## CONTENTS

	PAGE
PREFACE	V
CHAPTER I	
MOTION—VECTORS—FORCE AND MOTION	1
Speed—Velocity—Acceleration—Units—Motion of a particle—Angular velocity—Angular acceleration—Scalar and vector quantities—Parallelogram of vectors—Polygon of vectors—Circular motion—Plane motion—Impulse—Centripetal force—Space-time graph—Speed-time graph—Acceleration-time graph	
CHAPTER II	
CENTRE OF GRAVITY-MOMENTS-COUPLE-MOMENT OF	
INERTIA—DYNAMICS OF SIMPLE ENGINE MECHANISM .	26
Centre of gravity—Moment of a force—Moment of a couple—Moment of inertia—Angular momentum—Radius of gyration—Work—Power—Load lifting machines—Principle of work—Overhauling of machines—Kinetic energy—Potential energy—Conservation of energy—Centripetal force on a rigid body—Accelerating forces—Inertia torque—Angular velocity of connecting rod—Crank effort diagram—Torque diagram—Flywheels	
CHAPTER III	
SIMPLE HARMONIC MOTION—OSCILLATIONS	64
Free vertical oscillations of a spring—Simple pendulum—Compound pendulum—Torsional oscillations—Oscillations of a rotating shaft—Damped oscillations—Forced oscillations—Equivalence of crank and eccentric—Sum and difference of harmonic motions—Combination of two harmonic motions	
CHAPTER IV	
PAIRS—ELEMENTS—MECHANISMS CONTAINING FOUR	
LOWER PAIRS—INVERSION	87
Lower and higher pairs—Sliding pairs—Constraint—Closure—Turning pairs—Screw pairs—Kinematic chain—Machine—Mechanisms of four links—Inversion of kinematic chains—Whitworth's quick return motion—Oscillating cylinder engine—Crank and slotted lever quick return motion—Inversions of the double slider crank chain—Rapson's slide—Plane motion of plane rigid body—Instantaneous centre of rotation—Space centrode and body centrode—Simple steam engine mechanism—Line of connection—Virtual centres—Relative angular velocities—Rubbing speeds—Cylinders in pure rolling contact	
Free vertical oscillations of a spring—Simple pendulum—Compound pendulum—Torsional oscillations—Oscillations of a rotating shaft—Damped oscillations—Forced oscillations—Equivalence of crank and eccentric—Sum and difference of harmonic motions—Combination of two harmonic motions  CHAPTER IV  PAIRS—ELEMENTS—MECHANISMS CONTAINING FOUR LOWER PAIRS—INVERSION	

CHAPTER V	
VELOCITIES AND ACCELERATIONS OF POINTS IN MECHAN-	PAGE
ISM-IMAGES-LINK-MOTION AND VALVE GEARS-THE	
SLIDE VALVE	114
Straight rigid bar in plane motion—Velocity diagram for a rigid bar—Velocity image—Acceleration image—Piston acceleration, Klein's construction—Reversing gears—Link motions—Equivalent eccentric—Slide valve displacement—Hackworth valve gear—Joy's valve gear—Walschaert's valve gear—Equivalent eccentric for any valve gear—The slide valve—Zeuner valve diagram—Reuleaux valve diagram—Velocity of valve—Expansion valves—Acceleration centre	
CHAPTER VI	
STRAIGHT LINE MECHANISMS—HOOKE'S JOINT	157
Exact straight line mechanisms made up of turning pairs—Scott Russell's parallel motion—Watt's parallel motion—Straight line, mechanisms derived from the four bar mechanism—The pantograph—Hooke's joint—Relation between the angular velocities—Use of double Hooke's joint—Velocity ratio between two shafts	
CHAPTER VII	
FRICTION—THEORY OF LUBRICATION—MICHELL BEARINGS	
-BALL AND ROLLER BEARINGS	181
Laws of solid friction—Limiting angle of friction—Equilibrium of a body on a rough inclined plane—Friction between a screw and a nut—Friction in a journal bearing—Effect of friction in simple engine mechanism—Thrust bearings—Friction couples—Lubrication—Michell bearings—Ball and roller bearings	
CHAPTER VIII	
HIGHER PAIRING—BELT, ROPE AND CHAIN DRIVES.	214
Belt drives—Tension in a belt—Effect of centripetal force—Horse power transmitted—Lengths of belts—Lateral displacement of belts on speed cones—Belts and non-parallel shafts—Jockey pulleys—Crowned pulleys—Coil friction due to a rope—Tensions on the two sides of a rope—Steel ropes—Steel chains—Bush roller chain—The inverted tooth chain	
CHAPTER IX	
HIGHER PAIRING (CONTD.)—WHEEL GEARING	242
Train of wheels—Simple train—Compound train—Epicyclic trains—Forms of wheel teeth—Cycloidal teeth—Velocity of sliding—Rolling circle and shape of tooth—Involute teeth—Helical teeth—Cutting teeth of cylindrical wheels—Bevel gears—Worm gearing—End-thrust—Root's blower—Friction between gear teeth—Limiting dimensions	

CONTENTS	xi
CHAPTER X	PAGE
HIGHER PAIRING (CONTD.)—CAMS	288
Cams—Offset cam—Straight-sided cam—Cam with swinging link—Cam with flat-footed follower—Displacement curves for high-speed cams  CHAPTER XI	
GOVERNORS	310
Variation of speed—Simple Watt governor—"Porter" Governor— Axial force on sleeve due to speed change—Isochronism—Proell governor—Hartnell governor—Controlling force—Hunting	010
CHAPTER XII	
ENGINE BALANCING	333
Balancing of rotating parts—Weights whose arms are not co- planar—Balancing reciprocating parts—Unbalanced secondary forces and couples—Balancing connecting rod—The Vee engine— Expression for inertia force—Radial engine—Direct and reverse cranks—Locomotive balancing	
CHAPTER XIII	
STEERING GEARS—PRECESSION	364
Motor-car steering gears—Davis's steering gear—Ackerman gear—Vectors representing rotation—Gyrostatic effects—Precession—Stability of a motor vehicle—Couple exerted on a shaft	
CHAPTER XIV	
OSCILLATIONS—WHIRLING OF SHAFTS—DYNAMICS	379
The energy equation—Transverse oscillations—Beams with concentrated loads—Whirling of shafts—Flexible shaft with pulley in centre—Uniform shaft with no attached masses—Ends fixed in direction—Frequency of transverse oscillations and whirling speed —Shafts with concentrated loads—Torsional oscillations—Equivalent systems—Further consideration of oscillations—Equivalent dynamical systems—Force and couple due to inertia—Free oscillations of a plane mechanism—Equivalent rotational systems	
APPENDIX A	
NOTE ON THE PARABOLA	441
APPENDIX B	
PISTON DISPLACEMENT, VELOCITY, AND ACCELERATION IN	
THE SIMPLE ENGINE MECHANISM	443
APPENDIX C	
THEORY OF UNITS AND DIMENSIONS	447
NOTE ON CENTRIPETAL FORCE	451
ANSWERS TO EXAMPLES	453
SUMMARY OF FORMULAE	461
INDEX	469