Subject Description Form

Subject Code	ME42011
Subject Title	Fundamentals of Robotics
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	Pre-requisite: ME31002 Linear systems and control; or ME41004 Mechatronics and Control
Objectives	1. To provide students with the concepts and techniques for the design, modeling, analysis of robots. 2. To provide students with the fundamental knowledge of machine vision for robot guidance and automation.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Identify different types of robots and their applications in the industry. b. Construct the kinematics and dynamics equations of robots for motion analysis. c. Apply motion planning algorithms to generate the path for robots. d. Apply different machine vision and image processing algorithms to automate robots.
Subject Synopsis/ Indicative Syllabus	**Robot Modelling.** Degrees of freedom, coordinate frame and homogeneous transformation, Denavit-Hartenberg (DH) convention, forward and inverse kinematics, Jacobian matrix, singularity, robot dynamic models, state estimation, motion planning and obstacle avoidance. **Computer Vision.** Image formation, acquisition, histogram, edge and line detections, image enhancement, filtering, object recognition, stereo vision, camera modeling and calibration, deep neural networks in computer vision. **Laboratory Work** There is at least 6-hour laboratory sessions or an equivalent project. Typical Experiments are: 1. Programming and control of robots. 2. Path planning of mobile robots for collision avoidance. 3. Programming of image processing and computer vision.

Teaching/Learning Methodology

Lectures aim at providing students with an integrated knowledge required for understanding and analyzing different robots, including system modeling, trajectory planning and image processing (Outcomes a to d)

Tutorials aim at enhancing students' analytical and problem solving skills on robotics. Students will be able to solve real-world problems using the knowledge they acquired in the class. (Outcomes a to d)

The project/experiments aims to have hand-on experience to automation of a robot system with vision or other functions. (Outcomes a to d)

Teaching/Learning Methodology	Outcomes			
	a	b	c	d
1. Lectures	√	√	√	√
2. Tutorials		√	√	√
3. Homework assignments		√	√	√
4. Project or experiments	√	√	√	√

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed			
		a	b	c	d
1. Examination	50%	√	√	√	√
2. Class Test	20%	√	√	√	√
3. Coursework including Project/Experimental Work	30%	√	√	√	√
Total	100%				

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

1. The assessment is comprised of 50% continuous assessment and 50% examination.
2. The continuous assessment consists of three components: homework assignments, test, and experiments/projects. They are aimed at evaluating the progress of students' study, assisting them in self-monitoring of fulfilling the respective subject learning outcomes, and enhancing the integration of the knowledge learnt.
3. The examination is used to assess the knowledge acquired by the students for understanding and analyse the problems critically and independently; as well as to determine the degree of achieving the subject learning outcomes.

Student Study Effort Expected	Class contact:	
	▪ Lecture	30 Hrs.
	▪ Tutorial/Laboratory	9 Hrs.
	Other student study effort:	
	▪ Reading and review	36 Hrs.
	▪ Coursework (assignments, project)	40 Hrs.
	Total student study effort	115 Hrs.
Reading List and References	1. Introduction to Robotics: Analysis, Control, Applications, Saeed B. Niku, John Wiley and Sons, latest edition. 2. Modern Robotics: Mechanics, Planning, and Control, Kevin M. Lynch, Frank C. Park, latest edition. 3. Introduction to Autonomous Mobile Robots, Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, latest edition. 4. Introduction to Autonomous Robots: Mechanisms, Sensors, Actuators, and Algorithms, Nikolaus Correll, Bradley Hayes, Christoffer Heckman and Alessandro Roncone, latest edition. 5. R. C. Gonzalez and R. E. Woods, Digital Image Processing, Prentice Hall, latest edition. 6. Deep Learning, Ian Goodfellow, Yoshua Bengio and Aaron Courville, latest edition.	

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