

Module 1

Chapter 1 : Kinetics of Rigid Bodies and Basic Kinematics 1-1 to 1-84

1.1 Kinetics of Rigid Bodies : Concept of mass moment of inertia and its application to standard objects.
Kinetics of rigid bodies : Work and energy
 Kinetic energy in translating motion, Rotation about fixed axis and in general plane motion, Work energy principle and Conservation of energy

1.2 Basic Kinematics : Structure, Machine, Mechanism, Kinematic link & its types, Kinematic pairs, Types of constrained motions, Types of Kinematic pairs, Kinematic chains, Types of joints, Degree of freedom (mobility), Kutzbach mobility criterion, Grubler's criterion & its limitations
 Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions

1.1 Simple Harmonic Motion (S.H.M.) 1-2

1.1.1 Period of Oscillation..... 1-2

1.2 Some Important Definitions in S.H.M..... 1-2

1.2.1 Amplitude of Oscillation 1-2

1.2.2 Time Period..... 1-2

1.2.3 Frequency 1-2

1.3 Pendulum Motion 1-2

1.3.1 Simple Pendulum 1-2

1.3.2 Compound Pendulum..... 1-3

1.3.3 Torsional Pendulum..... 1-4

1.4 Mass Moment of Inertia..... 1-4

1.5 Mass M.I. w.r.t. Co-ordinate Axis 1-4

1.6 Parallel Axis Theorem 1-5

1.7 Mass Moment of Inertia of Some Bodies 1-5

1.7.1 Mass M.I. of Uniform Rod of Mass M and Length L..... 1-5

1.7.2 Mass M.I. of a Rectangular Lamina of Mass M..... 1-5

1.7.3 Mass M.I. of a Circular Ring 1-6

1.7.4 Mass M.I. of Circular Lamina..... 1-6

1.7.5 M.I. of a Solid Cylinder 1-6

1.7.6 M.I. of a Homogeneous Hollow Right Circular Cylinder (Hoop) 1-6

1.7.7 M.I. of a Solid Sphere 1-7

1.8 Equations of Plane Motion : D'Alembert's Principle 1-12

1.9 Applications to Different Types of Motion..... 1-13

1.9.1 Motion of Translation 1-13

1.9.2 Centroidal Rotation..... 1-13

1.9.3 Non Centroidal Rotation..... 1-13

1.10 Motion of Rolling Bodies 1-13

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1.10.2 Slipping of Roller..... 1-13

1.11 Application of D'Alembert's Principle for Bars, Cylinders and Spheres..... 1-13

1.12 Work Done 1-27

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1.12.2 W.D. by Gravitational Force = mgh 1-27

1.12.3 W.D. by Frictional Force..... 1-27

1.12.4 W.D. by Spring Force 1-27

1.12.5 W.D. by a Couple or Moment 1-27

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1.13.2 K.E. of Rotation 1-27

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1.15 Principle of Conservation of Energy 1-28

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1.17.2 Types of Rigid Links..... 1-38

1.18 Machine 1-38

1.19 Structure 1-39

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1.22 Kinematic Chain..... 1-43

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1.24 Closed and Open Kinematic Chain 1-46

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1.26.1 Inversions of Four Bar Kinematic Chain 1-48

1.26.2 Inversions of Single Slider Kinematic Chain 1-51

1.26.3 Inversions of Double Slider Kinematic Chain 1-54

1.27 Grashoff's Law 1-59

1.27.1 Class - I four bar linkage ($s + l < p + q$) 1-59

1.27.2 Class - II Four Bar Linkage($s + l > p + q$) 1-60

1.27.3 Special Cases of Four Bar Linkage ($s + l = p + q$) 1-61

1.28 Degree of Freedom (DOF)..... 1-63

1.29 Mobility and Degree of Freedom (DOF) 1-64

1.30 Kutzbach Criterion 1-65

1.31 Grubler's Criterion 1-65

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1.31.4 Limitations of Grubler's Criteria..... 1-70

Module 2

Chapter 2 : Special Mechanisms 2-1 to 2-29

2.1 Straight line generating mechanisms :
Introduction to Exact straight line generating mechanisms – Peaucillier's and Hart's Mechanisms, Introduction to Approximate Straight line generating mechanisms – Watt's, Grasshopper mechanism, Tchebicheff's mechanisms

2.2 Offset slider crank mechanisms : Pantograph, Hook-joint (single and double).

2.3 Steering Gear Mechanisms : Ackerman, Davis steering gears

2.1 Pantograph..... 2-2

2.2 Straight Line Generating Mechanisms 2-3

2.2.1 Exact Straight Line Generating Mechanisms 2-3

2.2.2 Approximate Straight Line Generating Mechanisms..... 2-5

2.3 Automobile Steering Gear Mechanism 2-8

2.3.1 Davis Steering Gear Mechanism..... 2-9

2.3.2 Ackermann Steering Gear Mechanism..... 2-11

2.3.3 Differentiate between 'Davis Steering Gear Mechanism' and 'Ackermann Steering Gear Mechanism' 2-12

2.4 Hooke's Joint or Universal Coupling 2-13

2.4.1 Hooke's Joint Analysis..... 2-14

2.4.2 Maximum and Minimum Speeds of the Driven Shaft..... 2-15

2.4.3 For Equal Speeds of Driving and Driven Shafts..... 2-15

2.4.4 Maximum Fluctuation of Speed of Driven Shaft..... 2-16

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2.4.6 Angular Acceleration of Driven Shaft..... 2-16

2.4.7 Double Hooke's Joint..... 2-16

2.5 Offset Slider Crank Mechanism 2-26

Module 3

Chapter 3 : Velocity and Acceleration Analysis of Mechanisms 3-1 to 3-89

3.1 Velocity Analysis of Mechanisms (mechanisms up to 6 links) Velocity analysis by instantaneous centre of rotation method (Graphical approach), Velocity analysis by relative velocity method (Graphical approach)

3.2 Acceleration Analysis of Mechanisms (mechanisms up to 6 links) Acceleration analysis by relative method including pairs involving Coriolis acceleration (Graphical approach)

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3.2 Linear and Angular Velocity..... 3-2

3.3 Representation of Velocity by Vectors 3-2

3.4 Velocity Analysis by Relative Velocity Method 3-3

3.4.1 Relative Velocity of Two Bodies having their Absolute Motions 3-3

3.4.2 Velocity Diagram of a Rigid Link 3-4

3.5 Rubbing Velocity at a Pin Joint..... 3-5

3.6 Mechanical Advantage..... 3-5

3.7 Applications of the Relative Velocity Method 3-5

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3.8.5 Properties of the Instantaneous Centre..... 3-18

3.8.6 Centrodes..... 3-18

3.9 Three Centres in Line Theorem (Aronhold - Kennedy's Theorem) 3-18

3.10 Steps to Locate Instantaneous Centres..... 3-19

3.11 Angular Velocity Ratio Theorem 3-20

3.12 Freudenstein's Theorem..... 3-20

3.13 Acceleration Analysis by Relative Velocity Method..... 3-42

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3.15 Motion of a Particle Moving in a Circular Path..... 3-42

3.15.1 Tangential Acceleration, f^t 3-43

3.15.2 Centripetal Acceleration, f^c 3-43

3.15.3 Total Acceleration, f 3-43

3.16 Acceleration Diagram of a Link by Relative Acceleration Method 3-43

3.17 Outline Procedure of Drawing the Acceleration Diagram of a Mechanism 3-44

3.18 Coriolis Component of Acceleration..... 3-64

3.18.1 Magnitude of Coriolis Component of Acceleration..... 3-65

3.18.2 Method of Finding the Direction of Coriolis Component..... 3-65

Module 4

Chapter 4 : CAM Mechanisms 4-1 to 4-38

4.1 Cam and its Classification based on shape, follower movement, and manner of constraint of follower; Followers and its Classification based on shape, movement, and location of line of movement; Cam and follower terminology

4.2 Motions of the follower : SHM, Constant acceleration and deceleration (parabolic), Constant velocity, Cycloidal; Introduction to cam profiles (No problems on this point)

4.1 Introduction 4-2

4.2 Classification of Followers 4-2

4.3 Classification of Cams 4-3

4.3.1 Classification of Cam According to Types of Shape..... 4-3

4.3.2 Classification of Cam According to Type of Follower Movement..... 4-4

4.3.3 Classification of Cam According to Type of Constraint of the Follower..... 4-5

4.4 Terminology and Definitions..... 4-6

4.5 Types of Motions of the Follower 4-6

4.6 Motion of Follower with Uniform Velocity 4-7

4.6.1 Analytical Solution for Calculation of Displacement Velocity, Acceleration and Jerk of Follower having Uniform Velocity..... 4-7

4.7 Motion of Follower with Simple Harmonic Motion..... 4-8

4.7.1 Method of Drawing the Displacement Diagram..... 4-8

4.7.2 Analytical Solution for Calculation of Displacement, Velocity, Acceleration and Jerk of Follower having Simple Harmonic Motion..... 4-9

4.8 Motion of Follower with Uniform Acceleration and Retardation 4-10

4.8.1 Method of Drawing the Displacement Diagram 4-11

4.8.2 Analytical Solution for Calculation of Displacement Velocity, Acceleration and Jerk of Follower having Uniform Acceleration and Retardation 4-11

4.9 Motion of Follower with Cycloidal Motion..... 4-12

4.9.1 Method of Drawing the Displacement Diagram... 4-12

4.9.2 Analytical Solution for Calculation of Displacement, Velocity, Acceleration and Jerk of Follower having Cycloidal Motion 4-12

4.10 Determination of Cam Profile for a given Follower Motions..... 4-15

Module 5

Chapter 5 : Belts, Chains and Breaks 5-1 to 5-54

5.1 Belts : Introduction, Types and all other fundamentals of belting, Dynamic analysis –belt tensions, condition of maximum power transmission

5.2 Chains (No problems) : types of chains, chordal action, variation in velocity ratio, length of chain (No problems)

5.3 Brakes (No problems) : Introduction, types and working principles, Introduction to braking of vehicles

<p>5.1 Introduction to Belt and Rope Drive 5-2</p> <p>5.2 Types of Belts 5-2</p> <p>5.2.1 Materials used for Belt and Rope Drives 5-2</p> <p>5.2.2 Selection of Belt Drive..... 5-3</p> <p>5.3 Types of Belt Drives 5-3</p> <p>5.4 Crowning of Pulley 5-4</p> <p>5.5 Law of Belting..... 5-5</p> <p>5.6 Velocity Ratio of Belt Drive..... 5-5</p> <p>5.6.1 Velocity Ratio of Open Belt Drive 5-5</p> <p>5.6.2 Velocity Ratio of Compound Belt Drive..... 5-6</p> <p>5.7 Slip of Belt..... 5-6</p> <p>5.8 Creep of Belt 5-7</p> <p>5.9 Length of Belt 5-9</p> <p>5.9.1 Length of an Open Belt Drive 5-9</p> <p>5.9.2 Length of Cross Belt Drive 5-10</p> <p>5.10 Angle of Contact or Angle of Lap 5-11</p> <p>5.11 Limiting Tension Ratio 5-11</p> <p>5.12 Limiting Tension Ratio in V-belt or Rope 5-12</p> <p>5.13 Centrifugal Tension in Belt 5-15</p> <p>5.14 Stress Induced in Belt..... 5-15</p> <p>5.15 Power Transmitted by Belt..... 5-16</p> <p>5.16 Maximum Power Transmitted by Belt..... 5-19</p> <p>5.17 Initial Tension in the Belt..... 5-23</p> <p>5.18 Rope Drive..... 5-31</p> <p>5.18.1 Types of Rope Drives..... 5-31</p> <p>5.18.2 Advantages and Limitations of Rope Drives over Other Drives..... 5-31</p>	<p>5.19 Chain Drive5-33</p> <p>5.20 Advantages and Disadvantages of Chain Drive over Belt or Rope Drive5-33</p> <p>5.21 Classification of Chains.....5-34</p> <p>5.22 Terms used in Chain Drive5-35</p> <p>5.23 Relation between Pitch and Pitch Circle Diameter5-35</p> <p>5.24 Relation between Chain Speed and Angular Velocity of Sprocket5-35</p> <p>5.25 Chordal Action.....5-36</p> <p>5.26 Length of Chain.....5-37</p> <p>5.27 Introduction to Brakes.....5-37</p> <p>5.27.1 General Requirements of a Good Braking System5-38</p> <p>5.27.2 General Requirements of a Good Brake Lining Material5-38</p> <p>5.28 Classification of Brakes.....5-38</p> <p>5.29 Block or Shoe Brakes5-38</p> <p>5.29.1 Single Block or Shoe Brake.....5-39</p> <p>5.29.1.1 Self Locking and Self Energizing of Brakes.....5-41</p> <p>5.29.2 Pivoted Block Brake ($2\theta > 60^\circ$).....5-41</p> <p>5.29.3 Double Block or Shoe Brake5-41</p> <p>5.30 Band Brakes5-42</p> <p>5.30.1 Simple Band Brake5-42</p> <p>5.30.2 Differential Band Brake5-43</p> <p>5.30.2.1 Self Locking and Self Energizing of Differential Band Brake5-44</p> <p>5.31 Band and Block Brake5-44</p> <p>5.32 Internal Expanding Shoe Brake5-45</p> <p>5.32.1 Braking Torque of an Internal Expanding Shoe Brake.....5-46</p> <p>5.33 Braking of a Vehicles.....5-47</p> <p>5.34 Hydraulic Brakes.....5-49</p> <p>5.34.1 Construction5-49</p> <p>5.34.2 Working Principle.....5-50</p> <p>5.34.3 Advantages of Hydraulic Brake System5-50</p> <p>5.34.4 Disadvantages of Hydraulic Brake System5-50</p> <p>5.35 Disc Brakes5-50</p> <p>5.36 Pneumatic (Air) Brakes5-51</p>
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Module 6

Chapter 6 : Gears and Gear Trains 6-1 to 6-100

6.1 Gears : Introduction, Types, Law of gearing, Forms of teeth, Details of gear terminology, Path of contact, Arc of contact, Contact ratio, Interference in involutes gears, Minimum number of teeth for interference free motion, Methods to control interference in involutes gears, Static force analysis in gears - spur, helical, bevel, worm & worm wheel (No problems on this point)

6.2 Gear Trains : Kinematics and dynamic analysis of simple and compound gear trains, reverted gear trains, epi-cycle gear trains with spur or bevel gear combination.

6.1 Introduction..... 6-2
6.2 History of Gears..... 6-2
6.3 Advantages and Disadvantages of Gear Drive..... 6-2
6.4 Classification of Gears..... 6-3
 6.4.1 Classification of Gears According to the Position of Shaft Axis..... 6-3
 6.4.1.1 Spur Gears..... 6-3
 6.4.1.2 Helical Gears..... 6-4
 6.4.1.3 Rack and Pinion 6-4
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 6.4.1.6 Worm and Worm Wheel..... 6-6
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6.7 Law of Gearing (Condition for Constant Velocity Ratio)..... 6-10

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