Coimisiún na Scrúduithe Stáit
State Examinations Commission

# LEAVING CERTIFICATE 2011

# MARKING SCHEME

# ENGINEERING – MATERIALS AND TECHNOLOGY

## ORDINARY LEVEL

# LEAVING CERTIFICATE 2011

# MARKING SCHEME

**Written Examination and Practical Examination**

# *ENGINEERING – MATERIALS AND TECHNOLOGY*

# ORDINARY LEVEL

# *LEAVING CERTIFICATE*

## *ENGINEERING - Materials and Technology*

(Ordinary Level – 200 marks)

**Written Examination Marking Scheme 2011**

**Answer Question 1, Sections A and B** and **Three other questions.**

**Question 1:** **Total - 65 Marks.**

Section A – **30 Marks**
Any six @ 5 marks each — Two part answers 3 + 2

Section B – **35 Marks**
Any three parts @ 12 + 12 + 11 Marks — Two part answers 6 + 6 or 6 + 5

Question 2 Total - **45 Marks**.

(a) Three parts @ 5each (15)

(b) Three parts @ 5 each (15)

(c) Three parts @ 3 each (9)

(d) Two parts @ 3 each (6)

Question 3 Total - **45 Marks**.

(a) Two parts @ 8 each (16)

(b) Two parts @ 5 each (10)

(c) Two parts @ 5 each (10)

(d) Two parts 5 & 4 (9)
**OR**
(d) Two parts 5 & 4 (9)

Question 4 Total - **45 Marks**.

(a) Three parts @ 5 each (15)

(b) Three parts @ 4 each (12)

(c) Three parts @ 4 each (12)

(d) Two parts @ 3 each (6)

Question 5 Total - **45 Marks**.

(a) Two parts @ 2 marks
Two parts @ 5 marks
Two parts @ 2 marks (18)

(b) Two parts @ 3 each (6)

(c) Three parts @ 5 each (15)

(d) Two parts @ 3 each (6)

Question 6 Total - **45 Marks**.

(a) Three parts @ 5 each (15)

(b) Three parts @ 5 each (15)

(c) Three parts @ 5 each (15)
**OR**
(c) Three parts @ 5 each (15)

Question 7 Total - **45 Marks**.

(a) Two parts @ 5 each (10)

(b) Four parts @ 5 each (20)

(c) Three parts @ 5 each (15)
**OR**
(c) Three parts @ 5 each (15)

## Sample Answers *and* Marking Scheme

***Note:*** **The solutions presented are examples only.**
**All other valid solutions are acceptable and are marked accordingly.**

## Question 1 (65 Marks)

| | Marks |
|---|---|
| **SECTION A - 30 MARKS** | **6 parts @ 5 marks each**<br>**For two part answers award 3 + 2** |
| **SECTION B - 35 MARKS** | **2 parts @ 12 marks each**<br>**1 part @ 11 marks**<br>**Award 6 + 6 or 6 + 5 as Appropriate** |

**MARKS**

### SECTION A – 30 MARKS

(a) (i) To highlight the need to wear protective goggles when working on a centre lathe. **3 + 2 Marks**

(ii) To ensure eyes are protected when using a pillar drilling machine.

(b) The alloy produced from copper and zinc is brass. **5 Marks**

(c) A countersinking drill is used to enlarge the mouths of holes to accommodate the heads of countersunk screws or rivets. **5 Marks**

(d) An acme thread is used on a lathe leadscrew to provide automatic power feed to the carriage when screw cutting. **5 Marks**

(e) The toggle switch can be used to turn a control circuit for a DC motor on or off. **5 Marks**

(f) Galvanised iron is the term given to steel when coated with zinc. **5 Marks**

(g) (i) Computer Aided Manufacturing can be used to produce high quality design products.

(ii) Computer Aided Manufacture supports the development and production of better and more complex design ideas. **3 +2 Marks**

(h) (i) The gear mechanism shown is a worm and wheel mechanism.

(ii) A worm and wheel mechanism can be used to provide a large reduction in output speed. **3+2 Marks**

## SECTION B – 35 MARKS

**(i) Any one**

Good clear description
**Award 12 (11) Marks**
**Total (12, 11) Marks**

**Ratchet and pawl mechanism**

A ratchet and pawl mechanism is used to allow a shaft, axle or pin to rotate in one direction only. The teeth on the ratchet wheel are so shaped that the pawl slides over them in one direction and engages to restrict movement in the other direction. Ratchet and pawl mechanisms are used in ratchet spanners, fishing reels, ratchet screwdrivers, micrometers and winding machines etc.

**Micrometer**

A micrometer is a precision measuring instrument used for accurately Measuring small distances of up to 0.01mm. Usually based on a caliper design, the operation of a micrometer depends on the opening and closing of a screw thread (spindle). Articles are measured between the face of an anvil and the end face of the screw thread. One complete turn of the screw thread closes the micrometer a distance equal to the pitch of the spindle thread.

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**Lathe Tailstock**

A tailstock is part of a centre lathe. The tailstock sits on the lathe bed at the opposite end to the lathe headstock. It can be clamped to the bed at any point. The tailstock contains a barrel which slides in the body when you turn the hand wheel. The barrel can be locked in any position. The barrel can accommodate different tools for drilling, reaming or for supporting long shafts when machining. The tailstock can be moved from side to side on its base, this feature is used for taper turning.

## (i) Any two

Good clear description
**Award 6 + 6(5)**
**Total (12, 11) Marks**

**Wireless connection**
Wireless connection allows computers / phones share information without the use of connecting cables. Information data is moved between computers by radio waves allowing laptops to move about within wireless networks. The cost and complexity of cable connections is removed.

**USB key**
A USB (Universal Serial Bus) key is a small portable data memory storage device. The key consists of a flash memory device integrated with a USB interface with can be inserted into a PC or laptop's USB port. USB keys are removable and rewritable and physically much smaller than CD's or DVD's. Because of their design USB keys are faster, have thousands of times more storage capacity and are more durable and reliable because of their lack of moving parts.

**Graphics card**
A graphic card is a printed circuit board that plugs into a computer to give it display capabilities. The graphics card generates output images for a display monitor or screen. Graphic cards, located in expansion slots, can offer added functions such as improved rendering of 3D & 2D drawings, video capture, TV-tuner adapter, MPEG-2/MPEG-4 decoding, firewall, light pen, and TV output etc.

**Video conferencing**
Video conferencing uses telecommunications of audio and video to bring people at different locations together for a meeting. This can be as simple as a conversation between two people in private offices or involve several different locations with more than one person in large rooms. Video conferencing can also be used to share documents, computer - displayed information and whiteboards.

**(k)**

Definition
**Award 6(5) Marks**
Eample
**Award 6(5) Marks**
**Total (12,11) Marks**

**Elasticity**
Elasticity is the ability of a material to return to its original shape when freed from a force which was distorting it.

Materials used to produce compression or tension springs need to have good elasticity to ensure they exert the correct type of force when trying to return to their original shape.

**(l) Any two**

Good description
**Award 6 + 6 (5)**
**Total (12, 11) Marks**

**Engraving**
Engraving is a process of cutting designs or text into metal surfaces with sharp tools. Different shaped tools may be used to provide a range of designs while power tools are often used for engraving letters and numbers on ornamental objects.

**Printed circuit board (PCB)**
A printed circuit board (PCB) is usually a plastic board about 1.6mm thick with a thin layer of copper on one side. Unwanted portions of the copper are routed or etched away to leave pads and strips which form electrical connections between the components. The components are soldered to the pads. The strips allow the current to move from component to component.

**Parting-off tool**
Parting – off is a machining process of cutting off metal in the centre lathe. A narrow tool is fed into and through the centre of the work. The tool is kept as narrow as possible to reduce waste and power requirements.

**Lacquering**
Lacquering is the process of applying a lacquer or varnish to metals to protect and preserve their surface finish. Lacquers are applied by brushing or spraying and can be used on both ferrous and non ferrous metals.

**(m)**

Name
**Award 6(5) Marks**
Function
**Award 6(5) Marks**
**Total (12,11) Marks**

**Name:**
A combination centre or slocombe drill.

**Function:**
A combination centre drill is used to locate the centre of round bars when drilling on the centre lathe. The combination centre drill is also used to produce the correct seating for the tailstock centre and / or headstock centre when supporting work between centres.

## Question 2 (45 Marks)

**(a) Any three**

Name and function
**Award 3 @ 5 Marks**
**Total (15) Marks**

(i) **Name:** Electric Arc Furnace.
**Function:** Electric Arc Furnace is used to produce High Carbon Steel.
(ii) **Name:** Basic Oxygen Furnace.
**Function:** Basic Oxygen Furnace is used to produce Steel.
(iii) **Name:** Cupola Furnace.
**Function:** Cupola furnace is used to produce Cast Iron.
(iv) **Name:** Blast Furnace.
**Function:** Blast furnace is used to produce Iron.

**(b) Any three descriptions**

Good clear description
**Award 3 @ 5 Marks**
**Total (15) Marks**

(i) High carbon steel
High carbon steel is hard and wear resistant. It can be hardened and tempered and contains 0.65% to 1.4% of carbon.

(ii) Metal Ore
A metal ore is required when producing metals. It contains a mixture of earthy materials in the form of rocks, clay, sand with a metal mix through it.

(iii) Tinplate
Tinplate is produced by coating both sides of thin sheets of steel with tin. The tin protects the steel from rusting as well as giving it an attractive appearance.

(iv) Tuyere
Tuyeres are large nozzles found near the base of a Blast Furnace. They allow hot air to be blown through the base of the mix to aid in the smelting process.

**(c) Any three metals**

Component
**Award 3 @ 3 Marks**
**Total (9) Marks**

| | | | |
|---|---|---|---|
| (i) | Aiuminium | - | Airplane bodies |
| (ii) | Cast Iron | - | Bench vices |
| (iii) | Lead | - | Roof flashing |
| (vi) | High-speed steel | - | Twist drills |

**(d) Two advantages**

Advantages
**Award 2 @ 3 Marks**
**Total (6) Marks**

Alloys improve the properties of metals or give them new properties.

- Stainless steel is resistant to corrosion and is suitable for household kitchen use.
- High speed steel can retain its hardness at high temperatures and is suitable for making H.S.S. cutting tools.

## Question 3 (45 Marks)

**(a) Any two descriptions**

Good clear description
**Award 2 @ 8 Marks**
**Total (16) Marks**

(i) **Hardening**
High carbon steel is hardened by heating to a cherry red and then cooling rapidly or quenching in oil or water. At the cherry red temperature the steel will undergo structural changes and the rapid cooling does not allow it to revert to it's normal condition.

(ii) **Annealing**
Annealing is carried out to soften metal and to relieve internal stresses. When annealing a metal it is heated to a red color and allowed to cool as slowly as possible i.e. in a furnace which is cooling down.

(iii) **Tempering**
Tempering is used to reduce the hardness level of components which have been hardened. To temper the point of a centre punch, first polish with emery cloth so that the tempering colours can appear. Heat slowly behind the hardened portion and allow the heat to travel gradually to the point. The tempering colours will appear as the temperature rises. When the correct colour reaches the point i.e. brown, cool it in oil or water.

.

**(b)**

Reason
**Award 5 Marks**
Method
**Award 5 Marks**
**Total (10) Marks**

(i) **One reason**
The point of the centre punch has not been hardened / tempered correctly leaving it too soft for use **or** the point has been over heated when sharpening on a grindstone.

(ii) **One method**
Ensure the point is hardened and tempered to the correct level / ensure regularly cooling when grinding.

**(c) Two safety precautions**

Safety
**Award 2 @ 5 Marks**
**Total (10) Marks**

- Wear protective clothing to protect from hot water splashes or rising steam.
- Perform hardening process in a well protected area away from busy environments.

**(d) Any two material properties**

Description
**Award 1 @ 5 Marks**
**Award 1 @ 4 Marks**
**Total (9)**

(i) **Brittleness**
A brittle material can easily be fractured by an impact. Glass is an example of a brittle material.

(ii) **Malleability**
A property which allows a material to be exerted in all directions without rupture, by rolling or hammering. The malleability of most metals is increased by heating.

(iii) **Conductivity**
This is the ability of a material to allow heat or electricity to flow through it. Silver, copper and aluminium are good conductors of heat and electricity.

**OR**

**(d)** (i) **Pneumatics**
Pneumatics uses compressed air to do work. Stored energy in compressed air can open and close pistons or turn pneumatic motors.

(ii) A simple pneumatic circuit is the compressed air drill used by dentists for drilling teeth.

## Question 4 (45 Marks)

**(a)**

(i) **Three oxy-acetylene flames**
Neutral flame - Oxidising flame - Carbonising flame

(ii) **Proportions of oxygen and acetylene**
**Neutral :** Equal amounts of oxygen and acetylene
**Oxidising:** More oxygen than acetylene
**Carbonising:** More acetylene than oxygen

Name & proportions
**Award 3 @ 5 Marks**
**Total (15) Marks**

**(b)** **Any three**
(i) Quick and easy to achieve a permanent joint. Only need for access to one side of the joint.
(ii) Manual metal arc welding produces high temperatures, too high for light gauge sheet metal.
(iii) Work in well ventilated area and keep adhesives away from hands and face.
(iv) **A** is a castle nut which can be locked in place by inserting a pin through any of the top grooves. **B** is a wing nut which can be loosened by hand.

Explanation
**Award 3 @ 4 Marks**
**Total (12) Marks**

**(c)** **Any three terms**

(i) **Oxides**
Oxides (rust) are produced when oxygen reacts with the surface of a metal, heat speeds up the production of oxides. Oxides must be removed from metal surfaces before soldering or welding.

Description
**Award 3 @ 4 Marks**
**Total (12) Marks**

(ii) **Passive flux**

A passive flux is non-corrosive and resin based. It prevents oxidation during soldering. Suitable for electrical work and other applications where it is not possible to wash away the flux from the joint afterwards.

(iii) **Tinning**

Tinning is the process of applying a thin layer of solder to the surface of metals before sweating together. It is good practice to tin the tip of a soldering bit before soldering.

(iv) **Chemically clean**

The surface of a metal reacts with the atmosphere to produce an oxide coating on the surface of the metal. This oxide coating must be removed for successful soldering. Chemically cleaning is using an active flux to dissolve away the oxide coating, this allows the tin in the solder to form an alloy with the surface of the metal.

**(d) Two reasons**

Reasons
**Award 2 @ 3 Marks**
**Total (6)**

(i) Dark goggles must be worn to protect the eyes from the bright light produced by the flame.

(ii) To protect the eyes from molten spelter which can often splash / spit out.

## Question 5 (45 Marks)

**(a)** (i) **Names**

**A** - Vacuum Forming
**B** - Blow Molding

Name
**Award 2 @ 2 Marks**
**Total (4)**

(ii) **Main Differences**

**Vacuum forming (A)**
Used to produce articles from flat thermoplastic sheet. A pre-designed manufactured 3D mould is also required. The flat sheet is clamped

Differences
**Award 2 @ 5 Marks**
**Total (10)**

and a heater raises the temperature of the sheet until it becomes soft and flexible. The mould table is raised and air is removed from beneath the sheet allowing atmospheric pressure to push down, forcing the sheet to take up the shape of the 3D mould. When the mould table is lowered the vacuum formed sheet can be removed for finishing.

**Blow Moulding (B)**
Used to produce articles from a heated thermoplastic tube called a parison. The article is moulded by the internal shape of a split mould. The mould closes around the extruded parison and air is blow inside forcing the parison out against the wall of the mould. The component is allowed to cool before being removed from the opened mould.

(iii) **End - product**

Vacuum forming can be used to produce car bumpers / baths.
Blow moulding can be used to produce water bottles / plastic bins.

End-product
**Award 2 @ 2 Marks**
**Total (4)**

**(b) Two safety precautions**

A plastic cup takes up to 50-80 years to decompose. Plastic bags and other plastic waste which makes its way into the sea kills as many as 1 million sea creatures every year. Waste plastics should not be disposed of with land fill refuge.

Careless disposal of plastics causes serious threat to the environment. Identification of plastic types can help when recycling. Always separate plastic waste into biodegradable and non- biodegradable.

Safety precautions
**Award 2 @ 3 Marks**
**Total (6) Marks**

**(c) Any three**

(i) **Laminating**
High strength plastics can be produced by impregnating sheets of paper or cloth with a resin. Layers of this material are bonded by allowing the resin to set into a solid structure. Heat and pressure are often used in this process.

Explanation
**Award 3 @ 5 Marks**
**Total (15) Marks**

(ii) **Adhesives**
Adhesives are glues which can be used to join plastics. They provide a strong permanent joint distributing the load more evenly throughout. Adhesives can withstand stresses caused by flexing and expansion of joints. They can also provide a good seal for gases and liquids.

(iii) **Strip heating**
Strip heating provides local heating along a straight line. When used

on thermoplastics it softens the plastic along a line allowing the formation of straight or small curvature bends in thermoplastic sheet material. A strip heater can be used to strip heat plastics.

(iv) **Dip coating**

Dip coating is a process of coating a component with a protective thin layer of plastic. Carried out in a plastic dip coating tank, the article is heated and dipped into a fluidized plastic power. The plastic power melts and sticks to the article providing an even coat all over. Articles made of steel such as shopping baskets, kitchen utensils and dish washer holding trays are all dip coated in plastic for protection against corrosion.

**(d) Any two**

(i) Polystyrene

(ii) Acrylic

Material
**Award 2 @ 3 Marks**
**Total (6)**

## Question 6 (45 Marks)

(a) **Any three lathe parts**

(i) Three jaw self centering chuck
(ii) Fixed three point steady
(iii) Four jaw independent chuck
(iv) Face plate

Name
**Award 3 @ 5 Marks**
**Total (15) Marks**

(b) (i) **Two reasons**

To improve surface finish
To allow faster cutting speeds

(ii) **One safety precaution**

Cutting fluids
**Award 3 @ 5 Marks**
**Total (15) Marks**

Change cutting fluid regularly to reduce rancidity

(c) (i) **Names**

**A** is the Rake angle
**B** is the Clearance angle

Name & description
**Award 3 @ 5 Marks**
**Total (15) Marks**

(ii) **Function of any one**

**Rake angle**
Rake aids the removal of the chip being cut. Increasing the rake reduces the amount of power consumed in cutting and also the amount of heat generated.

**Clearance angle**
The clearance angle ensures that only the cutting edge of the tool comes into contact with the work. Without clearance, the tool would just rub against the work without cutting.

**OR**

(c) **Any three**

Explanation
**Award 3 @ 5 Marks**
**Total (15) Marks**

(i) **CAD**
The term CAD, Computer Aided Drawing / Design, refers to the use of computers in the production of 2D or 3D drawings. 2D dimensioned drawings can be used for manufacturing while 3D drawings can be used to help visualise design ideas.

(ii) **Simulation**
This is a means of performing a test run of a CNC program. The machining of the component can be simulated on the computer screen. It allows the detection of errors thus avoiding lathe damage and waste of material.

(iii) **G Codes**
Determine the tool path. The cutting tool will move in a particular way depending on the number following the letter G. G01, for example, will cause the tool to travel in a straight line.

(iv) **CNC program**
A CNC program contains co-ordinates for defining the positions that the tool must move to during various operations, commands for controlling the tool movement and commands for controlling the chuck. Distances perpendicular to the lathe centre line are given as X co-ordinates and distances parallel to the centre line are given Z co-ordinat

## Question 7 (45 Marks)

(a) **Types of fit**

**A: Name: Clearance fit**
A clearance fit results when the size of a shaft is smaller than the size of the hole.

**B: Name: Interference fit**
Interference fit results when the size of the shaft is larger than the size of the hole

Name & description
**Award 2 @ 5 Marks**
**Total (10)**

(b) (i) Nominal diameter of the hole : 30.00
(ii) Smallest diameter of the hole: 29.94
(iii) Largest diameter of the shaft : 30.08
(iv) Type of fit: Interference fit

Calculations
**Award 4 @ 5 Marks**
**Total (20)**

(c) **Any three**

(i) Plug gauge - for checking the size of holes
(ii) Height gauge - for accurate marking out of components
(iii) Feeler gauges - for checking the gap between two surfaces
(iv) Surface plate - for marking out and checking flat surfaces

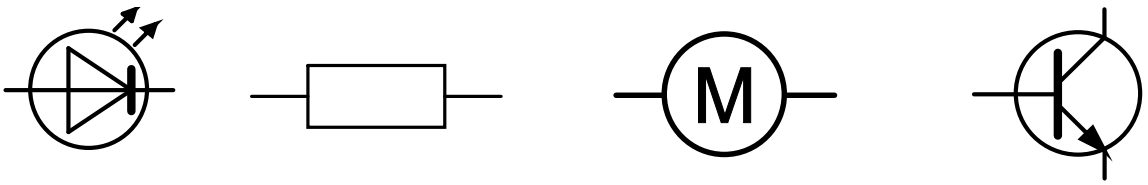
Name & application
**Award 3 @ 5 Marks**
**Total (15)**

**OR**

(c) **Any three**

Symbols
**Award 3 @ 5 Marks**
**Total (15)**

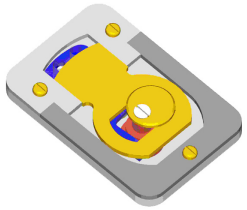
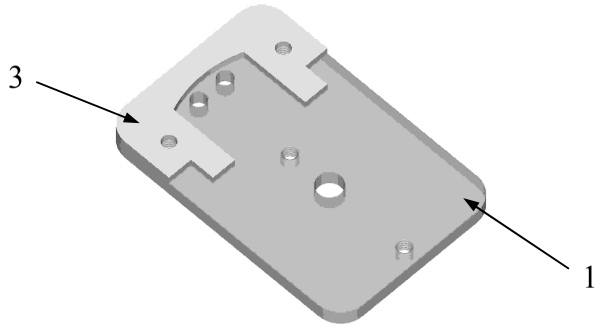
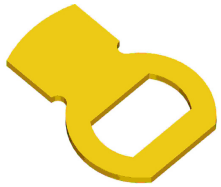
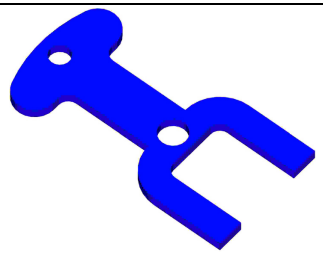
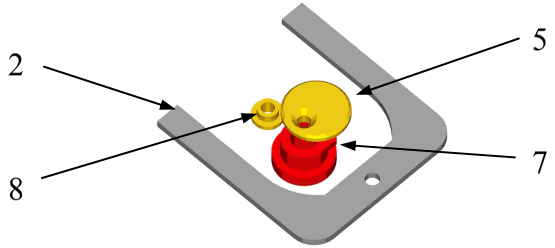
(i) LED (ii) Fixed resistor (iii) Motor (iv) Transistor



**Coimisiún na Scrúduithe Stáit**
**State Examinations Commission**

# Leaving Certificate Engineering Practical Marking Scheme 2011

Subjective Marking 1 - 20 17 - 20 Excellent 13 - 16 Very Good 9 - 12 Good 5 – 8 Poor 1 - 4 Very Poor

| Section | Part Number | Pictorial Sketch / Description | Concept | | Mark | Mark |
|---|---|---|---|---|---|---|
| **1** | **All Parts of Project** |  | Assembly, Function & Finish<br>Subjective Mark 1-20 | | **20** | 20 |
| **2** | **Parts 1 and 3** |  | **Part 1** | Marking Out | **2** | 20 |
| | | | | 10mm Radii | **2** | |
| | | | | M5 Tapped Holes | **2** | |
| | | | | Ø10mm and 6mm Holes | **2** | |
| | | | **Part 3** | Marking Out | **2** | |
| | | | | 10mm Radii | **2** | |
| | | | | 10mm × 10mm Steps | **4** | |
| | | | | Internal Profile | **4** | |
| **3** | **Part 4** |  | **Part 4** | Marking Out | **4** | 20 |
| | | | | 20mm Slot | **4** | |
| | | | | 44mm Radius | **2** | |
| | | | | 25mm Radius | **4** | |
| | | | | External Profile | **6** | |
| **4** | **Part 6** |  | **Part 6** | Marking Out | **4** | 20 |
| | | | | Ø6mm and 8mm Holes | **2** | |
| | | | | 20mm Slot | **4** | |
| | | | | 42mm and 6mm Radii | **5** | |
| | | | | External Profile | **5** | |
| **5** | **Parts 2, 5, 7 and 8** |  | **Part 2** | Bench Work | **8** | 20 |
| | | | **Part 5** | Lathe Work | **4** | |
| | | | **Part 7** | Lathe Work | **4** | |
| | | | **Part 8** | Lathe Work | **4** | |

**100 Marks**(× 1.5 = 150 Total)