Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate Examination, 2021

Technology

Higher Level

Monday, 28 June
Afternoon, 2:00 - 4:30

There are **three** Sections in this paper. Attempt **all three** Sections.

Section A: Core - Short-answer questions.

Section B: Core - Long-answer questions.

Section C: Options - Long-answer questions.

Section A - Core *(72 marks)*

Instructions:

(a) *Answer **any twelve** questions in the spaces provided. All questions in Section A carry 6 marks.*

(b) *Draw all sketches in pencil.*

(c) *Hand up this booklet at the end of the examination.*

(d) *Write your examination number in the box provided and on all other pages used.*

Examination Number

Centre Number

Section	Mark
Section A	
Section B	
Section C	
Total	
Grade	

Section A. *Answer **any twelve** questions. All questions carry 6 marks.*

1. Lighting company, SELC, was launched in 1982 in Belmullet, Co. Mayo.
The company specialises in networked smart street lighting using Wi-Fi and radio signals.

Explain the benefits of **each** of the following features:

(i) Dimmable LED lights replacing traditional lighting.

(ii) Automated control of lighting rather than manual switching.

2. The SELC light controller uses a housing made from polycarbonate.
Outline **two** reasons for the use of polycarbonate to house the controller.

1.

2.

3. In December 2019, the U.S. Department of Justice charged the leader of an organised cyber-criminal group for his part in a global *Dridex* malware attack. The public are advised to ensure that electronic devices are patched, antivirus is turned on and updated, and files are backed up.

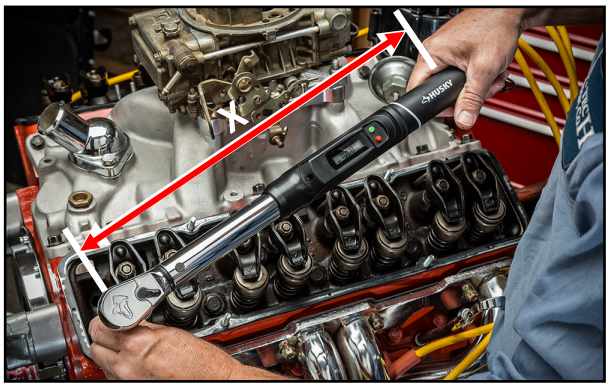
Explain the terms:

(i) 'patched'.

(ii) Antivirus.

4. The torque wrench shown is set to deliver a torque of 206 N m.
Calculate the force exerted by the operator to achieve this torque if X = 700 mm.

Calculation:



5. The faceshield shown consists of a 3D printed headband and a removable plastic sheet.
Compile a Work Breakdown Structure (WBS) for the manufacture of the faceshield shown.

6. The *skin-frame* type structure has gained popularity in 3D printing for items such as the Voronoi mushroom lamp shown. This approach uses a combination of frame and shell structures.

Outline **two** reasons for the use of such a combined structure.

1. _____

_____

2. _____

_____

7. Amazon have used artificial intelligence (AI) to develop their virtual assistant, Alexa. The device is capable of undertaking a range of tasks including voice interaction, music playback, etc.

Alexa can be *paired* with devices such as lights and speakers. Outline the process of pairing electronic devices.

8. Outline **two** features that might be integrated into the bench-mounted belt sander shown, to reduce vibration and minimise dust.

1. Reduce vibration.

2. Minimise dust.

9. Electronic components can be distinguished by material, electrical properties, and use. Complete the table below.

Category	**Material**	**Electrical Property**	**Use**
Conductor	*Copper*	*Allows current to pass through*	*Electrical wire*
Insulator			
Semiconductor			

10. The helical-cut gears shown are mounted in a cast iron gearbox.

(i) State **two** reasons for using helical gears rather than straight spur gears.

1. _____

_____

2. _____

_____

(ii) Describe how such a gear system could be lubricated.

_____

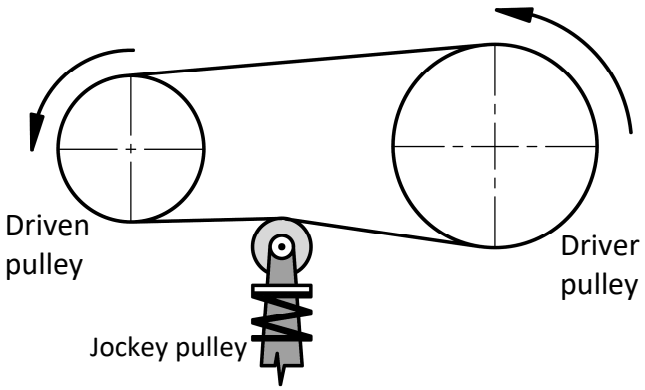
_____

_____

11. The system shown has a driver pulley, diameter 40 mm, and a driven pulley, diameter 25 mm.

(i) Calculate the angular velocity (rotational speed) ratio of the system shown.

Calculation:



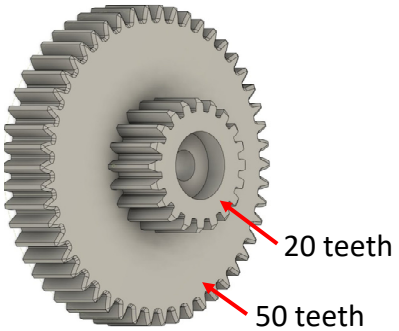
(ii) Explain the purpose of the spring-loaded jockey pulley.

_____

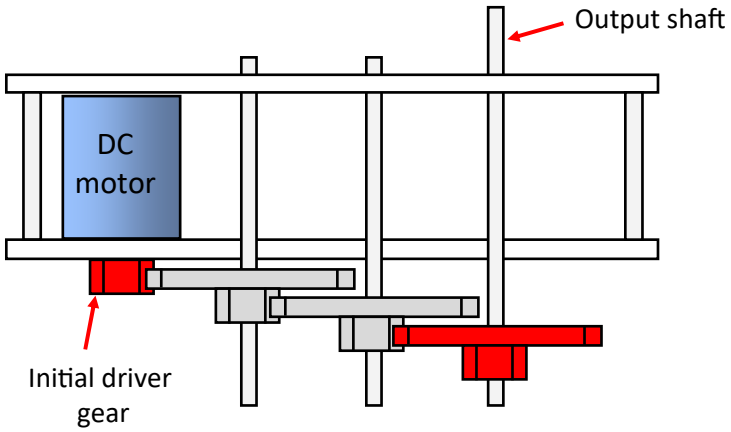
_____

_____

12. The gearbox shown uses three identical compound gears. The initial driver gear (20 teeth) is secured to the motor. For each of the three subsequent compound gears, the driver gear has 20 teeth and the driven gear has 50 teeth.



Compound gear



Initial driver gear

If the motor runs at 2000 rpm, calculate the angular velocity (rotational speed) at the output shaft.

Calculation:

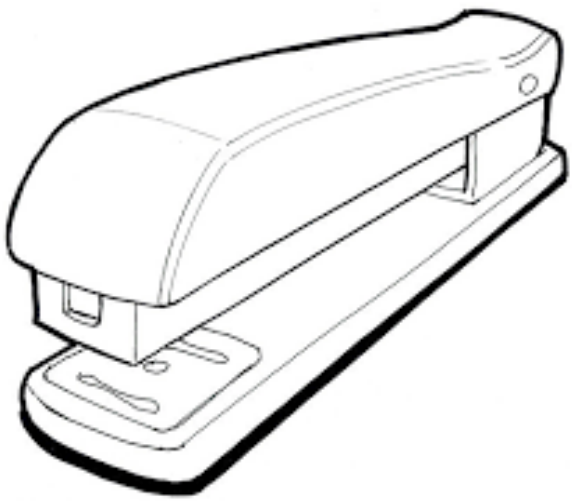
13. An exploded view of a retro games console is shown.
Sketch a pictorial view of the *assembled* console.

14. The Irish-designed *Gúna* occasional table is shaped to emulate the elegant sweep of a dress. The table is produced by *laminating* lengths of oak and African wenge timber.

(i) Explain the lamination process.

(ii) Outline **two** reasons for reducing the use of tropical hardwoods such as wenge.

15. Use **two** graphic techniques to enhance the representation of the materials used in the stapler shown.



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Section B - Core *(24 marks)*

*Answer **one** question from the two questions presented.*
Each question in Section B carries 24 marks.

Section C - Options *(40 marks)*

*Answer **one** of the five optional questions presented.*
All questions in Section C carry 40 marks.

Instructions:

(a) Answer these questions in the answerbook provided.

(b) Write your examination number on the answerbook.

(c) Draw all sketches in pencil.

(d) Hand up the answerbook at the end of the examination.

Section B - Core - *Answer Question 2* ***OR*** *Question 3.*

Question 2 *- Answer 2(a)* ***and*** *2(b)*

2(a) On 30th May 2020, the Elon Musk inspired 'Crew Demo-2' spacecraft by SpaceX was launched to the International Space Station. Crew Demo-2 is the first commercial orbital spaceflight launched from the United States.

(i) Describe **one** benefit of commercial input into space exploration.

(ii) Outline **two** materials or processes developed for space exploration that are now commonly used in daily life.

2(b) The astronaut seats of the spacecraft are *anthropometrically designed* using carbon fibre and the synthetic textile, alcantara.

(i) Explain what is meant by anthropometrically designed.

(ii) Using annotated sketches, identify **three** anthropometric features of the customised seats of the Demo-2.

(iii) Explain **one** reason for the use of carbon fibre and **one** reason for the use of synthetic textile in the seats.

Answer 2(c) ***or*** *2(d)*

2(c) Most spacecraft use control levers and manual inputs but Demo-2 features a touchscreen interface.

(i) Outline **two** advantages of touchscreens over control levers and manual inputs.

(ii) Describe, using annotated sketches, an electro-mechanical means of tilting the touchscreen for better viewing by the astronaut team.

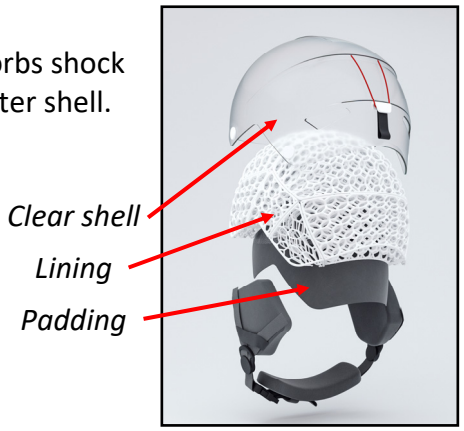
OR

2(d) Spacecraft must be of the highest quality to ensure the safety of astronauts and all other staff associated with space exploration.
Explain, with **one** example in each case, **each** of the following dimensions of quality:

- *Performance*
- *Reliability*
- *Conformance*.

Question 3 *- Answer 3(a)* ***and*** *3(b)*

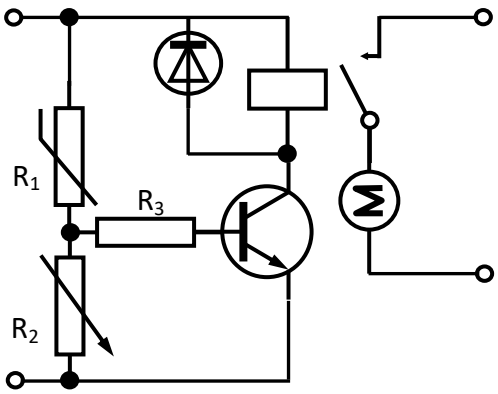
3(a) HexGen is an award-winning design for a ski helmet. The helmet absorbs shock using a combination of a soft padding, 3D printed lining and a hard outer shell.



(i) Name a suitable plastic material for the outer shell and the padding layer respectively.

(ii) Outline **two** advantages of using 3D printing for the lining.

3(b) The prototype circuit shown operates an automated fan.



(i) Outline the function of the resistors R_1 and R_2.

(ii) Describe the operation of the circuit, making reference to **two** methods of protecting the transistor.

(iii) The circuit needs to be tested before the design is finalised. Outline **one** advantage and **one** disadvantage of **each** of the following approaches to designing and testing circuits:

- circuit simulation software
- physical prototyping boards.

Answer 3(c) ***or*** *3(d)*

3(c) Outline, with annotated sketches, how to safely use a multimeter to determine:

- the precise value of a resistor
- the voltage of a motorcycle battery
- the direction of current in a diode.

OR

3(d) In adventure sports, helmet cameras with GPS capability can be used to analyse performance.

(i) Outline **two** aspects of sports performance that could be analysed using data captured by a helmet camera.

(ii) The camera has an internal battery. Suggest **one** method of enhancing the environmental sustainability of the camera's power source.

Section C - Options - *Answer **any one** of the five optional questions.*

Option 1 - Applied Control Systems - *Answer 1(a) **and** 1(b)*

1(a) The use of control systems in the food industry seeks to improve quality and affordability. Describe, with **one** example in each case, a technological innovation which has improved **each** of the following:

- Farming production
- Food preservation
- Packaging.

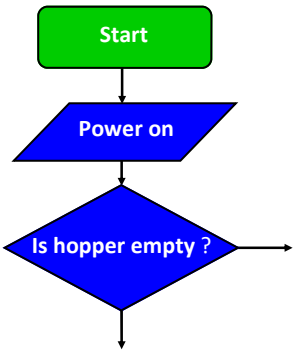
1(b) A battery powered automated pet-food dispenser, controlled by a programmable circuit, will fill the food tray every 6 hours if the tray is less than half full. When the food hopper is empty, a warning buzzer will sound continuously to alert the owner to refill.

(i) Outline **three** reasons why the programmable interface controller (PIC) is a suitable component to control the feeder.

(ii) Redraw and complete the flowchart to control the feeder.

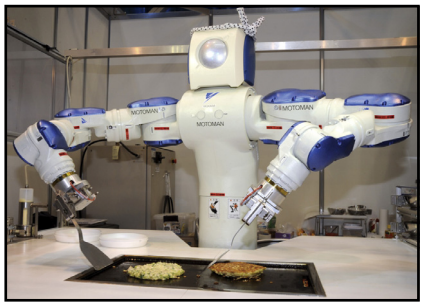
(iii) After a period of usage, a design problem was identified - the warning buzzer discharged the battery.

Suggest a modification to the flowchart to rectify this problem.



*Answer 1(c) **or** 1(d)*

1(c) Humanoid robots can be found throughout the restaurant industry, flipping burgers to specific preferences, pouring the perfect cup of coffee or even preparing fast-casual 'ready to eat' meals.



(i) Describe the main features of a humanoid robot.

(ii) Proper placement of food constituents is vital in the cooking and presentation of a meal.
Describe how *closed-loop control* is used to achieve accurate placement.

OR

1(d) (i) Draw a pneumatic circuit diagram to operate the pneumatic bottle-capping machine shown.

(ii) Outline a method of controlling the speed of the piston as it places the cap on the bottle.

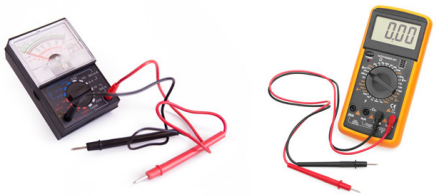
Option 2 - Electronics and Control - *Answer 2(a) **and** 2(b)*

2(a) Both *analogue* and *digital* signals are used in electronic circuits.

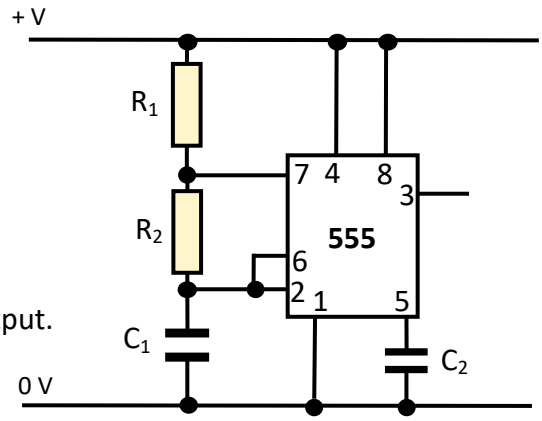
(i) Name **one** digital electronic component and **one** analogue electronic component.

(ii) Draw the typical waveform of:

- a digital signal
- an analogue signal.



2(b) An *astable* timer circuit is shown.



(i) Explain the term astable.

(ii) Describe the operation of the circuit making reference to R_1 , R_2 , C_1 and the threshold pin.

(iii) Redraw and complete the circuit in your answerbook to include a transistor and an LED output.

*Answer 2(c) **or** 2(d)*

2(c) (i) A transistor has a collector current of 0.1 A and a base current of 1 mA.
Select the most suitable transistor from the table given and justify your answer.

Transistor	Name	Current gain
A	BFY50	30
B	2N3053	50
C	BC107	100
D	TIP31	20

(ii) Calculate the collector current for transistor D (TIP31) if the base current is 0.3 mA.

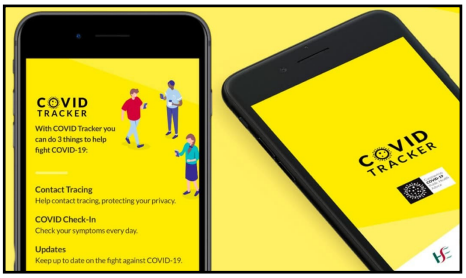
OR

2(d) The flight controller of a drone needs to ensure that all propellers are operational, heat does not build up excessively and batteries have sufficient charge to continue flying.
If these conditions are not met a parachute can be deployed and power shut off.

(i) Draw a logic circuit for the flight controller to ensure the drone remains undamaged.

(ii) Describe an electronically controlled method of deploying the parachute.

Option 3 - Information and Communications Technology - *Answer 3(a) **and** 3(b)*



3(a) *COVID Tracker* is a free mobile app to help us to protect each other and slow the spread of coronavirus in Ireland. The app uses Bluetooth® technology and anonymous IDs to log contact details of users.

(i) Explain the term Bluetooth®.

(ii) Outline the importance of personal data security in the use of the app.

3(b) *8GB of RAM, 256GB SSD and 5GHz dual core central processing unit (CPU)* is regarded as a basic specification for a laptop computer.

(i) Explain **each** of the elements of the specification given above.

(ii) Suggest **three** other features to be considered when purchasing a laptop.

(iii) The increased use of video conferencing platforms and communication tools has been a notable feature of coping with the COVID-19 crisis.

Explain any **two** of the following - *encryption*, *screen sharing, breakout rooms*.

*Answer 3(c) **or** 3(d)*

240 V laptop power supply

3(c) (i) Outline **two** functions of the mains-powered laptop power supply shown.

(ii) Most wireless charging devices rely on AC inductive coupling to transmit power.

Outline **three** advantages of wireless charging devices.

Wireless charging device

OR

3(d) Analysts have predicted that sales of 2-in-1 computing devices, such as detachable tablets and convertible computers, will grow by up to 5% annually.

(i) Outline **two** advantages of 2-in-1 devices.

(ii) These devices have a range of sensors such as *temperature sensors* and *gyro sensors*.

Explain why temperature sensors and gyroscopes are used in 2-in-1 devices.

Option 4 - Manufacturing Systems - *Answer 4(a) **and** 4(b)*

4(a) The *Conformité Européenne (CE)* and *Fairtrade*® logos shown are indicators that specified product standards have been reached.

(i) Distinguish, using a specific example in each case, the use of both the CE and Fairtrade® standards.

(ii) Businesses that achieve quality standards generally have a competitive advantage over other businesses.

Explain the competitive sales advantages for **either** Fairtrade ® **or** CE marked products.

4(b) The submersible solar-powered pump shown requires accurate fittings.
Measurements of samples of the fittings produced by two manufacturers are summarised below:

Manufacturer A - standard deviation σ = 0.04077 mm
Manufacturer B - standard deviation σ = 0.01620 mm

The fitting must have an outside diameter between 39.85 mm and 39.95 mm.

(i) Calculate the process capability index (Cp) for **each** manufacturer:

$$\text{where } Cp = \frac{\text{Tolerance Range}}{6\sigma}$$

(ii) Select Manufacturer A **or** Manufacturer B to produce the fittings. Justify your selection.

(iii) Outline the key features, with examples, of the Pareto principle of quality management.

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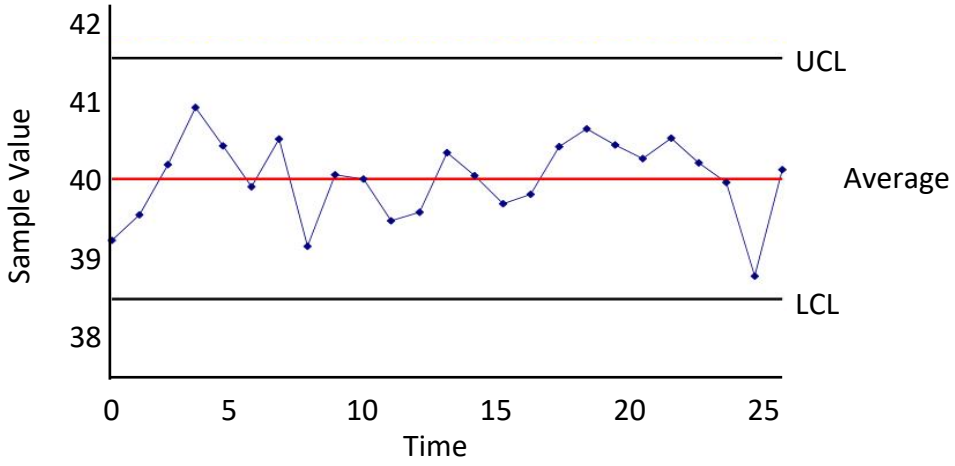
Answer 4(c) ***or*** *4(d)*

4(c) The simplified control chart shown is a representation of product consistency.



(i) Explain the terms LCL and UCL.

(ii) Using the chart, assess the degree of control exhibited by the manufacturer.

OR

4(d) *Dubarry of Ireland* is a renowned Irish-owned company with a collection of premium performance footwear, clothing, leather goods and accessories.

(i) Outline, using annotated sketches, a typical product lifecycle chart for a style of shoe. Explain **each** stage of the chart.

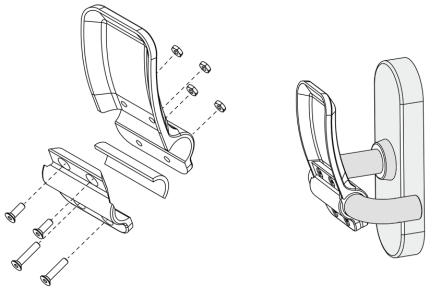
(ii) Outline **two** strategies that a business might adopt in order to extend the product lifecycle of a range of shoes.

Option 5 - Materials Technology - *Answer 5(a) **and** 5(b)*

5(a) DuPont company chemist, Stephanie Kwolek, is known for inventing Kevlar. Kevlar is a *synthetic fibre* with exceptional strength and stiffness, and is used in the making of protective clothing, ropes, and tyres.

(i) Explain the term synthetic fibre.

(ii) Name **two** composite materials and list their main consituents.



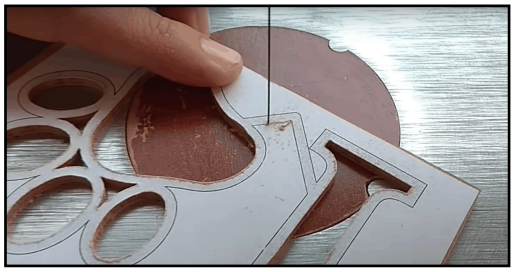
5(b) Door handles can harbour a large volume of germs in houses, hospitals, factories and care homes. The hands-free door opener shown can be fitted to existing handles to help prevent the spread of germs.

(i) Select a material that could be used to manufacture the door opener and justify your selection.

(ii) Describe, using annotated sketches, a production method to produce a large quantity of hands-free door openers.

(iii) Outline the role of polymer additives in the production of items such as the door opener.

*Answer 5(c) **or** 5(d)*



5(c) (i) Describe a method of cutting an intricate design in thin plywood making reference to equipment used, cutting action, and safety.

(ii) Outline why **both** thin sheets of plywood **and** thin aluminium tubing have a high strength-to-weight ratio.

OR

5(d) Large volumes of nylon are produced every year to make clothes, carpets, bottles, car interiors and toothbrushes. American biotechnology company, Genomatica, want to replace conventional nylon with sustainable bio-nylon, which is made from plant-based sugars.

(i) Outline **two** properties of nylon that make it suitable for the applications above.

(ii) Explain **two** advantages of using bio-nylon instead of conventional nylon.

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