MEC 402

Mechanical Vibrations

Fall 2019

Instructor: Prof. Seung-Bok Choi (Inha University), Email seungbok@inha.ac.kr

Lectures: Friday, 09:00 – 11:50

Office Hours: TBA

Course Description:

Modeling, analysis and design for mechanical vibration. Fundamentals of free vibration, harmonically excited vibration, and vibration under general forcing conditions; one degree, two degree and multi-degree of freedom systems; continuous systems; vibration design strategies including isolation and absorbers. Prerequisites: MEC 262 (Engineering Dynamics) and MEC 363 (Mechanics of Solids)

Textbook: D.J. Inman, *Engineering Vibrations*, 4th edition, Pearson International edition, 2014

Grading Distribution:

Homework	15%
Exams	20%(midterm)+40%(final)
Lab Project	15%
Attendance	10%

Grading Scale:

The grading distribution will be converted to the point with the given weight percentage, and the total point (sum of each point) is to be normalized to 100. Then, the final grade will be given based the following point range.

A: 95-100, A-: 90-95

B+: 85-90, B: 80-85, B-: 75-80

C+: 70-75, C: 65-70, C-: 60-65

D+: 55-60, D: 50-55

F: below 50

Topics:

1) Fundamentals of vibration; modeling of vibration systems
2) Free vibration of single degree of freedom systems; time responses; vibration damping
3) Harmonically excited vibration; frequency response
4) Vibration under general conditions; Convolution methods
5) Two degree of freedom systems; multi-degree of freedom system; vibration mode shapes and orthogonality; coordinate coupling and principal coordinates; solution for free or forced vibration
6) Vibration control; design of vibration isolator and absorbers: passive control
7) Vibration of continuous systems: natural frequency, mode shape, vibration control
8) **Lab Experiments:**
   (1) Measurement of natural frequency and mode shape of beam structures
   (2) Measurement of damping ration from transient response and frequency response
   (3) Passive vibration control of a beam using damping core material
   (4) Active vibration control of a beam using piezoelectric actuator and sensor (optional)

Lab Reports Format:

1) **Title Page**: Course No., Experiment Title, Student Name and ID, Submitted Date
2) **Abstract**: A single short paragraph which represents the entire experiment including purpose of experiment, the variables to be measured, measurement basic concepts.
3) **Experimental Apparatus and Procedure**: Explain about the detailed specifications of experimental equipment, and Detailed description of the steps performed during your experiment to obtain the required data.
4) **Results and Discussion**: Including calculation of experimental results, figures, tables. Discussing the trends in the results, comparison with theoretical predictions, etc.
5) **Conclusion**
6) **References**

Course Learning Objectives:

1) Students can identify the frequency, period, and amplitude of an oscillatory signal.
2) Students can express a periodic function in terms of a Fourier series.
3) Students can identify the mass, stiffness, and damping elements of a vibration system.
4) Students can model a vibration system by incorporating the elements of a vibrations system into a free-body diagram.
5) Students can apply Newton's second law to obtain the differential equations of motion for mass particle and rigid bodies.

6) Students can compute and interpret the natural frequency and damping ratio.

7) Students can determine the free responses of single-degree-of-freedom systems due to initial conditions for damped and undamped systems.

8) Students can determine the forced responses of single-degree-of-freedom systems under direct excitation, base excitation, and rotating imbalance.

9) Students can determine the free and forced response of two-degrees-of-freedom systems.

10) Students can compute mode shapes and natural frequencies for systems with two degrees of freedom

11) Students can decouple a coupled two-degree-of-freedom systems by using properties of linear normal modes.

12) Students can design vibration absorbers (torsional and translational).

13) Students can design for vibration isolation and vibration control via passive and semi-active methods.

14) Students can understand the principle of accelerometers, seismometers and other vibration.

Week Schedule:

Week No.	Lecture Day	Lecture Method	Lecture Subject
1	8. 28	Classroom	Introduction of Mechanical Vibration
2	9. 4	Classroom	Free Vibration: SDF
3	9. 11	Online	Free Vibration: MDF
4	9. 18	Online	Vibration Parameters
5	9. 25	Classroom	Measurement of Natural Frequency and Damping Ratio **(Lab Experiment I)**
6	10. 2	No Class	Korean Thanksgiving Day
7	10. 9	Classroom	Response to Harmonic Excitation: Undamped System
8	10. 16	Classroom	Response to Harmonic Excitation: Damped System
9	10. 23	Online	Base Excitation Problem **(Midterm Examination)**
10	10. 30	Online	Types of Damping
11	11. 6	Classroom	Measurement of Modal Parameters from Forced Vibration Responses **(Lab Experiment II)**
12	11. 13	Classroom	Response to Arbitrary Input
13	11. 20	Online	Multi-degree of System Analysis
14	11. 27	Online	Continuous System Analysis (Beam Vibration)
15	12. 4	Classroom	Test for Passive/Semi-Active Vibration Control **(Lab Experiment III)**
16	12. 11	Classroom	**Final Examination**

Academic Integrity Statement:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website: http://www.stonybrook.edu/commcms/academic integrity/index.html

Critical Incident Management Statement:

The State University of New York, Korea expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn.

Attendance Policy of SUNY Korea:

1. All students of SUNY Korea are required to attend every class.
2. Unexcused absences will affect seriously the student's final grade in the course.
3. If a student has over 20% unexcused absence, the student's final course grade will be an 'F'.

Example)

- If the class is a 150-minute class, and is held once a week, the 4th unexcused absence of a student will lead to an F grade of the course.
- If the class is a 75-minute class, and is held twice a week, the 7th unexcused absence of a student will lead to an F grade of the course.
- If the class is a 50-minute class, and is held three times a week, the 10th unexcused absence of a student will lead to an F grade of the course.
- In Intensive English Course (IEC), if a student misses the class more than 40 hours in a semester, the student will receive an F grade on the course.

4. Students should report the reason of absence to the instructor in advance, or immediately after the absence.
5. When a student excuses his/her absence, the student must provide documentation of the reason for the absence to the instructor.
6. The instructor of the course reserves the right to excuse absences.
7. The course instructor may excuse the absence if the submitted documentation fulfills the conditions below.
   - Extreme emergencies (e.g. death in the family)
   - Severe medical reasons with doctor's note (Not a slight illness)
   - Very important events (e.g. national conference, official school event)
8. At the end of semester, the course instructor should submit a copy of the attendance sheet to the Academic Affairs Office.