Contents

PREFACE

Introduction: Mainly a Revision of Basic Mechanics

0.1 Objective; 0.2 Sign conventions; 0.3 D'Alembert's principle; 0.4 Scalar and vector quantities; 0.5 Vectorial representation of angular quantities; 0.6 Newton's 'Axioms, or Laws of motion'; 0.7 The 'Conservation principles' – Energy and momentum; 0.8 Entities, fundamental and derived; 0.9 Units for dynamical calculations; 0.10 The manipulation of units; 0.11 Motion in a circular path; 0.12 The simple engine governor; 0.13 The simple gyroscope; 0.14 Simple harmonic motion

1. Mechanisms

1.1 Introduction: Preparatory definitions and terminology; 1.2 Kinematic constraint: principles and practice; 1.3 Motion of elements in machines: analytical treatment; 1.4 Velocity diagrams; 1.5 Determination of accelerations from velocity diagrams: hodograph; 1.6 Instantaneous centres; 1.7 Acceleration diagrams; 1.8 Acceleration diagrams (continued); Coriolis's term; 1.9 Forces required to accelerate elements of machines; 1.10 Transmission of forces through machines: torque diagrams; 1.11 Flywheels

2. Transmission of Rotational Motion

2.1 Introduction; 2.2 Transmission of rotational motion between parallel but misaligned shafts: the Oldham coupling; 2.3 Transmission of rotational motion between shafts which are not collinear but whose axes intersect; 2.4 Belt drives; 2.5 Types of gearing; 2.6 Spur gears; 2.7 Helical and skew gears; 2.8 Unconventional helical gears: the Wildhaber-Novikov system of 'circular arc' tooth profiles; 2.9 Worm gears; 2.10 Efficiency of gearing; 2.11 The strength of gear-teeth and their resistance to wear; 2.12 Gear trains: simple and compound; 2.13 Gear trains: Epicyclic

3. Balancing of Machines

3.1 Introduction; 3.2 Balancing of rotating masses; 3.3 Balancing of reciprocating masses; 3.4 Other machinery

4. Free Vibrations

4.1 Introduction; 4.2 Degrees of freedom; 4.3 Vibration of a two-mass system, one mass being infinite; 4.4 Vibration of a two-mass system, both masses finite; 4.5 Vibration of multi-mass systems, general consis-

vii

1

44

115

192

237

Contents

derations; 4.6 Three-mass system, all masses finite; 4.7 Three-mass system, one mass infinite; 4.8 The Vibration of multi-mass systems; 4.9 Vibration of systems involving gearing; 4.10 Vibration of systems with a distributed mass and stiffness; 4.11 Transverse vibration of beams; 4.12 Rayleigh's method; 4.13 Coupled vibrations; 4.14 Free vibration of a gyroscope; 4.14 Experimental techniques for finding natural frequencies

5. Damped and Forced Vibrations

5.1 Introduction; 5.2 Damping forces; 5.3 Damped vibrations; 5.4 Forced vibrations; 5.5 Vibration isolation; 5.6 Dynamic absorber; 5.7 Vibration of a mass supported on foundations subject to vibration; 5.8 Whirling of shafts; 5.9 The response of a lightly damped spring-mass system to a suddenly applied harmonic force with a frequency close to resonance; 5.10 Response of spring-mass system to a force of steadily increasing frequency; 5.11 Sources of vibration excitation; 5.12 Self-excited vibrations

6. Automatic Control

6.1 Introduction; 6.2 Unmonitored and monitored control systems; 6.3 Continuous and discontinuous controllers; 6.4 Transducers; 6.5 Transfer functions; 6.6 Open- and closed-loop transfer functions; 6.7 Remote-position controller; 6.8 The effect on the performance of a controller of modifying the error signal; 6.9 Stability; 6.10 Graphical methods of investigating stability and overall response

7. Friction and Lubrication

7.1 Introduction; 7.2 Dry friction; 7.3 Boundary lubrication; 7.4 Film lubrication; 7.5 Thrust bearings; 7.6 Lubricants other than oil; 7.7 Hydrostatic bearings; 7.8 Lubrication in higher pairing

Answers

Index

367

307

422

449

457