1. *Course number and name*
   ENGR 461: Mechanical and Structural Vibration

2. *Credits and contact hours*
   3 credit hours; two 75-minute lecture sessions/week

3. *Instructor's or course coordinator's name*
   Instructor: Cheng Chen, Associate Professor of Civil Engineering

   Course coordinator: Cheng Chen, Associate Professor of Civil Engineering

4. *Text book, title, author, and year*
   Rao, S. S. *Mechanical Vibrations.* 6th edition, Pearson Prentice Hall, 2016.

   a. *other supplemental materials*

   - A. K. Chopra. *Dynamics of Structures: theory and applications to earthquake engineering.* 4th ed. Prentice Hall, 2011.
   - W. T. Thomson and M. D. Dahleh. *Theory of Vibration with Applications.* 5th ed. Prentice Hall, 1998.
   - R. F. Steidel, Jr. *An Introduction to Mechanical Vibrations.* 3rd ed. John Wiley & Sons, 1989.
   - A. K. Chopra. *Dynamics of Structures: a primer*. Earthquake Engineering Research Institute, 1980.

5. *Specific course information*
   a. *brief description of the content of the course (catalog description)*
   Dynamic excitation and response of mechanical and structural systems; time domain analysis; D' Alembert's principle; modal analysis; vibration damping; resonance and tuned mass damper.

   b. *prerequisites or co-requisites*
   ENGR 201, ENGR 309 and MATH 245.

   c. *indicate whether a required, elective, or selected elective course in the program*
   Selected elective for Civil and Mechanical Engineering.

6. *Specific goals for the course*
   a. *specific outcomes of instruction.*
   - Student understands basic concepts of mass, stiffness, and damping for a SDOF system.
   - Student is able to determine the mass and stiffness for a SDOF system using dynamic equilibrium.
   - Student is able to obtain system damping using log decrement from free vibration test.
   - Student is able to generate the free vibration response to an impact load.

- Student is able to generate the steady-state response due to a harmonic load or ground motion.
- Student can determine the transient vibration to shock loads and earthquake motion.
- Student can determine maximum response using response spectra.
- Student can use dynamic equilibrium to create the differential equation of motion for a MDOF system, thus determining mass and stiffness matrices.
- Student can obtain stiffness and flexibility matrices using influence coefficients.
- Student can obtain modal frequencies and mode shapes.
- Student can obtain steady-state solutions for harmonic loads using modal analysis.
- Student can obtain transient solutions and maximum responses for non-harmonic loads using modal analysis.
- Student understands the concept of using a vibration absorber to eliminate excessive vibrations when SDOF systems are subjected to input frequencies at or near resonant frequency.
- Student can select the stiffness and mass for a vibration absorber.

b. *Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.*
   Course addresses ABET Student Outcome(s): a, c, e, i.

7. *Brief list of topics to be covered*
- Introduction to vibration
- Derivation of equation of motion
- Free body diagram
- D' Alembert's Principle
- Natural frequency and damping ratio
- Free vibration of undamped single-degree-of-freedom system
- Free vibration of damped single-degree-of-freedom system
- Forced vibration of undamped single-degree-of-freedom system
- Forced vibration of damped single-degree-of-freedom system
- Resonance
- Half-power rule
- Transient and steady-state response
- Equation of motions for multiple-degree-of-freedom system
- Vibration modes
- Vibration control through tuned mass damper