COURSE TITLE	**MULTIBODY DYNAMICS**
COURSE CODE	**01CA1213**
COURSE CREDITS	**3**

Objective:

1 This course reviews and reinforces the student's understanding Kinematics and Dynamics of multi body systems with immediate application to the dynamics of systems of rigid bodies. The course will place equal emphasis on gaining both an analytical understanding and insight/intuition on the subject.

Course Outcomes: After completion of this course, student will be able to:

1 Apply principles of particle dynamics and 2D rigid body mechanics to analyze motion of 3D rigid bodies.

2 Analyze kinematics and dynamics of interconnected bodies in multi-body systems.

3 Apply numerical methods to analyze and solve multi-body system problems and interpret the results.

Pre-requisite of course: Dynamics of Machine

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	0	50	30	20	0	0

Contents : Unit	Topics	Contact Hours
1	**Basic concepts in 3-D rigid-body mechanics** Degrees-of-freedom; Rigid body vs flexible body, Spatial kinematics (3-D rotation transformations); Euler theorem, Moments and products of inertia; Newton-Euler equations of motion, Lagrange Equation; Generalized forces	11
2	**Inter-connected rigid bodies** Kinematic pairs (joints) with classification of constraints; holonomic and non- holonomic constraints, Springs, dampers, actuators and controllers with brief introduction of controls theory.	6
3	**Formulation of equations of motion for inter-connected bodies** Relative coordinates, generalized coordinates, Cartesian co-ordinates, Lagrange' s equations and other approaches; Differential equations (ODE) and differential algebraic equations (DAE), Co-ordinate partitioning and Lagrange multipliers, Types of analyses (kinematic, static, quasi-static, kineto-static, dynamic and linear dynamic)	11

Contents : Unit	Topics	Contact Hours
4	**Application of numerical methods** NR method, Jacobian, ODE integrators (Euler methods and Implicit methods), Stability, accuracy and Dahlquist's tradeoff criteria, Stiffness and damping - physical vs numerical; Lock-up, bifurcation and singularities.	7
5	**Flexible Multi-body Systems** Dynamic analyses using classical approximation, FEM	7
Total Hours		**42**

Textbook :

1 Computational dynamics, Shabana A. A, John Wiley & Sons., 2009

2 Dynamics of Multi body Systems, Roberson R. E., and Richard S., Springer-Verlag, 1988

References:

1 Dynamics of Multi body Systems, Dynamics of Multi body Systems, Shabana A. A., Cambridge University press, 2014

2 4. Flexible Multi body Dynamics, 4. Flexible Multi body Dynamics, Bauchau O. A., Springer, 2011

3 Dynamics and Balancing of Multi body Systems, Dynamics and Balancing of Multi body Systems, Chaudhary H. and and S K Saha, Springer, 2009

4 Nonlinear Dynamics: A Two-Way Trip from Physics to Math, Nonlinear Dynamics: A Two-Way Trip from Physics to Math, Yurii A. Mitropolsky and Nguyen Van Dao, Springer, 2012

5 Multibody Systems Approach to Vehicle Dynamics, Multibody Systems Approach to Vehicle Dynamics, Michael Blundell and Damian Harty, Elsevier, 2014

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
10.00	10.00	20.00	15.00	25.00	20.00

Instructional Method:

1 Presentation

Supplementary Resources:

1 https://onlinecourses.nptel.ac.in/noc22_me96/preview