Course Number : AR501/ ME452
Course Name : Robot Kinematics, Dynamics, and Control
Credit Distribution : 3-1-0-4
Intended for : UG, PG and Ph.D
Prerequisite : Consent of faculty advisor
Mutual Exclusion **:** None

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1. Preamble:

This course will give students a complete understanding of not only how robots move (kinematics) but also why they move (dynamics). In this course, they will learn to develop the dynamics models of basic robotic systems, as well as create intelligent controllers for them. The students will learn several things. To name a few are: solve the dynamics for the motion of rigid bodies in 3D space, model the dynamics of a robotic system and derive its equations of motion, and create a full state feedback controller to allow a robotic system to balance.

2. Course Modules with quantitative lecture hours:

Introduction to Robotics: Basic definitions, mechanism, degree of freedom, Rigid Body Motions - Fundamentals, Classification of robots, actuators, sensors, and control systems. **(3 hours)**

Kinematics: Tracking Rigid Bodies (position and orientation), Coordinate transformation, Differential Kinematics, Kinematic Chains - Forward Kinematics (FK), Inverse Kinematics (IK), Differential Manipulator Kinematics. **(11 hours)**

Dynamics: Rigid Body Dynamics - Dynamics of Constrained Particles, Dynamics of a Rigid Body; Manipulator Dynamics - Dynamics of Serial Manipulators, Manipulator Dynamics with Constraints. **(11 hours)**

Trajectory generation: Determining the joint variables for desired trajectory. **(5 hours)**

Control: Fundamentals of Control - Linear Time Invariant Systems with Single Input and Output, Feedback Control and Stability, PID Controller, State Estimation in Feedback Systems; Manipulator Control - Local vs Centralized Motion Control Strategies, Indirect vs Direct Force Control Strategies. **(12 hours)**

Laboratory/practical/tutorial Modules:

Kinematics, Dynamics, Trajectory generation, Control

3. Textbooks:

1. Modern Robotics: Mechanics, Planning, and Control," Kevin M. Lynch and Frank C. Park, Cambridge University Press, 2017.
2. Craig John J., “Introduction to robotics: Mechanics & Control”, 3rd Ed., Pearson. 2008.
3. M. W. Spong and M. Vidyasagar, Robot Dynamics and Control, John Wiley, New York, 1989.
4. Murray R., Li Z., and Sastry S., *A Mathematical Introduction to Robotic Manipulation*, CRC Press.
5. Siciliano B., Sciavicco L., Villani L. and Oriolo G., *Robotics: Modeling, Planning and Control*, Springer.

4. References:

1. Ellis G., *Control System Design Guide*, Elsevier.
2. Jazar R. N., *Theory of Applied Robotics: Kinematics, Dynamics, and Control*, Springer.Moon F., Applied Dynamics, Wiley-VCH.

3. Astrom K. and Murray R., *Feedback Systems: An Introduction for Scientists and Engineers*, Princeton.
4. Friedland B., *Control System Design: An Introduction to State-Space Methods*, Dover.

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		None	None	None

6. Justification of new course proposal if cumulative similarity content is >30%: None