

**I. Tantárgyleírás****1. Alapadatok***1.1 Tantárgy neve***DYNAMICS OF STRUCTURES***1.2 Azonosító (tantárgykód)***BMEEOTMMSFST02-00***1.3 Tantárgy jellege*

Kontaktórás tanegység

*1.4 Óraszámok*

| Típus             | Óraszám / (nap) |
|-------------------|-----------------|
| Előadás (elmélet) | 2               |
| Gyakorlat         | 1               |

*1.5 Tanulmányi teljesítményértékelés (minőségi értékelés) típusa*

Félévközi érdemjegy

*1.6 Kreditszám*

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*1.7 Tárgyfelelős*

|          |                                                                        |
|----------|------------------------------------------------------------------------|
| név      | Dr. Németh Róbert                                                      |
| beosztás | Egyetemi docens                                                        |
| email    | <a href="mailto:nemeth.robert@emk.bme.hu">nemeth.robert@emk.bme.hu</a> |

*1.8 Tantárgyat gondozó oktatási szervezeti egység*

Tartószerkezetek Mechanikája Tanszék

*1.9 A tantárgy weblapja*[epito.bme.hu](http://epito.bme.hu)<https://edu.epito.bme.hu/course/view.php?id=5118>*1.10 Az oktatás nyelve*

magyar

*1.11 Tantárgy típusa*

Kötelezően választható a Szerkezet-építőmérnök (MSc) szak Tartószerkezetek specializációján

*1.12 Előkövetelmények**1.13 Tantárgyleírás érvényessége*

2025. szeptember 1.

## **2. Célkitűzések és tanulási eredmények**

### *2.1 Célkitűzések*

The purpose of the course is that students become familiar with the dynamic tasks occurring in the structural engineering practice, and the mechanical-mathematical background of their solution methods. There will be emphasized: the differential equations used to describe the continuum of mechanical vibration and their analytical and numerical solution methods, free vibration of multiple degrees of freedom systems and its approximate solutions, computation methods of mass and stiffness matrix of the (finite element method) discretized structures, taking into account the damping, dynamic issues supporting effect of the soil, the mechanical background of earthquake analysis of structures and the effect of wind. By completing the subject, this knowledge will enable the student to accomplish tasks related to civil engineering problems.

### *2.2 Tanulási eredmények*

A tantárgy sikeres teljesítése után a hallgató

#### A. Tudás

1. has a comprehensive knowledge of the partial differential equations of mechanical vibrations, and their solution methods, 2. knows the approximate solution methods of the generalized eigenvalue problem (Rayleigh-quotient, summation theorems), 3. aware of the methodology of the calculation of static and dynamic stiffness matrices, and the meaning of their entries, 4. understands the modeling of boundary conditions in the stiffness matrix both on element and structural level, 5. confidently knows the calculation of the damping matrix in case of proportional damping, 6. knows the method for the consideration of the supporting and damping effect of soils, 7. has a comprehensive overview of the analysis of support vibration, and the concepts used in a seismic analysis,

#### B. Képesség

1. writes the frequency matrix of the free vibration problem from the boundary conditions of a continuum, 2. calculates selected entries of stiffness matrices, 2. creates a suitable mechanical model for the dynamic analysis of structures, 4. compiles the stiffness and mass matrix of a structure, considers the boundary conditions in them, 5. executes the discretized dynamic analysis of a mechanical problem with a finite element software, 6. takes the damping effect of the structure and the soil into account while performing a dynamic analysis, 7. performs real modal analysis on an engineering structure, 8. keeps in mind the mechanical background while performing the seismic analysis of a typical engineering structure,

#### C. Attitűd

1. endeavors to discover and routinely use the tools necessary to the problem solving of structural mechanical problems, 2. endeavors to the precise and error-free problem solving, 3. aspires to prepare a well-organized documentation in writings,

#### D. Önellőség és felelősség

1. independently carries out the conceptual and numerical analysis of structural engineering problems, based on the literature.

### *2.3 Oktatási módszertan*

Lectures, exercises, oral and written communication, application of IT tools and technologies, optional individual assignment.

### *2.4 Részletes tárgyprogram*

1. Free and forced vibration of SDOF- and MDOF-systems 2. Free longitudinal and transversal vibration of bars 3. Forced vibration of continuum (harmonic forcing, moving loads) 4. Numerical solution of the equation of motion: modal analysis, direct integral 5. Approximate methods of the calculation of natural periods and modal shapes 6. Calculation of a dynamic stiffness matrix, mass matrices 7. Boundary conditions, real modal analysis 8. Damping in the FEM analysis of frame structures 9. Proportional damping, rate independent damping, complex stiffness 10. Dynamic stiffness and damping of soils 11. Analysis of structures for support vibration 12. Mechanical basis of earthquake analysis of structures 13. Special dynamic loads of structures 14. Summary  
A félév közbeni munkaszüneti napok miatt a program csak tájékoztató jellegű, a pontos időpontokat a tárgy honlapján elérhető "Részletes féléves ütemterv" tartalmazza.

### *2.5 Tanulástámogató anyagok*

Chopra, A.K.: Dynamics of Structures Theory and Applications to Earthquake Engineering Lecture notes:

Kocsis - Németh: Hidden Beauty of Structural Dynamics

### *2.6 Egyéb tudnivalók*

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Due to the strong connection between theory and practice, attendance at lectures and exercise classes is mandatory. Students attending tests/exams must not communicate with others without explicit permission during the test/exam, and must not have an electronic or non-electronic device capable of communication switched on.

### *2.7 Konzultációs lehetőségek*

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The instructors are available for consultation during their office hours, as advertised on the department website. Special appointments can be requested via e-mail.

*Jelen TAD az alábbi félévre érvényes:*

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## II. Tárgykövetelmények

### 3. A tanulmányi teljesítmény ellenőrzése és értékelése

#### 3.1 Általános szabályok

Evaluation of learning outcomes described in Section 2.2. is based on two mid-term written checks and three individual assignments. The duration of each mid-term test is 90 minutes. There is a 24 hours time span for the submission of each individual assignment, with an estimated workload of 60 min. There is no consultation on the topic of the HW between the issue and the due date. The dates of checks and the deadlines of homeworks can be found in the "Detailed semester schedule" on the website of the subject.

#### 3.2 Teljesítményértékelési módszerek

| Assessment Name (Type) | Code | Assessed Learning Outcomes          |
|------------------------|------|-------------------------------------|
|                        | ZH1  | A.1-A.4; B.1-B.5, B.7; C.1-C.3; D.1 |
|                        | ZH2  | A.1-A.7; B.1-B.8; C.1-C.3; D.1      |
|                        | IA1  | A.1-A.4; B.1-B.3; C.1-C.3; D.1      |
|                        | IA2  | A.1-A.7; B.1-B.8; C.1-C.3; D.1      |
|                        | IA3  | A.1-A.5; B.1-B.7; C.1-C.3; D.1      |

A szorgalmi időszakban tartott értékelések pontos idejét, a házi feladatok ki- és beadási határidejét a "Részletes féléves ütemterv" tartalmazza, mely elérhető a tárgy honlapján.

#### 3.3 Teljesítményértékelések részaránya a minősítésben

| Code  | Weight |
|-------|--------|
| ZH1   | 35%    |
| ZH2   | 35%    |
| IA1   | 10%    |
| IA2   | 10%    |
| IA3   | 10%    |
| Total | 100%   |

#### 3.4 Az aláírás megszerzésének feltétele, az aláírás érvényessége

There is no signature from the subject.

#### 3.5 Érdemjegy megállapítása

| Grade            | Score (P)          |
|------------------|--------------------|
| excellent (5)    | $85 \leq P$        |
| good (4)         | $75 \leq P < 85\%$ |
| satisfactory (3) | $65 \leq P < 75\%$ |
| pass (2)         | $50 \leq P < 65\%$ |
| fail (1)         | $P < 50\%$         |

#### 3.6 Javítás és pótlás

There is no delayed submission of the individual assignments. The mid-semester checks can be retaken at the date announced at the beginning of the semester in one single summarizing retake (from the topics of the whole semester). The result of the retake overwrites the earlier result of both mid-term checks. There is no second retake in the subject.

#### 3.7 A tantárgy elvégzéséhez szükséges tanulmányi munka

| Activity                                    | Hours/Semester     |
|---------------------------------------------|--------------------|
| contact lesson                              | $14 \times 3 = 42$ |
| preparation for lessons during the semester | $14 \times 2 = 28$ |
| preparation for the checks                  | $5 \times 6 = 30$  |
| preparation of homework                     | 42                 |
| individual study of the prescribed material | 8                  |
|                                             |                    |

*3.8 A tárgykövetelmények érvényessége*

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2025. szeptember 1.

*Jelen TAD az alábbi félévre érvényes:*

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