel forces. Breaking down forces into three components. Equilization with multiple forces in a plane. General force systems, finding resultant force and moment. Types of constraints, degrees of freedom.	Vector Chapter 3, 4		
3.	Introducing internal forces and load diagrams. Load and moment diagrams on cantilever and two-post supported beams.	Vector Chapters 7.1 and 7.2		
4.	Friction. Rope and belt friction. Rolling resistance.			
5.	Planar frames. Articulated structures.	Vector Chapter 8		
6.	Cross - sectional characteristics of supporting structures. Center of gravity concept. Center of gravity of lines and planes. Moment of inertia. Centroid of body parts.	Vector Chapters 5.1, 9.1, 9.2 and 9.3		
7.	The concept and representation of tension. Uniaxial stress and deformation state (Hooke's law). Central tension and pressure. Pure shear. Pure twist. Pure straight bending.	Materials Chapters 1.3 to 1.8, 1.11, 2.2, 2.5, 3, 4, 6,		
8.	Unidirectional complex loads. Inclined bending. Simultaneous bending and shearing. Eccentric tension. Simultaneous bending and twisting.	Materials Chapters 1.3 to 1.8, 1.11, 2.2, 2.5, 3, 4, 6,		
9.	AUTUMN BREAK AT MIK			
10.	Centrally pressed slender structures. The differential equation of the axis of an elastic beam. Euler's elastic buckling. Tetmajer’s plastic buckling. Buckling of bones.	Materials Chapters 9, 10		
11.	Mechanics of the musculoskeletal system. Biomechanics and material properties of bones.			
12.	Responses of tissues to forces. Viscoelasticity. Biomechanics of the passive muscle-tendon unit (MTU). Biomechanics of ligaments.			
13.	The biochemistry of muscles. The mechanical characteristics of muscles. Force-velocity-length-time relationships.			
14.	Biomechanics of walking. Walking disorders. Assistive devices.			
15.				

PRACTICE, LABORATORY PRACTICE

week	**Topic**	**Compulsory literature**	**Required tasks**	**Completion date, due date**
1.	Addition of force vector components. Finding out the resultant force in an intersecting force system.	Vector Chapters 1.2; 2.1; 2.2 and 2.3		
2.	Calculating moments. Equilization problems Complex force system problems. Calculating reaction forces and moments with various supports.	Vector Chapter 3, 4		
3.	Calculating reaction forces and moments on simple beams and drawing load diagrams	Vector Chapters 7.1 and 7.2		
4.			1st assignment	
5.	Balancing problems with various forms of friction.	Vector Chapter 8		
6.	Center of gravity of planar shapes. Determination of inertia of planar shapes for centers of gravity.	Vector Chapters 5.1, 9.1, 9.2 and 9.3		
7.	Introducing stress calculation. checking the strength of the beam for central tension and pressure	Materials Chapters 1.3 to 1.8, 1.11, 2.2, 2.5, 3, 4, 6,		
8.	Calculating stresses from load diagrams, pure shear, twist and bending.			
9.	AUTUMN BREAK AT MIK			
10.	Stress check problems for unidirectional complex loads. Shear coupled with bending. Sizing of bent and sheared supports.	Materials Chapters 1.3 to 1.8, 1.11, 2.2, 2.5, 3, 4, 6,		
11.			2nd assignment	
12.	Check for buckling.	Materials Chapters 9, 10		
13.			Correcting 1st assignment	
14.			Correcting 2nd assignment	
15.				

3. ASSESSMENT AND EVALUATION

ATTENDANCE

In accordance with the Code of Studies and Examinations of the University of Pécs, Article 45 (2) and Annex 9. (Article 3) a student may be refused a grade or qualification in the given full-time course if the number of class absences exceeds 30% of the contact hours stipulated in the course description.

Method for monitoring attendance *(e.g.: attendance sheet / online test/ register, etc.)*

Randomized attendance checks.

ASSESSMENT

Course-unit with final exam

Mid-term assessments, performance evaluation and their weighting as a pre-requisite for taking the final exam

Type	**Assessment**	***Weighting as a proportion of the pre-requisite for taking the exam***
1. *Assignment 1*	*max 10 points*	*25 %*
2. *Assignment 2*	*max 10 points*	*25 %*

Requirements for the end-of-semester signature

Midterm assessment of 40%

Re-takes for the end-of-semester signature (PTE TVSz 50§(2))

The assignments can be repeated once in case of failure, absence or to get better results. In case of a failed assignment or absence, the correction is obligatory.

Type of exam: *written*

The exam is successful if the result is minimum 40%.

Calculation of the grade *(TVSz 47§ (3))*

The mid-term performance accounts for ***50***%, the performance at the exam accounts for ***50***% in the calculation of the final grade.

Calculation of the final grade based on aggregate performance in percentage.

Course grade	Performance in %	Performance in points
excellent (5)	85 % …	34 … 40
good (4)	70 % ... 85 %	28 … 33
satisfactory (3)	55 % ... 70 %	22 … 27
pass (2)	40 % ... 55 %	16 … 21
fail (1)	below 40 %	0 … 15

The lower limit given at each grade belongs to that grade.

4. SPECIFIED LITERATURE

COMPULSORY READING AND AVAILABILITY

1. F. P. Beer, E. R. Johnston, D. F. Mazurek, P. J. Cornwell, B. P. Self: **Vector Mechanics for Engineers: Statics and Dynamics, 12th edition**; Published by McGraw-Hill Education, 2019. ISBN 978-1-259-63809-1
2. F. P. Beer, E. R. Johnston, J.T. Dewolf: **Mechanics of Materials 4th edition**; Published by McGraw-Hill Education 2006. ISBN 007-124999-0

RECOMMENDED LITERATURE AND AVAILABILITY

1. A. Bedford, W. Fowler: **Engineering Mechanics –Statics 5th edition**; Published by Pearson Education Inc. 2008. ISBN 0-13-612915-3
2. J. L. Merian, L. G. Kraige: **Engineering Mechanics –Statics 7th edition**; Published by John Wiley & Sons Inc. 2006. ISBN: 978-0-470-61473-0

Comment:
Other edition of the abovementioned books might be usable as well, but please consult about the appropriate chapters.