1. **Catalog Description:**
Single-degree-of-freedom systems. Multiple-degree-of freedom systems. Applications to mechanical and aerospace structures and systems.

2. **Pre-requisites:**
EGM 3400 or EGM 3401, CGS 2425, EGM 3520 and EGM 4313

3. **Course Objectives:**
This course stresses fundamental engineering science and mathematical principles required for understanding of vibrations. Students will (a) learn the concepts needed for understanding and analysis of the dynamic behavior of vibrating systems, and (b) will develop skills for designing vibrating systems with desired properties that enhance vibration when it is wanted and reduce vibration when it is unwanted. Upon completion of this course, students will be able to

1) Generate simplified mechanics models for vibrating systems
2) Derive the equations of motion of single- and multiple-degree-of-freedom systems using mechanics principles
3) Solve the equations using mathematical methods of ordinary differential equations and linear algebra
4) Analysis of the mathematical solutions to find natural frequencies of the systems and to predict the dynamic response of the systems to external stimuli or excitations
5) Design mechanical systems with prescribed vibratory performance.

4. **Contribution of course to meeting the professional component:**
EML 4220 supports program outcomes enumerated in the Mission Statement of the Department of Mechanical and Aerospace Engineering. The specific ME program outcome supported by this course includes: (1) Using knowledge of advanced mathematics through multivariate calculus and differential equations (**ME Program Outcome M2**); and (2) Being able to work professionally in both thermal and mechanical systems areas including the design and realization of such systems. (**ME Program Outcome M4**)

The course content may be categorized as follows:
Mathematics 30%, Physical sciences 20%, Engineering sciences 40%, Engineering design 10%

5. **Relationship of course to program outcomes:**
This course supports the mission of the undergraduate Mechanical and Aerospace Engineering program at the University of Florida with respect to following ABET outcomes:

(a) Apply knowledge of mathematics, science, and engineeringA1,A2,M1,M2 [medium coverage, 30%; method of assessment is homework assignments and 3 exams]
(b) Design a system, component, or process to meet desired needsM4 [low coverage, 10%; method of assessment is homework assignments and 3 exams]
(c) Identify, formulate, and solve engineering problemsM4 [medium coverage, 30%; method of assessment is homework assignments and 3 exams]

Program specific outcomes for Aerospace (A) and Mechanical (M) engineering:
A1, M1 Apply knowledge of chemistry and calculus based physics with depth in at least one of them
A2, M2 Apply knowledge of advanced mathematics through multivariate calculus and differential equations
M4 Possess ability to work professionally in both thermal and mechanical systems areas, including the design and realization of such systems.
6. Instructor:
   Youping Chen
   Department of Mechanical and Aerospace Engineering
   MAE-B228
   Tel (352) 392-8494/Fax (352) 392-1071
   Email: ypchen2@ufl.edu
   Office Hours: Tuesday and Thursday 4:00 – 6:00 PM or by appointment

Teaching Assistants:
   Liming Xiong
   Email: limxiong@ufl.edu
   Office hours: MAE-B223 Monday 2:00-5:00PM
   Shengfeng Yang
   Email: saint628@ufl.edu
   Office hours: MAE-B223 Friday 2:00-5:00PM

7. Meeting Times and Location: MWF 3\textsuperscript{rd} period (9:35-10:30am).  Weil 270

8. Material and Supply Fees: None


10. Recommended Reading: None

11. Course Outline:

   (1). Fundamentals of Vibration
      a. Free and forced vibration, undamped and damped vibration
      b. Linear and nonlinear vibration, deterministic and random vibration
      c. Vibration analysis procedure
      d. Newton’s Laws
      e. Moment of a force and angular momentum
      f. Work and energy
      g. Stiffness
      h. Stability
      i. Modeling of mechanical systems

   (2). Free Vibration of Single-Degree-of-Freedom (SDOF) Systems
      a. Free vibration of undamped systems
      b. Stability conditions
      c. Free vibration with viscous damping

   (3). Response to Harmonically Excitation
      a. Harmonic excitation to undamped systems
      b. Harmonic excitation to damped systems
      c. Base motion
      d. Rotating unbalance
      e. Measurement devices

   (4). General Forced Response
      a. The unit impulse and impulse response
      b. The unit step function and step response
c. Response to arbitrary excitations and the convolution integral  
d. Shock spectrum  
e. Laplace transformation method  
f. General system response  

(5). Multiple-Degree-of-Freedom (MDOF) Systems  
a. The equations of motion  
b. Free vibrations  
c. Modal analysis  
d. Response to initial excitations by modal analysis  
e. Response to harmonic external excitations  
f. Response to external excitations by modal analysis  

(6). Design for Vibration Suppression  
a. Acceptable levels of vibration  
b. Vibration isolation  
c. Vibration absorbers  
d. Damping in vibration absorption  

12. Attendance and Expectations: Attendance is mandatory. Excused absences will be given for documented medical reasons, UF related travel or job interview travel. Documentation must be in the form of a doctor’s note, or letter from the sponsor of the travel. During class, cell phones must be turned off.  

13. Assessment Methods and Grading:  
There will be 3 exams. All exams will be cumulative but will emphasize the most recently covered material. The exams will be during the regular class period. The relative weighting of the Homework and Exams will be:  

- Homework 20%  
- Exam 1 20%  
- Exam 2 20%  
- Final Exam 40%  

<table>
<thead>
<tr>
<th>HW#</th>
<th>Problems</th>
<th>Due Date</th>
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<tbody>
<tr>
<td>1</td>
<td>1.5, 1.6, 1.16, 1.18; 1.22, 1.25, 1.26, 1.29; 1.31, 1.40, 1.43, 1.50</td>
<td>09/10</td>
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<tr>
<td>2</td>
<td>1.55, 1.56, 1.62; 1.69, 1.72, 1.83, 1.89, 1.90</td>
<td>09/24</td>
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<tr>
<td></td>
<td><strong>EXAM 1</strong></td>
<td><strong>09/29</strong></td>
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<tr>
<td>3</td>
<td>2.7, 2.13, 2.14; 2.29, 2.30, 2.31; 2.37, 2.40, 2.41; 2.50, 2.53, 2.57</td>
<td>10/18</td>
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<td>4</td>
<td>3.1, 3.6, 3.8, 3.11, 3.14; 3.15, 3.18, 3.28</td>
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<td><strong>EXAM 2</strong></td>
<td><strong>11/10</strong></td>
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<td>5</td>
<td>4.12; 4.28; 4.36; 4.46, 4.47, 4.48, 4.49; 4.67, 4.71, 4.72, 4.74</td>
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<td><strong>FINAL EXAM (7:30 – 9:30am)</strong></td>
<td><strong>12/17</strong></td>
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14. Grading Scale:  

<table>
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<tbody>
<tr>
<td>A</td>
<td>93 – 100</td>
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<tr>
<td>A-</td>
<td>90 – 92.9</td>
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<tr>
<td>B+</td>
<td>87 – 89.9</td>
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<tr>
<td>B</td>
<td>83 – 86.9</td>
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<tr>
<td>B-</td>
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<td>77 – 79.9</td>
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<tr>
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<td>73 – 76.9</td>
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<tr>
<td>C-</td>
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<tr>
<td>D+</td>
<td>67 – 69.9</td>
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<tr>
<td>D</td>
<td>63 – 66.9</td>
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<tr>
<td>D-</td>
<td>60 – 62.9</td>
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<tr>
<td>E</td>
<td>0 – 59.9</td>
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15. **Make-up Policy:** No late assignments will be accepted. Makeup exams are not normally allowed. If you cannot attend an exam or cannot meet a due date, you must contact the instructor prior to the exam or due date. Arrangements will be made for students on a case by case basis. (Failure to contact the instructor prior to the exam or assignment prior to the due date will result in a zero on that exam/assignment.)

16. **Honesty Policy** – All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a UF student and to be honest in all work submitted and exams taken in this course and all others.

17. **Accommodation for Students with Disabilities** – Students requesting classroom accommodation must first register with the Dean of Students Office. That office will provide the student with documentation that he/she must provide to the course instructor when requesting accommodation.

18. **UF Counseling Services** – Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:

- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

19. **Software Use** – All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.