2016 Suite

OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 3**

Cambridge TECHNICALS 2016

ENGINEERING

Unit 21

Maintenance

H/506/7287

Guided learning hours: 60

VERSION 4 -June 2017 black line indicates updated content

LEVEL 3

UNIT 21: MAINTENANCE

H/506/7287

Guided learning hours: 60

Essential resources required for this unit: suitable equipment to perform a maintenance operation on, tools and equipment to undertake a maintenance operation, suitable PPE

This unit is internally assessed and externally moderated by OCR.

UNIT AIM

Maintenance, and maintenance engineering, are vital for all other aspects of engineering to function. From basic vehicle maintenance, to the increasingly complex devices, equipment, machinery and structures that are used in modern industry, the role of maintenance in keeping everything operating at optimum performance is crucial.

The aim of this unit is to develop learners' knowledge and understanding of different maintenance strategies and operations, then to be able to plan and undertake maintenance operations themselves.

They will also be able to analyse maintenance data, develop an understanding of failure modes, and an understanding of how maintenance issues can inform future design.

TEACHING CONTENT

The teaching content in every unit states what has to be taught to ensure that learners are able to access the highest grades.

Anything which follows an i.e. details what must be taught as part of that area of content. Anything which follows an e.g. is illustrative, it should be noted that where e.g. is used, learners must know and be able to apply relevant examples in their work, although these do not need to be the same ones specified in the unit content.

For internally assessed units you need to ensure that any assignments you create, or any modifications you make to an assignment, do not expect the learner to do more than they have been taught, but must enable them to access the full range of grades as described in the grading criteria.

Please note – if learners are completing this unit as part of the Extended Diploma qualification they will be required to complete the synoptic unit 25: Promoting continuous improvement. Before your learners complete the assessment of this unit, you must refer to the specification and model assignment requirements for unit 25, so if applicable you can ensure learners gather the appropriate feedback on their own performance and performance of the system, process or artefact that they may have produced in this unit.

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
1. Know about maintenance strategies and operations	1.1 maintenance strategies and associated operations, i.e. • planned or scheduled maintenance • preventative maintenance, i.e. o use of safeguards o inspections o regular cleaning o checking and replacing consumables o operator training • predictive maintenance, i.e. o monitoring methods o evaluating condition • repair on demand or run to failure 1.2 analysis of different maintenance strategies, i.e. • advantages and disadvantages (e.g. effectiveness, predictability, staff/training requirements) • cost of repair v cost of prevention • suitability for different situations (e.g. plants, processes or systems) 1.3 use of computers to manage maintenance, i.e. • inventories • ordering • tracking

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
2. Understand failure modes	2.1 factors that contribute to failure of mechanical and electrical systems and their causes, i.e. • maladjustment • maloperation • run to failure • stress fracture, fatigue, wear, embrittlement • overloading, seizure • anodic and chemical corrosion • lubrication failure, fouling, vibration • poor training 2.2 common failures in mechanical and electrical systems (e.g. relay contacts, brushes on a motor, bush replacement, lack of oil application on moving parts, dirt/grime, corrosion, contamination, belt tension, oil in compressors) 2.3 incorrect component selection (e.g. use of incorrect rated part, use of non-Original Equipment Manufacturer (OEM) part) 2.4 component failure (e.g. broken nuts, bolts or screws; blown circuit board components)
3. Be able to analyse reliability-centred maintenance data	3.1 use of statistical methods in determining maintenance strategies for engineered systems, i.e. • how to calculate: o Mean Time Between failures (MTBF) o Mean Time To Repair (MTTR) o Mean Time To Failure (MTTF) • the significance of: o standard deviation in extreme performance variations of different clusters o sample size • how to use MTTF, MTTR and frequency to inform maintenance strategy 3.2 how to use software packages in Computerised Maintenance Management Systems (CMMS) i.e. • monitoring/data logging • planning • predicting

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
4. Be able to plan maintenance operations	4.1 how to fault find, i.e. • visual inspection • the half split method of fault location • the six point fault finding technique: o test o analyse o locate fault o determine cause o repair o re-test • testing i.e. o use of manuals, data sheets and fault finding data o expected values • use of expert systems 4.2 how to plan maintenance operations for a mechanical, electrical or mechatronic system 4.3 interpretation of circuit diagrams to identify faults 4.4 how to plan a sequence of operations that will result in successful maintenance 4.5 the benefits of standardisation of tools 4.6 use of manuals and data sheets
5. Be able to undertake maintenance operations	5.1 safe working in maintenance operations, i.e. • clear safe working area • how to conduct a risk assessments in engineering • appropriate use and storage of Personal Protective Equipment (PPE) • need for electrical isolation • need to ensure against unwanted movement 5.2 techniques to identify and mitigate against hazards, i.e. • visual inspection of equipment • use of spill response systems • COSHH • manual handling 5.3 use of appropriate tools (e.g. ring spanners versus open ended spanners, torque wrench, soldering iron, wire strippers, pliers, screwdrivers, meters)

Learning outcomes	Teaching content
The Learner will:	**Learners must be taught:**
6. Understand how maintenance issues can inform design	6.1 design for maintenance, i.e. • use standard, universally available components, interfaces and fasteners • components that are regularly replaced need to be easy to handle • design to fail safe • use of modular systems • positioning components that often need to be maintained at in easily accessible place and maintenance points close to each other • design-out moving parts • avoid unnecessary components but provide redundancy • save useful life time data • design for the use of standard tools • effects on whole life cost

GRADING CRITERIA

LO	Pass	Merit	Distinction
	The assessment criteria are the Pass requirements for this unit.	To achieve a Merit the evidence must show that, in addition to the Pass criteria, the candidate is able to:	To achieve a Distinction the evidence must show that, in addition to the pass and merit criteria, the candidate is able to:
1. Know about maintenance strategies and operations	P1 Describe different maintenance strategies and associated operations.	M1 Analyse why different maintenance strategies are suitable for different situations.	D1 Evaluate a range of methods for predicting failure.
	P2 Explain how computers can be used to manage maintenance.		
2. Understand failure modes	P3 Explain factors which contribute to failure of mechanical and electrical systems and their causes.		
	P4 Describe common failures in mechanical and electrical systems.		
3. Be able to analyse reliability-centred maintenance data	P5 Explain the terms MTBF, MTTR and MTTF.	M2 Explain the significance of standard deviation and sample size when using statistical methods to determine maintenance strategies.	D2 Evaluate the effectiveness of using reliability-centred maintenance data to improve the efficiency of engineered systems.
	P6 Calculate MTBF, MTTR and MTTF using statistical methods. **Synoptic with unit 1 Mathematics for engineering*		

LO	Pass	Merit	Distinction
	P7 Describe how computers and software are used to data log in maintenance applications.	M3 Explain how a CMMS system can be used to help in maintenance planning.	
4. Be able to plan maintenance operations	P8 Explain different fault finding methods	M4 Accurately interpret manuals, data sheets and expected values when planning and undertaking fault finding and maintenance operations	D3 Design a detailed maintenance strategy for a system.
	P9 Design a maintenance plan for a system.		
		M5 Adapt a maintenance plan to address new faults found.	
5. Be able to undertake maintenance operations	P10 Work safely in the chosen environment.		
	P11 Carry out a visual inspection to locate a fault.		
	P12 Follow a maintenance plan using tools appropriately.		
	P13 Demonstrate ability to deal appropriately with any waste generated and return maintenance area to “as found” condition.		

LO	Pass	Merit	Distinction
6. Understand how maintenance issues can inform design	P14 Explain the need for fail safe design.	M6 Explain how and why a moving part has been designed out of a specific product or system.	D4 Analyse how an existing product or system could be redesigned for maintenance.
	P15: Explain the benefits of modular systems.		
	P16: Give examples of where and why redundancy might be built into a product or system.		

*SYNOPTIC ASSESSMENT AND LINKS BETWEEN UNITS

When learners are taking an assessment task, or series of tasks, for this unit they will have opportunities to draw on relevant, appropriate knowledge, understanding and skills that they will have developed through other units. We've identified those opportunities in the grading criteria. Learners should be encouraged to consider for themselves which skills/knowledge/understanding are most relevant to apply where we have placed an asterisk.

ASSESSMENT GUIDANCE

LO1: Know about maintenance strategies and operations
Learners should be able to describe and analyse different maintenance strategies, and explain how computers can be used in maintenance. D1 requires the evaluation of a range of methods for predicting failure across LO1 and LO2. Specific examples of applications of engineering maintenance strategies and operations could be used as the basis for investigations.

LO2: Understand failure modes
Learners should demonstrate understanding of failure modes including factors which contribute to failure of mechanical and electrical systems, and causes of failure. Specific examples could again be used for the basis of investigations.

LO3: Be able to analyse reliability-centred maintenance data
Learners should be able to analyse reliability-centred maintenance data. Teachers might supply learners with suitable data to analyse. P6 provides an opportunity to draw upon and apply mathematical skills learnt in Unit 1.

LO4: Be able to plan maintenance operations
Learners should be able to plan maintenance operations, and to develop an actual plan. Learners could develop a maintenance plan in preparation to undertake the maintenance operation in LO5. Attention to working safely is important.

LO5: Be able to undertake maintenance operations
Learners should be able to undertake a maintenance operation. This could be based upon planning undertaken in LO4. Learners will require access to suitable equipment, tools and safety equipment in order to undertake the maintenance operation. Appropriate teacher guidance and supervision will be required.

LO5: Understand how maintenance issues can inform design
Learners should demonstrate understanding of how maintenance issues can inform design. Teachers might supply learners with suitable designs for existing products or systems which can be investigated for redesign.

Feedback to learners: you can discuss work-in-progress towards summative assessment with learners to make sure it's being done in a planned and timely manner. It also provides an opportunity for you to check the authenticity of the work. You must intervene if you feel there's a health and safety risk.

Learners should use their own words when producing evidence of their knowledge and understanding. When learners use their own words it reduces the possibility of learners' work being identified as plagiarised. If a learner does use someone else's words and ideas in their work, they must acknowledge it, and this is done through referencing. Just quoting and referencing someone else's work will not show that the learner knows or understands it. It has to be clear in the work how the learner is using the material they have referenced to inform their thoughts, ideas or conclusions.

For more information about internal assessment, including feedback, authentication and plagiarism, see the centre handbook. Information about how to reference is in the OCR Guide to Referencing available on our website: http://www.ocr.org.uk/i-want-to/skills-guides/.

MEANINGFUL EMPLOYER INVOLVEMENT - a requirement for the Foundation Diploma, Diploma and Extended Diploma (tech level) qualifications

The 'Diploma' qualifications have been designed to be recognised as Tech Levels in performance tables in England. It is a requirement of these qualifications for centres to secure for every learner employer involvement through delivery and/or assessment of these qualifications.

The minimum amount of employer involvement must relate to at least one or more of the elements of the mandatory content.

Eligible activities and suggestions/ideas that may help you in securing meaningful employer involvement for this unit are given in the table below.

Please refer to the *Qualification Handbook* for further information including a list of activities that are not considered to meet this requirement.

Meaningful employer engagement	Suggestion/ideas for centres when delivering this unit
1. Learners undertake structured work-experience or work-placements that develop skills and knowledge relevant to the qualification.	Placements with engineering firms working with maintenance department, both electrical and mechanical maintenance engineers, carrying out planned preventative maintenance and unplanned maintenance activities.
2. Learners undertake project(s), exercises(s) and/or assessments/examination(s) set with input from industry practitioner(s).	Measure and inspection of production equipment/tooling, using industry standard equipment, to determine if the production equipment requires maintenance interventions.
3. Learners take one or more units delivered or co-delivered by an industry practitioner(s). This could take the form of master classes or guest lectures.	Input from practicing Maintenance engineers involved in production equipment inspection and maintenance. Input to include examples of methodology and working documentation within professional commercial engineering practice.
4. Industry practitioners operating as 'expert witnesses' that contribute to the assessment of a learner's work or practice, operating within a specified assessment framework. This may be a specific project(s), exercise(s) or examination(s), or all assessments for a qualification.	Input from practicing Maintenance engineers relating to the correct identification of maintenance principles by learners, set in operation during project work and documentation.

To find out more
ocr.org.uk/engineering
or call our Customer Contact Centre on **02476 851509**

Alternatively, you can email us on **vocational.qualifications@ocr.org.uk**

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