

<p>Kingdom of Saudi Arabia Ministry of Higher Education Qassim University College of Engineering</p>		<p>المملكة العربية السعودية وزارة التعليم العالي جامعة القصيم كلية الهندسة</p>
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Optimal Control

College: Engineering

Department: Mechanical Engineering

First: Course Definition

1- Course Code: ME 668

2- Units : 3 credit hrs

3 – Semester:

4 -Prerequisite

5- Co-requisite

6- Location (if not on main Campus):

Second: Course Objectives

1. *To provide a basic knowledge of the theoretical foundations of optimal control.*
2. *To develop the skill needed to design controllers using available optimal control theory and software.*
3. *To introduce the evolutionary algorithms as powerful numerical computational tools to solve constraint optimal dynamical problems.*

Third: Course Specifications

1- Topics to be covered		
Subject	No of Weeks	Units
Introduction to the principles and methods of the optimal control approach	2	6
Performance measures	1	3
Dynamic programming	2	6
Calculus of variations	2	6
Pontryagin's principle	2	6
optimal linear regulators; minimum-time and	2	6

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minimum-fuel problems		
steepest descent and quasi-linearization methods for determining optimal trajectories	2	6
Numerical optimization using to evolutionary optimization techniques.	2	6

2- Course components (Total hrs in the Semester)

Lecture	Exercise or lab	Other
45	---	

3- Intended Learning Outcomes of the Course (ILO's)

a. Knowledge

i) Description of the knowledge to be acquired:

- Understanding the concept of optimality, constraints, feasible solutions, and performance indices.
- Understanding the principles of stochastic search techniques such as genetic algorithms

ii) Teaching strategies to be used to develop that knowledge

- Lectures and tutorials
- Home assignments
- Open class discussions and forums
- Case study report using data collection, internet search, numerical computation, simulation, and reporting
- Matlab sessions

iii) Methods of assessment of knowledge acquired

- Home assignments
- Quizzes
- Midterm Exams
- Term Project
- Final Exam

b- Cognitive (Intellectual) Skills

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i) Cognitive skills to be developed

- Ability to formulate the optimization problems by defining the problem variables and objective function.
- Ability to use the calculus of variation to determine the optimal solution for dynamic systems.
- Ability to use evolutionary algorithms to determine the optimal solution for static and dynamics systems

ii) Teaching strategies to be used to develop these cognitive skills

- Lectures and tutorials
- Home assignments
- Open class discussions and forums
- Case study report using data collection, internet search, numerical computation, simulation, and reporting
- Matlab sessions

iii) Methods of assessment of students cognitive skills

- Home assignments
- Quizzes
- Midterm Exams
- Term Project
- Final Exam

c. Interpersonal Skills and Responsibility

i) Description of the interpersonal skills and capacity to carry responsibility to be developed

- Team work in Term project and Assignments

ii) Teaching strategies to be used to develop these skills

- Home assignments (group)
- Open class discussions and forums
- Case study report using data collection, internet search, numerical computation, simulation, and reporting

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iii) Methods of assessment of students interpersonal skills and capacity to carry responsibility

- Home assignments.
- Quizzes.
- Term Project.

d. Communication, Information Technology and Numerical Skills

i) Description of the skills to be developed in this domain

- Ability to use the internet to search for specific information in the area of optimal control and evolutionary algorithms.
- Ability to use the available numerical computational tools such as Matlab to determine the optimal solution for static and dynamic problems.
- Ability to use the modern presentation techniques to demonstrate the students' ideas and work.

ii) Teaching strategies to be used to develop these skills

- Assignments, at home.
- Case study report using data collection, internet search, numerical computation, simulation, and reporting

iii) Methods of assessment of students numerical and communication skills

- Home assignments.
- Term Project.

e. Psychomotor (if applicable) & Other Non-cognitive Skills

i) Description of the psychomotor or other skills to be developed and the level of performance required

ii) Teaching strategies to be used to develop these skills

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iii) Methods of assessment of student's psychomotor skills

4- Student Assessment Schedule

Assessment	Assessment task (test, group project, examination etc.)	Week due	Weight of
1	Quiz 1	Week 2	4%
2	Quiz 2	Week 4	4%
3	Quiz 3	Week 6	16%
4	Mid Term Exam1	Week 7	15%
5	Case Study Term project & Regular Assignments	Week 8	5%
6	Quiz 4	Week 9	4%
7	Quiz 5	Week 11	4%
8	Mid Term Exam2	Week 13	15%
9	Quiz 6	Week 14	4%
10	Final Exam	Week 16	50%

5- Student Support

- Arrangements for availability of faculty for individual student consultations and academic advice. (include amount of time faculty are available each week.
- Three (3) Office hours per week are offered by the instructor to aid the students and support them.

6- Learning Resources

i) Essential Books (References)

1. B. Anderson and J. Moore, *Optimal Control*, Dover, 2007
2. Randy Haupt and Sue Haupt "Practical Genetic Algorithms" Wiley, 2004
3. D. Kirk, "Optimal Control Theory", Dover, 2004

ii) Course Notes-

Course notes will be prepared in handled to the students through the web

iii) Recommended Books

1. R. Stengel, "Optimal Control and Estimation", Dover, 1994
2. K. Astrom, *Introduction to Stochastic Control Theory*, Dover, 2006

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3. Bryson and Y. Ho, *Applied Optimal Control*, Taylor & Francis, 1975
4. Bryson, " *Applied Linear Optimal Control*", Cambridge University Press, 2002
5. M. Athans and P. Falb, " *Optimal Control*", Dover, 2006
6. D. Naidu, " *Optimal Control Systems*", CRC Press, 2002

iv) Electronic Books & Web Sites:

www.mathworks.com

v) Periodicals

- IEEE Conferences and Journals
- Optimal Control Applications and Methods

7- Course Evaluation and Improvement Processes

i) Strategies for Obtaining Student Feedback on Effectiveness of Teaching

- Questionnaire,
- Observing the students opinions recorded in the college student sit
- Appeal box
- Carrying out extensive questioners by a sample of the distinguished students just after the graduation from the college

ii) Other Strategies for Evaluation of Teaching by the Instructor or by the Department

- Periodical review of the teaching methods by both the department council and the education affairs vice dean
- Questionnaire,
- Observing the students opinions recorded in the college student site.

iii) Processes for Improvement of Teaching

- Evaluation of the course outlines by external staff member from outside the university
- Periodical contact with the different engineering authorities and industries for evaluating and getting their feedback and suggestions concerning the course outlines.

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iv) Processes for verifying standards of student achievement (e.g. check marking by an independent faculty member of a sample of student work, periodic exchange and remarking of a sample of assignments with a faculty member in another institution)

- Check marking of a sample of student work by an independent faculty member

v) Describe the planning arrangements for periodically reviewing course effectiveness and planning for improvement.

- Assessment and evaluation of the level of achieving the course outcomes through a continuous improvement process (part of a quality assurance system established by the university).
- Consequently, actions are to be taken to improve the course delivery when necessary.
- Review of the course objectives, outcomes and curriculum each 2 years.