Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2006

ENGINEERING – MATERIALS AND TECHNOLOGY

(Higher level – 300 marks)

MARKING SCHEME

AND

SAMPLE ANSWERS

LEAVING CERTIFICATE ENGINEERING

MATERIALS AND TECHNOLOGY

(Higher Level – 300 marks)

Marking Scheme 2006

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

Question 1 Section A – **50 marks**

Any ten @ 5 marks each.

(a) **Any one** @ 5
(b) 3 + 2
(c) 5
(d) **Any two** @ 3 + 2
(e) 3 + 2
(f) 3 + 2
(g) **Any one** @ 5
(h) **Any one** @ 3 + 2
(i) 3 + 2
(j) 5
(k) 5
(l) **Any two** 3 + 2
(m) 3 + 2

Question 1 Section B – 50 marks

Answer **all** of the following.

(n) 4 + 3 + 3

(o) (i) Name 1 + 1 + 1 + 1

(ii) **Any two @** 3 + 3

(p) **Any two** @ 5 + 5

(q) (i) 3 + 2
(ii) 3 + 2

(r) 10

Question 2 – 50 marks

(a) **Any two** @ 8 + 8

(b) Plot load-extension diagram 8

(i) 5
(ii) 5

(c) (i) 4 + 4
(ii) 8

Question 3 – 50 marks

(a) **Any two** @ 8 + 8

(b) **Any two** @ 8 + 8

(c) (i) 4

(ii) 4

(iii) 10

Question 4 – 50 marks

(a) **Any two** @ 8 + 8

(b) (i) 1 +1 + 1

(ii) 3 **descriptions** @ 2 marks each

(iii) 6

(iv) 3

(c) **Any two** @ 8 + 8

Question 5 – 50 marks

(a) (i) 4

(ii) 10

(iii) 4

(b) **Any three** @ 6 + 6 + 6

(c) **Any one** @ Describe 7
Diagram 7

OR

(c) (i) 7
(ii) 7

Question 6 – 50 marks

(a) (i) 4

(ii) 4

(iii) 4

(iv) 4

(b) **Any three** @ 6 + 6 + 6

(c) (i) Name 4 Operation 6
(ii) 2
(iii) 1 + 1 + 1 + 1

Question 7 – 50 marks

(a) **Any two** @ 9 + 9

(b) **Any three** @ 6 + 6 + 6

(c) (i) 7
(ii) 7

OR

(c) **Any two** @ 7 + 7

Question 8 – 50 marks

(a) **Any one** @ Operation 8
Application 8

(b) **Any three** @ 6 + 6 + 6

(c) 16

OR

(c) (i) Identify 2 + 2 + 2 + 2

(ii) Operation 4
Application 4

End.

Question 1 **(100 marks)**

Section A – 50 marks

(a) Highly or extremely flammable.

Corrosive: A substance which may on contact with living tissues destroy them.

(Any one) 5

(b) Factors that affect corrosion rates in metals include:

- The position of the metal in the electro-chemical series.
- Contact with dissimilar metals.
- Microstructure of the metal.
- Presence of internal stresses from cold working.
- Relative humidity/moisture.
- Presence of impurities in the atmosphere.
- Contact with corrosive fluids.
- Presence of external stresses due to loading or bending **3+2**

(c) Acetylene if directly compressed into a cylinder would explode under high pressure. Acetylene cylinders have to be packed with a porous material which is filled with acetone. Acetone is capable of absorbing up to 25 times its own volume of acetylene for each atmosphere of pressure applied to it. Dissolved acetylene is the name given to this form of acetylene fuel. **5**

(d) **(i)** Dropforging **(ii)** Injection moulding Blanking/ Pressing Vacuum forming **(iii)** Transfer moulding Compression moulding **(Any two) 3+2**

(e) Safety precautions include:

- Avoid contact with eyes or skin.
- Wear protective goggles, face mask, gloves, apron.
- Put in place strict safe work practices and procedures. **3+2**

(f) A **torsion** force acts to twist a structure by turning the ends in opposite directions. A **shear** force acts across a material when applied in different directions often cutting the structure in two. **3+2**

(g) **(i)** Ivan Sikorsky: Born in Kiev, Russia in May 1889. He developed an early interest in aviation. His most important contributions came in the area of helicopter design. His single rotor design was a major break-through in helicopter technology.

(ii) Theodore Maiman: Born in Los Angeles, California. He invented the first operable laser. Laser beams are today being used extensively in medicine, industry, electronic data processing and communications.

(iii) Dugald Clerk: Born in Glasagow in 1859. He is identified with the internal combustion engine and the two-stroke engine. **(Any one) 5**

(h) (i) Identify: Light dependent resistor (LDR).
Function: The resistance of an LDR drops as the light falling on it increases. It has a high resistance in the dark and a low resistance in daylight. Can be used in photographic exposure meters.

(ii) Identify: Capacitor.
Function: Stores electric charge. It consists of two metal plates separated by an insulator. **(Any one) 3+2**

(i) Advantages of non-metals over metals:

- Good thermal and electrical insulation.
- Good resistance to corrosion.
- Can be processed in a range of colours.
- Good oxidising agents. **(Any two) 3+2**

(j) Flotation: In mineral treatment and mining, the flotation process is used for concentrating the metal-bearing mineral in an ore. Crude oil is ground to a fine powder and mixed with water, frothing reagents, and collecting reagents. When air is blown through the mixture, mineral particles cling to the bubbles, which rise to form a froth on the surface. The waste material settles to the bottom. The frowth is skimmed off, and the water and chemicals are distilled, leaving a clean concentrate. This process is used for a number of minerals, especially silver. **5**

(k) Co-polymer: This is a polymer formed when two different mers are linked together in the same polymer chain. This new polymer may have a mixture of new improved properties. Co-polymers are similar to alloying in metals. **5**

(l) (i) CPU: Central processing unit. The unit of a computer system that controls the interpretation and execution of instructions.

(ii) ISP: Internet service provider. A company that provides individuals and companies access to the internet at high speeds and other related services such as e-mail and web hosting.

(iii) CD-RW: A CD- Rom that can be written, erased and be rewritten by the user.

(iv) E-MAIL: A service that sends messages on computers via local or global networks. **(Any two) 3+2**

(m) Name: Plug gauge.
Application: Used to accurately determine if a selected hole is within a specific range of limits. **3+2**

Section B – 50 marks

(n) Advantages of using pneumatic sequential control:

- Advanced industrial automation.
- Reduced labour costs.
- Can be extended to control a variety of complex tasks.
- High degrees of repeated accuracy.
- Reliability. **4+3+3**

(o) (i) **C:** Double acting pneumatic actuator/cylinder.
D: 3/2 roller operated spring return valve (3-port valve)
E: Flow control valve or restrictor valve.
F: 5/2 control valve (5-port valve) **(Name) 1+1+1+1**

(ii) **C –** A double acting pneumatic actuator/cylinder provides power and motion to pneumatic systems. It has a port at each end. Compressed air entering the rear port moves the piston forward and the piston rod goes positive. Air in front of the piston exhausts out of the front port. The reverse occurs when the air enters the front port. The force it exerts is determined by the cylinder's bore. The stroke of the cylinder determines the max. linear movement it can produce. It is usually controlled by a 5-port valve.

D – The 3/2 roller operated spring return valve. It's basic function is to switch and control the air flow. It has one port to which the supply from the compressed air main is connected, a second port connected to the cylinder or an other valve and a third port through which the cylinder can exhaust when the valve is turned off.

E – The flow control valve or restrictor valve is used to independently control the outstroke speed and the in-stroke speed of a piston rod. A unidirectional flow regulator has free flow in one direction and adjustable restricted flow in the other direction.

F- The 5/2 control valve or 5-port valve is usually used to control a double acting cylinder. It is like two 3-port valves combined into one. It has two different air flow patterns. **(Any two) 3 + 3**

(p) **(i) Cascade circuit:** To overcome the problem of in-operable circuits due to opposing signals cancelling each other a cascade system can be utilised. The basis or this system is the division of movement into groups. Each of these groups are provided with air supplies, where only one air supply is pressurised at any one time. Air supply is changed from valve to valve by activating a change over valve.

(ii) PLC: Programmable Logic Controller. The use of electronics for the control of sequencing of pneumatic applications. This further reduces any complications associated with cascade circuits or time delays where high degrees of accurate repeatability is essential. The PLC operates by monitoring input signals from sources such as heat, pressure sensors, limit switches or reed switches. The PLC interacts with a user-programmed internal logic switching network to produce an appropriate output signal which in turn operates a pneumatic sequence.

(iii) FRL: This stands for filter, regulator and lubricator. The FRL unit ensures that the air supply is clean and at the correct pressure. It also carries fine particles of oil in the air to lubricate all essential parts within the system. **(Any two) 5 + 5**

(q) (i) Industrial applications include:

- Packaging
- Painting
- Plastic moulding
- Drilling/machining **3 + 2**

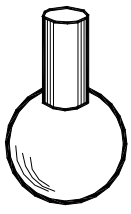
(ii) Benefits of using compressed air systems in industry:

- Versatile
- Safe in use
- Reliable power source
- Requires simple maintenance. **3 + 2**

(r) 1 – Cylinder A positive, this closes the vice and clamps the work-piece.
2 - Cylinder B positive, the drill comes down and drills the work-piece.
3 - Cylinder B negative, the drill is withdrawn and returns to it's starting position.
4 - Cylinder A negative, The vice opens and releases the work-piece. **10**

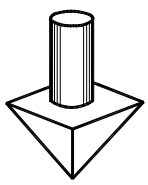
Question 2 **(50 marks)**

(a) (i) For Brinell the indenter used is a hardened steel or tungsten ball.



Ball indenter

(ii) For Vickers hardness testing a diamond shaped pyramid is used. It has a point angle of 136º.



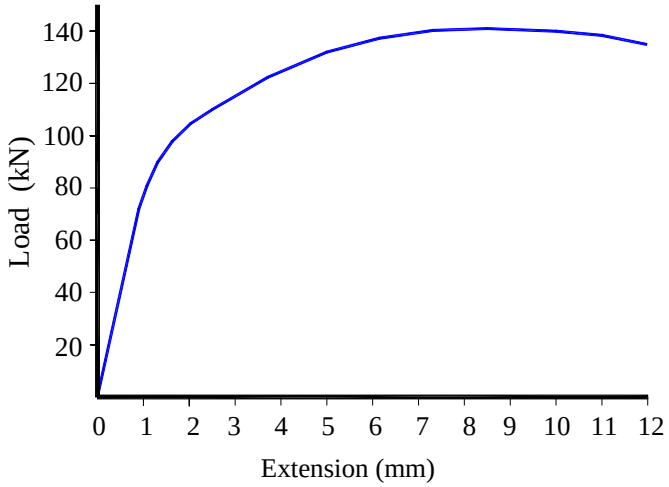
Square pyramid indenter

(ii) Elastic Limit: The point up to which the extension is proportional to the load applied and beyond which a material stays stretched and therefore an increase in load produces a larger extension in the material. This signifies the end of the elastic range for the material being tested.

(iii) Factors necessary to prevent early fatigue include:

- Make allowance for potential fatigue during component design.
- Removal of sharp corners.
- Reduce vibration in service.
- Improve surface finish.
- Prevent or minimise corrosion. **(Any two) 8 + 8**

(b) Plot the Load- Extension diagram. **8**



(i) Tensile strength:

$$\text{Tensile strength} = \frac{MaxLoad}{CSA} = \frac{142kN}{\pi R \times R} = \frac{142kN}{78.55} = 1.808\text{kN /mm}^2$$ **5**

(ii) Youngs Modulus: Select point on elastic region of diagram eg. **(32,0.4)**
Diameter = 10mm, Gauge length = 60mm.

$$\text{Youngs Modulus} = \frac{Stress}{Strain} \qquad \text{Stress} = \frac{Load}{CSA} = \frac{32}{78.55} = 0.407\text{kN /mm}^2$$

$$\text{Strain} = \frac{Extension}{OrigLgth} = \frac{0.4}{60} = 0.0067$$

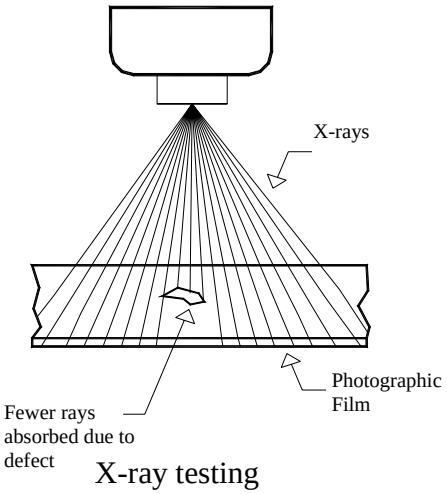
$$\text{Youngs Modulus} = \frac{0.407}{0.0067} = 60.7\ \text{kN /mm}^2$$ **5**

(c) (i) Reasons include:

- Quality control.
- Detection of surface and internal flaws without damage to the component. **8**

(ii) All of the following may be used for the detection of internal flaws.

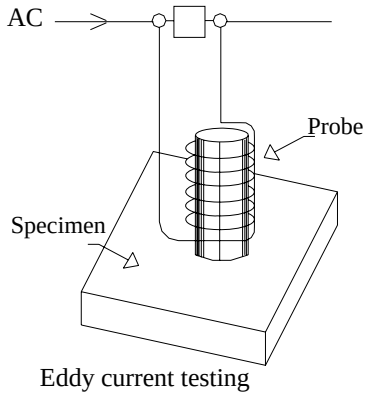
X-ray testing: Radiation from an x-ray tube is passed through the weld. If defects are not present, the amount of absorption is uniform across the area exposed to the x-ray beam. If a defect is present a smaller amount of rays are absorbed and there is a variation in the intensity of the emergent beam. This can be readily detected by placing a photographic film on the side of the material opposite the source of the radiation. On a negative film, the defect shows as a dark spot. A suitable application is the detection of internal flaws in welds.



X-ray testing

Ultrasonic testing: This test is based on pulse reflection. A probe is passed over the test specimen, sending high frequency vibrations which are reflected back on contact with the lower surface of the specimen. When a void or flaw is present, vibration will be reflected back from this point. These will show up on the cathode ray tube as smaller peaks.

Eddy current testing: When a coil, energised with high frequency alternating current, is placed close to a conductive material it will produce eddy currents in the material. These currents produce a magnetic field in the test specimen. A search coil, used in conjunction with the energised coil, can be connected to an electronic recording device. Any defect in the material distorts the magnetic field. This is indicated on the recording device. The magnitude of the distortion reflects the size of the defect. A suitable application is the detection of surface or subsurface flaws in nonferrous metals of uniform section.



Eddy current testing

Magnetic Particle testing: Magnetic particles are applied to the surface of the specimen. The specimen is then magnetised. If flaws are present the magnetic particles form an arrangement around the fault. This method is used on magnetic materials such as steels and cast irons. Magnetic particles can detect defects up to 18 mm below the surface of a weld. The component should be demagnetised after the test. **8**

Question 3 **(50 marks)**

(a) **A –** Normalising
B – Annealing or Hardening
C – Spheroidising or Process Annealing or Stress Relieving.
D – Tempering

A – Normalising: Normalising removes internal stresses and refines abnormal grain structures which occur during hot or cold rolling and forging. The steel is heated to approximately 50˚C above its upper critical temperature and allowed cool in air. This improves machinability.

B – Annealing: This process fully softens the steel. The steel is heated to above its upper critical temperature. It is then allowed to "soak" in the furnace at this temperature. Cooling is controlled by, reducing the temperature of the furnace gradually.

B – Hardening: The steel is heated above its upper critical temperature and is quenched rapidly in water or brine. This rapid cooling causes a distorted structure called martensite. Martensite is a hard needle like structure, which is strong but very brittle. This distorted structure occurs due to excess carbon having insufficient time to come out of solution during rapid quenching in hardening.

C – Spheroidising or Process Annealing: This process is limited to steel having in excessof 0.5% carbon. It consists of heating the steel to 700°C and "soaking" the material. At this temperature any cold worked ferrite will re-crystallise and the iron carbide present in the ferrite will form as spheroids of cementite or carbide. This has an effect of reducing the strength and hardness of the steel developing good shearing qualities necessary for improving machinability.

D - Tempering removes much of the brittleness present in martensite. It involves heating the steel to 500˚C and cooling it rapidly. This allows time for some of the carbon to diffuse out of the BCC structure producing a tougher, less brittle steel. **(Any two) 8 + 8**

(b) **(i)** **Ferrite** is iron which contains a maximum of 0.02% carbon dissolved in solid solution. It is almost pure iron and has a body centered cubic structure.
Martensite is a hard needle like structure, which is strong but very brittle. This distorted structure occurs due to excess carbon having insufficient time to come out of solution during rapid quenching in hardening.

(ii) The **upper** critical temperature is the temperature at which a substance is changing state. On cooling there is a change in state or phase from liquid to pasty.
The **lower** critical temperature signifies a change in state or phase from pasty to solid.

(iii) Stainless steel: An alloy steel which can contain carbon, chromium (at least 12%), nickel, and manganese. It has excellent corrosion resistance, the chromium produces a very thin oxide film on the surface of the metal which prevents any further corrosion. It is capable of cold working to form sinks or other domestic appliances. It is also used in chemical plants and for food processing.

High speed steel: An alloy steel which can contain carbon, chromium (at least 4%), tungsten, cobalt, and vanadium. It is excellent as a cutting tool material where operation at high temperatures and under severe pressure is essential. It is used for lathe tools, milling cutters, drills and reamers.

(iv) Eutetic point: This is in a special change point where a liquid to solid change occurs. This occurs at 1140ºC for the iron carbon alloy with 4.3% carbon. Liquid steel changes to solid austenite and cementite.

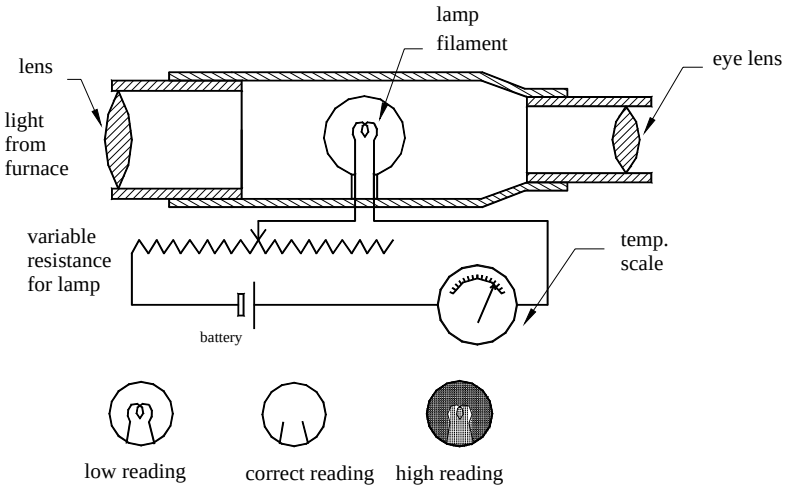
Eutectoid point: This reaction occurs during the solid state. Solid austenite changes to solid pearlite. This occurs at 723ºC for the iron carbon alloy with 0.83% carbon.

(Any two) 8 + 8

(c) (i) Optical pyrometer. (Disappearing filament pyrometer) **4**

(ii) Used to calculate or measure furnace temperatures for heat treatment. **4**

(iii) The optical pyrometer compares the intensity of the light coming from the filament of a lamp. The current flowing in the lamp is adjusted to match the light from the furnace using a variable resistance. When a colour match is obtained the lamp filament disappears and a temperature scale reading is taken.



FILAMENT IMAGES

OPTICAL PYROMETER

10

Question 4. **(50 marks)**

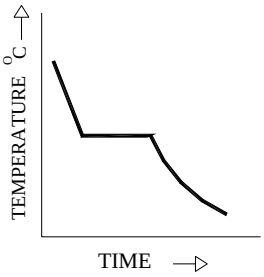
(a) (i) Solid solution: When two metals are completely soluble in each other in both the liquid and solid states. When the alloy solidifies only one type of crystal is formed and it looks like a pure metal.

(ii) The stages of crystal solidification of a metal from the liquid phase is known as dentritic growth. Initially the cell forms and grows to form a dendrite. As dendrites grow, they intrude on each other with spike-like formation. This continues until they eventually form a grain boundary.

Dendritic growth

(iii) Allotropy is the ability of a material to exist in more than one crystalline structure. Common examples include steel, which exists as BCC when cold and as FCC austenite when heated above its upper critical temperature, and carbon, which exists as graphite or as diamond under extremely high pressure.

(iv) Cooling curve: If the temperature of a cooling molten metal is plotted against time a cooling curve results.



(Any two) 8 + 8

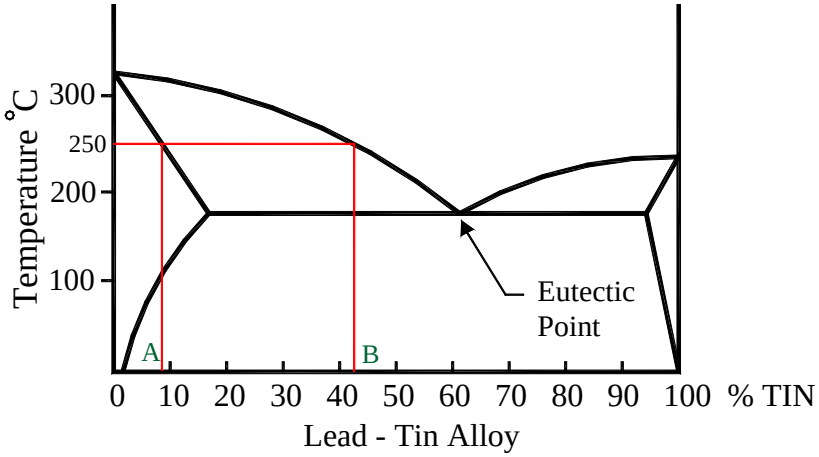
(b) (i) A – Liquidus line. **B –** Solvus line. **C –** Solidus line. **1 + 1 + 1**

(ii) A – Liquidus line. For the alloy system this line represents the boundary between the fully liquid state and the beginning of solidification.

B – Solvus line. The transition line from one solid form to another solid form of an alloy is called the solvus line. This line indicates the maximum amount of tin which can be dissolved in the lead.

C – Solidus line. The boundary line that determines the end of solidification. Below this line the alloy is completely solid. **2 + 2 + 2**

(iii) and (iv)



A – Solid composition consisting of 8% tin and 92% lead.
B – Liquid composition consisting of 43% tin and 57% lead. **(iii) 6**
(iv) 3

(c) (i) Interstitial solid solution occurs where small solute atoms fit into the spaces between the parent or solvent atoms.

(ii) Dislocation: An incomplete layer of atoms in a crystal structure is called a dislocation or line defect. Dislocations often account for the difference between the estimated and the actual strength of metal crystals. Stressing the structure causes the dislocation to move and the material yields.

(iii) Substitutional solid solution: When atoms of two materials of similar size are completely soluble in each other in both the liquid and solid states. When the alloy solidifies only one type of crystal is formed and it looks like a pure metal. The copper-nickel alloy is an example. **(Any two) 8 + 8**

Question 5 **(50 marks)**

(a) (i) Metal inert gas (MIG) welding. **4**

(ii) Metal inert gas welding is a semi-automatic process. It operates on principles similar to manual metal arc welding. A consumable bare wire electrode is fed continuously through the welding torch or gun into the weld pool area. Fluxing is achieved through the use of an inert gas such as argon, the gas exits through the torch nozzle and creates a protective shield around the weld pool The operator sets the feed rate of the electrode and the flow rate of the gas. Once the arc is generated between the electrode and the work, the operator simply guides the torch to complete the weld. **10**

(iii) Car assembly, robotic welding, high quality versatile welding on stainless steel or aluminium. **4**

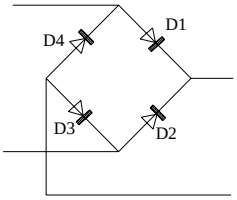
(b) (i) Functions of the electrode coating include:

- To generate a shield of carbon dioxide gas to protect welded joints from contamination by oxygen and nitrogen in the air.
- To form a slag coating which protects the weld from oxidation and ensures a slow cooling rate for the weld thus preventing cracks and brittleness.
- Facilitates the striking of the arc between work and the electrode.

(ii) Functions of the slag:

- Protects the weld from oxidation.
- Slows down the rate at which the weld cools.
- Prevents brittleness.

(iii) Bridge rectifier: A rectifier permits current to flow in only one direction. For manual metal are welding it changes AC to DC. This is used to supply direct current when arc welding. The voltage is rectified by using the rectifier which consists of four diodes. The diodes are arranged to allow current to flow across the arc in the same direction regardless of the polarity of the AC supply.



RECTIFIER

(iv) Hazard - **Electric shock**
Remedy - Ensure conditions are dry, and use well maintained equipment where cables are properly secured, insulated and earthed.

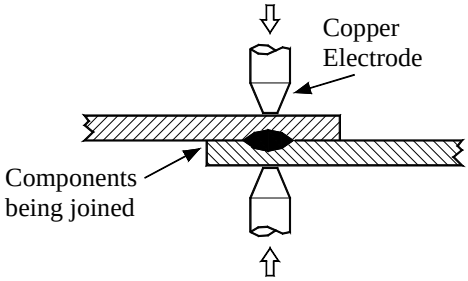
Hazard – **UV light radiation**
Remedy – Use helmet/goggles with dark face plates. New helmets feature a liquid crystal type face plate that self darkens upon exposure to uv light. Use a welding curtain to shield nearby workers/classmates from exposure to uv light.

Hazard – **Inhalation of fumes and gasses**
Remedy - Proper ventilation systems.

Hazard – **Exposure to extreme heat or flames**
Remedy – Wear protective clothing including heavy leather gloves and protective long sleeve jackets. **(Any three) 6 + 6 + 6**

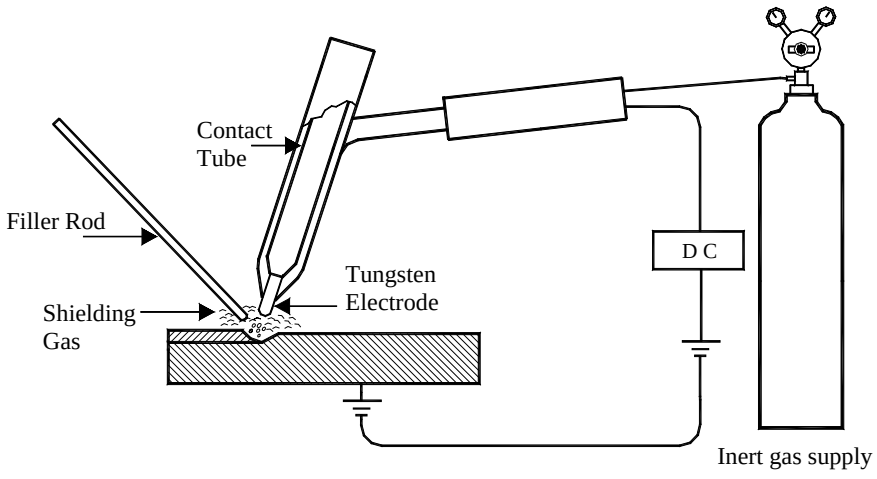
(c) (i) Resistance Spot Welding.

The components to be joined are placed between two electrodes and pressed together. Current is passed through the electrodes, and the resistance to this current causes local rapid heating at the interface, resulting in a nugget type spot weld. It can be used to join overlapping metal sheets. The advantages of this method include efficient energy use, limited work deformation, high production, easy automation and no filler metal requirements. Its overall strength is often significantly lower than with other welding methods. Commonly used in the automobile industry it is also used for unique applications such as orthodontics where small scale spot welding equipment is used when resizing metal "molar bands".



(ii) Tungsten inert gas (TIG) welding.

Tungsten inert gas welding is a commonly used high quality welding process where precision is required. In tig welding an arc is formed between a non-consumable tungsten electrode and the metal being welded. Fluxing of the joint is achieved by the use of an inert gas shielded arc. Argon is used and it flows over the electrode preventing oxygen in the air contacting the weld joint. A high frequency generator provides a path for the welding current through the shielding gas. Because the welder must maintain a short arc length, great care and skill are required to prevent contact between the electrode and the work. A filler metal is added manually to the front end of the weld pool as it is required. Typical applications include high quality welds in aluminium, stainless steel, and in areas such as air craft construction.



(Any one) Describe 7
Diagram 7

OR

(c) (i) Benefits of using robots in car assembly include:

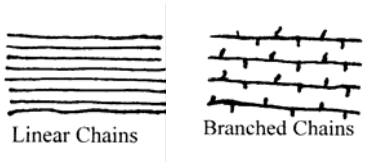
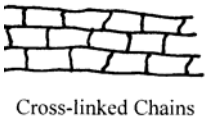
- Accuracy and repeatability.
- Capability of working in a number of axes and from multiple angles.
- Reliability and cost effective. **7**

(ii) Working envelope:

The volume of space within which a robot can move and perform its designated tasks. **7**

Question 6. **(50 marks)**

(a)

Thermoplastics	Thermosetting plastics
(i) Chemical Bonding Covalent bonding: Secondary bonding with weak van der waals forces.	**(i) Chemical Bonding** Covalent bonding:Primary bonded strong 3-d structure held together by strong rigid cross-links **2 + 2**
(ii) Polymerisation process Addition polymerisation	**(ii) Polymerisation process** Condensation polymerisation **2 + 2**
(iii)Internal structure  	**(iii)Internal structure**  Cross-linked Chains **2 + 2**
(iv) Properties • Low melting point • Allows for easy moulding • Easily disrupted by heat • Low tensile strength • Branched structures have higher tensile strength than linear • Ideal for recycling	**(iv) Properties** • High melting point • High tensile strength • Good thermal insulation • Can withstand high temperatures without loosing rigidity • Stiff and less flexible **2 + 2**

(b) (i) Fillers are additives such as chalk and wood flour which control mechanical properties of the polymer and reduce material costs. The higher the proportion of filler, the greater in general the strength of the material.

(ii) Stabilisers are substances which stop a polymer ageing. These improve a polymers resistance to heat and light.

(iii) A **catalyst** is an additive added to a polymerisation process to speed up or slow down a chemical reaction.

(iv) Foaming agents are substances which add bubbles to a polymer. They increase the bulk of the polymer making it lighter. Examples include sponges and buoyancy aids.

(Any three) 6 + 6 + 6

(c) (i) Name: Injection moulding. **4**

Principle of operation: Injection moulding: Plastic granules of the thermoplastic materials are fed into the hopper. A plunger forces the plastic along the machine barrel where they are melted by the heaters and compacted by the torpedo. The softened polymer is then forced into the mould where it solidifies. The mould is opened and the plastic product is ejected. **6**

(ii) Component produced:

Milk crates, Golf tees are examples of end products. **2**

(iii) A – Hopper. **B –** Plunger/Ram. Piston **C –** Mould/Die. **D –** Torpedo.

1 + 1 + 1 + 1

Question 7. **(50 marks)**

(a) (i) Machining processes used to produce cylindrical surfaces include:
Parallel turning, Cylindrical grinding, Drilling, Reaming, Boring, Milling.

(ii) In **up-cut milling** the milling cutter is rotating against the direction of the workpiece. This is the more common method used in milling. Correct clamping of the workpiece is essential.
In **down-cut milling** the cutter rotation is in the same direction as the workpiece movement. This can lead to the cutter climbing the work. Machines that have been fitted with backlash eliminator are suitable for down-cut milling. An advantage with this method occurs when taking heavier cuts, as the pressure is directed downwards and there is no lifting tendency.

(iii) Advantages include:

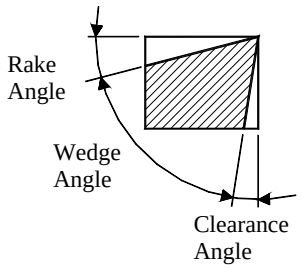
- Uniform performance throughout machining.
- No regrinds or brazing of tool edges required.
- Better tool materials and geometries can be used.
- Insert has excellent wear resistance at high temperatures.
- Involves simpler and safer handling.

(Any two) 9 + 9

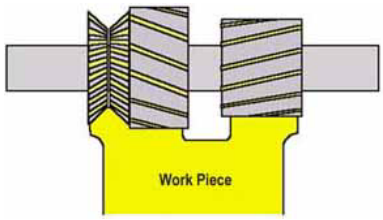
(b) (i) Loading: A grinding wheel become loaded when small particles of grinding debris become trapped in the space between the abrasive grains in the wheel. Grinding with a loaded wheel will cause overheating and possible burning of the work piece.
Glazing: A glazed grinding wheel has a shiny appearance as the abrasive particles have lost their edge and have failed to break away from the wheel. The result is an inefficient grinding wheel which will burn the work piece.

(ii) Feeler gauge: A set of steel blades having a range of thickness values. This is used to gauge small distances e.g. spark plug gaps, or for flatness tests. They can be stacked together to gauge different values.
Drill gauge: Used for checking drill sizes.

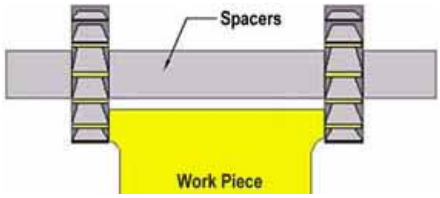
(iii) Rake angle: This gives the tool nose a more wedge like form and is varied according to the metal being cut. A large rake reduces the wedge angle making the tool sharper but weak at the cutting edge. A small rake is used to machine hard materials.
Clearance angle: Clearance is put on a cutting tool so that every part of the tool except the point clears the work thus allowing the tool to cut.



(iv) Gang Milling: When milling cutters are mounted adjacently on the arbour. This is used to mill a complex surface in one pass. The type and size of the cutter are selected to achieve the desired profile.



Straddle milling: When cutters mounted on the arbour are separated by spacing collars. This is used for the milling of two surfaces parallel to each other at a given distance.



(Any three) 6 + 6 + 6

(c) (i) Safety hazards associated with using cutting fluids include:

- Skin irritation or dermatitis.
- Staining the work piece especially for aluminium.
- Some give off hazardous odours (rancidity).
- Some create a mist or smoke making the work environment unsafe for the operator.
- Some leave an oily film on the work piece and require the use of cleaning solvents.

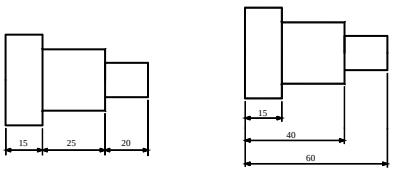
7

(ii) Safety hazards associated with machining mild steel:

- Excessive heat may result in deformation of the cutting tool.
- The hardness of mild steel may cause tool wear.
- Discontinuous chips may be excessively hot and sharp. **7**

OR

(c) (i) **Incremental –** Each dimension is taken relative to the previous position.
Absolute – All dimensions are taken from a fixed datum point or line.



Incermental Absolute

(ii) Stepper motor: This is an electromagnetic device that converts digital pulses into mechanical shaft rotation. The degree and speed of rotation is controlled by an electric signal called a pulse. To enable rotation, a magnetic field generated by the stator windings needs to move. This is achieved by switching the current flow through each winding.

(iii) With a **canned cycle** a required number of repetitive operations can be executed by a single program block.

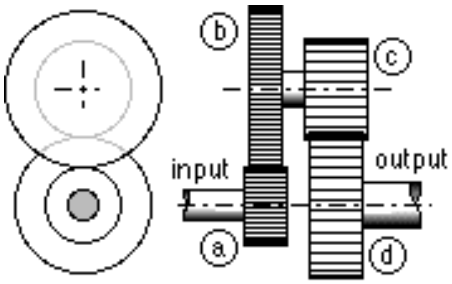
(Any two) 7 + 7

Question 8 **(50 marks)**

(a) (i) The operation of the toothed belt and pulley system ensures that there is no slippage between the driver and driven pulley. Therefore the driven shaft rotates at a consistent rate in sequence. This gives a quite, positive drive. **Applications** include, driving the camshaft of an engine, used for accurate movement of the pen of a graphic plotter.

(ii) A snail or drop cam is used where drop or fall of the follower must be sudden. The system shown rotates in an anticlockwise direction as clockwise rotation would lead to the entire mechanism jamming. This is an obvious drawback with this mechanism. When rotating for one complete revolution the follower stays level for approximately the first 120°. The follower then rises slowly and then suddenly drops when it passes its peak. **Applications** include, toys where sudden up and down movement is essential, clock and watch mechanisms, automated lifting mechanisms. **(Any one) Operation 8**
Application 8

(b) (i) A compound gear train is a gearing system that uses more than one pair of gears combined together on a common axis. The gear ratios for each individual gear pair are multiplied together to compute the overall gear ratio for the gear train. This allows the operator to devise any desired gear ratio and can be of significant advantage where large speed reductions are required.



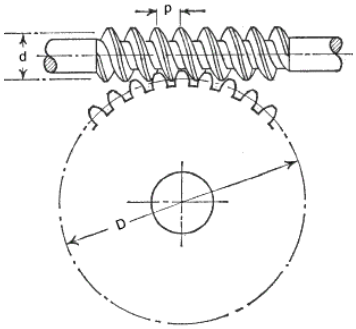
(ii) Advantages of gears over pulleys:

- Less slip.
- More efficient.
- Neater more compact arrangements.

(iii) An **idler gear** is a gear that is inserted between two other gears. Idler gears do not affect the gear ratio between the input and output gears. The gear ratio would be computed just the same if there were no idler gear. Idler gears are used to change the direction of gear rotation. By adding an idler gear between the two, the output axle rotates in the same direction as the input axle.

(iv) **Bevel gears** have teeth cut on a cone instead of a cylinder. They are used in pairs to transmit rotary motion and torque where bevel gear shafts are positioned at right angles to each other.

The **worm** and worm wheel transmit torque and rotary motion through a right angle. The worm always drives the worm wheel and never the other way round. The mechanism locks if the worm wheel tries to drive the worm. Worm mechanisms are very quiet running. A worm is used to reduce speed. For each complete turn of the worm shaft the gear shaft advances only one tooth of the gear. As the speed is reduced the power to the drive increases correspondingly. Worm gears are a compact, efficient means of substantially decreasing speed and increasing power. Ideal for use with small electric motors.

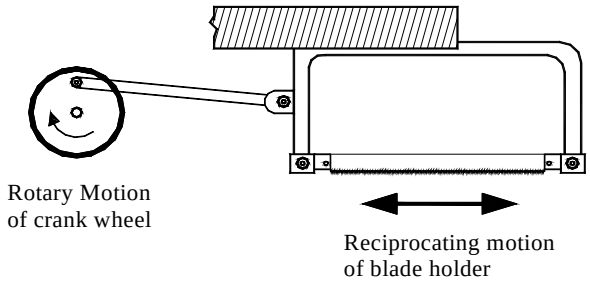


(v) Applications of rack and pinion:

- Steering in a car.
- Up and down movement of a drill feed lever.
- Electric windows.
- Automated gates.

(Any three) 6 + 6 + 6

(c) The power hacksaw is powered by an electric motor. The electric motor turns a crank which in turn is linked to a slider mechanism incorporating the blade. This conversion from reciprocating to linear is the basis for its operation. The power hacksaw has an automatic, adjustable rate of feed to suit cutting conditions. The return stroke is raised to avoid blade wear.



16

OR

(c) (i) **A –** Variable resistor.

B - Diode.

C – Bulb

D – Transistor. **2 + 2 + 2 + 2**

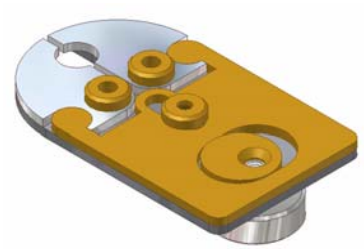
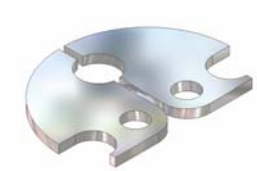
(ii) **Operation:** In daylight the LDR has a very low resistance and therefore has a low potential difference. This produces a low voltage at the base of transistor D. Therefore no current flows across the base emitter junction and the output (lamp) is off. When darkness falls the LDR has high resistance. The darlington pair switches on and the coil of the relay is energized. This switches the AC circuit to on and the lamp lights. The diode is used to protect damage to the transistors. **4**

Application: Outside lights for security. Emergency lighting. Street lights. **4**

Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Common Level Engineering Practical Marking Scheme 2006

Subjective Grading /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 Practical Examination**		Assembly Function &Finish Subjective Grade 1-20	20	**20**
2	**Part 1**		Marking out	4	**20**
			13mm Slot	4	
			30mm Radius	4	
			4mm Radii	4	
			Drilling	4	
3	**Parts 2**		Marking Out	4	**20**
			30mm Radius	4	
			6mm Radii	4	
			Profile	4	
			Drilling	4	
4	**Part 3**		Marking Out	4	**20**
			24mm Slot	4	
			6mm Radii	4	
			8mm Slot	4	
			Profile	4	
5	**Parts 4, 5, 6, & 7**		Part 4 Lathe Work	4	**20**
			Part 5 Lathe Work	4	
			Part 6 Lathe Work	4	
			Part 7 Lathe Work	4	
			Part 7 Lathe Work	4	

Total: 100 Marks