NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF MECHANICAL ENGINEERING
NAVAL ENGINEERING PROGRAM

MC571 – MECHANICAL VIBRATIONS

I. GENERAL INFORMATION

CODE	**:**	MC571 Mechanical Vibrations
SEMESTER	**:**	7
CREDITS	**:**	3
HOURS PER WEEK	**:**	4 (Theory–Practice)
PREREQUISITES	**:**	MB536 Numerical Methods MV477 Naval Structures II
CONDITION	**:**	Compulsory
DEPARTMENT	**:**	Mechatronics Engineering

II. COURSE DESCRIPTION

The course prepares students for the analysis of the response of vibration systems subject to different types of inputs. One-degree and two-degrees of freedom systems are analyzed in the time and frequency domains, and with different damping characteristics. Students apply the methods for designing and optimizing vibration isolation systems.

III. COURSE OUTCOMES

At the end of the course, students:

1. Model, calculate and interpret the response of vibrating systems of one and multiple degrees of freedom.
2. Analyze the behavior of diverse mechanical structures subject to diverse loads such as harmonic, impulsive, constant and step forces.
3. Understand the role of damping in mechanical vibrating systems.
4. Design systems that minimize the transmission of vibration.

IV. LEARNING UNITS

1. FREE, DAMPED AND WITH HARMONIC EXCITATION VIBRATION SYSTEMS

Free vibration: introduction to mechanical vibrations / Mass-spring model / Drive-shaft model. / Simple pendulum model / Harmonic motion: viscous damping / Sub-damped motion / Over-damped motion / Critically damped motion / Vibrations with harmonic excitation: Non-damped systems. Damped systems / Base excitation: alternative representations.

2. TOTAL FORCED RESPONSE

Impulse response function / Response to an arbitrary input force / Response to an arbitrary periodic force / Transformation methods.

3. MULTIPLE DEGREES OF FREEDOM SYSTEMS

Systems with multiple degrees of freedom: two degrees of freedom models / Eigenvalues and natural frequencies / Modal analysis / Multiple degrees of freedom / Systems with viscous damping / Modal damping / Proportional damping / Modal analysis of the forced response.

4. DESIGN FOR SUPRESSION OF VIBRATIONS

Acceptable levels of vibration / Vibration isolation / Vibration absorbers / Shock absorbers / Damping in vibration absorption / Optimized design for vibration isolation / Fundamentals of predictive maintenance using vibration analysis.

V. PRACTICAL EXPERIENCE

Practice 1: Free and harmonically excited vibration.
Practice 2: Forced response and multiple degrees of freedom systems.
Practice 3: Basic design for suppression of vibrations.
Practice 4: Optimal design for suppression of vibrations and predictive maintenance.

VI. METHODOLOGY

The course takes place in theory and practice sessions. In theory sessions faculty presents the theory, concepts and methods. In practice sessions, students apply theory to analyze the response of vibration systems subject to different excitation inputs, as well as for designing vibration suppression systems for particular applications. At the end of the course, students submit and defend a final report. Student active participation is promoted throughout the course.

VII. GRADING FORMULA

The Final Grade PF is calculated as follow:

PF = (EP + 2*EF + PP) / 4

EP: Mid-term Exam EF: Final Exam
PP: Average of Practice Work

VIII. BIBLIOGRAPHY

1. DANIEL J. INMAN.
   Engineering Vibration, Prentice Hall, 2006.
2. ROIG CRAIG.
   Structural Dynamics: An Introduction to Computer Methods, John Wiley and Sons, 2001.
3. GIANCARLO GENTA.
   Vibration and Control, Springer, 2009.