Coimisiún na Scrúduithe Stáit
State Examinations Commission

LEAVING CERTIFICATE 2008

MARKING SCHEME

ENGINEERING - MATERIALS AND TECHNOLOGY

HIGHER LEVEL

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Written Examination and Practical Examination

ENGINEERING - MATERIALS AND TECHNOLOGY

HIGHER LEVEL

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ENGINEERING - MATERIALS AND TECHNOLOGY

(Higher Level – 300 marks)

Written Examination - Marking Scheme 2008

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

Question 1 Section A – 50 marks
Any ten @ 5 marks each.

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

Question 1 Section B – 50 marks
Answer **all** of the following.

(n) 4 +3 + 3

(o) (i) 5
(ii) 3 + 2

(p) (i) 8
(ii) 2

(q) 5 + 5

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

Question 2 – 50 marks

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

(b) Graph @ 10
(i) 4
(ii) 4

(c) (i) 4 + 4
(ii) Describe 4
Diagram 4

Question 3 – 50 marks

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

(b) (i) Name 2 + 2 + 2 + 2 + 2
(ii) 8

(c) (i) 8
(ii) Outline 4
Diagram 4

Question 4 – 50 marks

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

(b) (i) Draw 8
(ii) Label 5
Describe 5

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

Question 5 – 50 marks

(a) (i) 2
(ii) 10
(iii) 4
(b) **Any three** @ 6 + 6 + 6

(c) **Any one** @ Describe 8
Diagram 8

OR

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

Question 6 – 50 marks

(a) (i) Name 2
Operation 6
(ii) 2 + 2 + 2
(iii) 2

(b) (i) 3 + 3
(ii) 3 + 3
(iii) 2 + 2

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

Question 7 – 50 marks

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

(b) (i) 8
(ii) 4 + 4

(c) Describe 8
Diagram 8

OR

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

Question 8 – 50 marks

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

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

(c) Describe 8
Diagram 8

OR

(c) (i) 2 + 2 + 2 + 2
(ii) 4 + 4

LEAVING CERTIFICATE, ENGINEERING - MATERIALS AND TECHNOLOGY

Higher Level Written Examination - Suggested Solutions and Marking Scheme 2008.

Question 1 **(100 Marks)**

Section A – 50 marks

(a)

(i)

Corrosive substance: a substance that may destroy living tissues.

(ii)

Caution: warning of an immediate danger.

5

(b) Design aspects of design that may minimise corrosion:

- Selection of suitable materials
- Choice of appropriate surface finish
- Reduce sharp corners and other potential stress points
- Avoid the electro-chemical action of dissimilar metals in contact.

3 + 2

(c) **Pyrometallurgy** uses heat energy to separate ore, this principle is used during the smelting of iron ore in the blast furnace.
Hydrometallurgy incorporates the use of aqueous solutions, or leaches, to extract metals from their ores.

3 + 2

(d) (i) Ionic bond: ions are held together by electrostatic forces, the larger ions are negative. This structure is generally hard and brittle.
(ii) Metallic bond: the cations are bonded by a 'sea' of electrons giving metals that are usually malleable, ductile and conductive.

3 + 2

(e) Narcotic effects result from the inhalation of toxic substances, to avoid these effects:

- Solvents should be used a well-ventilated area
- Manufacturers instructions need to be rigorously followed
- Extraction equipment should be installed and used
- Appropriate masks to be worn.

3 + 2

(f) **Amorphous structures** have an irregular and disorganised molecular pattern.
Crystalline structures display regular and repeating molecular patterns.

3 + 2

(g) (i) Christopher Cockerall: British engineer who invented the hovercraft in 1959.

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

(iii) Charles Parsons: Irish engineer who is credited as the inventor of the steam turbine.

(Any one) 5

(h) (i) Transistor: acts as an amplifier or an electronic switch in a circuit.

(ii) Light-emitting diode (l.e.d.): gives out light when current is applied.

(Any one) 5

(i) Benefits of using compressed air systems

- Relatively clean
- Can be employed in hazardous situations where electric spark might be a danger
- Strong and precise action
- Range of applications in a production situation
- Can be programmed for a sequence of actions.

3 + 2

(j) (i) Metal pressing.

(ii) Drop forging.

(iii) Injection or Compression moulding.

(Any two) 3 + 2

(k) (i) Central Processing Unit.

(ii) Local Area Network.

(iii) Integrated Circuit.

(iv) Compact Disk – Read Write.

(Any two) 3 + 2

(l) Submerged arc welding, electro-slag welding, resistance welding are forms of automatic welding.

5

(m) A tolerance is the extent by which a dimension is allowed to deviate from the nominal or basic size. If a nominal size of an object is 20.00mm with a tolerance of 0.15 then the upper limit is 20.15mm and the lower limit is 19.85mm.

5

Section B – 50 marks

(n) Applications for the photovoltaic cell include:

- Calculators, watches
- Electricity generation
- Space transport
- Heating systems
- Emergency telephones
- Parking meters, temporary traffic signs, camera systems, etc.

4 + 3 + 3

(o) (i) Electrical **conductors** are materials that will carry current due to the presence of free electrons, metals are good conductors. **Semiconductors** allow some current to flow with the introduction of an impurity to a material such as silicon.

5

(ii) Advantages of using photovoltaic systems in developing economies:

- Many developing economies have good levels of sunlight throughout the year, due to geographic location, the use of photovoltaic systems is appropriate.
- It can be set up in remote rural locations for specific uses such as running water pumps for agriculture.
- There is less need to develop electricity generation stations powered by fossil fuels. This has a positive environmental effect.

3 + 2

(p) **(i)** A photovoltaic cell consists of a layer of n-type silicon joined to a layer of p-type silicon that have been 'doped' with other elements to alter their electric properties. The n-type layer has an excess of negatively charged electrons and the p-type layer has fewer electrons than normal giving 'holes' with atoms lacking electrons. As the materials come together, electrons at the junction drift from the n-type layer to the p-type layer. A voltage is set up across the junction. When sunlight strikes the photovoltaic cell, the photons of energy free electrons. This electron movement provides the required current flow.

8

(ii) The antireflective coating is necessary as silicon is a reflective material. A coating is used to minimise losses as reflected light photons will not be used by the cell.

2

(q) Most solar generating stations need supplemental fuel plants to ensure continuity of supply when weather conditions are not favourable.
Solar technology is still in a developmental stage with a small proportion of available energy captured. The concentration of sunlight, through uses such as solar furnaces, will deliver an increase in efficiency.

Sparsely populated areas close to the equator receive more sunlight than regions at higher latitudes, where most electricity is used.
Much of the energy from the sun is reflected back into space. It can be blocked or dispersed by passing clouds.

5 + 5

(r) **(i)** Regarded as a 'clean' technology, solar cells provide a renewable source of energy. It eliminates the dangers of emissions associated with the burning of fossil fuels.
Solar panels do have a visual impact as they can be large and need to be situated to maximise the energy of the sun.

(ii) A **photovoltaic module** has a number of photovoltaic cells electrically connected to each other. The amount of cells will determine the voltage of the system.

(iii) Solar power uses a large amount of photovoltaic cells connected together to produce direct current with an inverter to convert to alternating current. This **'on-grid'** current is directed into the grid network.
Photovoltaic systems can be used to power isolated uses such as water pumps, heating and communication equipment. It can be used for other **'off-grid'** applications such as calculators and watches.

(Any two) 5 + 5

Question 2 **(50 marks)**

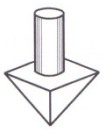
(a) **(i)** **Microscopic** examination of metals allows for more detailed examination of grain size and some impurities. An optical microscope is used for this type of inspection. **Macroscopic** is a visual inspection process. Physical manufacturing defects can be detected by eye or low powered magnifying glass.

(ii) Creep is the slow deformation of a metal over time, resulting from a constant force acting on the metal. Factors that contribute to creep include:

- Time
- Temperature
- Nature of the force.

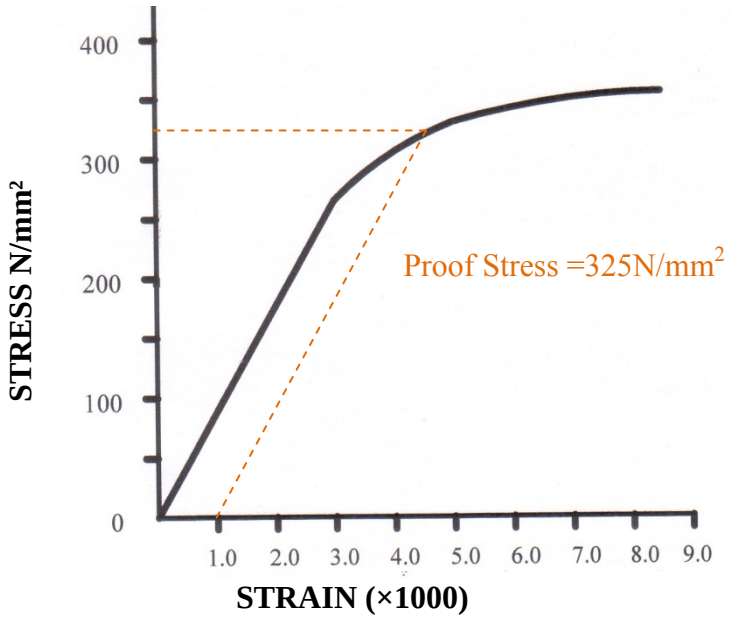
(iii) In the **Brinell** hardness test, a hardened steel or tungsten ball used.

For the **Vickers** hardness test, a diamond shaped pyramid is indenter is used. It has a point angle of 136^{o}



(Any two) 8 + 8

(b) Plot the stress-strain graph. **10**



(i) From the graph, the 0.1% proof stress is **325N/mm²**

4

(ii) Youngs Modulus: $\frac{\text{Stress}}{\text{Strain}} = \frac{125}{1.4} =$ **90 kN/mm²**

4

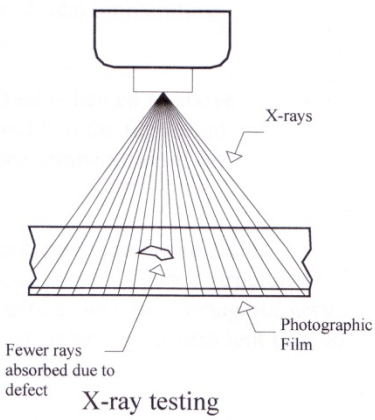
(c) (i) Suggested suitable non-destructive tests:

A – Penetrant or magnetic particle tests could be used to test for surface flaws.

B – X-ray testing could be used to test for internal faults.

4 + 4

(ii) A suitable non-destructive test for assessing for internal faults would be **X-ray testing**.



X-ray testing

Radiation from an x-ray tube is passed through the weld. If no defects are present, the amount of absorption is uniform across the area exposed to the x-ray beam. If a defect is present in the weld, a smaller amount of rays is absorbed giving a variation in the intensity of the emergent beam. This can be detected by placing a photographic film on the side of the material opposite the radiation source. On a negative film, the defect shows as a dark spot.

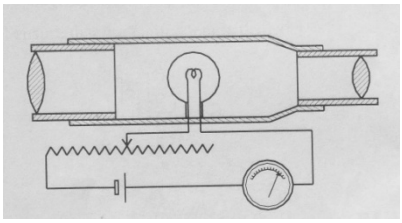
(Any one) 8

Question 3 **(50 marks)**

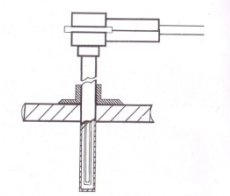
(a) (i) **Eutectic point:** A liquid to solid change occurs at this point. It happens at 1140^{o}C for the iron carbon alloy with 4.3% carbon. Liquid steel changes to solid austenite and cementite.
Eutectoid point: a reaction that occurs in the solid state when solid austenite changes to solid pearlite. It happens at 723oC for the iron carbon alloy with 0.83% carbon.

(ii) As very high temperatures are generated in a furnace, ordinary thermometers can not be used. Other methods used to measure furnace temperature must be used.

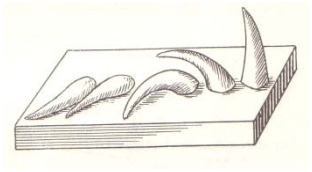
Optical pyrometer: this method compares the intensity of light from the filament of a lamp. Current flow from the lamp can be adjusted, using a variable resistor, to match the light from the furnace. When the filament seems to 'disappear', a temperature reading can be taken.



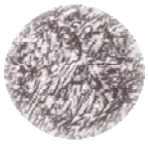
Thermo-electric pyrometer: A galvanometer measures the electrical current generated by a rise in temperature of two dissimilar metals joined together. A temperature output is converted from the electrical units.



Seager cones: A traditional method of measuring furnace temperature in which cones of slightly different composition are placed on the furnace. As the temperature rises, the cones begin to wilt until the correct temperature is maintained.



(iii) Martensite has a hard needle-like structure giving a strong but brittle material. The distortion in the structure occurs because of the rapid quenching in hardening where excess carbon does not come out of solution.



Ferrite is iron that contains less than 0.02% carbon dissolved in solution, it is almost pure iron. It has a body centred cubic structure.

(iv) Recrystallisation: During cold working distorted nuclei are formed and then replaced by new crystals during recrystallisation. This is achieved by heating and cooling the component during annealing and allowing large grains to form. Properties such as hardness and tensile strength benefit from recrystallisation.

(Any two) 8 + 8

(b) (i) 1 – Austenite and Ferrite.
2 – Austenite.
3 – Austenite and Cementite.
4 – Pearlite and Ferrite.
5 – Pearlite and Cementite.

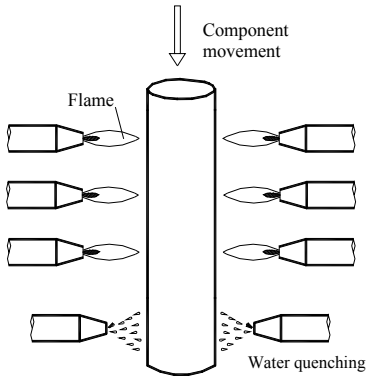
(Name) 2 + 2 + 2 + 2 + 2

(ii) At 900^{o}C, above the upper critical temperature, the carbon is dissolved in a solid solution called austenite. This has a face-centre cubic (FCC) structure above 910^{o}C.
As slow cooling takes place to below the lower critical temperature of 723^{o}C, ferrite and soft pearlite (ferrite and thin layers of cementite) are formed. This makes the material as soft as possible. A body-centred cubic form exists below 910^{o}C.

8

(c) (i) Carburising is a surface hardening process that increases the carbon content of the surface layers.
In **pack carburising**, the object is placed in a furnace surrounded with a carbon-rich compound. The carbon will diffuse into the surface layers at a temperature above the upper critical point. The depth of penetration of carbon into the surface depends on the temperature and length of time in the furnace.
The pack carburising process is time consuming and makes some objects prone to cracking. Grain refining is necessary. After pack carburising, the component may be immersed in a salt bath to allow for uniform surface heating. **8**

(ii) Flame hardening
The surface of the steel object is heated to 850^{o}C with an oxy-acetylene flame and quenched quickly. This creates a hard outside layer as the heated austenite structure changes to hard martensite. The depth of hardening depends on the rate of heating.



Flame hardening

8

Question 4 **(50 marks)**

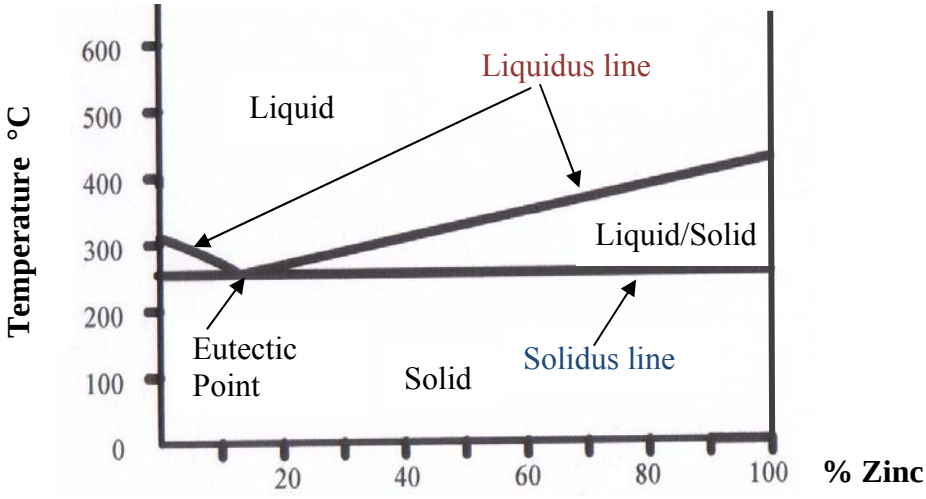
(a) (i) Vacancy or vacant site defect: if there is an atom missing from the lattice, a distortion occurs as other atoms are forced toward the vacant space.

(ii) Interstitial: a different type of atom moves into the spaces between the atoms of the lattice.

(iii) Substitutional: the structure has foreign atoms in the lattice. Distortion will be caused if these atoms are a different size.

(Any two) 8 + 8

(b) (i)



(Draw) 8

(ii) **Liquid:** the two metals are soluble in each other in the liquid state.

Liquidus line: the change from fully liquid to pasty state. Above the liquidus line, the alloy is liquid. This is the beginning of solidification.

Liquid + solid: the alloy is in a pasty form.

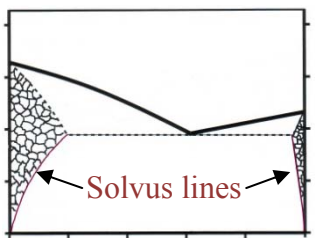
Solidus line: the change from pasty to solid. Below the solidus line, the alloy is cooling and solid. This is the end of solidification.

Solid: alloy is in solid form.

Eutectic point: a change point in which the alloy changes from liquid to solid without going through a pasty phase.

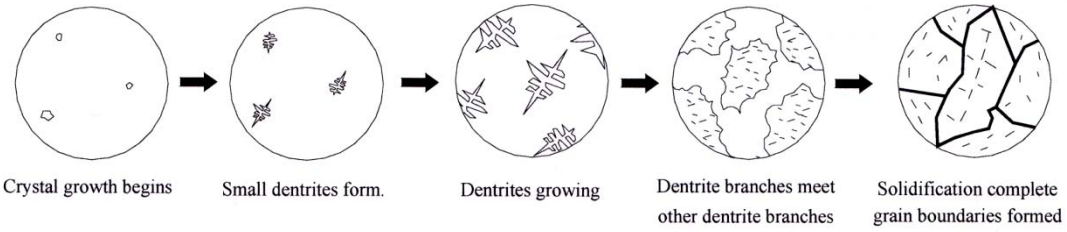
(Label) 5
(Describe) 5

(c) (i) Solvus line: The transition from one solid form to another solid form of an alloy is called the solvus line. On the lead-tin diagram shown, the solvus lines indicate the maximum amount of lead that can be dissolved in tin and the maximum amount of tin that will dissolve in lead.



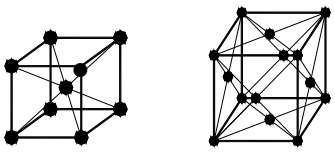
(ii) Solid solution: when two metals are completely soluble in each other in both the liquid and solid states. When viewed under a microscope, a solid solution appears like a pure metal. Copper-nickel and iron-chromium are examples.

(iii) The stages of metal solidification from liquid phase: This is known as dendritic growth. As the metal cools, solidification starts from cells and begin to grow to form a dendrite. These have a tree-like formation with branches reaching out in all directions. Grain boundaries with solid metal crystals are formed.



(iv) The differences between BCC and FCC structures:

In a **BCC** structure, atoms are arranged with an atom at the corner of a cube and an atom in the centre of the cube. This structure is associated with brittleness.



BCC FCC

In a **FCC** structure atoms are atoms at the corners of a cube and one atom in the centre of each face of the cube. Atoms are more tightly packed which allows metals to be more ductile. Slip is more likely to occur in an FCC structure.

(Any two) 8 + 8

Question 5 **(50 marks)**

(a) (i) Name: Tungsten Inert Gas (TIG) welding.

2

(ii) Operation: An arc is formed between the non-consumable electrode and the metal being welded. The inert gas shielded arc is used to flux the joint, Argon is often used to prevent oxygen getting to the joint area. A filler metal is added manually to the weld pool when necessary. A high frequency generator provides a path for the welding current.

10

(iii) Application: Commonly used as a high quality welding process where precision is needed. It allows aluminium and stainless steel to be welded.

4

(b) (i) Safety features incorporated into oxy-acetylene equipment:

- Colour coding: oxygen cylinder is black and acetylene is maroon, hoses and regulators are colour coded with oxygen as blue and acetylene as red
- The acetylene connection on the torch has a left hand thread and the oxygen connection has a right hand thread to prevent interchange
- Flashback arrestors are placed on the acetylene and oxygen lines to prevent feedback of gases
- Regulators are designed to fit only on acetylene or high pressure oxygen cylinders and cannot be changed.

(ii) **A** – There are two gauges in the regulator. The low pressure gauge shows the pressure set in the supply pipe to the torch. The high pressure gauge indicates the pressure of the contents of the cylinder.
B – The pressure regulator controls the pressure of Oxygen or gas.

(iii) If acetylene is compressed into a cylinder, it would explode under high pressure. Acetylene cylinders are packed with a porous material that is filled with acetone, this can absorb 25 times its own volume of acetylene. **Dissolved acetylene** is the name given to this form of acetylene fuel.

(iv) Oxidising flame:

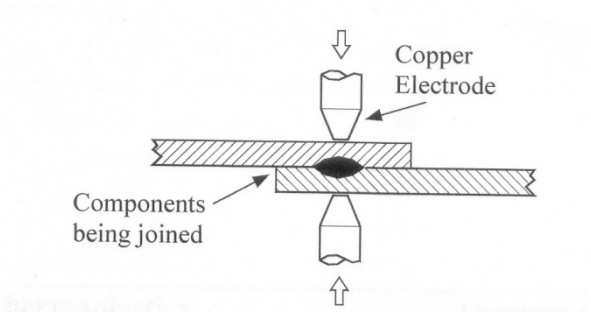
- Contains excess oxygen
- Has a working temperature of up to 3500^{o}C
- Used to weld copper and brass, it would oxidise steel
- Flame appears smaller.

Carburising flame:

- Contains excess acetylene
- It has a working temperature of 3150^{o}C
- Used to weld aluminium and alloy steel where it gives protection against oxidation
- Flame is bigger with the distinctive acetylene feather.

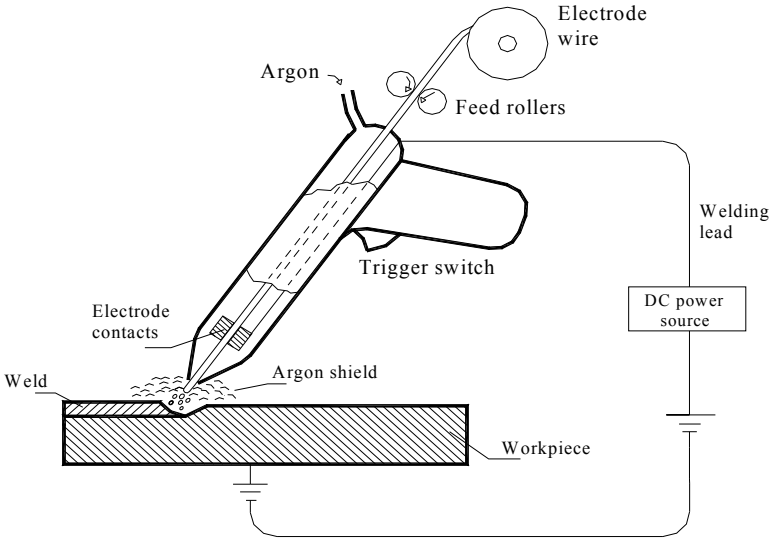
(Any three) 6 + 6 + 6

(c) (i) Resistance spot welding:



The components to be joined are placed between the electrodes and then pressed together. A nugget weld is achieved as current is passed through the electrodes generating a large heat between the metals. It is very effectively used to join sheet metal together and is recognised by the distinctive circular mark left at the site of the weld. Spot welding gives a lower strength joint than other forms of welding but it is energy efficient, giving little work deformation, it can be easily automated and does not require a filler metal. It is commonly used in sheet metal uses such as presses, filing cabinets and car body panels.

(ii) Metal inert gas welding: MIG welding is a semi-automatic process. A consumable bare wire electrode is fed continuously into the weld pool area through the welding torch. An inert gas, such as Argon, creates a protective shield around the weld pool giving a fluxing action. The feed rate and flow rate of the gas are set by the operator. This allows the operator to guide the torch along the weld once the arc is generated between the electrode and the work. MIG welding can be used on heavy plate as well as sheet metals, it does notproduce a slag on the weld.



(Any One) Describe 8
Diagram 8

OR

(c) (i) Industrial applications of robotic control include:

- Welding on car panels
- Spray painting
- Assembly of parts
- Placing components on circuit boards
- Testing component parts, etc.

4 + 4

(ii) Advantages of using stepper motors in robotic control:

- Precision control of movement
- Reliability of operation.

4 + 4

Question 6 **(50 marks)**

(a) (i) **Name :** Extrusion **2**

Principle of operation: The thermoplastic powder or granules are fed into the heated compartment from the hopper. The rotating screw, part B, moves the softening plastic along this compartment and exerts a pressure to force the plastic through a die. The die, part C, determines the extruded shape, which is then cooled in the chamber at D. The plastic lengths are supported and cut at the required length.

6

(ii) **A** – The screw feeds the plastic from the hopper through the heating compartment towards the die.

B – The hopper which holds a supply of plastic granules or powder.

C – The die determines the shape of the extruded object.

D – The cooling chamber hardens the extruded plastic using water or air.

(Any three) 2 + 2 + 2

(iii) Used to produce long shapes of regular section such as pipes, rails, electric conduit, gutters, etc. **2**

(b)

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 **3 + 3**
(ii) Polymerisation process Addition polymerisation	**(ii) Polymerisation process** Condensation polymerisation **3 + 3**
(iii) 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.	**(iii) Properties:** • High melting point • High tensile strength • Good thermal insulation • Can withstand high temperatures without loosing rigidity • Stiff and less flexible. **2 + 2**

(c)

(i) Transfer moulding: the powder is placed in a compartment above the mould where it is heated. A plunger forces the molten polymer into the mould cavity where the polymer takes the shape of the cavity and solidifies. It can be used to produce thermosetting objects with high definition such as plug tops.

(ii) GRP: Glass-reinforced plastics: the addition of glass fibre greatly increases the strength of plastic, commonly polyester resins are used. Boats and storage tanks are commonly made from these materials.

(iii) Cross-linking: In condensation polymerisation, a strong rigid 3-D network is formed by primary covalent bonds between adjacent chains. These bonds are cross-linking and provide high tensile strength, rigidity and heat resistance. Thermosetting plastics are formed due to cross-linking.

(iv) Laminate: Thin layers of materials bonded together. High strength plastics can be produced by layers of paper or cloth coated with resin being bonded together. Heat and pressure can be used.

(v) Polymer filler materials: These additives control the mechanical properties, such as material strength, of the polymer. They reduce the amount of expensive polymer used. Fillers such as chalk, wood flour and glass fibre can be used.

(Any three) 6 + 6 + 6

Question 7 **(50 marks)**

(a) (i) Three types of chip formed in metal cutting:

- Continuous chip
- Discontinuous chip
- Chip with built-up edge.

(ii) A reamer can be used to make a hole more accurate in size and have a smoother finish.

(iii) Factors that influence heat in machining:

- Use of coolants help to reduce heat generated
- Type of material
- Machining operation
- Condition of machine and cutting tool.

(iv) Safety issues in machining mild steel:

- Mild steel generates heat while machining, it is important to have cutting tools sharp.
- Cutting chips will be generated while machining, all guards and personal protection equipment must be in place.
- Considerable cutting force is used to machine mild steel, machines need to be in good condition.
- The material may need to be degreased before machining to minimise fumes.

(v) Clearance fit has the shaft is smaller than the part it fits into, there is a space to allow the parts to fit together easily.
Interference fit has the shaft made larger than the part it is intended to fit. The parts will have to be forced together.

(Any three) 6 + 6 + 6

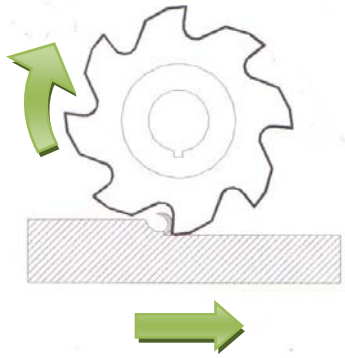
(b)(i) In the grinding process, wheel dressing is used to restore the cutting surface of any irregularities. Grinding wheels are designed to have a self dressing action in which grains should break free and expose sharp edges. Wheel dressing will renew a sharp cutting face and correct irregularities such as wheel concentricity. The process can remove any undulations from the wheel.

8

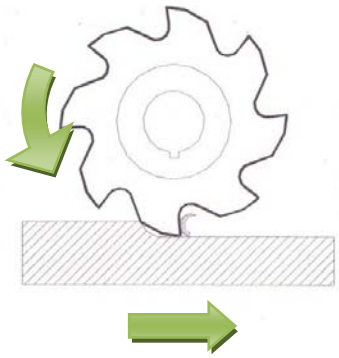
(ii) **Loading:** a grinding wheel becomes loaded with small particles when grinding debris becomes trapped in the space between the abrasive grains and the wheel. This will cause overheating of the work piece.
Glazing: the grinding wheel has a shiny appearance as the abrasive particles have lost their edge and failed to break away from the wheel. The grinding wheel not cut effectively.
These faults are caused by inappropriate choice of grinding wheel for the material being ground.

4 + 4

(c) **Up-cut milling:**
The conventional milling method. In this process the milling cutter is rotating against the direction of the workpiece. There is a danger of the workpiece lifting out of the vice, therefore effective clamping is necessary. A smoother cutting action is achieved.
Down-cut milling:
The milling cutter rotates in the same direction as the workpiece movement, it is also known as 'climb milling'. A blacklash eliminator should be fitted to the machine for this type of milling to allow heavier cuts to be taken without the tendency to lift. It produces a finish with less defined cuter marks.



Up-cut milling



Down-cut milling

Describe 8
Diagram 8

OR

(c) (i) The machine allows a rapid movement when the tool returns to start a next cutting action.
Minimal setting-up between batch production of parts.

(ii) - Both can carry similar functions such as turning, drilling, drilling, etc. to a high degree of accuracy.
- Due to the time taken to develop, set-up and test CNC programmes, it is often less expensive to machine once-off parts using conventional processes. However, CNC machining will produce a large volume of parts in a cost effective manner.
- In terms of comparative machine sizes, CNC machines are more expensive than traditional machines.
- For general purpose work, it is quicker to train workers to carry out CNC machining. However, those with experience of traditional machining can use their experience to be more effective operators of computerised processes.

(iii) Safety features include:

- Large clear guard encloses machining
- Machine will not run when guard is not in place
- Emergency stop on the front of the machine
- Programme must have test run before machining.

(Any two) 8 + 8

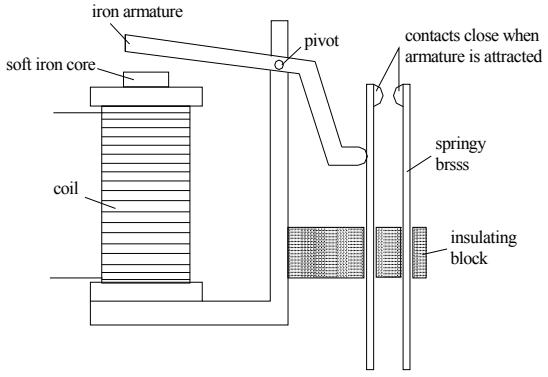
Question 8 **(50 marks)**

(a) (i) Bevel gear system: used transfer motion at right angles, applications include hand drill.

(ii) Ball thrust bearing system: allows an axial load on a rotating shaft, used in robotic control, transmission systems, turntables, rotating stools, etc.

(Any one) Name 8
Application 8

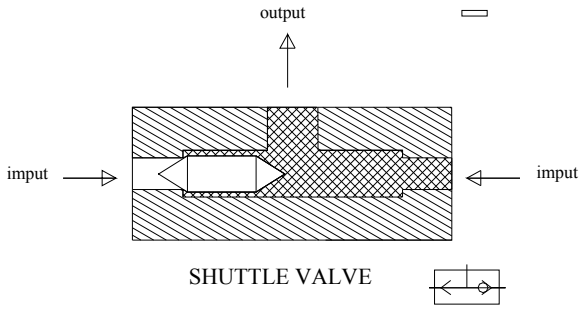
(b) (i) Electrical relay: when a small current passes through the coil, it closes the switch contacts of the relay. A larger current can be controlled by a relay. It is used as a switching component for lighting systems and motors.



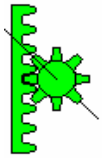
Electrical Relay

(ii) Clutch: used in a transmission system to break and make the drive between the engine and wheels. When the clutch engages, the pressure plate and friction plate are pushed together.

(iii) Shuttle valve: controls a single-acting pneumatic cylinder from two positions. An air signal from one side of the valve closes the opposite side.



(iv) Rack and pinion: converts rotary motion to linear motion. As the pinion rotates, the gear teeth mesh with those on the rack. This allows the rack to be moved in a line. Applications of the rack and pinion include raising and lowering the table of a pillar drill and steering in a car.

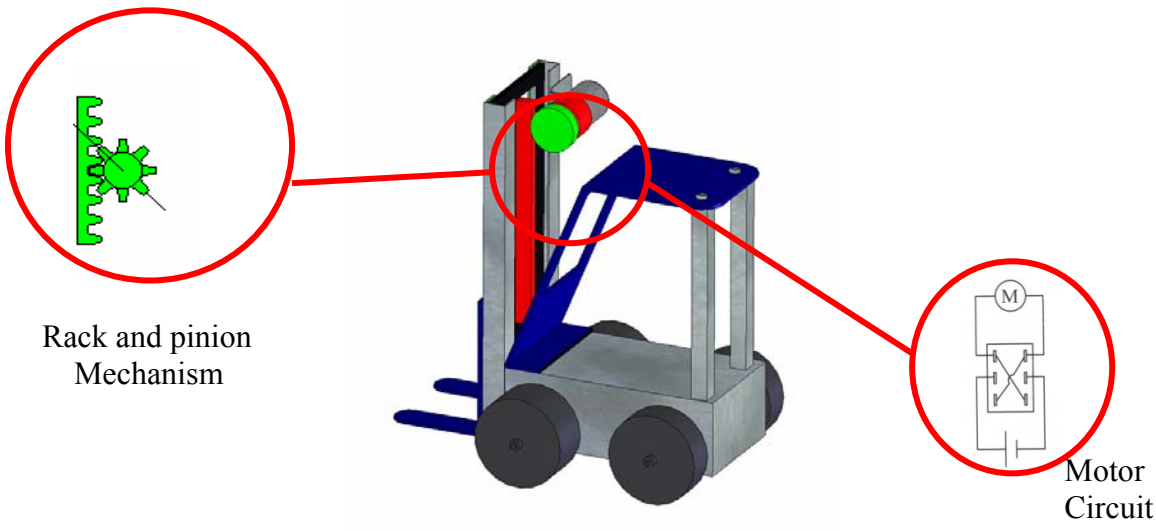


(v) Capacitor: it is used to store charge, it can discharge through a circuit so that the stored charge can be used. Capacitors are commonly used in timer circuits.

(Any three) 6 + 6 + 6

(c) A number of suitable mechanisms for elevating heavy loads, are possible, including: rack and pinion, linkages, chain drive, toothed pulleys, hydraulics, pneumatic control, etc.

A suggested solution:



Rack and pinion Mechanism

Motor Circuit

The design is based on a forklift shape in which the load is lifted at the front and must be balanced by:

1. the shape of the body and its centre of gravity,
2. the weight of the vehicle and
3. position of wheels.

The mechanised system for elevating the load is a rack and pinion as it can be raised and lowered effectively by the geared motor and will not slip. Override switches are placed at the top and bottom of the rack to prevent the pinion running off the end of the rack.

The motor control circuit consist of a DPDT (centre off) switch to allow the motor to run upwards and downwards.

Description 8
Diagram 8

OR

(c) (i) A – Light dependent resistor.
B – Variable resistor.
C – Transistor.
D – Light bulb.

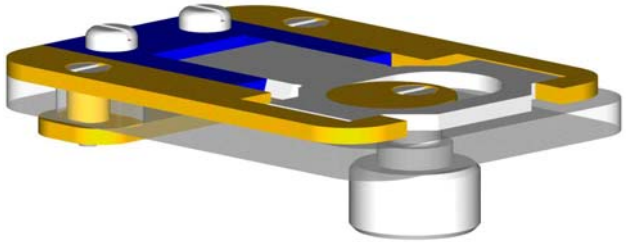
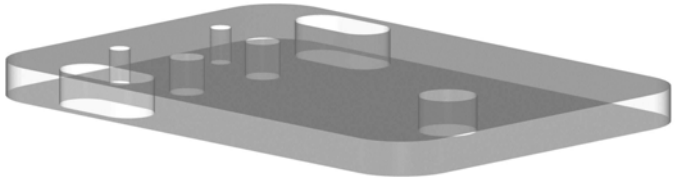
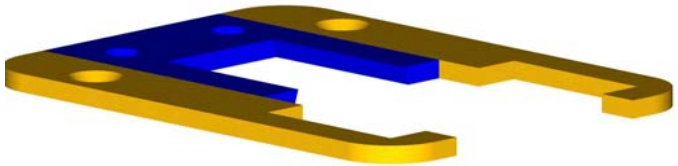
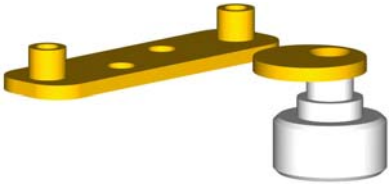
2 + 2 + 2 + 2

(ii) The component **A** is a light dependent resistor (l.d.r.), it will change resistance as light falls on it and is commonly used as a light sensor.
The component **B** is a variable resistor which can adjust its resistance and is commonly used as a dimmer switch.
In the circuit, the variable resistor and l.d.r. form a potential divider which determines the light intensity needed to turn on the transistor. The l.d.r. senses the light and the variable resistor can adjust the sensitivity of the circuit.

4 + 4

Leaving Certificate Engineering Practical, Common Level, Marking Scheme 2008

Subjective Grading: 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 Mechanism**		Assembly Function & Finish Subjective Grade 1-20		20	20
2	**Part 1**		Marking Out		5	20
			10mm Radii		4	
			9mm Slots		6	
			Drill & Tap M5		2	
			Drill 6mm Holes		2	
			Drill 10mm Hole		1	
3	**Part 3**		Marking Out		5	20
			24mm Slot		5	
			Dovetail		4	
			Profile		4	
			Drill 3mm Holes		2	
4	**Parts 2, 4 & 5**		Part 2	Marking Out	2	20
				Dovetail Slot	6	
				Drill 6mm Holes	2	
			Parts 4 & 5	Marking Out	2	
				28mm x 8mm Recesses	4	
				10mm Radii	2	
				5mm CSK Holes	2	
5	**Parts 6, 7, 8 & 9**		Part 6 Bench Work		5	20
			Part 7 Lathe Work		6	
			Part 8 Bench Work		5	
			Part 9 Lathe Work		2	
			Part 9 Lathe Work		2	

100 Marks (× 1.5 = 150 Total)