GUJARAT TECHNOLOGICAL UNIVERSITY

Minor Degree – Robotics
Subject Code: 115AO01

Semester: V
Subject Name: Mechanics of Robotics

Type of course: Minor Degree (Module 2)
Prerequisite: Minor Degree (Module 1)

Rationale:

This course aims to inculcate thorough understanding about basic knowledge of mathematics, kinematics and dynamics required for understanding motion programming and operational / control functionality in robotics.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	0	0	0	70

Content:

Sr. No.	Content	Total Hrs
1	**Mathematical Preliminaries of Robotics:** Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, Euler Parameters.	**10**
2	**Robot Kinematics:** Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations, Homogeneous Transformation Matrix, Forward Kinematics. Inverse Kinematics, Geometric and analytical approach.	**10**
3	**Velocities & Statics**: Cross Product Operator for kinematics, Jacobians - Direct Differentiation, Basic Jacobian, , Jacobian Jv / Jw, Jacobian in a Frame, Jacobian in Frame {0}, Kinematic Singularity, Kinematics redundancy, Force balance equation, Forces, Velocity/Force Duality, Virtual Work, Force ellipsoid, Jacobian, Kinematic Singularity, Kinematics redundancy, Mechanical Design of robot linkages,	**08**
4	**Robot Dynamics:** Introduction to Dynamics, Velocity Kinematics, Acceleration of rigid body, mass distribution Newton's equation, Euler's equation, Iterative Newton –Euler's dynamic formulation, closed dynamic, Lagrangian formulation of manipulator	**08**

	dynamics, dynamic simulation, computational consideration.	

Reference Books:

1. S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014).
2. Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)
3. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)
4. M. Spong, M. Vidyasagar, S. Hutchinson, Robot Modeling and Control, Wiley & Sons, (2005).
5. J. J. Craig, "Introduction to Robotics: Mechanics and Control", 3rd edition, Addison-Wesley (2003).

Distribution of marks weightage for cognitive level

Bloom's Taxonomy for Cognitive Domain	**Marks % weightage**
Recall	10
Comprehension	10
Application	30
Analysis	40
Evaluate	5
Create	5

Course Outcome:

After learning the course the students will able to:

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	To understand terminologies related to Kinematics and Dynamics of Robotics.	20
CO-2	To apply mathematics for manipulator positioning and motion planning.	30
CO-3	To analyse basics of motion programming as per kinematics.	30
CO-4	To estimate the force/torque required to drive a robot.	20

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Major Equipment:

1. Computational facility.
2. Robotics laboratory

Alternative SWAYAM/NPTEL Course:

NPTEL Course Name	Instructor	Host Institute
Robotics	Prof. Dilip Kumar Pratihar	IIT Kharagpur
Robotics	Prof. P. Seshu, Prof. P.S. Gandhi, Prof. K. Kurien Issac, Prof. B. Seth, Prof. C. Amarnath	IIT Bombay