Engineering Tripos Part IB, 2P1: Mechanics, 2018-19

Lecturer
Dr H Hunt [1]

Leader
Dr JS Biggins [2]

Timing and Structure
16 Lectures, 2 lectures/week

Aims
The aims of the course are to:

- Show how the concepts of kinematics are applied to rigid bodies.
- Explain how Newton's laws of motion and the equations of energy and momentum are applied to rigid bodies.
- Develop an appreciation of the function, design and schematic representation of mechanical systems.
- Develop skills in modelling and analysis of mechanical systems, including graphical, algebraic and vector methods.

Objectives
As specific objectives, by the end of the course students should be able to:

- Specify the position, velocity and acceleration of a rigid body in cartesian, polar and intrinsic co-ordinates, using graphical, algebraic and vector methods.
- Understand the concepts of relative velocity, relative acceleration and instantaneous centres of rigid bodies.
- Determine the centre of mass and moment of inertia of a plane lamina.
- Understand and apply the perpendicular and parallel axes theorems.
- Recognise whether a body is in static or dynamic equilibrium.
- Understand the concepts of energy, linear momentum and moment of momentum of a rigid body, and recognise when they are conserved.
- Apply Newton's laws and d'Alembert's principle to determine the acceleration of a rigid body subject to applied forces and couples, including impact in planar motion.
- Determine the forces and stresses in a rigid body caused by its motion.
- Understand the concepts of static and dynamic balance of rotors and the methods for balancing rotors.
- Understand simple gyroscopic motion.

Content

Introduction and Terminology

Kinematics

- Differentiation of vectors (4: pp 490-492)
- Motion of a particle Data book p2
• Motion of a rigid body in space (3: ch 20)
• Velocity and acceleration images (1: p 124)
• Acceleration of a particle moving relative to a body in motion (2: pp 386-389)

Rigid Body Dynamics I - Inertia Forces and Energy

• Centre of mass, moments of inertia Data book Section 4
• D’Alembert force for a particle (3: p 101)
• D’Alembert force and torque for a rigid body in plane motion (4: pp 787-788)
• Kinetic energy of a rigid body in plane motion (2: p 461)
• Conservation of energy for conservative systems (3: pp 453-458)
• Inertia forces in plane mechanisms (1: pp 200-206)
• Method of virtual power (4: pp 429-432)
• Inertia stress and bending (1) Ch 5
• Balancing simple rotors (1: pp 180-182)

Rigid Body Dynamics II - Conservation of Momentum

• Momentum of a rigid body in plane motion (2: pp 267-271)
• Moment of momentum about G in plane motion (3: pp 555-558)
• Moment of momentum about a fixed point (4: p 894)
• Impact problems in plane motion (3: pp 487-493)
• Introduction to gyroscopic motion (2: pp 564-571)
• Lamina rotating about an axis in its own plane (1: pp 185-187)

REFERENCES

(1) BEER, F.P. & JOHNSTON, E.R. VECTOR MECHANICS FOR ENGINEERS: STATICS AND DYNAMICS
(2) HIBBELER, R.C. ENGINEERING MECHANICS – DYNAMICS (SI UNITS)
(3) MERIAM, J.L. & KRAIGE, L.G. ENGINEERING MECHANICS. VOL.2: DYNAMICS
(4) PRENTIS, J.M. ENGINEERING MECHANICS

Booklists

Please see the Booklist for Part IB Courses [3] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [4].

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [5] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the ‘Accreditation of Higher Education Programmes’ (AHEP) document [6] which sets out the standard for degree accreditation.

The Output Standards Matrices [7] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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