**VILLANOVA UNIVERSITY**
**MECHANICAL ENGINEERING DEPARTMENT**

ME 7502                                                                                                Fall 2012
Composite Structures                                                                      Dr. B.J. Sullivan

<u>COURSE OBJECTIVE</u>

The primary objective of this course is to present the analytical methods used to analyze and design structural components fabricated with composite materials.  The unique properties of composites and their influence on material and structural design will be emphasized.  The course will present both fundamental concepts as well as practical information and methods used on composite materials currently in use in industry.

<u>TENTATIVE COURSE OUTLINE</u>

| Lecture | Date | Topic | Supplementary Readings |
|---|---|---|---|
| 1 | 27 Aug | Introduction to Composite Materials and Composite Structures | Kassapoglou 1-31 |
| 2 | 10 Sep | Effective Properties of Particulate Reinforced and Unidirectional Fiber Reinforced Composites; Lamina Stress-Strain Relations | Kassapoglou 33-39 |
| 3 | 17 Sep | Lamination Theory; Laminate Properties | Kassapoglou 39-53 |
| 4 | 24 Sep | Laminate Properties (cont'd) | Kassapoglou 55-61 |
| 5 | 1 Oct | Laminate Stress Analysis | Kassapoglou 83-113 |
| 6 | 8 Oct | Fatigue of Laminated Composites | Talrega 1-70 |
| 7 | 15 Oct | Analysis and Design of Composite Beams – Part 1 | Kassapoglou 179-212 |
|  | 22 Oct | **MID-TERM EXAM electronic distribution – no class** | |
| 8 | 29 Oct | Analysis and Design of Composite Beams – Part 2 | Barbero 231-274 |
| | | **Electronic & Hard Copy of Mid-Term Exam solutions are due in class at 6:00 pm** | |
| 9 | 5 Nov | Analysis and Design of Composite Plates – Part 1 | Kaasapoglou 119-132; Whitney 87-176 |
| 10 | 12 Nov | Analysis and Design of Composite Plates – Part 2 | Whitney 177-208; Whitney 263-312; Kassapoglou 145-163 |
| 11 | 19 Nov | Analysis and Design of Composite Shells | Vinson 215-258; Barbero 301-320 |
| 12 | 26 Nov | Composite Structural Analysis and Design Issues – Part 1 | Jones 372-417; Jones 422-465 |
| 13 | 3 Dec | Composite Structural Analysis and Design Issues – Part 2 | Kassapoglou 289-295; Jones 339 – 344 |
| 14 | 10 Dec | Analysis and Design of Adhesively Bonded and Mechanically Fastened Joints **Final Exam Distribution** | Jones 417-421; Messler 477-508; Vinson 333-360 |
| 15 | 17 Dec | **FINAL EXAM – Electronic & Hard Copy of Final Exam solutions are due in class at 6:00 pm** | |

COURSE CONDUCT

Course Materials
Before and after each class, electronic versions of course materials (i.e., the lecture notes, lecture handouts, current homework assignments, and previous homework solutions) will be available to the students by accessing the website http://vucoe.drbriansullivan.com/me-7502/.

To access videos of the lectures, students should access the website
https://elearning.villanova.edu/webapps/login/

Use the "Login" feature to enter your **Villanova email** username and password.  When you login, you will see a complete list of all the classes you are registered for.  If you cannot login, please dial 610-519-7777 (option 3) and they will help you out.  When you successfully login into your class, you will find the a link marked, "**Content Hompage**", Then Click "**Course Videos and Notes**", the recorded lectures can be accessed from there, Click the **Title** of the lecture you wish to view, either live or previously recorded.

Homework Assignments
Homework assignments are due exactly one week after they have been assigned in class. Without instructor approval provided on the Friday prior to the Monday due date, and granted only due to special circumstances (e.g., illness), *no late homework assignments will be accepted*. Printed copies of homework solutions are the required form of submittal for in-class students. Electronic submission is permitted for Distance Learning students.  In-class students may wish to submit electronically also, but the hard copy homework solutions will be the form graded. Electronic submission by in-class students will be accepted only in the event that the in-class student is unable to attend the class in person.

Examinations
All exams are take-home, open book and open notes examinations.

The Mid-Term examination will be provided to the students electronically no later than 22 October 2012 (and earlier if possible).  Student solutions are due at the start of class on Monday, 29 October 2012.  The Final Examination will be provided to the students on December 10, 2012. Student solutions are due at 6:00 p.m. on Monday, 17 December 2012. In-class students are required to provide exam solutions in hard-copy format.

Course Text
There is no single text book which treats each of the above topics in exactly the same way as they will be covered in this course, or which places the exact same emphasis on the topics as will be placed on them in this course.  Consequently, class notes developed by the students from the lectures, supplemented by regularly assigned homework problems, will form the primary source of information.  The text book which will be used in the class is the Kassapoglou AIAA text cited below.

C. Kassapoglou, <u>Design and Analysis of Composite Structures with Applications to Aerospace Structures</u>, Copublished by the American Institute of Aeronautics and Astronautics, Inc. and John Wiley & Sons, 2010, ISBN 978-1-60086-780-4.

It is suggested that the students refer to any of the following books for supplementary material:

R.M. Jones, <u>Mechanics of Composite Materials</u>, Second Edition, Taylor & Francis, New York, NY, 1999, ISBN 1-56032-712-X.

J.M. Whitney, <u>Structural Analysis of Laminated Anisotropic Plates</u>, Technomic Publishing Co., 1987.

J.R. Vinson and R.L. Sierakowski, <u>The Behavior of Structures Composed of Composite Materials</u>, Martinus Nijoff Publishers, 1987.

E.J. Barbero, <u>Introduction to Composite Materials Design</u>, Taylor & Francis Publishers, 1999.

R.W. Messler, Jr., <u>Joining of Advanced Materials</u>, Butterworth-Heinemann Publishing, Inc., 1993.

<u>Engineered Materials Handbook, Vol. 1: Composites</u>, ASM International, 1987.

M.M. Schwartz, <u>Composite Materials Handbook</u>, McGraw Hill, Second Edition, 1992.

G. Lubin, Editor, <u>Handbook of Composites</u>, Van Nostrand Reinhold Company, 1982.

<u>Aerospace Composites: A Design & Manufacturing Guide</u>, Gardner Publications, Inc., 2008.

R. Talrega, <u>Fatigue of Composite Materials</u>, Technomic Publishing Co. Inc., Lancaster, PA, 1987, ISBN 87762-516-6.

The final course grade will be determined on the following basis:

| | |
|---|---|
| Homeworks | 10% |
| Course Project | 30% |
| Mid-Term Examination | 30% |
| Final Examination | 30% |

## INSTRUCTOR AVAILABILITY

The best way to contact me is via email. My e-mail address is brian.sullivan@villanova.edu. I will respond as promptly as possible. I can be available to meet with students by an appointment request made in person or submitted via email.

## COURSE PROJECT

One course project will be assigned to the students during this course.

| Class Project No. | Description | Due Date |
| --- | --- | --- |
| 1 | Design of minimum weight composite beam | 26 Nov |

Complete descriptions of the assigned Class Projects will be provided to the students on or about October 15, 2012..

The preferred file for the submission of the course project is Microsoft PowerPoint. The format to be used by the students in the preparation of their Class Project report is the following:

- A cover page slide providing the title of the report and the name of the student.
- A brief introductory section providing some background on the nature of the topic.
- A short section describing the objective of the course project.
- A section describing the technical approach used by the student, including key equations. This portion of the report should also describe where the equations were obtained and how they were used in the study.
- A section describing results obtained by the students. The use of graphs and tables, sequentially numbered and containing appropriately descriptive captions, should be freely used in this section.
- A section summarizing the principal conclusions of the research project.
- References used in the performance of the class project can be placed at the end of the report, or can be cited as footnotes and appear at the bottom of selected, specific slides.
- Any other materials deemed sufficiently important to be included in the PowerPoint file, but perhaps too detailed to be included in one of the above sections, should be contained in a Back-Up Slides section of the PowerPoint file. *A perfect example of this is calculations performed by the student, either by hand, Mathcad, Excel, etc. Such calculations should be converted to Adobe Acrobat (i.e., pdf) format and inserted onto the back-up slides.*