Unit 36: Advanced Mechanical Principles

Unit code R/615/1504
Unit level 5
Credit value 15

Introduction

A mechanical engineer is required to have an advanced knowledge of most of the machinery used within the engineering industry, and should understand the physical laws that influence their operation.

The aim of this unit is to continue covering the topics discussed in Unit 9: Mechanical Principles. It will provide students with advanced knowledge of the mechanical theories associated with engineering applications.

Topics included in this unit are: Poisson’s Ratio and typical values of common materials; the relationship between the elastic constants such as Bulk Modulus, Modulus of Elasticity, Modulus of Rigidity; the relationship between bending moment, slope and deflection in beams; calculating the slope and deflection for loaded beams using Macaulay’s method; analysing the stresses in thin-walled pressure vessels; and stresses in thick-walled cylinders, flat and v-section belt drive theory.

On successful completion of this unit students will be able to have more advanced knowledge of mechanical principles to determine the behavioural characteristics of materials subjected to complex loading; assess the strength of loaded beams and pressurised vessels; determine specifications of power transmission system elements; and examine operational constraints of dynamic rotating systems.

Learning Outcomes

By the end of this unit students will be able to:

1. Determine the behavioural characteristics of materials subjected to complex loading.
2. Assess the strength of loaded beams and pressurised vessels.
3. Analyse the specifications of power transmission system elements.
4. Examine operational constraints of dynamic rotating systems.
Essential Content

LO1  **Determine the behavioural characteristics of materials subjected to complex loading**

*Characteristics of materials:*
Definition of Poisson’s Ratio and typical values of metals, plastics and composite materials
The relationship between the elastic constants such as Bulk Modulus, Modulus of Elasticity, Modulus of Rigidity and Poisson’s Ratio
Characteristics of two-dimensional and three-dimensional loading
Calculation of volumetric strain and volume changes

LO2  **Assess the strength of loaded beams and pressurised vessels**

*Strength:*
The relationship between bending moment, slope and deflection in beams
Calculating the slope and deflection for loaded beams using Macaulay’s method
Analysing the stresses in thin-walled pressure vessels and stresses in thick-walled cylinders

LO3  **Analyse the specifications of power transmission system elements**

*Specifications:*
Flat and v-section belt drive theory
Operation of friction clutches with uniform pressure and uniform wear theories
Principles of both epicyclic and differential gearing, and the torque required to accelerate these systems
Areas of failure when transmitting power mechanically

LO4  **Examine operational constraints of dynamic rotating systems**

*Operational constraints:*
Design of both radial plate and cylindrical cams to meet operating specifications
Operating principles of flywheels to store mechanical energy
Balancing of rotating mass systems
The effects of coupling on freely rotating systems
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<th>Learning Outcomes and Assessment Criteria</th>
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<tr>
<td><strong>Pass</strong></td>
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<tr>
<td><strong>LO1</strong> Determine the behavioural characteristics of materials subjected to complex loading</td>
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<tr>
<td><strong>P1</strong> Discuss the relationship between the elastic constants</td>
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<td><strong>P2</strong> Illustrate the effects of two-dimensional and three-dimensional loading on the dimensions of a given material</td>
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<td><strong>P4</strong> Evaluate the variation of slope and deflection along a simply supported beam</td>
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<td><strong>P5</strong> Determine the principal stresses that occur in a thin-walled cylindrical pressure vessel and a pressurised thick-walled cylinder</td>
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<td><strong>P7</strong> Analyse the force requirements to engage a friction clutch in a mechanical system</td>
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<td><strong>P8</strong> Analyse the holding torque and power transmitted through epicyclic gear trains</td>
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<td><strong>LO2</strong> Assess the strength of loaded beams and pressurised vessels</td>
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<td><strong>LO3</strong> Analyse the specifications of power transmission system elements</td>
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<tr>
<td><strong>LO4</strong> Examine operational constraints of dynamic rotating systems</td>
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<td><strong>P9</strong> Explore the profiles of both radial plate and cylindrical cams that will achieve a specified motion</td>
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<td><strong>P10</strong> Show the mass of a flywheel needed to keep a machine speed within specified limits</td>
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<td><strong>P11</strong> Investigate the balancing masses required to obtain dynamic equilibrium in a rotating system</td>
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Recommended Resources

Textbooks


Websites
https://www.khanacademy.org/ Khan Academy
Physics
(Tutorials)

Links
This unit links to the following related units:

*Unit 8: Mechanical Principles*