Unit 225 Dynamics of mechanical systems

Unit summary
This unit is about analysing engineering problems where dynamic behaviour is a major consideration.

Aims
The unit aims to develop the candidate's knowledge of the dynamics of rigid bodies, dynamics of machines and vibration of mechanical systems.

Prerequisites
It is expected that the candidates will have a working knowledge of the materials in the four compulsory papers of the Certificate examinations.

Learning outcomes
There are **three** outcomes to this unit. The candidate will be able to:

- Solve problems involving three dimensional motion of solids bodies
- Analyse common engineering machines and mechanisms
- Analyse vibration involved in mechanical systems

Guided learning hours
It is recommended that 300 hours should be allocated for this unit. 120 of those hours are actual taught hours. This may be on a full time or part time basis.

Key Skills
This unit contributes towards the Key Skills in the following areas:

N4.1
Develop a strategy for using application of number skills over an extended period of time.

N4.2
Monitor progress and adapt your strategy, as necessary, to achieve the quality of outcomes required in work involving:

- deductive and inferential reasoning;
- algebraic manipulation.

N4.3
Evaluate your overall strategy and present the outcomes from your work, including use of charts, diagrams and graphs to illustrate complex data.

Occupational Standards
This unit has been mapped to the following National Occupational Standards:

1.3.2 Evaluate the results of research
8.1.1 Maintain and develop own engineering expertise

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Outcome 1 Solve problems involving three dimensional motion of solids bodies

Knowledge requirements
The candidate knows how to:

1 solve problems involving the motion of rigid bodies in three dimensions
   a linear momentum
   b moment of momentum (angular momentum)
   c kinetic energy
2 use the momentum equation of motion
   a rotating frames of reference
   b Euler's equations
   c work/energy equations
3 solve problems involving gyroscopic motion with steady precession
4 analyse the effects of impulsive forces and moment of force

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Outcome 2 Analyse common engineering machines and mechanisms

Knowledge requirements
The candidate knows how to:

1 solve problems involving Kinetics of planar mechanisms with

- a revolute (pin) joints
- b prismatic (sliding) joints

2 solve problems involving forces and torques in planar mechanisms including those due to the inertia and moments of force associated with acceleration of the links

3 analyse the balancing of rigid rotors

- a the out-of-balance forces in single and multi-cylinder reciprocating engines, pumps and compressors
- b the moments of force of the above

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Outcome 3 Analyse vibration involved in mechanical systems

Knowledge requirements
The candidate knows how to:

1 analyse free vibration of systems with two degrees of freedom
   a undamped natural frequencies
   b normal modes of vibration of undamped systems (eigenvalues and eigenvectors)
   c the orthogonality principle
   d coupling and beat phenomena

2 analyse undamped and damped force vibration of systems with one degree and two degrees of freedom
   a with forcing by harmonic displacement
   b rotating out-of-balance
   c force or moment of force applied to a body in the system

3 investigate frequency response characteristics
   a resonant frequencies
   b magnification factor and peak magnification
   c modulus and phase diagrams

4 determine the forces transmitted to supports

5 examine the dynamic vibration absorber and the untuned viscous damper

6 extend vibration analysis to undamped multi-degrees of freedom systems
   a influence coefficients
   b Holzer's method

7 analyse free vibration of undamped continuous systems
   a longitudinal vibration of bars
   b torsional vibration of circular shafts
   c flexural vibration of beams
   d analytical solutions for simple systems
   e Rayleigh's method for multi-body and continuous linear systems

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Recommended reading list

Core texts	Author(s)	Publisher	ISBN
Engineering Mechanics Vol 2: Dynamics	Meriam, Kraige	John Wiley	0471241679
Mechanics and Dynamics of Machinery	Mabie, Reinholtz	John Wiley	0471802379
Theory of Vibration with Applications	Thomson	Unwin Hyman	0044450699
Other useful texts			
The Theory of Vibration with Applications	Thomson	Nelson Thornes	0748743804