

Syllabus

(Mechanical & Automotive Engineering)



Year 1 & Year 2

Kings Cornerstone International College

Unit 1: Engineering Design

Unit code	K/615/1475
Unit type	Core
Unit level	4
Credit value	15

Introduction

The tremendous possibilities of the techniques and processes developed by engineers can only be realised by great design. Design turns an idea into a useful artefact, the problem into a solution, or something ugly and inefficient into an elegant, desirable and cost-effective everyday object. Without a sound understanding of the design process the engineer works in isolation without the links between theory and the needs of the end user.

The aim of this unit is to introduce students to the methodical steps that engineers use in creating functional products and processes; from a design brief to the work, and the stages involved in identifying and justifying a solution to a given engineering need.

Among the topics included in this unit are: Gantt charts and critical path analysis, stakeholder requirements, market analysis, design process management, modelling and prototyping, manufacturability, reliability life cycle, safety and risk, management, calculations, drawings and concepts and ergonomics.

On successful completion of this unit students will be able to prepare an engineering design specification that satisfies stakeholders' requirements, implement best practice when analysing and evaluating possible design solutions, prepare a written technical design report, and present their finalised design to a customer or audience.

Learning Outcomes

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

1. Plan a design solution and prepare an engineering design specification in response to a stakeholder's design brief and requirements.
2. Formulate possible technical solutions to address the student-prepared design specification.
3. Prepare an industry-standard engineering technical design report.
4. Present to an audience a design solution based on the design report and evaluate the solution/presentation.

Downloaded from cornerstone.edu.in

Essential Content

LO1 Plan a design solution and prepare an engineering design specification in response to a stakeholder's design brief and requirements

Planning techniques used to prepare a design specification:

Definition of client's/users objectives, needs and constraints

Definition of design constraints, function, specification, milestones

Planning the design task: Flow charts, Gantt charts, network and critical path analysis necessary in the design process

Use of relevant technical/engineering/industry standards within the design process

Design process:

Process development, steps to consider from start to finish

The cycle from design to manufacture

Three- and five-stage design process

Vocabulary used in engineering design

Stage of the design process which includes:

Analysing the situation, problem statement, define tasks and outputs, create the design concept, research the problem and write a specification

Suggest possible solutions, select a preferred solution, prepare working drawings, construct a prototype, test and evaluate the design against objectives, design communication (write a report)

Customer/stakeholder requirements:

Converting customer request to a list of objectives and constraints

Interpretation of design requirements

Market analysis of existing products and competitors

Aspects of innovation and performance management in decision-making

LO2 Formulate possible technical solutions to address the student-prepared design specification

Conceptual design and evaluating possible solutions:

Modelling, prototyping and simulation using industry standard software, (e.g. AutoCAD, Catia, SolidWorks, Creo) on high specification computers

Use of evaluation and analytical tools, e.g. cause and effect diagrams, CAD, knowledge-based engineering

LO3 Prepare an industry-standard engineering technical design report

Managing the design process:

Recognising limitations including cost, physical processes, availability of material/components and skills, timing and scheduling

Working to specifications and standards, including:

The role of compliance checking, feasibility assessment and commercial viability of product design through testing and validation

Design for testing, including:

Material selection to suit selected processes and technologies

Consideration of manufacturability, reliability, life cycle and environmental issues

The importance of safety, risk management and ergonomics

Conceptual design and effective tools:

Technologies and manufacturing processes used in order to transfer engineering designs into finished products

LO4 Present to an audience a design solution based on the design report and evaluate the solution/presentation

Communication and post-presentation review:

Selection of presentation tools

Analysis of presentation feedback

Strategies for improvement based on feedback

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Plan a design solution and prepare an engineering design specification in response to a stakeholder's design brief and requirements			D1 Compare and contrast the completed design specification against the relevant industry standard specification
P1 Produce a design specification from a given design brief	M1 Evaluate potential planning techniques, presenting a case for the method chosen		
P2 Explain the influence of the stakeholder's design brief and requirements in the preparation of the design specification	M2 Demonstrate critical path analysis techniques in design project scheduling/planning and explain its use		
P3 Produce a design project schedule with a graphical illustration of the planned activities			
LO2 Formulate possible technical solutions to address the student-prepared design specification			D2 Evaluate potential technical solutions, presenting a case for the final choice of solution
P4 Explore industry standard evaluation and analytical tools in formulating possible technical solutions	M3 Apply the principles of modelling, simulation and/or prototyping, using appropriate software, to develop an appropriate design solution		
P5 Use appropriate design techniques to produce a possible design solution			

Pass		Merit	Distinction
LO3 Prepare an industry-standard engineering technical design report		M4 Assess any compliance, safety and risk management issues specific to the technical design report	D3 Evaluate the effectiveness of the industry standard engineering technical design report for producing a fully compliant finished product
P6 Prepare an industry-standard engineering technical design report P7 Explain the role of design specifications and standards in the technical design report			
LO4 Present to an audience a design solution based on the design report and evaluate the solution/presentation		M5 Reflect on the effectiveness of the chosen communication strategy in presenting the design solution	D4 Justify potential improvements to the design solution and/or presentation based on reflection and/or feedback
P8 Present the recommended design solution to the identified audience P9 Explain possible communication strategies and presentation methods that could be used to inform the stakeholders of the recommended solution			

Recommended Resources

Textbooks

DUL, J. and WEERDMEESTER, B. (2008) *Ergonomics for beginners*. 3rd Ed. Boca Raton: CRC Press.

DYM, C.L., LITTLE, P. and ORWIN, E. (2014) *Engineering Design: a Project Based Introduction*. 4th Ed. Wiley.

GRIFFITHS, B. (2003) *Engineering Drawing for Manufacture*. Kogan Page Science.

REDDY, K.V. (2008) *Textbook of Engineering Drawing*. 2nd Ed. Hyderabad: BS Publications.

Websites

www.epsrc.ac.uk Engineering and Physical Sciences Research Council
(General Reference)

www.imeche.org Institution of Mechanical Engineers
(General Reference)

Unit 2: Engineering Maths

Unit code	M/615/1476
Unit type	Core
Unit level	4
Credit value	15

Introduction

The mathematics that is delivered in this unit is that which is directly applicable to the engineering industry, and it will help to increase students' knowledge of the broad underlying principles within this discipline.

The aim of this unit is to develop students' skills in the mathematical principles and theories that underpin the engineering curriculum. Students will be introduced to mathematical methods and statistical techniques in order to analyse and solve problems within an engineering context.

On successful completion of this unit students will be able to employ mathematical methods within a variety of contextualised examples, interpret data using statistical techniques, and use analytical and computational methods to evaluate and solve engineering problems.

Learning Outcomes

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

1. Identify the relevance of mathematical methods to a variety of conceptualised engineering examples.
2. Investigate applications of statistical techniques to interpret, organise and present data.
3. Use analytical and computational methods for solving problems by relating sinusoidal wave and vector functions to their respective engineering applications.
4. Examine how differential and integral calculus can be used to solve engineering problems.

Essential Content

LO1 Identify the relevance of mathematical methods to a variety of conceptualised engineering examples

Mathematical concepts:

Dimensional analysis

Arithmetic and geometric progressions

Functions:

Exponential, logarithmic, trigonometric and hyperbolic functions

LO2 Investigate applications of statistical techniques to interpret, organise and present data

Summary of data:

Mean and standard deviation of grouped data

Pearson's correlation coefficient

Linear regression

Charts, graphs and tables to present data

Probability theory:

Binomial and normal distribution

LO3 Use analytical and computational methods for solving problems by relating sinusoidal wave and vector functions to their respective engineering application.

Sinusoidal waves:

Sine waves and their applications

Trigonometric and hyperbolic identities

Vector functions:

Vector notation and properties

Representing quantities in vector form

Vectors in three dimensions

LO4 Examine how differential and integral calculus can be used to solve engineering problems

Differential calculus:

Definitions and concepts

Definition of a function and of a derivative, graphical representation of a function, notation of derivatives, limits and continuity, derivatives; rates of change, increasing and decreasing functions and turning points

Differentiation of functions

Differentiation of functions including:

- standard functions/results
- using the chain, product and quotient rules
- second order and higher derivatives

Types of function: polynomial, logarithmic, exponential and trigonometric (sine, cosine and tangent), inverse trigonometric and hyperbolic functions

Integral calculus:

Definite and indefinite integration

Integrating to determine area

Integration of functions including:

- common/standard functions
- using substitution
- by parts

Exponential growth and decay

Types of function: algebraic including partial fractions and trigonometric (sine, cosine and tangent) functions

Engineering problems involving calculus:

Including: stress and strain, torsion, motion, dynamic systems, oscillating systems, force systems, heat energy and thermodynamic systems, fluid flow, AC theory, electrical signals, information systems, transmission systems, electrical machines, electronics

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Identify the relevance of mathematical methods to a variety of conceptualised engineering examples			LO1 & LO2
P1 Apply dimensional analysis techniques to solve complex problems		M1 Use dimensional analysis to derive equations	D1 Present data in a method that can be understood by a non-technical audience
P2 Generate answers from contextualised arithmetic and geometric progressions			
P3 Determine solutions of equations using exponential, logarithmic, trigonometric and hyperbolic functions			
LO2 Investigate applications of statistical techniques to interpret, organise and present data			
P4 Summarise data by calculating mean and standard deviation		M2 Interpret the results of a statistical hypothesis test conducted from a given scenario	
P5 Calculate probabilities within both binomially distributed and normally distributed random variables			

Pass		Merit	Distinction
LO3 Use analytical and computational methods for solving problems by relating sinusoidal wave and vector functions to their respective engineering application			D2 Model the combination of sine waves graphically and analyse the variation in results between graphical and analytical methods
P6 Solve engineering problems relating to sinusoidal functions P7 Represent engineering quantities in vector form, and use appropriate methodology to determine engineering parameters	M3 Use compound angle identities to combine individual sine waves into a single wave		
LO4 Examine how differential and integral calculus can be used to solve engineering problems			D3 Analyse maxima and minima of increasing and decreasing functions using higher order derivatives
P8 Determine rates of change for algebraic, logarithmic and trigonometric functions P9 Use integral calculus to solve practical problems relating to engineering	M4 Formulate predictions of exponential growth and decay models using integration methods		

Recommended Resources

Textbooks

SINGH, K. (2011) *Engineering Mathematics Through Applications*. 2nd Ed. Basingstoke:Palgrave Macmillan.

STROUD, K.A. and BOOTH, D.J. (2013) *Engineering Mathematics*. 7th Ed. Basingstoke:Palgrave Macmillan.

Websites

<http://www.mathcentre.ac.uk/> Maths Centre
(Tutorials)

<http://www.mathtutor.ac.uk/> Maths Tutor
(Tutorials)

Downloaded from cornerstone.edu.in

Unit 3: Engineering Science

Unit code	T/615/1477
Unit type	Core
Unit level	4
Credit value	15

Introduction

Engineering is a discipline that uses scientific theory to design, develop or maintain structures, machines, systems, and processes. Engineers are therefore required to have a broad knowledge of the science that is applicable to the industry around them.

This unit introduces students to the fundamental laws and applications of the physical sciences within engineering and how to apply this knowledge to find solutions to a variety of engineering problems.

Among the topics included in this unit are: international system of units, interpreting data, static and dynamic forces, fluid mechanics and thermodynamics, material properties and failure, and A.C./D.C. circuit theories.

On successful completion of this unit students will be able to interpret and present qualitative and quantitative data using computer software, calculate unknown parameters within mechanical systems, explain a variety of material properties and use electromagnetic theory in an applied context.

Learning Outcomes

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

1. Examine scientific data using both quantitative and qualitative methods.
2. Determine parameters within mechanical engineering systems.
3. Explore the characteristics and properties of engineering materials.
4. Analyse applications of A.C./D.C. circuit theorems, electromagnetic principles and properties.

Essential Content

LO1 Examine scientific data using both quantitative and qualitative methods

International system of units:

The basic dimensions in the physical world and the corresponding SI base units

SI derived units with special names and symbols

SI prefixes and their representation with engineering notation

Interpreting data:

Investigation using the scientific method to gather appropriate data

Test procedures for physical (destructive and non-destructive) tests and statistical tests that might be used in gathering information

Summarising quantitative and qualitative data with appropriate graphical representations

Using presentation software to present data to an audience

LO2 Determine parameters within mechanical engineering systems

Static and dynamic forces:

Representing loaded components with space and free body diagrams

Calculating support reactions of beams subjected to concentrated and distributed loads

Newton's laws of motion, D'Alembert's principle and the principle of conservation of energy

Fluid mechanics and thermodynamics:

Archimedes' principle and hydrostatics

Continuity of volume and mass flow for an incompressible fluid

Effects of sensible/latent heat of fluid

Heat transfer due to temperature change and the thermodynamic process equations

LO3 Explore the characteristics and properties of engineering materials

Material properties:

Atomic structure of materials and the structure of metals, polymers and composites

Mechanical and electromagnetic properties of materials

Material failure:

Destructive and non-destructive testing of materials

The effects of gradual and impact loading on a material.

Degradation of materials and hysteresis

LO4 Analyse applications of A.C./D.C. circuit theorems, electromagnetic principles and properties

D.C. circuit theory:

Voltage, current and resistance in D.C. networks

Exploring circuit theorems (Thevenin, Norton, Superposition), Ohm's law and Kirchhoff's voltage and current laws

A.C. circuit theory:

Waveform characteristics in a single-phase A.C. circuit

RLC circuits

Magnetism:

Characteristics of magnetic fields and electromagnetic force

The principles and applications of electromagnetic induction

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
L01 Examine scientific data using both quantitative and qualitative methods			D1 Analyse scientific data using both quantitative and qualitative methods
P1 Describe SI units and prefix notation		M1 Explain how the application of scientific method impacts upon different test procedures	
P2 Examine quantitative and qualitative data with appropriate graphical representations			
L02 Determine parameters within mechanical engineering systems			D2 Compare how changes in the thermal efficiency of a given system can affect its performance.
P3 Determine the support reactions of a beam carrying a combination of a concentrated load and a uniformly distributed load		M2 Determine unknown forces by applying d'Alembert's principle to a free body diagram	
P4 Use Archimedes' principle in contextual engineering applications			
P5 Determine the effects of heat transfer on the dimensions of given materials			

Pass		Merit	Distinction
LO3 Explore the characteristics and properties of engineering materials			D3 Compare and contrast theoretical material properties of metals and non-metals with practical test data
P6 Describe the structural properties of metals and non-metals with reference to their material properties P7 Explain the types of degradation found in metals and non-metals	M3 Review elastic and electromagnetic hysteresis in different materials		
LO4 Analyse applications of A.C./D.C. circuit theorems, electromagnetic principles and properties			D4 Evaluate different techniques used to solve problems on a combined series-parallel RLC circuit using A.C. theory.
P8 Calculate currents and voltages in D.C. circuits using circuit theorems P9 Describe how complex waveforms are produced from combining two or more sinusoidal waveforms. P10 Solve problems on series RLC circuits with A.C. theory.	M4 Explain the principles and applications of electromagnetic induction		

Recommended Resources

Textbooks

BIRD, J. (2012) *Science for Engineering*. 4th Ed. London: Routledge. BOLTON, W.

(2006) *Engineering Science*. 5th Ed. London: Routledge.

TOOLEY, M. and DINGLE, L. (2012) *Engineering Science: For Foundation Degree and Higher National*. London: Routledge.

Journals

International Journal of Engineering Science.

International Journal of Engineering Science and Innovative Technology.

Websites

<https://www.khanacademy.org/>

Khan Academy
Physics
(Tutorials)

Unit 4: Managing a Professional Engineering Project

Unit code	A/615/1478
Unit type	Core
Unit level	4
Credit value	15

Introduction

The responsibilities of the engineer go far beyond completing the task in hand. Reflecting on their role in a wider ethical, environmental and sustainability context starts the process of becoming a professional engineer – a vital requirement for career progression.

Engineers seldom work in isolation and most tasks they undertake require a range of expertise, designing, developing, manufacturing, constructing, operating and maintaining the physical infrastructure and content of our world. The bringing together of these skills, expertise and experience is often managed through the creation of a project.

This unit introduces students to the techniques and best practices required to successfully create and manage an engineering project designed to identify a solution to an engineering need. While carrying out this project students will consider the role and function of engineering in our society, the professional duties and responsibilities expected of engineers together with the behaviours that accompany their actions.

Among the topics covered in this unit are: roles, responsibilities and behaviours of a professional engineer, planning a project, project management stages, devising solutions, theories and calculations, management using a Gantt chart, evaluation techniques, communication skills, and the creation and presentation of a project report.

On successful completion of this unit students will be able to conceive, plan, develop and execute a successful engineering project, and produce and present a project report outlining and reflecting on the outcomes of each of the project processes and stages. As a result, they will develop skills such as critical thinking, analysis, reasoning, interpretation, decision-making, information literacy, and information and communication technology, and skills in professional and confident self-presentation.

This unit is assessed by a Pearson-set theme. The project brief will be set by the centre, based on a theme provided by Pearson (this will change annually). The theme and chosen project within the theme will enable students to explore and examine a relevant and current topical aspect of professional engineering.

***Please refer to the accompanying Pearson-set Assignment Guide and the Theme Release document for further support and guidance on the delivery of the Pearson-set unit.**

Learning Outcomes

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

1. Formulate and plan a project that will provide a solution to an identified engineering problem.
2. Conduct planned project activities to generate outcomes which provide a solution to the identified engineering problem.
3. Produce a project report analysing the outcomes of each of the project processes and stages.
4. Present the project report drawing conclusions on the outcomes of the project.

Essential Content

LO1 Formulate and plan a project that will provide a solution to an identified engineering problem

Examples of realistic engineering based problems:

Crucial considerations for the project

How to identify the nature of the problem through vigorous research

Feasibility study to identify constraints and produce an outline specification

Develop an outline project brief and design specification:

Knowledge theories, calculations and other relevant information that can support the development of a potential solution

Ethical frameworks:

The Engineering Council and Royal Academy of Engineering's Statement of Ethical Principles

The National Society for Professional Engineers' Code of Ethics

Regulatory bodies:

Global, European and national influences on engineering and the role of the engineer, in particular: The Royal Academy of Engineering and the UK Engineering Council

The role and responsibilities of the UK Engineering Council and the Professional Engineering Institutions (PEIs)

The content of the UK Standard for Professional Engineering Competence (UKSPEC)

Chartered Engineer, Incorporated Engineer and Engineering Technician

International regulatory regimes and agreements associated with professional engineering:

European Federation of International Engineering Institutions.

European Engineer (Eur Eng)

European Network for Accreditation of Engineering Education

European Society for Engineering Education

Washington Accord

Dublin Accord

Sydney Accord

International Engineers Alliance

Asia Pacific Economic Cooperation (APEC) Engineers Agreement

LO2 Conduct planned project activities to generate outcomes which provide a solution to the identified engineering problem

Project execution phase:

Continually monitoring development against the agreed project plan and adapt the project plan where appropriate

Work plan and time management, using Gantt chart or similar.

Tracking costs and timescales

Maintaining a project diary to monitor progress against milestones and timescales

Engineering professional behaviour sources:

Professional responsibility for health and safety (UK-SPEC)

Professional standards of behaviour (UK-SPEC)

Ethical frameworks:

The Engineering Council and Royal Academy of Engineering's Statement of Ethical Principles

The National Society for Professional Engineers' Code of Ethics

LO3 Produce a project report analysing the outcomes of each of the project processes and stages

Convincing arguments:

All findings/outcomes should be convincing and presented logically where the assumption is that the audience has little or no knowledge of the project process

Critical analysis and evaluation techniques:

Most appropriate evaluation techniques to achieve a potential solution

Secondary and primary data should be critiqued and considered with an objective mindset

Objectivity results in more robust evaluations where an analysis justifies a judgement

LO4 Present the project report drawing conclusions on the outcomes of the project

Presentation considerations:

Media selection, what to include in the presentation and what outcomes to expect from it. Audience expectations and contributions

Presentation specifics. Who to invite: project supervisors, fellow students and employers. Time allocation, structure of presentation

Reflection on project outcomes and audience reactions

Conclusion to report, recommendations for future work, lessons learned, changes to own work patterns

Reflection for learning and practice:

The difference between reflecting on performance and evaluating a project – the former considers the research process, information gathering and data collection, the latter the quality of the research argument and use of evidence

The cycle of reflection:

To include reflection in action and reflection on action

How to use reflection to inform future behaviour, particularly directed towards sustainable performance

The importance of Continuing Professional Development (CPD) in refining on-going professional practice

Reflective writing:

Avoiding generalisation and focusing on personal development and the research journey in a critical and objective way

Downloaded from cornerstone.edu/in

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Formulate and plan a project that will provide a solution to an identified engineering problem			D1 Illustrate the effect of legislation and ethics in developing the project plan
P1 Select an appropriate engineering based project, giving reasons for the selection	M1 Undertake a feasibility study to justify project selection		
P2 Create a project plan for the engineering project			
LO2 Conduct planned project activities to generate outcomes which provide a solution to the identified engineering problem			D2 Critically evaluate the success of the project plan making recommendations for improvements
P3 Conduct project activities, recording progress against original project plan	M2 Explore alternative methods to monitor and meet project milestones, justify selection of chosen method(s)		
LO3 Produce a project report analysing the outcomes of each of the project processes and stages			LO3 & LO4 D3 Critically analyse the project outcomes making recommendations for further development
P4 Produce a project report covering each stage of the project and analysing project outcomes	M3 Use appropriate critical analysis and evaluation techniques to analyse project findings		
LO4 Present the project report drawing conclusions on the outcomes of the project			
P5 Present the project report using appropriate media to an audience	M4 Analyse own behaviours and performance during the project and suggest areas for improvement		

Recommended Resources

Textbooks

PUGH, P. S. (1990) *Total Design: Integrated Methods for Successful Product Engineering*.
Prentice Hall.

STRIEBIG, B., OGUNDIPE, A. and PAPADAKIS, M. (2015) *Engineering Applications in Sustainable Design and Development*. Cengage Learning.

ULRICH, K. and EPPINGER, S. (2011) *Product Design and Development*. 5th Ed.
McGraw-Hill Higher Education.

Journals

Journal of Engineering Design.

Downloaded from cornerstone.edu.in

Unit 13: Fundamentals of Thermodynamics and Heat Engines

Unit code	D/615/1487
Unit level	4
Credit value	15

Introduction

Thermodynamics is one of the most common applications of science in our lives, and it is so much a part of our daily life that it is often taken for granted. For example, when driving your car you know that the fuel you put into the tank is converted into energy to propel the vehicle, and the heat produced by burning gas when cooking will produce steam which can lift the lid of the pan. These are examples of thermodynamics, which is the study of the dynamics and behaviour of energy and its manifestations.

This unit introduces students to the principles and concepts of thermodynamics and its application in modern engineering.

On successful completion of this unit students will be able to investigate fundamental thermodynamic systems and their properties, apply the steady flow energy equation to plant equipment, examine the principles of heat transfer to industrial applications, and determine the performance of internal combustion engines.

Learning Outcomes

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

1. Investigate fundamental thermodynamic systems and their properties.
2. Apply the Steady Flow Energy Equation to plant equipment.
3. Examine the principles of heat transfer to industrial applications.
4. Determine the performance of internal combustion engines.

Essential Content

LO1 Investigate fundamental thermodynamic systems and their properties

Fundamental systems:

Forms of energy and basic definitions

Definitions of systems (open and closed) and surroundings

First law of thermodynamics

The gas laws: Charles' Law, Boyle's Law, general gas law and the Characteristic Gas Equation

The importance and applications of pressure/volume diagrams and the concept of work done

Polytropic processes: constant pressure, constant volume, adiabatic and isothermal systems

LO2 Apply the Steady Flow Energy Equation to plant equipment

Energy equations:

Conventions used when describing the behaviour of heat and work

The Non-Flow Energy Equation as it applies to closed systems

Assumptions, applications and examples of practical systems

Steady Flow Energy Equation as applied to open systems

Assumptions made about the conditions around, energy transfer and the calculations for specific plant equipment e.g. boilers, super-heaters, turbines, pumps and condensers

LO3 Examine the principles of heat transfer to industrial applications

Principles of heat transfer:

Modes of heat transmission, including conduction, convection & radiation

Heat transfer through composite walls and use of U and k values

Application of formulae to different types of heat exchangers, including recuperator and evaporative

Regenerators

Heat losses in thick and thin walled pipes, optimum lagging thickness

LO4 Determine the performance of internal combustion engines

Performance:

Application of the second law of thermodynamics to heat engines

Comparison of theoretical and practical heat engine cycles, including Otto, Diesel and Carnot

Explanations of practical applications of heat engine cycles, such as compression ignition (CI) and spark ignition engines, including their relative mechanical and thermodynamic efficiencies

Describe possible efficiency improvements to heat engines

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Investigate fundamental thermodynamic systems and their properties		M1 Calculate the index of compression in polytrophic processes	D1 Illustrate the importance of expressions for work done in thermodynamic processes by applying first principles
P1 Describe the operation of thermodynamic systems and their properties	P2 Explain the application of the first law of thermodynamics to appropriate systems		
P3 Explain the relationships between system constants for a perfect gas			
LO2 Apply the Steady Flow Energy Equation to plant equipment		M2 Derive the Steady Flow Energy Equation from first principles	D2 Produce specific Steady Flow Energy Equations based on stated assumptions in plant equipment
P4 Explain system parameters using the Non-Flow Energy Equation	P5 Apply the Steady Flow Energy Equation to plant equipment		

Pass		Merit	Distinction
LO3 Examine the principles of heat transfer to industrial applications			D3 Distinguish the differences between parallel and counter flow recuperator heat exchangers
P6 Determine the heat transfer through composite walls		M3 Explore heat losses through lagged and unlagged pipes	
P7 Apply heat transfer formulae to heat exchangers			
LO4 Determine the performance of internal combustion engines			D4 Evaluate the performance of two stroke and four stroke diesel engines
P8 Describe with the aid of a PV (pressure volume) diagram the operational sequence of four stroke spark ignition and four stroke compression ignition engines.		M4 Review the relative efficiency of ideal heat engines operating on the Otto and Diesel cycles	
P9 Explain the mechanical efficiency of two and four stroke engines			

Recommended Resources

Textbooks

DUNN, D. (2001) *Fundamental Engineering Thermodynamics*. Longman.

EASTOP, T.D. and MCCONKEY, A. (1996) *Applied Thermodynamics for Engineering Technologists*. 5th Ed. Prentice Hall.

EASTOP, T.D. and MCCONKEY, A. (1997) *Applied Thermodynamics for Engineering Technologists Student Solution Manual*. 5th Ed. Prentice Hall.

RAYNER, J. (2008) *Basic Engineering Thermodynamics*. 5th Ed. Pearson.

ROGERS, G.F.C. and MAYHEW, Y.R. (1994) *Thermodynamic and Transport Properties of Fluids: S. I. Units*. 5th Ed. Wiley-Blackwell.

Downloaded from cornerstone.edu.in

Unit 39: Further Mathematics

Unit code H/615/1507

Unit level 5

Credit value 15

Introduction

The understanding of more advanced mathematics is important within an engineering curriculum to support and broaden abilities within the applied subjects at the core of all engineering programmes. Students are introduced to additional topics that will be relevant to them as they progress to the next level of their studies, advancing their knowledge of the underpinning mathematics gained in *Unit 2: Engineering Maths*.

The unit will prepare students to analyse and model engineering situations using mathematical techniques. Among the topics included in this unit are: number theory, complex numbers, matrix theory, linear equations, numerical integration, numerical differentiation, and graphical representations of curves for estimation within an engineering context. Finally, students will expand their knowledge of calculus to discover how to model and solve engineering problems using first and second order differential equations.

On successful completion of this unit students will be able to use applications of number theory in practical engineering situations, solve systems of linear equations relevant to engineering applications using matrix methods, approximate solutions of contextualised examples with graphical and numerical methods, and review models of engineering systems using ordinary differential equations.

Learning Outcomes

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

1. Use applications of number theory in practical engineering situations.
2. Solve systems of linear equations relevant to engineering applications using matrix methods.
3. Approximate solutions of contextualised examples with graphical and numerical methods.
4. Review models of engineering systems using ordinary differential equations.

Downloaded from cornerstone.edu.in

Essential Content

LO1 Use applications of number theory in practical engineering situations

Number theory:

Bases of a number (Denary, Binary, Octal, Duodecimal, Hexadecimal) and converting between bases

Types of numbers (Natural, Integer, Rational, Real, Complex)

The modulus, argument and conjugate of complex numbers

Polar and exponential forms of complex numbers

The use of de Moivre's Theorem in engineering

Complex number applications e.g. electric circuit analysis, information and energy control systems

LO2 Solve systems of linear equations relevant to engineering applications using matrix methods

Matrix methods:

Introduction to matrices and matrix notation

The process for addition, subtraction and multiplication of matrices

Introducing the determinant of a matrix and calculating the determinant for a 2x2 and 3x3 matrix

Using the inverse of a square matrix to solve linear equations

Gaussian elimination to solve systems of linear equations (up to 3x3)

LO3 Approximate solutions of contextualised examples with graphical and numerical methods

Graphical and numerical methods:

Standard curves of common functions, including quadratic, cubic, logarithm and exponential curves

Systematic curve sketching knowing the equation of the curve

Using sketches to approximate solutions of equations

Numerical analysis using the bisection method and the Newton–Raphson method

Numerical integration using the mid-ordinate rule, the trapezium rule and Simpson’s rule

LO4 Review models of engineering systems using ordinary differential equations

Differential equations:

Formation and solutions of first-order differential equations

Applications of first-order differential equations e.g. RC and RL electric circuits, Newton’s laws of cooling, charge and discharge of electrical capacitors and complex stresses and strains

Formation and solutions of second-order differential equations

Applications of second-order differential equations e.g. mass-spring-damper systems, information and energy control systems, heat transfer, automatic control systems and beam theory and RLC circuits

Introduction to Laplace transforms for solving linear ordinary differential equations

Applications involving Laplace transforms such as electric circuit theory, load frequency control, harmonic vibrations of beams, and engine governors

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Use applications of number theory in practical engineering situations		M1 Solve problems using de Moivre's Theorem	D1 Test the correctness of a trigonometric identity using de Moivre's Theorem
P1 Apply addition and multiplication methods to numbers that are expressed in different base systems			
P2 Solve engineering problems using complex number theory P3 Perform arithmetic operations using the polar and exponential form of complex numbers			
LO2 Solve systems of linear equations relevant to engineering applications using matrix methods		M2 Determine the solution to a set of given engineering linear equations using the Inverse Matrix Method for a 3x3 matrix	D2 Validate solutions for the given engineering linear equations using appropriate computer software
P4 Calculate the determinant of a set of given linear equations using a 3x3 matrix	P5 Solve a system of three linear equations using Gaussian elimination		

Pass	Merit	Distinction
LO3 Approximate solutions of contextualised examples with graphical and numerical methods		D3 Critically evaluate the use of numerical estimation methods, commenting on their applicability and the accuracy of the methods
P6 Estimate solutions of sketched functions using a graphical estimation method P7 Calculate the roots of an equation using two different iterative techniques P8 Determine the numerical integral of engineering functions using two different methods	M3 Solve engineering problems and formulate mathematical models using graphical and numerical integration	
LO4 Review models of engineering systems using ordinary differential equations		D4 Critically evaluate first and second-order differential equations when generating the solutions to engineering situations using models of engineering systems
P9 Formulate and solve first order differential equations related to engineering systems P10 Formulate and solve second order homogeneous and non-homogeneous differential equations related to engineering systems P11 Calculate solutions to linear ordinary differential equations using Laplace transforms	M4 Demonstrate how different models of engineering systems using first-order differential equations can be used to solve engineering problems	

Recommended Resources

Textbooks

BIRD, J. (2014) *Higher Engineering Mathematics*. 7th Ed. London: Routledge.

SINGH, K. (2011) *Engineering Mathematics Trough Applications*. Basingstoke, Palgrave Macmillan.

STROUD, K.A. and BOOTH, D.J. (2013) *Engineering Mathematics*. 7th Ed: Basingstoke, Palgrave Macmillan.

Journals

Communications on Pure and Applied Mathematics. Wiley.

Journal of Engineering Mathematics. Springer.

Journal of Mathematical Physics. American Institute of Physics.

Websites

<http://www.mathcentre.ac.uk/> Maths Centre
(Tutorials)

<http://www.mathtutor.ac.uk/> Maths Tutor
(Tutorials)

Unit 6: Mechatronics

Unit code T/615/1480

Unit level 4

Credit value 15

Introduction

Auto-focus cameras, car cruise control and automated airport baggage handling systems are examples of mechatronic systems. Mechatronics is the combination of mechanical, electrical and computer/controlled engineering working together in automated systems and 'smart' product design.

Among the topics included in this unit are: consideration of component compatibility, constraints on size and cost, control devices used, British and/or European standards relevant to application, sensor types and interfacing, simulation and modelling software functions, system function and operation, advantages and disadvantages of software simulation,

component data sheets, systems drawings, flowcharts, wiring and schematic diagrams.

On successful completion of this unit students will be able to explain the basic mechatronic system components and functions, design a simple mechatronic systems specification for a given application, use appropriate simulation and modelling software to examine its operation and function, and solve faults on mechatronic systems using a range of techniques and methods.

Learning Outcomes

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

1. Explain the design and operational characteristics of a mechatronic system.
2. Design a mechatronic system specification for a given application.
3. Examine the operation and function of a mechatronics system using simulation and modelling software.
4. Identify and correct faults in a mechatronic system.

Downloaded from cornerstone.edu.in

Essential Content

LO1 Examine the design and operational characteristics of a mechatronic system

Origins and evolution:

History and early development, evolution
Practical examples and extent of use
Current operational abilities and anticipated improvements

Systems characteristics:

Design of systems in an integrated way
Sensor and transducer types used
Consideration of component compatibility
Constraints on size and cost
Control device requirements and examples of applications

LO2 Design a mechatronic system specification for a given application

Systems specifications:

British and/or European standards relevant to application
Sensor types and interfacing
Actuator technology availability and selection
Selection and use of appropriate control software/devices.
Consideration of the interaction of system variables
System commissioning parameters

LO3 Examine the operation and function of a mechatronics system using simulation and modelling software

Operation and functions:

Simulation and modelling software functions
System function and operation
Modes of operation simulation, loading and surges
Advantages and disadvantage of software simulation

LO4 Identify and correct faults in a mechatronic system

Locating and correcting system faults:

Component data sheets, systems drawings, flowcharts, wiring and schematic diagrams
Original system correct function and operation

Inspection and testing using methodical fault location techniques and methods, use of control software to aid fault location

Identification, evaluation and verification of faults and their causes, rectification, final system testing and return to service

Downloaded from cornerstone.edu.in

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
L01 Examine the design and operational characteristics of a mechatronic system			D1 Investigate an actual mechatronics system specification to propose alternative solutions
P1 Describe the key components of a given mechatronics system		M1 Explore how the mechatronics components operate as part of an integrated system	
P2 Identify the types of actuators, sensors and transducers used in the mechatronics system		M2 Investigate the methods of control used by mechatronics systems	
L02 Design a mechatronic system specification for a given application			D2 Evaluate the operational capabilities and limitations of the mechatronics system design specification produced
P3 Select the relevant sensor and the appropriate actuator technologies and produce a design specification suitable for these selections		M3 Justify the sensor and actuator technologies selected with reference to available alternatives	
L03 Examine the operation and function of a mechatronics system using simulation and modelling software			D3 Explain the function and operation of a simulated mechatronics system
P4 Demonstrate industry standard mechatronics simulation/modelling software		M4 Describe the advantages and disadvantages of the software simulation	

Pass	Merit	Distinction
L04 Identify and correct faults in a mechatronic system		D4 Investigate the causes of faults on a mechatronics system and suggest alternatives to the design specification to improve reliability
P5 Explain the safe use of fault finding test equipment	M5 Apply and document the correct use of fault finding techniques/ methods	
P6 Locate and rectify faults on a mechatronic system		

Downloaded from cornerstone.edu.in

Recommended Resources

Textbooks

BOLTON, W. (2015) *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*. 5th Ed. Essex: Pearson Education Limited.

MAHALIK, N.P. (2010) *Mechatronics: Principles, Concepts and Applications*. New Delhi: McGraw-Hill.

ONWUBOLU, G.C. (2005) *Mechatronics: Principles and Applications*. Oxford: Elsevier.

RAMACHANDRAN, K.P., VIJAYARAGHAVAN, G.K. and BALASUNDARAM, M.S. (2008)

Mechatronics: Integrated Mechanical Electronic Systems. India: Wiley.

Journals

International Journal of Advanced Mechatronic Systems.

Links

This unit links to the following related units:

Unit 15: Automation, Robotics and Programmable Logic Controllers (PLCs)

Unit 54: Further Control Systems Engineering

Unit 8: Mechanical Principles

Unit code F/615/1482

Unit level 4

Credit value 15

Introduction

Mechanical principles have been crucial for engineers to convert the energy produced by burning oil and gas into systems to propel, steer and stop our automobiles, aircraft and ships, amongst thousands of other applications. The knowledge and application of these mechanical principles is still the essential underpinning science of all machines in use today or being developed into the latest technology.

The aim of this unit is to introduce students to the essential mechanical principles associated with engineering applications.

Topics included in this unit are: behavioural characteristics of static, dynamic and oscillating engineering systems including shear forces, bending moments, torsion, linear and angular acceleration, conservation of energy and vibrating systems; and the movement and transfer of energy by considering parameters of mechanical power transmission systems.

On successful completion of this unit students will be able to explain the underlying principles, requirements and limitations of mechanical systems

Learning Outcomes

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

1. Identify solutions to problems within static mechanical systems.
2. Illustrate the effects that constraints have on the performance of a dynamic mechanical system.
3. Investigate elements of simple mechanical power transmission systems.
4. Analyse natural and damped vibrations within translational and rotational mass-spring systems.

Essential Content

LO1 Identify solutions to problems within static mechanical systems

Shafts and beams:

The effect of shear forces on beams

Bending moments and stress due to bending in beams

Selection of appropriate beams and columns to satisfy given specifications
The theory of torsion in solid and hollow circular shafts

LO2 Illustrate the effects that constraints have on the performance of a dynamic mechanical system

Energy and work:

The principle of conservation of energy and work-energy transfer in systems
Linear and angular velocity and acceleration

Velocity and acceleration diagrams of planar mechanisms

Gyroscopic motion

LO3 Investigate elements of simple mechanical power transmission systems

Simple systems:

Parameters of simple and compounded geared systems

Efficiency of lead screws and screw jacks

Couplings and energy storage:

Universal couplings and conditions for constant-velocity
Importance of energy storage elements and their applications

LO4 Analyse natural and damped vibrations within translational and rotational mass-spring systems

Types of motion:

Simple harmonic motion

Natural frequency of vibration in mass-spring systems

Damped systems:

Frequency of damped vibrations in mass-spring-damper systems
The conditions for an external force to produce resonance

Downloaded from cornerstone.edu.in

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Identify solutions to problems within static mechanical systems			D1 Calculate the magnitude of shear force and bending moment in cantilever and encastred beams for a variety of applications
<p>P1 Calculate the distribution of shear force, bending moment and stress due to bending in simply supported beams</p> <p>P2 Justify the selection of standard rolled steel sections for beams and columns</p> <p>P3 Determine the distribution of shear stress and the angular deflection due to torsion in solid and hollow circular shafts</p>	<p>M1 Determine the material of a circular bar from experimental data of angle of twist obtained from a torsion test</p>		
LO2 Illustrate the effects that constraints have on the performance of a dynamic mechanical system			D2 Calculate solutions of velocities and accelerations within planar mechanisms using trigonometric methodology
<p>P4 Explain the effects of energy transfer in mechanical systems with uniform acceleration present</p> <p>P5 Identify the magnitude and effect of gyroscopic reaction torque</p>	<p>M2 Construct diagrams of the vector solutions of velocities and accelerations within planar mechanisms</p>		

Pass		Merit	Distinction
LO3 Investigate elements of simple mechanical power transmission systems			D3 Examine the cause of a documented case of mechanical power transmission failure and the steps taken to correct the problem and rectify any design faults
P6 Determine the velocity ratio for compound gear systems and the holding torque required to securely mount a gearbox P7 Calculate the operating efficiency of lead screws and screw jacks P8 Explain the conditions required for a constant velocity ratio between two joined shafts	M3 Examine devices which function to store mechanical energy in their operation		
LO4 Analyse natural and damped vibrations within translational and rotational mass-spring systems			D4 Identify the conditions needed for mechanical resonance and measures that are taken to prevent this from occurring
P9 Explain the natural frequency of vibration in a mass-spring system	M4 Determine the amplitude and phase angle of the transient response within a mass-spring damper system		

Recommended Resources

Textbooks

BIRD, J. and ROSS, C. (2014) *Mechanical Engineering Principles*. 3rd Ed. London:Routledge.

TOOLEY, M. and DINGLE, L. (2012) *Engineering Science: For Foundation Degree and Higher National*. London: Routledge.

Websites

<https://www.khanacademy.org/>

Khan Academy
(Tutorials)

Links

This unit links to the following related units:

Unit 1: Engineering Design

Unit 2: Engineering Maths

Unit 36: Advanced Mechanical Principles

Unit 11: Fluid Mechanics

Unit code R/615/1485

Unit level 4

Credit value 15

Introduction

Fluid mechanics is an important subject to engineers of many disciplines, not just those working directly with fluid systems. Mechanical engineers need to understand the principles of hydraulic devices and turbines (wind and water); aeronautical engineers use these concepts to understand flight, while civil engineers concentrate on water supply, sewerage and irrigation.

This unit introduces students to the fluid mechanics techniques used in mechanical engineering. The hydraulic devices and systems that incorporate the transmission of hydraulic pressure and forces exerted by a static fluid on immersed surfaces.

Topics included in this unit are: pressure and force, submerged surfaces, fluid flow theory, aerodynamics, and hydraulic machinery.

On successful completion of this unit students will be able to work with the concept and measurement of viscosity in fluids, and the characteristics of Newtonian and non-Newtonian fluids; examine fluid flow phenomena, including energy conservation, estimation of head loss in pipes and viscous drag; and examine the operational characteristics of hydraulic machines, in particular the operating principles of various water turbines and pumps.

Learning Outcomes

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

1. Determine the behavioural characteristics of static fluid systems.
2. Examine the operating principles and limitations of viscosity measuring devices.
3. Investigate dynamic fluid parameters of real fluid flow.
4. Explore dynamic fluid parameters of real fluid flow.

Essential Content

LO1 Determine the behavioural characteristics of static fluid systems

Pressure and force:

How Pascal's laws define hydrostatic pressure
Pressure with the use of manometers
Transmission of force in hydraulic devices

Submerged surfaces:

Determining thrust on immersed surfaces
Moments of area and parallel axis theorem
Calculating centre of pressure with moments of area

LO2 Examine the operating principles and limitations of viscosity measuring devices

Viscosity in fluids:

Dynamic and kinematic viscosity definitions
Characteristics of Newtonian fluids
Effects of temperature on viscosity
Classification of non-Newtonian fluids

Operating principles and limitations:

Operating principles of viscometers
Converting results acquired from viscometers into viscosity values

LO3 Investigate dynamic fluid parameters of real fluid flow

Fluid flow theory:

Energy present within a flowing fluid and the formulation of Bernoulli's Equation

Classification of fluid flow using Reynolds numbers

Calculations of flow within pipelines

Head losses that occur within a fluid flowing in a pipeline

Viscous drag resulting from fluid flow and the formulation of the drag equation

Aerodynamics:

Application of prior theory of fluid flow to aerodynamics

Principles of aerofoils and how drag induces lift

Flow measuring devices and their operating principles

LO4 Explore the operating principles and efficiencies of hydraulic machines

Hydraulic machinery:

Operating principles of different types of water turbine

Reciprocating and centrifugal pump theory

Efficiencies of these different types of hydraulic machinery
Environmental concerns surrounding hydraulic machines

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
L01 Determine behavioural characteristics of static fluid systems			D1 Explain the use and limitations of manometers to measure pressure
P1 Describe force and centre of pressure on submerged surfaces P2 Carry out appropriate calculations on force and centre of pressure on submerged surfaces		M1 Determine the parameters of hydraulic devices that are used in the transmission of force	
L02 Examine the operating principles and limitations of viscosity measuring devices			D2 Illustrate the resultsof a viscosity test on a Newtonian fluid at various temperatures with that which is given on a data sheet and explain discrepancies.
P3 Explain the operation and constraints of different viscometers that quantify viscosity in fluids P4 Carry out appropriate calculations on the effect of changes in temperature and other constraints on the viscosity of a fluid		M2 Explain, with examples, the effects of temperature and shear forces on Newtonian and non-Newtonian fluids	

Pass	Merit	Distinction
L03 Investigate dynamic fluid parameters of real fluidflow		D3 Determine the head losses accumulated by a fluid when flowing in a pipeline for various applications
P5 Determine parameters of a flowing fluid using Bernoulli's Equation P6 Define the flow of a fluid using Reynold's numbers and the significance of this information	M3 Explain the effect of aerodynamic drag and lift on aerofoils	
L04 Explore the operating principles and efficiencies of hydraulic machines		D4 Describe and analyse the arguments concerning the ecological impact of hydroelectric power.
P7 Determine the efficiency of a water turbine P8 Calculate the input power requirements of centrifugal pumps	M4 Identify the limitations that exist within different types of water turbine	

Recommended Resources

Textbook

MASSEY, B.S. and WARD-SMITH, J. (2011) *Mechanics of Fluids*. 9th Ed. Oxford: Spon Press.

Journals

Journal of Fluid Mechanics. Cambridge University Press.

Annual Review of Fluid Mechanics. Annual Reviews, California.

Websites

<https://www.khanacademy.org/>

Khan Academy
Fluids
(Tutorials)

Links

This unit links to the following related units: *Unit 29:*

Electro, Pneumatic and Hydraulic Systems *Unit 64:*

Thermofluids

Unit 19: Electrical and Electronic Principles

Unit code	M/615/1493
Unit level	4
Credit value	15

Introduction

Electrical engineering is mainly concerned with the movement of energy and power in electrical form, and its generation and consumption. Electronics is mainly concerned with the manipulation of information, which may be acquired, stored, processed or transmitted in electrical form. Both depend on the same set of physical principles, though their applications differ widely. A study of electrical or electronic engineering depends very much on these underlying principles; these form the foundation for any qualification in the field, and are the basis of this unit.

The physical principles themselves build initially from our understanding of the atom, the concept of electrical charge, electric fields, and the behaviour of the electron in different types of material. This understanding is readily applied to electric circuits of different types, and the basic circuit laws and electrical components emerge. Another set of principles is built around semiconductor devices, which become the basis of modern electronics. An introduction to semiconductor theory leads to a survey of the key electronic components, primarily different types of diodes and transistors.

Electronics is very broadly divided into analogue and digital applications. The final section of the unit introduces the fundamentals of these, using simple applications. Thus, under analogue electronics, the amplifier and its characteristics are introduced. Under digital electronics, voltages are applied as logic values, and simple circuits made from logic gates are considered.

On successful completion of this unit students will have a good and wide-ranging grasp of the underlying principles of electrical and electronic circuits and devices, and will be able to proceed with confidence to further study.

Learning Outcomes

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

1. Apply an understanding of fundamental electrical quantities to evaluate circuits with constant voltages and currents.
2. Evaluate circuits with sinusoidal voltages and currents.
3. Describe the basis of semiconductor action, and its application to simple electronic devices.
4. Explain the difference between digital and analogue electronics, describing simple applications of each.

Downloaded from cornerstone.edu.in

Essential Content

LO1 Apply an understanding of fundamental electrical quantities to analyse circuits with constant voltages and currents

Fundamental electrical quantities and concepts:

Charge, current, electric field, energy in an electrical context, potential, potential difference, resistance, electromotive force, conductors and insulators

Circuit laws:

Voltage sources, Ohm's law, resistors in series and parallel, the potential divider, Kirchhoff's and Thevenin's laws; superposition

Energy and power:

Transfer into the circuit through, for example, battery, solar panel or generator, and out of the circuit as heat or mechanical. Maximum power transfer

LO2 Analyse circuits with sinusoidal voltages and currents

Fundamental quantities of periodic waveforms:

Frequency, period, peak value, phase angle, waveforms, the importance of sinusoids

Mathematical techniques:

Trigonometric representation of a sinusoid. Rotating phasors and the phasor diagram. Complex notation applied to represent magnitude and phase

Reactive components:

Principles of the inductor and capacitor. Basic equations, emphasising understanding of rates of change (of voltage with capacitor, current with inductor). Current and voltage phase relationships with steady sinusoidal quantities, representation on phasor diagram

Circuits with sinusoidal sources:

Current and voltage in series and parallel RL, RC and RLC circuits. Frequency response and resonance

Mains voltage single-phase systems. Power, root-mean-square power quantities, power factor

Ideal transformer and rectification:

The ideal transformer, half-wave and full-wave rectification. Use of smoothing capacitor, ripple voltage

LO3 Describe the basis of semiconductor action, and its application to simple electronic devices

Semiconductor material:

Characteristics of semiconductors; impact of doping, p-type and n-type semiconductor materials, the p-n junction in forward and reverse bias

Simple semiconductor devices:

Characteristics and simple operation of junction diode, Zener diode, light emitting diode, bipolar transistor, Junction Field Effect Transistor (FET) and Metal Oxide Semiconductor FET (MOSFET). The bipolar transistor as switch and amplifier

Simple semiconductor applications:

Diodes: AC-DC rectification, light emitting diode, voltage regulation

Transistors: switches and signal amplifiers

LO4 Explain the difference between digital and analogue electronics, describing simple applications of each

Analogue concepts:

Analogue quantities, examples of electrical representation of, for example, audio, temperature, speed, or acceleration

The voltage amplifier; gain, frequency response, input and output resistance, effect of source and load resistance (with source and amplifier output modelled as Thevenin equivalent)

Digital concepts:

Logic circuits implemented with switches or relays

Use of voltages to represent logic 0 and 1, binary counting

Logic Gates (AND, OR, NAND, NOR) to create simple combinational logic functions

Truth Tables

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Apply an understanding of fundamental electrical quantities to analyse circuits with constant voltages and currents			D1 Evaluate the operation of a range of circuits with constant sources, using relevant circuit theories.
P1 Apply the principles of circuit theory to simple circuits with constant sources, to explain the operation of that circuit	M1 Apply the principles of circuit theory to a range of circuits with constant sources, to explain the operation of that circuit		
LO2 Analyse circuits with sinusoidal voltages and currents			D2 Analyse the operation and behaviour of series and parallel RLC circuits, including resonance and using the principles of circuit theory with sinusoidal sources.
P2 Analyse series RLC circuits, using the principles of circuit theory with sinusoidal sources.	M2 Analyse series and parallel RLC circuits, using the principles of circuit theory with sinusoidal sources.		
LO3 Describe the basis of semiconductor action, and its application to simple electronic devices			D3 Analyse the performance of a range of discrete semiconductor devices in terms of simple semiconductor theory, and suggest applications for each.
P3 Describe the behaviour of a p-n junction in terms of semiconductor behaviour P4 Demonstrate the action of a range of semiconductor devices	M3 Explain the operation of a range of discrete semiconductor devices in terms of simple semiconductor theory		

Pass	Merit	Distinction
L04 Explain the difference between digital and analogue electronics, describing simple applications of each		D4 Evaluate the use of analogue and digital devices and circuits using examples.
P5 Explain the difference between digital and analogue electronics P6 Explain amplifier characteristics P7 Explain the operation of a simple circuit made of logic gates	M4 Explain the benefits of using analogue and digital electronic devices using examples	

Downloaded from cornerstone.edu.in

Recommended Resources

Textbooks

BIRD, J. (2013) *Electrical Circuit Theory and Technology*. Routledge.

HUGHES, E., HILEY, J., BROWN, K. and MCKENZIE-SMITH, I. (2012) *Electrical and Electronic Technology*. Pearson.

SINGH, K. (2011) *Engineering Mathematics through Applications*. Palgrave.

Pearson BTEC Higher Nationals Study Guide (2011) Custom Publishing. Pearson.

Links

This unit links to the following related units:

Unit 20: Digital Principles

Unit 22: Electronic Circuits and Devices

Unit 52: Further Electrical, Electronic and Digital Principles

Downloaded from cornerstone.edu.in

Unit 50: Advanced Manufacturing Technology

Unit code	R/615/1518
Unit level	5
Credit value	15

Introduction

The ability of successful companies to meet the growing demand of customers is heavily influenced by the development of advanced manufacturing technologies. Customers expect high complexity products, on demand, and with a growing element of customisation. In adopting advanced manufacturing technologies, successful companies will ensure faster time to market of new products, improve products and processes, use new, sustainable, materials, and customise to customer requirements. Manufacturing systems engineering underpins this development.

In order to meet changing customer expectations and gain competitive advantage, focus needs to be applied to developing smart factories and advanced manufacturing technologies. Manufacturing organisations will seek integration between manufacturing technology, high performance computing, the internet, and the product at all stages of its life cycle.

Industry 4.0 is the term that has been adopted to describe the 'fourth' industrial revolution currently underway, at present, in the manufacturing and commercial sectors of our society. It is a revolution based on the integration of cyber-physical systems with the Internet of Things and services. For the manufacturing sector, this integration has been enabled by successfully combining high performance computing, the internet and the development of advanced manufacturing technologies. Industry 4.0 is changing the way the world's most successful companies produce the products that their global customers demand.

On successful completion of this unit students will be able to analyse and evaluate the potential of using advanced manufacturing technologies to improve the competitive advantage of the organisations adopting them. The student will develop knowledge and understanding of advanced manufacturing technologies, digitalisation and a range of advanced manufacturing technologies. They will also develop their own research activities into the latest developments.

Learning Outcomes

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

1. Recognise a range of advanced manufacturing processes and cite examples of where they are most effective.
2. Analyse advanced manufacturing technologies to determine their appropriateness for an application or process.
3. Analyse an existing manufactured product and associated process to introduce proposals for possible improvements based on the introduction of advanced manufacturing technologies.
4. Evaluate the concept of the next industrial revolution to determine the impact on both manufacturers and the consumer.

Downloaded from cornerstone.edu.in

Essential Content

LO1 Recognise a range of advanced manufacturing processes to cite examples of where they are most effective

Manufacturing processes:

Pressing and forming, casting and moulding, joining and soldering, mixing, final assembly, packaging, material handling, quality control/inspection

Advanced manufacturing processes:

Additive manufacturing technology (e.g. replacing forming, moulding, pressing), 3D printing, impact on rapid prototyping, availability of spares/obsolete parts, medical components available and customised

Mass customisation through 3D printing, opening up a self-serve market

Robotics/human interface and automation, high-precision technology and productivity e.g. aerospace, automotive, electronics assembly

Types of application or industry:

Industry examples: aerospace, automotive, healthcare, electronics, food and beverage, chemical and pharmaceutical, minerals, oil and gas, retail, fashion

Application examples: assembly, joining, moulding, soldering

LO2 Analyse advanced manufacturing technologies to determine their appropriateness for an application or process

Manufacturing technologies:

High precision robotics and automation: healthcare (components and processes), aerospace, automotive, process control and visualisation through automation technology

Improvement in productivity through greater automation

Quality of manufacturing processes improved through integration of robotics

Examples of using 3D printing and other forms of additive manufacturing to produce medical equipment, spares parts for items that may have become obsolete, mass customisation; what the customer wants, when they want it

LO3 Analyse an existing manufactured product and associated process to introduce proposals for possible improvements based on the introduction of advanced manufacturing technologies

Manufactured product:

Research the traditional methods used to manufacture an existing product, determine the associated processes required to bring it to market and identify the limitations of these methods and processes

Explore how advanced manufacturing technology could be applied to produce this product and suggest how applying such processes would influence its production, costs, time to market and customer satisfaction (e.g. healthcare/medical such as hip joint, traditional method vs mass customisation and the possible use of 3D printing)

3D printing and its availability is opening up new markets, but also new business models for organisations; explore the future possibilities for self-serve/or self- production of items

LO4 Evaluate the concept of the next industrial revolution to determine the impact on both manufacturers and the consumer

Next industrial revolution:

Industry 4.0

Internet of Things: over time industry has transformed from being local-based to communication-based technology; the possibilities for connected technology and connected factories are ever increasing

Cyber-physical systems: collaborative robotics and highly integrated manufacturing systems

Mass customisation: there is a growing demand and desire for individual products. In 1908, referring to the Model T, Henry Ford said, "You can have any colour, as long as it's black." In 2015 you can have trillions of variations of the Ford F150; advanced manufacturing technology and the ability to manage complexity is key to that realisation

Digitalisation and increased automation; the ability to simulate and create a digital twin has the potential to dramatically reduce time to market

The drive to increase efficiency requires innovation and innovative technology; 25% of all energy used is required by industry alone

Big data; the development of an ever connected production environment alongside cloud computing presents a challenge of having a stream of production data and the need to analyse this in order to make timely informed decisions

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Recognise a range of advanced manufacturing processes to cite examples of where they are most effective			D1 Research and evaluate a manufactured product and identify the technology used
P1 Recognise a range of advanced manufacturing process or technologies and cite examples of where they are most effective	M1 Compare a traditional manufacturer to one employing advanced manufacturing to discuss the fundamental differences		
LO2 Analyse advanced manufacturing technologies to determine their appropriateness for an application or process			D2 Examine the potential justification for an organisation to invest in advanced manufacturing technology
P2 Analyse advanced manufacturing technologies to determine their appropriateness for an application or process	M2 Explore how advanced manufacturing could be applied, and give examples of where technology would be suited		
LO3 Analyse an existing manufactured product and associated process to introduce proposals for possible improvements based on the introduction of advanced manufacturing technologies			D3 Critically evaluate the impact of utilising advanced manufacturing technology rather than the existing method on both the customer and the manufacturer
P3 Analyse an existing manufactured product and identify the key technology used to produce the item	M3 Evaluate the effectiveness of the current method and suggest an alternative advanced manufacturing technology		

Pass	Merit	Distinction
<p>LO4 Evaluate the concept of the next industrial revolution to determine the impact on both manufacturers and the consumer</p>		<p>D4 Investigate and justify the types of industry or product that would benefit most from an innovative advanced manufacturing approach</p>
<p>P4 Evaluate the concept of a 4th industrial revolution</p> <p>P5 Identify the key elements of Industry 4.0</p>	<p>M4 Evaluate the impact of advanced manufacturing on both manufacturers and the customer</p>	

Downloaded from cornerstone.edu.in

Recommended Resources

Textbooks

LEFTERI, C. (2012) *Making It: Manufacturing Techniques for Product Design*. 2nd Ed. Laurence King.

WRIGHT, P.K. (2000) *21st Century Manufacturing*. New Jersey: Prentice-Hall Inc.

Websites

<https://www.gov.uk>

GOV.UK

Future of manufacturing: a new era of opportunity and challenge for the UK
(Report)

<https://w3.siemens.com/>

Siemens

The Future of Manufacturing
(General Reference)

<https://hvm.catapult.org.uk/>

Catapult

High Value Manufacturing (General Reference)

Links

This unit links to the following related units: *Unit 48:*

Manufacturing Systems Engineering Unit 49:

Lean Manufacturing

Unit 51: Sustainability