Mechanical Vibrations

1. **Course number and name:** 020VMEES2 Mechanical Vibrations

2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours per week

3. **Name(s) of instructor(s) or course coordinator(s):** Ali AL Shaer

4. **Instructional Materials:** PowerPoint slides

   Textbooks/References:
   - Engineering Vibrations, D.J. Inman, 4th Edition, Pearson**.** ISBN: 0-13-136311-5.
   - Mechanical Vibrations, S. RAO, 4th Edition, Prentice Hall. ISBN: 0-13-120768-7.

5. **Specific course information**
   a. **Catalog description:**
   This course deals with the vibrations of one-dimensional systems (1 Degree of Freedom), undamped free oscillations, undamped forced oscillations, free damped oscillations, forced damped oscillations, stability, resonance, and systems with multiple degrees of freedom including mechanical engineering applications and examples. It allows students to learn how to model a system and carry out the analysis of its vibrational behavior. Linear systems with several degrees of freedom are solved with the mode superposition method and with the modal analysis method. An introduction to non-linear systems, resolution by the iterative method, and vibration suppression is also presented.

   b. **Prerequisite:** Mechanics 2 (020MC2CI3 or 020MC2NI3).

   c. **Required** for ME students.

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   A student who successfully fulfills the course requirements will have demonstrated an ability to:
   - Discuss and analyze the importance of the subject of vibration starting from basic concepts and classification of vibration.
   - Develop the concept of free vibration and analyze single degree of freedom for translation and rotational systems and derive their equations of motions using Newton's second law.
   - Differentiate the response of undamped and damped systems that are being excited with harmonic and arbitrary inputs.
   - Outline the equations of motions of two degree of freedom systems subjected to forced vibration and investigate its response subjected to undamped free vibration.

- Model continuous systems as multi-degree of freedom systems and rewrite the equations of motions using Newton's second law and Lagrange formulation.
- Use of eigenvalue concept to solve vibration problems that have coupled coordinates.
- Introduce the concept of modal analysis in vibration.

b. PI addressed by the course:

PI	1.1	1.2	1.3	6.4
Covered	x	x	x	x
Assessed	x	x	x	x

7. Brief list of topics to be covered

- **General Introduction:** Introducing vibrations and overall description. (1 Lecture).
- **Chapter 1: Introduction to Vibration and the Free Response**: Introduction to free vibration – Harmonic motion – Viscous damping – Modeling and energy method - Stiffness – Measurement – Design considerations – Stability. (7 Lectures).
- **Chapter 2: Response to Harmonic Excitation:** Harmonic Excitation of undamped system – Harmonic excitation of damped system – Base excitation – Rotating unbalance – Measurement devices. (6 Lectures).
- **Chapter 3: General Forced Response:** Impulse response function – Response to an arbitrary input – Response to an arbitrary periodic input – Transform methods – Response to random inputs. (4 Lectures).
- **Chapter 4: Multiple-Degree-of-Freedom Systems:** Two-degree-of-freedom model (undamped) – Eigenvalues and natural frequencies – Modal analysis – More than two degrees of freedom – Systems with viscous damping – Modal analysis of the forced response – Lagrange's equations – Iterative methods – Introduction to nonlinear systems – Examples. (8 Lectures).
- **Chapter 5: Design for Vibration Suppression:** Acceptable levels of vibration – Vibration isolations – Vibration absorbers. (2 Lectures).