Unit 2: Engineering Science

Unit code: L/601/1404

QCF level: 4

Credit value: 15

Aim

This unit aims to provide learners with an understanding of the mechanical and electrical principles that underpin mechanical and electrically focused engineering systems.

Unit abstract

Engineers, no matter from what discipline, need to acquire a fundamental understanding of the mechanical and electrical principles that underpin the design and operation of a large range of engineering equipment and systems.

This unit will develop learners' understanding of the key mechanical and electrical concepts that relate to all aspects of engineering.

In particular, learners will study elements of engineering statics including the analysis of beams, columns and shafts. They will then be introduced to elements of engineering dynamics, including the behavioural analysis of mechanical systems subject to uniform acceleration, the effects of energy transfer in systems and to natural and forced oscillatory motion.

The electrical system principles in learning outcome 3 begin by refreshing learners' understanding of resistors connected in series/parallel and then developing the use of Ohm's law and Kirchhoff's law to solve problems involving at least two power sources. Circuit theorems are also considered for resistive networks only together with a study of the characteristics of growth and decay of current/voltage in series C-R and L-R circuits.

The final learning outcome develops learners' understanding of the characteristics of various AC circuits and finishes by considering an important application – the transformer.

Learning outcomes

On successful completion of this unit a learner will:

1 Be able to determine the behavioural characteristics of elements of static engineering systems

2 Be able to determine the behavioural characteristics of elements of dynamic engineering systems

3 Be able to apply DC theory to solve electrical and electronic engineering problems

4 Be able to apply single phase AC theory to solve electrical and electronic engineering problems.

Unit content

1 **Be able to determine the behavioural characteristics of elements of static engineering systems**

Simply supported beams: determination of shear force; bending moment and stress due to bending; radius of curvature in simply supported beams subjected to concentrated and uniformly distributed loads; eccentric loading of columns; stress distribution; middle third rule

Beams and columns: elastic section modulus for beams; standard section tables for rolled steel beams; selection of standard sections eg slenderness ratio for compression members, standard section and allowable stress tables for rolled steel columns, selection of standard sections

Torsion in circular shafts: theory of torsion and its assumptions eg determination of shear stress, shear strain, shear modulus; distribution of shear stress and angle of twist in solid and hollow circular section shafts

2 **Be able to determine the behavioural characteristics of elements of dynamic engineering systems**

Uniform acceleration: linear and angular acceleration; Newton's laws of motion; mass moment of inertia and radius of gyration of rotating components; combined linear and angular motion; effects of friction

Energy transfer: gravitational potential energy; linear and angular kinetic energy; strain energy; principle of conservation of energy; work-energy transfer in systems with combine linear and angular motion; effects of impact loading

Oscillating mechanical systems: simple harmonic motion; linear and transverse systems; qualitative description of the effects of forcing and damping

3 **Be able to apply DC theory to solve electrical and electronic engineering problems**

DC electrical principles: refresh idea of resistors in series and parallel; use of Ohm's and Kirchhoff's laws; voltage and current dividers; review of motor and generator principles eg series, shunt; circuit theorems eg superposition, Thevenin, Norton and maximum power transfer for resistive circuits only; fundamental relationships eg resistance, inductance, capacitance, series C-R circuit, time constant, charge and discharge curves of capacitors, L-R circuits

4 **Be able to apply single phase AC theory to solve electrical and electronic engineering problems**

AC electrical principles: features of AC sinusoidal wave form for voltages and currents; explanation of how other more complex wave forms are produced from sinusoidal wave forms; R, L, C circuits eg reactance of R, L and C components, equivalent impedance and admittance for R-L and R-C circuits; high or low pass filters; power factor; true and apparent power; resonance for circuits containing a coil and capacitor connected either in series or parallel; resonant frequency; Q-factor of resonant circuit; transformer fundamentals: construction eg double wound; transformation ratio; equivalent circuit; unloaded transformer; resistance (impedance) matching; transformer losses; applications eg current transformers, voltage transformers

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	Assessment criteria for pass The learner can:
LO1 Be able to determine the behavioural characteristics of elements of static engineering systems	1.1 determine distribution of shear force, bending moment and stress due to bending in simply supported beams 1.2 select standard rolled steel sections for beams and columns to satisfy given specifications 1.3 determine the distribution of shear stress and the angular deflection due to torsion in circular shafts
LO2 Be able to determine the behavioural characteristics of elements of dynamic engineering systems	2.1 determine the behaviour of dynamic mechanical systems in which uniform acceleration is present 2.2 determine the effects of energy transfer in mechanical systems 2.3 determine the behaviour of oscillating mechanical systems
LO3 Be able to apply DC theory to solve electrical and electronic engineering problems	3.1 solve problems using Kirchhoff's laws to calculate currents and voltages in circuits 3.2 solve problems using circuit theorems to calculate currents and voltages in circuits 3.3 solve problems involving current growth/decay in an L-R circuit and voltage growth/decay in a C-R circuit
LO4 Be able to apply single phase AC theory to solve electrical and electronic engineering problems	4.1 recognise a variety of complex waveforms and explain how they are produced from sinusoidal waveforms 4.2 apply AC theory to solve problems on R, L, C circuits and components 4.3 apply AC theory to solve problems involving transformers.

Guidance

Links

This unit may be linked with *Unit 1: Analytical Methods for Engineers*.

Successful completion of this unit would enable learners to meet, in part, the Incorporated Engineer (IEng) requirements laid down in the UK Engineering Council Standard for Professional Engineering Competence (UK-SPEC) Competence A2, 'Use appropriate scientific, technical or engineering principles'.

Essential requirements

Learners will need access to suitable mechanical and electrical laboratory equipment.

Employer engagement and vocational contexts

Liaison with employers would prove of benefit to centres, especially if they are able to offer help with the provision of suitable mechanical or electrical systems/equipment that demonstrate applications of the principles.