Department of Mechanical and Aerospace Engineering
The University of Texas at Arlington
Introduction to Robotics - ME 5337

Instructor: Dr. P. S. Shiakolas
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Office Hours: Wed. 1:00 -2:30 pm and by appointment.
Prerequisites: Graduate standing or consent of instructor
Text: *Introduction to Robotics: Mechanics and Control* Third (preferred) and/or Second edition by John J. Craig

Grading Policy

Homework (5): Homework will be either analytical and/or computational. I reserved the right to inquire from you to demonstrate your work. Treat the homework as the means of practicing and understanding the concepts presented in class. It is imperative that you work all assigned homework since **not** all assigned problems will be graded. Late homework will not be accepted.

Projects (~ 4 or 5): **Each** project will be counted as **5 points** and added to your grade. The total for the class will be adjusted appropriately. Some projects utilize the robots and other resources in the MARS lab meaning that you will be required to learn the robot programming language on your own (partial support will be provided). Projects will require you to complete a project report, and be able to defend/present in class and demonstrate your work. We will also have research projects on topics of interest – you will have to write a research paper and have a short in class presentation usually the last week of classes. All projects will be individual unless otherwise specified. **All projects must be completed with a passing grade (> 60%) in order to get a passing grade in the course.**

Semester Exam (25): One mid-semester exam. The exam will be comprehensive and may consist of two parts (an analytical and a computational). Note that part or the whole exam may be take-home. In class exams are closed book-notes but I will provide some formulas if needed. The time of the exam will be announced later (approximately mid October).

Final Exam (40): The final exam will be comprehensive and may consist of two parts; an analytical and a computational. The final exam will be closed book-notes but I may provide some formulas if needed. The computational part if any could be assigned the last week of the semester.

Makeup Exam: No makeup exams will be given unless I am notified in writing in advance and approve of it. There will be only one comprehensive makeup exam the last week of the semester if needed.

Guaranteed Grading Scale: The guaranteed grading scale based upon the minimum percentage number of points obtained is shown below. The required percentages will not be increased but they may be decreased based upon the overall class averages at the end of the semester. Note that in order to get a passing grade you must complete all projects. No incomplete grades will be given for projects except in cases where prior arrangements are made with me.

90% - 100%: A, 80% - 89%: B, 70% - 79%: C, 60% - 69%: D, 0 - 60%: F

Email Communication: Email communication will be through the MyMav system to your official UTA issued email account. It is your responsibility to check your account often**.**

Software: You may use any computer software that you like, but make sure that you are proficient in it for solving the assignments for this class. Support will be provided for MATLAB and SCILAB (http://www.scilab.org). **Robotics Toolbox** – There are two versions of this toolbox; one requires MATLAB (http://www.mathworks.com) and the other requires SCILAB (http://www.scilab.org). Note that SCILAB is a free software package similar to MATLAB.

Miscellaneous: If you have a disability, any religious holidays that you need to observe or anything else that might interfere with this class and you would like for me to know about it you must inform me in writing no later than the second class meeting.

I encourage you to identify in the open literature topics of interest and new areas/applications of robotic technology and bring these to class. We will discuss interesting applications in class. Also, I will ask other faculty to give us guest lectures on their research in robotics as appropriate for this class.

Experimental Setups / Robot Programming Languages

IBM 7535 SCARA – programmed using AML Language
Adept Robots – Viper 6-dof articulated, Cobra 4-dof SCARA, Python 3-dof cartesian
The Adept robots are programmed using the V+ and MicroV+ languages (MicroV+ is a subset of V+)

Additional Reference Material

S. Y. Nof, Editor-in-Chief, *Handbook of Industrial Robotics*
A. Tucker, Jr, Editor-in-Chief, *Computer Science and Engineering Handbook*
L. Sciavicco and B. Siciliano, *Modeling and Control of Robot Manipulators*
R. P. Paul, *Robot Manipulators: Mathematics, Programming and Control*
M. W. Spong and M. Vidyasagar, *Robot Dynamics and Control*
R. M. Murray, Z. Xi, and S. S. Sastry, *A Mathematical Introduction to Robotic Manipulation*
Lung-Wen Tsai, *Robot Analysis: The Mechanics of Serial and Parallel Manipulators*
M. W. Spong, F.L. Lewis, and C.T. Abdallah, *Robot Control: dynamics, motion planning, and analysis*
F.L. Lewis, C.T. Abdallah, D.M. Dawson, *Control of robot manipulators*

Plethora of MATLAB books (In Science and Technology Library) and web resources
SCILAB reference material is available at SCILAB web page
Additional material will be provided as needed (either as photocopies or as PDF on the class web page).
It is your responsibility to check the class web page regularly for announcements

Americans with Disabilities Act

The University of Texas at Arlington is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 93112-The Rehabilitation Act of 1973 as amended. With the passage of new federal legislation entitled Americans with Disabilities Act – (ADA), pursuant to section 504 of The Rehabilitation Act, here is renewed focus on providing this population with the same opportunities enjoyed by all citizens.
As a faculty member, I am required by law to provide "reasonable accommodation" to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with informing faculty at the beginning of the semester and in providing *authorized* documentation through designated administrative channels. If you require an accommodation based on disability, I would like to meet with you in the privacy of my office no later than the second class meeting to make sure that you are properly accommodated.

Academic Dishonesty

It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspensions or expulsion from the University.
"Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts." (Regents' Rules and Regulations, Part One, Chapter VI, Section 3, Subsection 3.2, Subdivision 3.22)

Introduction to Robotics
Course Outline/Tentative Topics

Introduction	**Definitions, Robot Manufacturers, Applications, Classifications** **Robot types: Articulated, SCARA, Cartesian, Polar, etc.** **Robot Programming Languages** **Meso and Micro Robotics**
Spatial Transformations	**Homogeneous Transformations** **Reference Frames**
Robot kinematics	**Denavit-Hartenberg Parameters & Other Approaches** **Kinematic Equations** **Position and Velocity** **Degrees of Freedom** **Differential Relations** **Inverse Kinematics** **Manipulator Jacobian, Static Forces** **Accuracy and Repeatability**
Robot Dynamics	**Force Acceleration Equation** **Newtonian, Lagrangian, and Other approaches** **State Variable Representation** **Dynamic Equations Representations**
Motion Trajectory **Path Planning**	**Joint Space** **Cartesian Space**
Manipulator Control	**Position, Velocity** **Dynamic Characteristics** **Classical Control** **Computed Torque – Time permitting** **Digital Computed Torque – Time permitting** **Other Control Techniques – Time permitting**
Surgical Robots **Mobile Robots** **Biomimetic Robots** **Bacteria/Organism based Robots** **Micro/Nano Robots**	**These topics will be introduced in general from available literature.**

THINK SAFETY FIRST
RULES FOR THE MARS LAB

IN ADDITION TO THE SAFETY LECTURE,
THESE RULES MUST BE FOLLOWED WHILE IN THE ROBOTICS LAB

ONLY AUTHORIZED USERS ARE ALLOWED IN THE LAB

- **SOME OF THE ROBOTS DO NOT HAVE VISUALS (LIGHTS) INDICATING THAT THE ROBOT MOTOR POWER IS ON, ALWAYS BE ALERT AND STAY OUTSIDE THE ROBOT WORKSPACE IF THE POWER IS ON**

- **ONLY AUTHORIZED USERS ARE ALLOWED TO POWER ON THE ROBOTS AUTHORIZATION CAN ONLY BE GIVEN BY Dr. SHIAKOLAS**

- **FOR SAFETY REASONS YOU MUST OPERATE THE ROBOTS AT SLOW SPEEDS AND YOU MUST ALWAYS HAVE A TEAM MEMBER PRESENT WHILE POWER IS ON**

- **ALWAYS HOLD THE TEACH PENDANT AND STAY CLOSE TO THE EMERGENCY BUTTON WHILE THE ROBOT POWER IS ON**

- **IF A ROBOT IS IN A COLLISION COURSE OR ABOUT TO DAMAGE ANY EQUIPMENT DO NOT TRY TO STOP IT BY GRASPING IT, ALWAYS USE THE EMERGENCY BUTTON - GET OUT OF THE WAY!**

- **IF YOU INTENTIONALLY DAMAGE ANY ROBOTS OR OTHER EQUIPMENT YOU WILL BE GIVEN A FAILING CLASS GRADE AND REPORTED TO THE UNIVERSITY ADMINISTRATION**

- **THE MARS LAB IS USED BOTH FOR RESEARCH AND TEACHING.**
  DO NOT DISTURB ANY EXPERIMENTAL SETUPS IN THE LAB - YOU CAN GET MORE INFORMATION ABOUT THE EXPERIMENTS/RESEARCH PERFORMED BY CONSULTING THE RESEARCHERS.
  IF YOU DISTURB ANY EXPERIMENTAL TESTBEDS YOU WILL BE GIVEN A FAILING GRADE IN THE CLASS.

- **IT IS A PRIVILAGE AND NOT A RIGHT TO USE THE MARS LAB. IF YOU DO NOT FOLLOW THE RULES, YOU WILL BE DENIED ACCESS WHICH WILL AUTOMATICALLY YIELD TO A FAILING CLASS GRADE**

- **Dr. SHIAKOLAS, THE MAE DEPARTMENT AND THE UNIVERSITY OF TEXAS AT ARLINGTON AND UT SYSTEM ARE NOT TO BE HELD LIABLE FOR ANY INJURIES DUE TO NEGLICENSE AND/OR BY NOT FOLLOWING COMMON SENSE SAFETY RULES**

WHEN IN DOUBT ASK

I HAVE READ, UNDERSTOOD AND I WILL STRICTLY ADHERE TO THE ABOVE RULES

UTA ID# **NAME**

Signature **DATE**