Course Description: Theory of linear vibrations of finite & infinite number of degree of freedom systems via Lagrange, Newtonian and Energy approaches. Engineering applications and tools for frequency domain analyses.

Prerequisites: MEEN 364, MATH 308.

OBJECTIVES: To provide the fundamental analytical and numerical tools for analysis and modeling of vibration phenomena in discrete and continuum SDOF and MDOF linear systems. Learning of advanced analytical tools and methods for experimental identification of system parameters using recorded data, i.e. frequency domain parameter identification methods.

Class Time: T, R 11:10 am – 12:25 pm. ENPH 205

Instructor: Dr. Luis San Andrés, Phone 862 4744, LsanAndres@tamu.edu
Office hours: T, R 12:40-1:40 pm, MEOB 117, or by scheduled appointment (phone call or e-mail in advance).

References: Mechanical and Structural Vibrations: Theory and Applications, J. H. Ginsberg
MEEN 617 Class Notes (handouts), L. San Andrés, http://rotorlab.tamu.edu/me617/default.htm
Finite Element Procedures in Engineering Analysis, K. Bathe, Prentice Hall.

COURSE OUTLINE AND GRADING: TWO 75-minute lectures/week. GRADED group homework / computer assignments given on Thursday and turned in on next Tuesday, unless otherwise noted. Two evening exams (90’), and a comprehensive final exam (90’). No make-up exams will be given unless the student has a TAMU official excuse, and notified the instructor in advance.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Homework 30% Assigned T or R, turned in next T/R (one week)</th>
<th>Group work only</th>
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<tbody>
<tr>
<td>First Exam</td>
<td>25% Vibrations of SDOF systems</td>
<td>THURSDAY, February 26</td>
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<tr>
<td>Second Exam</td>
<td>25% Vibrations of MDOF systems</td>
<td>THURSDAY, April 16</td>
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<td>Final Exam</td>
<td>20% Vibrations of MDOF and continuum systems</td>
<td>THURSDAY May 7 3-5 pm</td>
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<td>100% grading scale (A= 90-100, B=80-89, C=70-79, etc.)</td>
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Notes: April 21: Last day for all students to drop course with no penalty (Q-drop).

For full credit homework should be presented in a professional way, including the problem(s) statement and objective, the steps in the modeling and procedure of solution, including a nomenclature and a sound discussion of the results obtained.

The instructor may make available (post) solutions to homework problems in MATHCAD. Students may work assignments using any type of computational software. However, learning MATHCAD or MATHLAB should prove beneficial in your education.

The class instructor will be absent a (TBA) number of times during the semester. He will schedule make up classes, 6:00-8:00 pm, usually a week ahead of his scheduled absence.
# MEEN 617, CLASS SYLLABUS  
Texas A&M University, Department of Mechanical Engineering  
Spring 2015  

**Key:**  
- **G:** X.Y: Ginsberg: Chapter.section  
- **HD:** Dr. San Andrés handout notes & appendices  

<table>
<thead>
<tr>
<th>w#</th>
<th>Dates</th>
<th>Lecture Material (subject to revision)</th>
<th>Reading Assignment</th>
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</table>
| 1  | 01/20      | **Introduction** Importance of system dynamics analysis and design.  
Physical modeling of mechanical systems: equivalent stiffness, inertia and damping elements, and associated energies. **Linearization**, Example of derivation of equation of motion for SDOF systems. The choice of a coordinate system. | Intro. HD#1 (self study)  
G: 1.1-.3  
App. B |
G: 1.4-.5  
HD # 2a,  
G: 2.2-.3 |
| 3  | 02/03      | **Forced response of SDOF systems** to impulsive and step forces.  
**Dynamic forced response of SDOF systems to periodic loading**. The complex frequency response (amplitude and phase). Periodic forced response to imbalance load. Interpretation of forces in the regimes of operation. **Force transmissibility to foundation. Forced response to ground motion** | HD #2b.  
G 3.1-.6  
HD #2c |
| 4  | 02/10      | **Uses of frequency response function** to design mechanical systems.  
**Forced response to an arbitrary periodic force excitation.** Response to a unit impulse. The convolution integral and **response to arbitrary loading** | App. F  
HD #2d |
| 5  | 02/17      | **Note** Instructor away at METS (Doha, Qatar) – Feb. 13-20  
**Instrumentation for vibration measurement.** (self-study) | App. E  
G: 3.7-.8  
HD #3 |
| 6  | 02/24      | **DFTs and vibrations.** The discrete Fourier transform and its applications. Experimental identification of parameters in simple mechanical systems. |  
EX I  
EXAM I R: 02/26 (evening)  
G: 3.7-.8  
HD #3 |
| 7  | 03/03      | **Analytical dynamics.** The principles of virtual work and the Hamiltonian. Lagrange’s equations of motion. Examples of Lagrangian Mechanics | HD #4.  
G: 1.5  
G: App A |
Application: **The dynamic vibration absorber:** design considerations | HD #7.  
G: 4.2  
HD #8.  
G: 4.3 |
| 9  | 03/10      | **Spring Break March 16-20**  
**Note** Instructor away to Singapore (ATPS) – March 14-21  
**Eigenvalue problems:** Numerical methods of solution (self-study) | HD #9  
G: App A |
| 10 | 03/24      | **Modal analysis of MDOF systems with proportional damping**  
**Numerical response of non-linear SDOF systems** | HD #10. G: 5.1-4  
HD #6  
HD #11 & addendum  
G: 10.1-.5 |
| 11 | 03/31      | **Modal analysis of MDOF systems with Viscous Damping.** State-space equations, modal coordinates and orthogonality properties, relations to undamped modes method.  
**Direct periodic forced response of MDOF systems.** |  
G: App A  
G: 5.4.1-.2 |
G: 7.1-7  
G: App A |
| 13 | 04/09      | **Finite Element Method in vibrations.** Fundamentals and FEM matrices for bars and beams. Assembly and solution of global system of equations. |  
EX II  
EXAM II R: 04/16 (evening)  
G: App A  
HD #13 |
| 14 | 04/21      | **Finite Element Method in vibrations – continued**  
**Direct numerical integration to find the response of MDOF systems.** Stability analysis and minimum time step. Average acceleration methods | HD #12.  
G: 8.2-.4  
HD #13  
G: 5.4.1-2 |
| 15 | 04/28      | **Identification of parameters in mechanical systems.** Time and frequency domain methods. Curve fits to impedances and the instrumental variable filter method. | HD #15.  
G: 5.4.1-2 |
| 16 | 05/05      | Reading day (Friday classes meet on Tuesday) |  |
| 17 | 05/07      | **FINAL Exam Thursday: 05/07 3:00-5:00 pm** |  |
Ginsberg’s Vibrations textbook is an excellent resource to learn about the modern theory of vibrations. The book includes the latest advancements in analysis using discrete Fourier transforms, their implementation in commercial software (MATHCAD and MATHLAB), and a sound method to identify system parameters from vibration test data in the frequency domain. The assigned reading material for each week seems excessive at first but I assure you that you will gain fundamental knowledge that can not be found in any other textbook.

The lectures will broaden the coverage of the textbook and provide examples of analysis as applied to the modeling, analysis and interpretation of the dynamic response of linear mechanical systems. There will be significant amounts of subject material mentioned in the lectures that are not in the textbook. The textbook is not a complete reference for this course. The class notes of Dr. Luis San Andrés are available at the URL [http://rotorlab.tamu.edu/me617/default.htm](http://rotorlab.tamu.edu/me617/default.htm). Attendance to the lectures is a must for success. References for outside reading will be recommended in class.

See [http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07) for official University excused absences.

**ABOUT HANDOUTS AND TEXTBOOK:** The handouts and textbook used in this course are copyrighted. By “handouts,” I mean all materials generated for the course, which include but are not limited to syllabi, quizzes, exams, worked problems, in-class materials and MATHCAD codes, review sheets, and additional problem sets. Because the course material is copyrighted, you do not have the right to distribute it, unless the author expressly grants permission.

**HOMEWORK:** will be assigned on Tuesday (Thursday) and turned in on the following Tuesday (Thursday). Homework will be worked in groups of max. 6 students (min. 3 students). Homework will be graded and returned in class the following week. **Homework makes 30% of your total grade.** There will be no excuses for missing homework or computer assignments.

Homework material encompasses solving assigned specific problems (textbook and other resources), completing computational analyses to model simple structural systems (write computer programs or modifying codes given to you in class), and performing measurements in simple systems.

Complete solutions to HOMEWORK problems will NOT be posted. Partial solutions, i.e. answers, MAY be released. Students should take advantage of office hours to obtain help in developing clear procedures for solution of problems and to improve their understanding of class materials. The instructor will not solve problems for you during office hours; instead he will aid you learn an engineering method for problem solving.

**ABOUT WRITING:** When developing a solution to homework problems, and in particular when developing solutions to exam problems, students must write (in English) the complete development in full sentences, with stated definitions of parameters and description of procedures and used physical principles. **A large portion or your grade (40% or more) will be given to presentation (writing: syntax and semantics).** It is NOT enough to just state formulas and an answer.

In other words, a full grade will be given for complete solutions that include written description of procedural steps to achieve task(s) and assumptions [full sentences, jargon-free], mathematical statements for calculations, and correct magnitudes of results with appropriate physical magnitudes. There will be NO partial credit for mishandling of physical units. ME graduate students should be able to gauge the order of magnitude and correct physical magnitude of the problem at hand.

**PRACTICE EXERCISES** will be recommended as the semester progresses. The textbook contains numerous exercises demonstrating particular concepts of interest. The practice exercises are not graded, but they are good practice for the exams. It cannot be emphasized enough that the way to learn how to work problems is to work problems. Use the given answer (odd numbered problems only) to determine that your strategy, solution procedure, and numerical
computations are correct. Working backwards from the answer will not teach you the engineering method, or the principles involved to solve the problem.

### Recommended problems (practice exercises) from your textbook

<table>
<thead>
<tr>
<th>week</th>
<th>chapter</th>
<th>Problem numbers</th>
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<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>5, 8, 13, 14, 15, 20, 43, 44, 56</td>
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<td>2</td>
<td>2</td>
<td>17, 19, 21, 29, 31, 33, 39, 51, 57, 61</td>
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<td>3&amp;4</td>
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<td>3, 7, 19, 20, 22, 25, 50, 52</td>
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<tr>
<td>5</td>
<td>1</td>
<td>Derive EOMs MODF systems: 25, 27, 30, 33, 36, 38, 39, 44, 49</td>
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<tr>
<td>6</td>
<td>4</td>
<td>10,19, 21, 30, 36, 39,34, 55</td>
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<td>3, 11, 43, 49</td>
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<td>10</td>
<td>6</td>
<td>3, 9, 11, 14, 15, 28, 38, 54</td>
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</table>

More recommended problems to follow…..

**Solutions to practice problems will not be posted.** I urge students, taking advantage of office hours, to seek help in developing clear procedures for solution of problems and to improve their understanding of class materials. The instructor will not solve problems for you in office hours; instead he will help you learn an engineering method for problem solving.

**ABOUT OFFICE HOURS:** The purpose of office hours is to encourage individual interaction between the students and the instructor. The instructor is available to discuss not only questions related to the course, but other issues where he can help as a professional engineer, educator and researcher. Please take advantage of office hours. To utilize this time efficiently, students should prepare by organizing questions in advance.

I am willing to help you at times other than office hours without an appointment. However, just like you, I have responsibilities other than MEEN 617 (teach other classes, direct graduate student research, write proposals and technical papers, organize laboratories, voluntary work for ASME, etc.). I must budget certain times to meet those responsibilities. My weekly work schedule is posted outside my office. **Please do not be offended** if I am in the office but cannot meet with you.

**The use of e-mail** for communication with your instructor is acceptable. I usually receive three types of e-mail messages:

a) a request to schedule a meeting at other times than office hours,

b) questions related to the impending take-home quiz due (say) next day,

c) questions related to the study material for an exam.

I reply promptly to all messages (usually within the next working hour if I am in town).

If you cannot find me in my Campus Office, please call me at 862 4744. I spend 60+ hours/week at the Turbomachinery Laboratory (corner of FM2818 and George Bush Dr). At the Turbo Lab I conduct research and manage an excellent team of engineers performing experimental and computational work serving the needs of industrial sponsors.

**About plagiarism:** As commonly defined, plagiarism consists of passing off as one’s own ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which knowledge and learning cannot be safely communicated. If you have any questions regarding plagiarism, please consult the latest issue of the Texas A&M University Student Rules, under the section “Scholastic Dishonesty.”
The textbook, homework assignments, problem sets, lecture notes, exams and handouts (appendices) used in this course are copyrighted. Because these materials are copyrighted, you do not have the right to distribute them freely, unless the author expressly grants permission. Note that (any) material downloaded from the www may be copyrighted. In all cases acknowledge the source of your information. Furthermore, passing as your own computer assignments/projects prepared by former students is NOT acceptable and will automatically bring you into disciplinary action by TAMU.

**Americans with Disabilities Act (ADA) Policy Statement**

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities, in Room B118 of the Koldus Building or call 845-1637.

Texas A&M University complies with the Americans with Disability Act. For this course, that means specifically that I will cheerfully work with identified students to provide appropriate alternative settings for tests and quizzes.

**Academic Integrity Statement**

Aggie Honor Code: *"An Aggie does not lie, cheat, or steal, or tolerate those who do."

Upon accepting admission to Texas A&M University, a student immediately assumes a commitment to uphold the Honor Code, to accept responsibility for learning and to follow the philosophy and rules of the Honor System. Students will be required to state their commitment on examinations, research papers, and other academic work. Ignorance of the rules does not exclude any member of the Texas A&M University community from the requirements or the processes of the Honor System. For additional information please visit: [http://aggiehonor.tamu.edu/](http://aggiehonor.tamu.edu/).

On all course work, assignments, and examinations at Texas A&M University, the following Honor Pledge shall be preprinted and signed by the student:

"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."

**MAKE UP CLASSES : when will the instructor be absent?**

I’ve scheduled my attendance to several technical Conferences this SPRING Semester. I will announce the exact date of my absences at least two weeks in advance. Make up recitations for lost classes will be scheduled within a week and be conducted at night time (6 pm. to 8 pm.).

- Jan 12-16    Houston, Rotordynamics Short Course
- Feb 15-10    Doha, Qatar, Middle East Turbomachinery Symposium (METS III)
- April 9      Turbomachinery Symposium, TAC (Abstract Review Meeting) – class meets on Thursday 04/09 aft.
- March 15-18  Singapore, Asia Turbomachinery Symposium ATPS (Abstract Review Meeting) – Spring Break
- May 17-22    Dallas, STLE Annual Meeting

**MEEN 617 - INDEX TO CLASS NOTES**

AVAILABLE AT [http://rotorlab.tamu.edu/me617/default.htm](http://rotorlab.tamu.edu/me617/default.htm)

**RESOURCES on the web**

AVAILABLE AT [http://rotorlab.tamu.edu/me617/default.htm](http://rotorlab.tamu.edu/me617/default.htm)