Course Change Request

New Course Proposal

Date Submitted: 09/22/17 12:03 pm

Viewing: MEEN 683: Multidisciplinary System Analysis and Design Optimization

Last edit: 10/04/17 9:47 pm
Changes proposed by: rebeccasimon

Faculty Senate Number

Contact(s)

<table>
<thead>
<tr>
<th>Name</th>
<th>E-mail</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tandilyn Morrel</td>
<td><a href="mailto:tmorrel@tamu.edu">tmorrel@tamu.edu</a></td>
<td>979-458-9196</td>
</tr>
</tbody>
</table>

Course prefix: MEEN  
Course number: 683

Department: Mechanical Engineering
College/School: College of Engineering
Academic Level: Graduate
Academic Level (alternate): Undergraduate
Effective term: 2018-2019

Complete Course Title: Multidisciplinary System Analysis and Design Optimization
Abbreviated Course Title: MULTIDIS SYS ANIY DESN OPTIM

Catalog course description:
Overview of principles, methods and tools in multidisciplinary system analysis and design optimization; engineering systems modeling for analysis, design and optimization; design variable selection, objective functions and constraints; subsystem identification and interface design; gradient-based and heuristic search methods; multi-objective optimization and Pareto optimality.

Prerequisites and Restrictions:
Graduate classification: No

Concurrent Enrollment: No

Should catalog prerequisites/concurrent enrollment be enforced?: No

Crosslisting: No
Crosslisted With:

Stacked: No
Stacked with:

Semester: 3  
Credit Hour(s): (per week):
Contact Hour(s): 3  
Lecture: 3  
Lab: 0  
Other: 0  
Total: 3

Repeatable for credit?: No

In Workflow
1. MEEN Department Head
2. Curricular Services Review
3. EN Committee Preparer GR
4. EN Committee Chair GR
5. EN College Dean GR
6. GC Preparer
7. GC Chair
8. Faculty Senate Preparer
9. Faculty Senate
10. Provost II
11. President
12. Curricular Services
13. Banner

Approval Path
1. 10/04/17 8:50 am
   Dan McAdams (dmcadams): Approved for MEEN Department Head
2. 10/04/17 9:47 pm
   Sandra Williams (sandra-williams): Approved for Curricular Services Review
3. 10/24/17 4:36 pm
   Jennifer Veracruz (jveracruz): Approved for EN Committee Preparer GR
4. 12/13/17 8:16 pm
   Prasad Enjeti (enjeti): Approved for EN Committee Chair GR
5. 12/18/17 3:58 pm
   Prasad Enjeti (enjeti): Approved for EN College Dean GR
6. 01/02/18 4:38 pm
   LaRhesa Johnson (ljohnson): Approved for GC Preparer
7. 01/20/18 9:38 pm
   LaRhesa Johnson (ljohnson): Approved for GC Chair

https://nextcatalog.tamu.edu/courseleaf/approve/
Three-peat? No
CIP/Fund Code 1419010006
Default Grade Mode Letter Grade(G)
Alternate Grade Modes Satisfactory/Unsatisfactory
Method of instruction Lecture
Will sections of this course be taught as non-traditional? (i.e., parts of term, distance education) No
Will this course be taught as a distance education course? No
Is 100% of this course going to be taught in Texas? Yes
Will classroom space be needed for this course? Yes

This will be a required course or an elective course for the following programs:

<table>
<thead>
<tr>
<th>Program(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(MS-MEEN) Master of Science in Mechanical Engineering</td>
</tr>
<tr>
<td>(PHD-MEEN) Doctor of Philosophy in Mechanical Engineering</td>
</tr>
<tr>
<td>(MEN-MEEN) Master of Engineering in Mechanical Engineering</td>
</tr>
</tbody>
</table>

Course Syllabus

Syllabus: Upload syllabus
Upload syllabus MEEN 683 Syllabus.pdf
Letters of support or other documentation No
Additional information Elective for M.EN. (Master of Engineering) in Mechanical Engineering as well. Option was not available from drop down box.
Reviewer Comments Sandra Williams (sandra-williams) (11/02/16 10:05 am): Updated workflow to remove MEEN Program Chair (QT). We are working with vendor to correct this issue.
Sandra Williams (sandra-williams) (03/24/17 3:19 pm): Rollback: Syllabus has wrong ADA statement and appears to be missing 14 week schedule of topics. Also, do not attach old course form with syllabus.
Sandra Williams (sandra-williams) (10/04/17 9:47 pm): Update received.
Reported to state? Add

Key: 17113
Course title and number
MEEN 683: Multidisciplinary System Analysis and Design Optimization

Term (e.g., Fall 200X)
Spring 2018

Meeting times and location
TBD

Course Description and Prerequisites

This course provides an overview of principles, methods, and tools in multidisciplinary system analysis and design optimization (MSADO). The topics studied are: engineering systems modeling for analysis, design, and optimization; selection of design variables, objective functions, and constraints; subsystem identification, development, and interface design; review of linear and non-linear constrained optimization formulations; scalar versus vector optimization problems from systems engineering and architecting of complex systems; heuristic search methods: simulated annealing and genetic algorithms; sensitivity, tradeoff analysis, approximation methods, goal programming and isoperformance; multiobjective optimization and Pareto optimality; specific applications from mechanical engineering and aerospace engineering.

Prerequisites: None.

Learning Outcomes or Course Objectives

• Learn how MSADO can support the product development process of complex, multidisciplinary engineered systems.
• Learn how to rationalize and quantify a system architecture or product design problem by selecting appropriate objective functions, design parameters, and constraints.
• Subdivide a complex system into smaller disciplinary models, manage their interfaces, and reintegrate them into an overall system model.
• Be able to use gradient-based numerical optimization algorithms, e.g., sequential quadratic programming and various modern heuristic optimization techniques such as simulated annealing or genetic algorithms and select the ones most suitable to the problem at hand.
• Perform a critical evaluation and interpretation of analysis and optimization results, including sensitivity analysis and exploration of performance, cost, and risk tradeoffs.
• Be familiar with the basic concepts of multiobjective optimization, including the conditions for optimality and Pareto front computation techniques.
• Sharpen presentation skills, acquire critical reasoning with respect to the validity and fidelity of MSADO models and experience the advantages and challenges of teamwork.

Instructor Information

Name
Dr. Douglas Allaire

Telephone number
979.458.9889

Email address
dallaire@tamu.edu

Office hours
TBD

Office location
MEOB 425

Textbook and/or Resource Material

There are no required textbooks for this course.
Recommended Texts:


Grading Policies

Your progress towards achieving the learning outcomes assessed in the following ways.

Homework Assignments (5 total)

Part (a): Small problems to be solved individually. Goal is to ensure learning of the key ideas. Some problems might require extensive computation.

Part (b): Application of theory to a project of your choice (potentially related to your research). We expect team sizes between two and four students.

Homework assignments will be due bi-weekly.

Class Project

The class project is the main means of assessing whether you can learn the material at a deeper level and apply it to a graduate level research project. There will be two major deliverables towards the end of the term:

(1) Project presentation (~15-20 minutes including Q&A)
(2) Final report in the format of a journal or conference article

The grading will be on the letter scale A-F and be weighted as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework Assignments</td>
<td>50%</td>
</tr>
<tr>
<td>Project Presentation</td>
<td>20%</td>
</tr>
<tr>
<td>Final Project Report</td>
<td>20%</td>
</tr>
<tr>
<td>Active Participation/Attendance</td>
<td>10%</td>
</tr>
</tbody>
</table>

There will be no mid-terms or final exams.

Grade Disputes

Under rare circumstances, graders may make errors in the performance of their duties. It also is possible in programming that a very small mistake results in a very large error in your results. If you believe the grade you received is an inaccurate reflection of the credit you deserve, you may submit your assignment for reevaluation. However, you must do this within ONE WEEK of when the assignments are returned to the class (whether or not you yourself got it back that day). The full grade dispute procedure is given below.

Grade Dispute Procedure:

1. Create a cover sheet with the following information: your name, the current date, the name of the assignment, the submission due date, the date it originally was returned to the class, your original score, and what you think your score should be. Below this information, provide a concise, well-reasoned explanation for your claim.
2. Return the assignment along with a written explanation to the instructor. (You may want to make yourself a copy of your original assignment prior to submitting it for reconsideration.)
3. Re-grading:
   a. If you believe the error is worth more than 50 points, the instructor will re-grade the assignment and return it to you within two weeks.
   b. If you believe the error is worth 50 points or less, the instructor will place the assignment
into a file that for consultation at the end of the semester. The instructor will re-grade your assignment if the points change could affect your final letter grade.

**Missed & Late Assignments**

Missed assignments count as a **ZERO** in your grade, except in the case of University approved absences (see below). General late submission policies are given elsewhere in the syllabus (see Course Assignment Specifications). Any deviation from the general policy will be stated in handout for an assignment. The submission policy stated in a handout overrides policy specified in this document.

**University-Approved Absences**

Work missed due to absences will only be excused for University-approved activities in accordance with Texas A&M University Student Rules (see http://student-rules.tamu.edu/rule07). Specific arrangements for make-up work in such instances will be handled on a case-by-case basis. Please be aware that in this class any "injury or illness that is too severe or contagious for the student to attend class" will require "a medical confirmation note from his or her medical provider" even if the absence is for less than 3 days (see 7.1.6.2 Injury or illness less than three days.).

**Grading Scale**

*Standard Letter Grading Scale:*

- A = 90-100
- B = 80-89
- C = 70-79
- D = 60-69
- F = <60

**Course Topics, Calendar of Activities, Major Assignment Dates**

(If the course is web-based, you may wish to provide links to academic calendar and final schedule. Avoid conflicts with religious observances. Major assignment due dates and test dates must be included, and should not be changed without notification of all students in the course. **THIS INFORMATION HAS BEEN PLACED HERE FOR REFERENCE ONLY. PLEASE REMOVE BEFORE PREPARING SYLLABUS.**)

**Topics Covered**

a. System characterization:
   i. Identification of objectives, design variables, constraints, subsystems
   ii. System-level coupling and interactions
   iii. Examples of MSDO in practice
   iv. Visualization techniques in design optimization

b. Subsystem model development:
   i. Model partitioning and decomposition, interface control
   ii. Collaborative Optimization, Bi-Level Formulations
   iii. Subsystem model selection: fidelity versus expense
   iv. Model and simulation development and validation

c. Optimization and exploration techniques:
   i. Review of linear and nonlinear programming
   ii. Heuristic techniques: genetic algorithms, simulated annealing
   iii. Design Space Exploration: Design of Experiments (DOE): Full factorial search, parameter study, Taguchi/orthogonal arrays, latin hypercubes
   iv. Mixed integer programming (application to hub spoke / network problems)

d. Sensitivity and post-optimality analysis:
   i. Jacobian matrix, Hessian, finite differences
   ii. Adjoint methods and Lagrange multipliers

e. Multiobjective optimization:
   i. Weighted sum optimization
   ii. Weak and strong dominance
   iii. Pareto front computation
f. Introduction to design under uncertainty
   i. Monte-Carlo Sampling
   ii. Design under uncertainty
   iii. Reliability analysis, Taguchi methods

g. System assessment and extensions:
   i. What is optimality?
   ii. Design for value: including lifecycle costing
   iii. Optimizing product families and platforms

h. Implementation issues:
   i. Model reduction
   ii. Approximation techniques: response surfaces, kriging, neural networks
   iii. Concurrent design

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction and Problem Formulation</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Modeling and Simulation</td>
<td>A1 Out</td>
</tr>
<tr>
<td>3</td>
<td>Unconstrained Optimization</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Constrained Optimization</td>
<td>A2 Out, A1 Due</td>
</tr>
<tr>
<td>5</td>
<td>Numerical Optimization</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Problem Decomposition</td>
<td>A3 Out, A2 Due</td>
</tr>
<tr>
<td>7</td>
<td>Design Space Exploration</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Simulated Annealing</td>
<td>A4 Out, A3 Due</td>
</tr>
<tr>
<td>9</td>
<td>Genetic Algorithms</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Goal Programming / Isoperformance</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Multiobjective Optimization</td>
<td>A5 Out, A4 Due</td>
</tr>
<tr>
<td>12</td>
<td>Post-Optimality Analysis</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Multifidelity Methods</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Design Under Uncertainty</td>
<td>Final Report Due</td>
</tr>
</tbody>
</table>

Other Pertinent Course Information

Computational infrastructure

For their projects and homework assignments, the students will be free to choose the platform and software of their choice. They can code their simulation modules in Matlab, Excel (Visual Basic), Java, FORTRAN or C/C++, among others.

The use of commercial disciplinary codes such as MSC/Nastran for structural modeling, ProEngineer, SolidWorks for Computer Aided Design or CPLEX for the solution of linear programs is also a possibility for your projects. There will be less emphasis on this point, however, since proficiency in these tools takes a long time to acquire and many of these codes have steep learning curves. Hence, the emphasis of the course is rather on learning the process of setting up, solving and interpreting multidisciplinary problems, rather than on creating physical models of very high fidelity as would be expected in an industry environment.

Americans with Disabilities Act (ADA)

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 Disability Services, currently located in the Disability Services building at the Student Services at White Creek complex on west campus or call 979-845-1637. For additional information, visit http://disability.tamu.edu.

**Academic Integrity**

For additional information please visit: http://aggiehonor.tamu.edu

“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: aggiehonor.tamu.edu

On all course work, assignments, and examinations at Texas A&M University, the following Honor Pledge will apply either implicitly or explicitly by the student:

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

__________________________
Signature of Student