SYLLABUS

1. **Course name:** ROBOTICS
2. **Course code:** ROBO320246
3. **Credits:** 2 (2/0/4)

   Duration: 15 weeks (30h main course and 60h self-study)
4. **Instructors:**

   1 – PhD. Nguyen Van Thai, PhD

   2 – M.Eng. Nguyen Tran Minh Nguyet

   3 - M.Eng. Tran Manh Son
5. **Course conditions**

   Prerequisites: Electric Circuits, Basic Electronics, Electric and Electrical Appliances, Models and Simulations on the Computer, Microcontroller

   Corequisites: N/A
6. **Course description**

The course provides the students with basic knowledge of forward manipulator kinematics, inverse manipulator kinematics, manipulator dynamics. Besides, the course also trains the students with basic skills in mechanical design a model of robot manipulator using Solidworks, and how to simulate its forward and inverse kinematics in Matlab.

7. **Course Goals**

Goals	***Goal Description*** *(The course provides the students with:)*	**ELOs**
G1	Ability to apply knowledge of transformations in 3-D space, forward manipulator kinematics, inverse manipulator kinematics, and manipulator dynamics.	
G2		
G3	Basic skills in mechanical design a model of robot manipulator using Solidworks.	
G4	Basic knowledge of simulation the forward manipulator kinematics and the inverse manipulator kinematics in Matlab	

8. **Course Learning Outcomes (CLOs)**

CLOs	***Description*** *(Students are able to:)*	**Outcome**

G1	G1.1	Describe positions, orientations and frames	
	G1.2	Interpret mappings: translations, rotations, and transformations	
	G1.3	Interpret operators: translations, rotations, and transformations	
G2	G2.1	Identify various robotic systems, such as: robot arm, mobile robot, etc.	
	G2.2	Identify links and joints in a robot manipulator.	
	G2.3	Classify different joints in a robot manipulator.	
	G2.4	Construct frames for links.	
	G2.5	Interpret parameters: length, twist, joint angle, offset.	
	G2.6	Construct the Denavit-Hartenberg parameter table.	
	G2.7	Formula the general transformation between frame{i-1} and frame{i}.	
	G2.8	Construct the Forward Kinematic problem.	
G3	G3.1	Solve the Inverse Kinematic problem using Algebraic Solution	
	G3.2	Solve the Inverse Kinematic problem using Geometric Solution	
G4	G4.1	Solve the Kinematic Dynamic problem	
G5	G5.1	Use the software Solidworks in basic mechanical design.	
	G5.2	Design a model of robot manipulator using Solidworks.	
G6	G6.1	Convert a model of robot manipulator designed in Solidworks to Matlab.	
	G6.2	Program for silumation the forward manipulator kinematics and the inverse manipulator kinematics in Matlab	

9. Study materials

❖ Textbooks

- John J. Craig, Introduction to Robotics: Mechanics and Control, 2005.
- K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics: Control, Sensing, Vision, and Intelligence, 1987.
- Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani and Giuseppe Oriolo, Robotics: Modelling, Planning and Control, 2009.

❖ References

- Ph.D Nguyen Van Thai's online lectures on YouTube:
  1. Forward Manipulator Kinematic: https://www.youtube.com/watch?v=gkYF6Rv8W5U&t=1120s
  2. Forward Manipulator Kinematic - Ex #1: https://www.youtube.com/watch?v=Rvod_NM4Vso&t=1664s

3. Forward Manipulator Kinematic - Ex #2: https://www.youtube.com/watch?v=nfbMzdTUu58&t=5s
4. Forward Manipulator Kinematic - Ex #3: https://www.youtube.com/watch?v=plDIYqRmO7E&t=72s
5. Forward Manipulator Kinematic - Ex #4: https://www.youtube.com/watch?v=R_U_2K6ii-8&t=3s
6. Inverse Manipulator Kinematic using algebraic solution: https://www.youtube.com/watch?v=0vnku9z3sNY&t=39s
7. Inverse Manipulator Kinematic using geometric solution: https://www.youtube.com/watch?v=p1wIJut1bTs&t=3s
8. Solidworks and Simulation the Forward & Inverse Kinematic in Matlab: https://www.youtube.com/watch?v=EAF2KQPeXBU
9. Installation Solidworks 2017 SP2: https://www.youtube.com/watch?v=5nGzo9tEcmY&t=14s

- PGS. Nguyễn Trường Thịnh, Giáo trình Kỹ thuật Robot, NXB Đại học Quốc gia TP.HCM, 2014.
- ThS. Tưởng Phước Thọ, Giáo trình Thực tập Robot Công nghiệp, NXB Đại học Quốc gia TP.HCM, 2014.
- PGS. TS. Đào Văn Hiệp, Kỹ thuật Robot, NXB Khoa học & Kỹ thuật, 2003.
- GS. TSKH. Nguyễn Thiện Phúc, Robot công nghiệp, NXB, Khoa học & Kỹ thuật, 2002.
- Presentation by Prof. Oussama Khatib from Stanford University, consists of 16 lectures: http://www.youtube.com/watch?v=0yD3uBshJB0&list=PL65CC0384A1798ADF&index=1

10. Sudent Assessments

- Grading points: 10
- The following is the plan for student assessment:

Test	Content	Week	Evaluation	Standards	Ratio (%)
Quick exercise at the end of each class					**5**
Homeworks					**20**
HW#1	Transformations in 3-D space	Week 4	Homework	G1.1, G1.2, G1.3	5
HW#2	Forward Manipulator Kinematics	Week 7	Homework	G2.2, G2.3, G2.4, G2.5, G2.6, G2.7, G2.8	5
HW#3	Inverse Manipulator Kinematics	Week 10	Homework	G3.1, G3.2	5
HW#4	Manipulator Dynamics	Week 14	Homework	G4.1	5
Midterm Exam					**25**
	- Overall contents that student has been studied until week #11. - Time for exam: 60 minutes. - Students are allowed to use materials at examination.	Week 12	Test quiz	G1.1, G1.2, G1.3, G2.1, G2.2, G2.3, G2.4, G2.5, G2.6, G2.7, G2.8, G3.1, G3.2	
Final Project					**50**

FP#1	- Team working - Max. 3 students/group - Design a model of robot manipulator in Solidworks - Simulate this model's forward and inverse kinematics - Oral defense presentation	Week 17	Evaluation	G1.1, G1.2, G1.3, G2.1, G2.2, G2.3, G2.4, G2.5, G2.6, G2.7, G2.8, G3.1, G3.2, G5.1, G5.2, G6.1, G6.2	40
FP#2	- Video to describe team's project	Week 18	Evaluation		10

11. Course details

Week	Content	Standards
1	***Chapter 1*** **Introduction**	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 1.1 What is Robotics? 1.2 Robotics Applications **Lecturing methods**: - Lecturing - Group discuss - Slide-show	
	B. Contents for self-study at home: *(4)* Watch videos about Robotics on YouTube.	
2	***Chapter 1*** *(Cont.)* **Introduction**	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 1.3 Briefly Preview of Topics a. Robot Mechanical Structure b. Description of Position and Orientation c. Forward Kinematics of Manipulators d. Inverse Kinematics of Manipulators e. Jacobians: Velocities & Static Forces f. Manipulator Dynamics **Lecturing method**: - Lecturing - Group discuss - Slide-show	
	B. Contents for self-study at home: *(4)*	

	Watch on YouTube about Gripper's mechanical structure.	
3	***Chapter 2*** **Spatial Descriptions & Transformations**	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 2.1 Descriptions: Positions, Orientations, and Frames 2.2 Mappings: Changing Descriptions from Frame to Frame **Lecturing methods**: - Lecturing - Group discuss - Slide-show	G1.1, G1.2
	B. Contents for self-study at home: *(4)* Read more at Chapter 2, from pages 19 to 29 in the book "*John J. Craig, Introduction to Robotics: Mechanics and Control, 2005*".	
4	***Chapter 2*** *(cont.)* **Spatial Descriptions & Transformations**	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 2.3 Operators: Translations, Rotations, and Transformations 2.4 Exercises **Lecturing methods**: - Lecturing - Group discuss - Slide-show	G1.3
	B. Contents for self-study at home: *(4)* 2.5 Homework	G1.1, G1.2, G1.3
5	***Chapter 3*** **Manipulator Kinematics**	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 3.1 Introduction 3.2 Link Description 3.3 Link-connection Description **Lecturing methods**: - Lecturing - Group discuss - Slide-show	G2.1, G2.2, G2.3
	B. Contents for self-study at home: *(4)* Read more at Chapter 3, from pages 62 to 67 in the book "*John J. Craig, Introduction to Robotics: Mechanics and Control, 2005*".	

6	***Chapter 3*** *(cont.)* **Manipulator Kinematics**	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 3.4 Convention for affixing frames to links 3.5 Manipulator Kinematic **Lecturing methods**: - Lecturing - Group discuss - Slide-show	G2.4, G2.5, G2.6, G2.7, G2.8
	B. Contents for self-study at home: *(4)* - Read more at Chapter 3, from pages 67 to 89 in the book "*John J. Craig, Introduction to Robotics: Mechanics and Control, 2005*". - Ph.D Nguyen Van Thai's online lectures on YouTube: 1. Forward Manipulator Kinematic: https://www.youtube.com/watch?v=gkYF6Rv8W5U&t=1120s 2. Forward Manipulator Kinematic - Ex #1: https://www.youtube.com/watch?v=Rvod_NM4Vso&t=1664s	
7	***Chapter 3*** *(cont.)* **Manipulator Kinematics**	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 3.6 Exercises **Lecturing methods**: - Lecturing - Group discuss - Slide-show	G2.1, G2.2
	B. Contents for self-study at home: *(4)* 3.7 Homework 3.8 Design a model of robot manipulator using Solidworks 3.9 Convert robot model from Solidworks to Matlab 3.10 Simulate forward and inverse kinematics in Matlab - Ph.D Nguyen Van Thai's online lectures on YouTube: 1. Forward Manipulator Kinematic - Ex #2: https://www.youtube.com/watch?v=nfbMzdTUu58&t=5s 2. Forward Manipulator Kinematic - Ex #3: https://www.youtube.com/watch?v=plDIYqRmO7E&t=72s 3. Forward Manipulator Kinematic - Ex #4: https://www.youtube.com/watch?v=R_U_2K6ii-8&t=3s 4. Solidworks and Simulation the Forward & Inverse Kinematic in Matlab: https://www.youtube.com/watch?v=EAF2KQPeXBU 5. Installation Solidworks 2017 SP2:	G2.1, G2.2, G2.3, G2.4, G2.5, G2.6, G2.7, G2.8

	https://www.youtube.com/watch?v=5nGzo9tEcmY&t=14s	
9	***Chapter 4*** **Inverse Manipulator Kinematics**	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 4.1 Algebraic vs. Geometric 4.2 Algebraic solution by reduction to polynomial **Lecturing methods**: - Lecturing - Group discuss - Slide-show	G3.1, G3.2
	B. Contents for self-study at home: *(4)* - Read more at Chapter 4, from pages 101 to 114 in the book "*John J. Craig, Introduction to Robotics: Mechanics and Control, 2005*". - Ph.D Nguyen Van Thai's online lectures on YouTube: 1. Inverse Manipulator Kinematic using algebraic solution: https://www.youtube.com/watch?v=0vnku9z3sNY&t=39s	
10	***Chapter 4*** *(cont.)* **Inverse Manipulator Kinematics**	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 4.3 Pieper's solution when three axes intersect **Lecturing methods**: - Lecturing - Group discuss - Slide-show	G3.1, G3.2
	B. Contents for self-study at home: *(4)* Read more at Chapter 4, from pages 114 to 125 in the book "*John J. Craig, Introduction to Robotics: Mechanics and Control, 2005*".	
12	***Chapter 4*** *(cont.)* ***Inverse Manipulator Kinematics***	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 4.4 *Exercises* **Lecturing methods**: - Lecturing - Group discuss - Slide-show	G3.1, G3.2
	B. Contents for self-study at home: *(4)* 4.5 Homework - Ph.D Nguyen Van Thai's online lectures on YouTube: 1. Inverse Manipulator Kinematic using geometric solution:	

	https://www.youtube.com/watch?v=p1wIJut1bTs&t=3s	
13	***Midterm Exam (2)***	
14	***Chapter 5*** **Manipulator Dynamics**	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 5.1 Acceleration of a rigid body 5.2 Mass distribution 5.3 Newton's equation, Euler's equation **Lecturing methods**: - Lecturing - Group discuss - Slide-show	G4.1
	B. Contents for self-study at home: *(4)* Read more at Chapter 6, from pages 165 to 180 in the book "*John J. Craig, Introduction to Robotics: Mechanics and Control, 2005*".	
15	***Chapter 5*** *(cont.)* **Manipulator Dynamics**	
	A. Contents and Lecturing methods at class: *(2)* **Contents:** 5.4 Iterative Newton - Euler dynamic formulation 5.5 The structure of a manipulator's dynamic equations 5.6 Lagrangian formulation of manipulator dynamics 5.7 Exercises **Lecturing methods**: - Lecturing - Group discuss - Slide-show	G4.1
	B. Contents for self-study at home: *(4)* Read more at Chapter 6, from pages 180 to 192 in the book "*John J. Craig, Introduction to Robotics: Mechanics and Control, 2005*". 5.8 Homework	

12. Learning ethics

- Home assignments and projects must be done by the students themselves. Plagiarism found in the assessments student will get zero score.

13. First approved date:

14. Approval level:

Dean **Department** **Instructor**

Assoc. Prof. PhD. Nguyen Minh Tam	**Assoc. Prof. PhD. Truong Dinh Nhon**	**PhD. Nguyen Van Thai**

15. Syllabus updated process

1st time: Updated content dated **2st time:** Updated content dated	Instructors Head of department