L-Università ta' Malta

MATSEC
Examinations Board

SEC 33 Syllabus

Design & Technology

2028

Table of Contents

Introduction

This syllabus is based on the curriculum principles outlined in *The National Curriculum Framework for All* (NCF) which was translated into law in 2012 and designed using the *Learning Outcomes Framework* that identify what students should know and be able to achieve by the end of their compulsory education.

As a learning outcomes-based syllabus, it addresses the holistic development of all learners and advocates a quality education for all as part of a coherent strategy for lifelong learning. It ensures that all children can obtain the necessary skills and attitudes to be future active citizens and to succeed at work and in society irrespective of socio-economic, cultural, racial, ethnic, religious, gender and sexual status. This syllabus provides equitable opportunities for all learners to achieve educational outcomes at the end of their schooling which will enable them to participate in lifelong and adult learning, reduce the high incidence of early school leaving and ensure that all learners attain key twenty-first century competences.

This programme also embeds learning outcomes related to cross-curricular themes, namely digital literacy; diversity; entrepreneurship creativity and innovation; education for sustainable development; learning to learn and cooperative learning and literacy. In this way students will be fully equipped with the skills, knowledge, attitudes and values needed to further learning, work, life and citizenship.

What is Design & Technology?

Design and Technology is a multidisciplinary subject that calls on students to become entrepreneurial, creative and problem solvers through a design and make methodology and the application of relevant technology education. The subject contributes greatly to S.T.E.M. Education (Science, Technology, Engineering, and Mathematics) in instilling key skills, knowledge and attitudes leading to STEM careers. The applied academic, yet, practical nature of Design and Technology [D&T] provides a distinctive constructivist approach to learning which caters for a wide spectrum of student learning styles through all learning domains.

What does a study of Design & Technology entail?

Learning D&T entails working in a technological environment, using workshop equipment, modelling of ideas and building original artefacts and projects that respond to given or found problems. Theory is discovered through a spiral approach combining the technological areas of materials, mechanical and electronic systems, workshop processes, use of digital and CNC equipment and the application of graphic techniques.

The syllabus expands significantly in the Design Aspect with a deep focus on innovation, research and entrepreneurial skills and attitudes and established design thinking methodologies as a learning vehicle for critical thinking, enquiry skills, creativity and self-development.

The Technology Aspect is dynamic and reflects the fast-changing needs of a modern digital society, which strives for both experiential and technological innovation. The areas of study in technology for this syllabus are designed to foster a multidisciplinary approach by streamlining strands that can be delivered simultaneously, thus focusing on Materials and Making, Systems and Control and Design Graphics. These are not only very relevant in every aspect of product innovation and engineering, but also inductive of a holistic approach towards technology.

These areas shall be considered as a single Technology Aspect and students will work within these strands in parallel, allowing for cross disciplinary projects to be tackled by the students as a means of learning by designing and doing.

One key innovation in this syllabus is the reference to Emergent Technology where students are encouraged to think critically about how their learning activities might evolve in the future through an awareness of emergent technologies, strategies and values in today's dynamic Industry and society.

The 6 Subject Foci, described below for Design and Technology are intended to be delivered in a spiral approach, focusing on individual or combined Technology Aspects, through an applied and holistic range of design and make activities.

How is Design & Technology related to candidates' lives, to Malta, and/or to the world?

D&T encourages candidates to explore practical and technological problems which they draw from real life and/or everyday experiences and which they can relate to. Such problems may also be selected or 'framed' by the candidates themselves during the carrying out of various tasks set by their teacher. Problems that respond directly to the candidate's immediate environment, at school, in their homes, in their communities, in Malta as well as problems that extend to global issues, are commonplace in D&T. The aim of such problems is to promote a sense of engagement with the proposed technological solutions, carried out in a variety of approaches following a structured design process.

The aspirational programme learning outcomes for Design and Technology are:

At the end of the programme, I can:

- become technologically literate in order to be able to cope and contribute towards modern society;
- develop my critical and creative thinking skills, fostering innovative and entrepreneurial attitudes;
- learn practical skills that empower my self-confidence, capabilities and aspirations;
- learn how to work safely and sustainably in a dynamic work environment;
- engage with STEM education, widening my future employability opportunities in the area, locally and internationally.

List of Subject Foci

Subject Focus 1: Design Aspect – Design, Entrepreneurship and Innovation

Subject Focus 2: Design Aspect – Data Collection and Interpretation

Subject Focus 3: Design Aspect – Critique and Evaluation

Subject Focus 4: Technology Aspect – Materials and Making

Subject Focus 5: Technology Aspect – Systems and Control

Subject Focus 6: Technology Aspect – Graphics, Communication and Digitisation

List of Learning Outcomes

At the end of the programme, I can:

LO 1. Explore a problem leading to a list of specifications.

LO 2. Use and communicate processes leading to a solution.

LO 3. Take new initiatives that respond to users', environmental and society's needs and values.

LO 4. Apply research techniques to collect, record and process useful information.

LO 5. Communicate and produce relevant data.

LO 6. Take and evaluate design decisions critically.

LO 7. Show an understanding of materials and components.

LO 8. Show an understanding of manufacturing processes.

LO 9. Carry out manufacturing processes safely and responsibly within the school workshop environment to make models and artefacts that satisfy the desired outcome.

LO 10. Show an understanding of systems and their application to achieve a desired outcome. (Mechanical, Electronic, Microcontroller systems).

LO 11. Understand and apply graphic techniques to communicate, guide and facilitate manufacturing.

LO 12. Understand and apply digital resources to enhance design and manufacturing.

Programme Level Descriptors

This syllabus sets out the content and assessment arrangements for the award of Secondary Education Certificate in Design and Technology at Level 1, 2 or 3. First teaching of this programme begins in September 2022. First award certificates will be issued in 2025.

The following levels refer to the qualification levels that can be obtained by candidates sitting for SEC examinations. These are generic statements that describe the depth and complexity of each level of study required to achieve an award at Level 1, 2 or 3 in Design and Technology. (Level 1 being the lowest and level 3 the highest).

Level 1: At the end of the programme the candidate will have obtained basic knowledge, skills and competences in the subject such as basic repetitive communication skills and the ability to follow basic, simple instructions to complete tasks. Support is embedded within the task.

Level 2: At the end of the programme the candidate will have obtained good knowledge, skills and competence in the subject such as the interpretation of given information and ideas. The candidate will have developed the ability to carry out complex tasks. Limited support may be embedded within the task.

Level 3: At the end of the programme the candidate will autonomously apply knowledge and skills to a variety of complex tasks. Candidates will utilise critical thinking skills to analyse, evaluate and reflect upon their own work and that of others. Problem solving tasks may be part of the assessment process.

Learning Outcomes and Assessment Criteria

Subject Focus:	**Design Aspect – Design, Entrepreneurship and Innovation**
Learning Outcome 1: (Paper I and Paper II)	**At the end of the programme, I can explore a problem leading to a list of specifications.** ● *Exploring problems* ● *Specifications* ● *Design brief* ** A content range referring to the following Assessment Criteria is found in Table A: Broad Iterative Design Process.*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
1.1a Identify the needs stated within a design situation.	1.2a Identify further needs and/or opportunities that are not stated within a design situation.	
1.1b Identify stakeholders stated within a design situation.	1.2b Describe the roles of contributors and stakeholders within a design situation.	1.3b Explain the needs of contributors and stakeholders within a design situation.
	1.2c Identify specifications stated within a design situation.	1.3c Write specifications from further needs and opportunities within a design situation.
1.1d Write a design brief that highlights stated needs with assistance.	1.2d Write a design brief that highlights stated needs and/or opportunities with minimal assistance.	1.3d Develop a marketable design brief that highlights further needs and opportunities within an explored design problem.

Subject Focus:	**Design Aspect – Design, Entrepreneurship and Innovation**
Learning Outcome 2: (Paper I and Paper II)	**At the end of the programme, I can use and communicate processes leading to a solution.** ● *Design process* ● *Design Communication* ● *Iteration* ** A content range referring to the following Assessment Criteria is found in Table A: Broad Iterative Design Process.*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
2.1a Collate information collected and generated through a design process.	2.2a Organise relevant information within specific stages of a broad design process (Explore, Design, Make, Evaluate).	2.3a Produce a structured design folio that considers the full process of Explore, Design, Make and Evaluate including any sub sections as required.
2.1b Produce basic design ideas that convey an intended purpose.	2.2b Communicate design ideas that satisfy the design brief.	
	2.2c Make developments on previous design ideas. *E.g. adding further research to address a problem in a previous concept, sketching further ideas.*	2.3c Make iterations by documenting leaps between design decisions with some reference to the broad design stages.

Subject Focus:	**Design Aspect – Design, Entrepreneurship and Innovation**
Learning Outcome 3: (Paper I and Paper II)	**At the end of the programme, I can take new initiatives that respond to users', environmental and society's needs and values.** ● *Generating relevant ideas* ● *Entrepreneurship* ● *Marketability* ** A content range referring to the following Assessment Criteria is found in Table A: Broad Iterative Design Process.*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
3.1a Suggest basic improvement on a given design idea with guidance	3.2a Modify design ideas beyond the specified situation to add value to a design solution.	3.3a Justify how the ideas generated, add relevant value (referring to established needs) to a proposed solution.
3.1b Implement my own creative initiative with assistance and guidance.	3.2b Implement my own design ideas and related creative initiatives with guidance.	3.3b Implement my own creative initiative without guidance (entrepreneurship).
3.1c Identify a key feature from own design situation/idea/design brief, with guidance.	3.2c Highlight the key features of my design.	3.3c Communicate the marketability of my design addressing the market stakeholders.

Subject Focus:	**Design Aspect – Data Collection and Interpretation**
Learning Outcome 4: (Paper I and Paper II)	**At the end of the programme, I can apply research techniques to collect, record and process useful information.** ● *Research tools* ● *Testing* ● *Data collection and organisation* ** A content range referring to the following Assessment Criteria is found in Table B: Data Collection and Interpretation.*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
4.1a Identify research tools for the purpose of data collection.	4.2a Describe research tools for the purpose of data collection.	4.3a Use the appropriate research tools to collect data relevant to the situation.
4.1b Make a simple claim based on given facts. *Note: a claim refers to a statement outlining how something is expected to perform, within a design task.*	4.2b Select an appropriate test to determine the validity of a claim or prediction.	4.3b Design an appropriate test to determine the validity of a claim or prediction.
4.1c List examples of data sources.	4.2c Use adequately varied data sources for the collection of relevant data.	
4.1d Identify tools used to record and organise data.	4.2d Make use of the adequate tools to record and organise the data collected.	

Subject Focus:	**Design Aspect – Data Collection and Interpretation**
Learning Outcome 5: (Paper I and Paper II)	**At the end of the programme, I can communicate and produce relevant data.** ● *Identify information* ● *Communicate knowledge* ● *Referencing* ● *User information* ** A content range referring to the following Assessment Criteria is found in Table B: Data Collection and Interpretation.*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
	5.2a Identify specific information from a given data sheet. *E.g. Product, part and component information, tolerances, units and dimensions, etc.*	
5.1b Identify several tools to communicate data.	5.2b Use adequate tools to communicate relevant data effectively.	5.3b Use adequate tools to communicate knowledge relevant to a design activity.
5.1c Recognize references to sources used. *E.g. data sources used, intellectual property references and personal data.*	5.2c Reference knowledge sources used, ethically and correctly.	
	5.2d Identify specific product health and safety information from given sources.	5.3d Document Health and Safety data relevant to my product.
	5.2e Identify specific product 'use and maintenance' information from given sources.	5.3e Document 'use and maintenance' information relevant to my product.

Subject Focus:	Design Aspect – Critique and Evaluation
Learning Outcome 6: (Paper I and Paper II)	**At the end of the programme, I can take and evaluate design decisions critically.** ● *Product analysis* ● *Against design specifications* ● *Against testing* ● *Against design values* ● *Against the work of others and my own.* ● *Against emergent technology, strategies and values* ● *Relevant to research practice* ** A content range referring to the following Assessment Criteria is found in Table A: Broad Iterative Design Process.*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
6.1a Identify features of an existing product in terms of form and function.	6.2a Associate features of existing products to the given situation.	
	6.2b List advantages and disadvantages of design ideas when compared to specifications from the situation. *Refer to Table A.*	6.3b Evaluate a chosen solution as a complete product against its original needs and values. *Refer to Table A.*
	6.2c Communicate key test results in the evaluation of a solution.	6.3c Interpret test results in the evaluation of a solution.
	6.2d Describe some advantages of adopting recommended manufacturing strategies, in performing a practical manufacturing task, with guidance. *Refer to Table G1, G2.*	6.3d Evaluate a self-performed manufacturing process referring to suitable manufacturing strategies, broadly. *Note: Such strategies may include reference to generic Process flow, 5'S' approach methods, Scale of manufacturing, sustainability, etc.* *Refer to Table G1, G2.*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
6.1e Use resources efficiently without unnecessary waste and dispose of waste appropriately.	6.2e Reflect on the consequences of design decisions in terms of sustainability and environmental values.	6.3e Suggest further improvements on a design solution that extend the sustainability factor of the design.
	6.2f Associate a design solution with a relevant emergent technology concept example or area with guidance. *The emergent technology itself does not need to be technically described.* *Note: Emergent technology areas may include any example from the concepts and areas listed in Appendix 2.*	6.3f Discuss how an emergent technology concept could be adopted as a further improvement or extension to a design solution. *The emergent technology itself does not need to be technically described.* *Note: Emergent technology areas may include any example from the concepts and areas listed in Appendix 2.*
6.1g Give a brief account upon a completed design-and-make task.	6.2g Outline some self-development experiences gained during a design-and-make task with guidance.	6.3g Write a self-evaluation which describes the learning experience during a design-and-make task.
	6.2h Give critical feedback about ideas.	6.3h Evaluate the critical contribution of peers, stakeholders and project contributors to ideas.
		6.3i Explain the implications/importance of being ethical with regards to intellectual property, data protection and referencing knowledge sources used. *Refer to Appendix 2.*

Subject Focus:	**Technology Aspect – Materials and Making**
Learning Outcome 7: (Paper I and Paper II)	**At the end of the programme, I can show an understanding of materials and components.** ● *in terms of class, origin and type* ● *in terms of different properties* ● *in terms of representation and standard forms*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
7.1a List material name in terms of type. *Refer to Table D.*	7.2a Identify different types of materials in terms of their aesthetic properties. *Refer to Table C and Table D.*	7.3a Classify different materials in terms of their type, origin and classification. *Refer to Table C and Table D.*
7.1b Associate a given property to a material. *Refer to Table C and Table D.*	7.2b Describe properties of specific materials.	7.3b Justify the selection of a material for its application.
7.1c Identify standard forms of supply of materials. *Refer to Table C.*	7.2c Describe standard forms of supply of materials.	7.3c Justify the selection of a standard form of supply of materials based on its intended application.
7.1d Identify components in terms of their intended function and domain. *Refer to Table E.*	7.2d Describe components, product and parts (made of various components, materials, features) in terms of their intended function and data.	7.3d Justify the selection of components and parts in terms of their intended function to satisfy the required needs.
7.1e Identify components physically, graphically (symbols and diagrams), verbally and pictorially (images and photographs). *Refer to Table E.*	7.2e Describe physical features of components, graphically (sketches, symbols and diagrams), verbally and pictorially (images and/or photographs).	

Subject Focus:	Technology Aspect – Materials and Making
Learning Outcome 8: (Paper I and Paper II)	**At the end of the programme, I can show an understanding of manufacturing processes.** ● *using tools, equipment and PPEs* ● *manufacturing processes* ● *process flow* ** A content range referring to the following Assessment Criteria is found in Table F: Tools, Machinery and Equipment and Table G: Manufacturing Processes.*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
8.1a Identify different tools, machinery and equipment. *Refer to Table F.1 – F.3.*	8.2a Identify operational and safety parts of tools machinery and equipment. *Refer to Table F excluding: High Risk Tools, Machines and Equipment; Subtractive manufacturing CNC machines and Graphic CNC machines.*	
8.1b Identify different tools, machines and equipment physically and pictorially (images and photographs). *Refer to Table F.1 – F.3.*	8.2b Select the appropriate tools, machines and equipment for a specific task.	8.3b Justify the selection of the appropriate tools, machines and equipment for a specific task.
8.1c Identify different PPEs. *Refer to Table F.4.*	8.2c Associate appropriate PPEs to hazards related to the use of specific tools, machines and equipment and vice versa.	
8.1d Identify specific tools, machines and equipment with reference, their purpose, domain and/or application material where applicable. *Refer to Table F.1 – F.3.*	8.2d Describe what is the use of specific tools, machines and equipment with reference to the domain, purpose and manufacturing process these serve. *Refer to Table F.1 – F.3 and Table G.*	

Assessment Criteria (MQF 1)	Assessment Criteria (MQF 2)	Assessment Criteria (MQF 3)
8.1e Identify different manufacturing processes. *Refer to Table G.1.*	8.2e Describe different manufacturing processes. *Refer to Table G.2.* *Limited to a generic description of the process.*	8.3e Justify the selection of a manufacturing process based on required properties of an artefact in terms of material, form, finish, scale of production, and function. *Refer to Table G.*
8.1f Follow a given sequence of work required to achieve a desired outcome. *Refer to Table G.*	8.2f Organise an effective sequence of work required to achieve a desired outcome referring to suitable manufacturing processes with guidance.	8.3f Organise an effective sequence of work required to achieve a desired outcome referring to suitable manufacturing processes, independently.
8.1g Follow recommended Process Flow aspects in performing a task. *Note: Process Flow includes aspects of efficiency, planning, resources, safety procedures.* *Refer to table G.*	8.2g Communicate Process Flow aspects for a task.	8.3g Propose improvements in the Process Flow of my manufacturing task.

Subject Focus:	Technology Aspect – Materials and Making
Learning Outcome 9: (Paper I and Paper II)	**At the end of the programme, I can carry out manufacturing processes safely and responsibly within the school workshop environment to make models and artefacts that satisfy the desired outcome.** ● *Handling tools and machinery* ● *Safe workshop practice* ● *Build initial models and artefacts*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
9.1a Carry out a range of manufacturing processes, following given instructions and assistance, to achieve a desired outcome. *Refer to Table G.*	9.2a Carry out a range of manufacturing processes, following given instructions, to achieve a desired outcome. *Note: Tools, machines and equipment should always be used under supervision*.	9.3a Carry out a range of manufacturing processes appropriately, effectively and independently, to achieve a desired outcome. *Note: Tools, machines and equipment should always be used under supervision*.
9.1b Identify Health and Safety hazards and procedures within the school workshop environment. *Refer to Table F.3 / F.4 and Table G.*	9.2b Follow Health and Safety procedures within the school workshop environment, with guidance.	9.3b Apply independently Health and Safety procedures within the school workshop environment.
		9.3c Devise procedures to reduce risks and hazards associated with specific manufacturing processes within the school workshop environment.
9.1d Identify good workshop practice procedures, within the school workshop environment. *Refer to Table F.3 / F.4 and Table G.*	9.2d Follow good workshop practice procedures within the school workshop environment, with guidance.	9.3d Apply independently good workshop practice procedures, including reference to the 5 'S' Approach, within the school workshop environment.
	9.2e Build a physical or digital mock-up model representing given design information.	9.3e Devise physical or digital models to inform design decisions.
	9.2f Assemble parts to form a complete artefact as guided.	9.3f Assemble parts of a complete design solution diligently, as per own design.

Subject Focus:	Technology Aspect – Systems and Control
Learning Outcome 10: (Paper I and Paper II)	**At the end of the programme, I can show an understanding of systems and their application to achieve a desired outcome. (Mechanical, Electronic, Microcontroller systems).** ● *System representation and behaviour* ● *Component interaction* ● *Microcontrollers* ● *Logic* ** A content range referring to the following Assessment Criteria is found in Table E: Components and Table H: Systems.*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
10.1a Describe a function in terms of inputs, processes, and outputs.	10.2a Describe a system in terms of inputs, processes, and outputs.	10.3a Develop a system in terms of inputs, processes, and outputs.
10.1b Can identify different functional representations of a system (block diagrams, system diagrams, schematic diagrams, mock-up models, physical layouts).	10.2b Translate between different representations of a system.	10.3b Justify the use of functional representations for a particular scenario.
10.1c Identify a given open or closed loop system.	10.2c Explain the function of a given open or closed loop system diagram.	10.3c Develop a system in terms of block diagrams including a minimum of one feedback loop.
10.1d Associate the values, terms and where applicable, SI units related to different functions of mechanical and electronic systems.	10.2d Describe the interaction between variables of mechanical and electronic systems. *Note: Approaches might include use of mathematical formulae, functional interactions.*	10.3d Explain how specific modifications done to mechanical and electronic systems affect the solution proposed. *E.g. Modifying values, variables, and components.*
	10.2e Describe the interaction between components and/or modules/parts in a system.	10.3e Design a system at a component level to satisfy the required needs.

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
10.1f List the generic advantages and disadvantages of microcontroller systems when compared to discrete electronics.	10.2f Describe the advantages and disadvantages of microcontroller systems in a specific application.	10.3f Propose alternative solutions to satisfy the required needs considering both discrete and microcontroller system solutions.
10.1g Edit variables within a given microcontroller programme to obtain a desired outcome, with assistance. *Note: editing may be done theoretically or by using any coding option from the graphic interface (e.g. flowchart design, block design, etc).*	10.2g Program a functional microcontroller system to satisfy a required need, with assistance. *Refer to Table H.*	10.3g Design independently a functional microcontroller system to satisfy a required need.
10.1h Use a microcontroller system physically and digitally using a graphic interface software simulator with guidance. *Refer to Table H.*	10.2h Operate a microcontroller system physically and digitally using graphic interface software. *Note: This includes setting up and connecting hardware, downloading a program to a PIC effectively.*	
10.1i Identify logical conditions within a given system. *Logical conditions (E.g. AND, OR and NOT) may be achieved mechanically and electronically including microcontrollers.*	10.2i Design a system incorporating logical conditions with guidance. *Logical Conditions: AND, OR and NOT.* *Limited to two inputs.*	10.3i Communicate the logical conditions of my system visually. *Logical Conditions: AND, OR, NOT, and combinations where applicable.* *Limited to: two inputs and communicating a truth table.*

Subject Focus:	Technology Aspect – Graphics, Communication and Digitisation
Learning Outcome 11: (Paper I and Paper II)	**At the end of the programme, I can understand and apply graphic techniques to communicate, guide and facilitate manufacturing.** ● *Elements of design* ● *Annotation* ● *2D design & Orthographic* ● *3D design* ● *Surface developments* ● *Product brand identity* ● *Information graphics* ** A content range referring to the following Assessment Criteria is found in Table I: Design Graphics.*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
11.1a Identify the basic elements of design.	11.2a Apply appropriately the basic elements of design by making good use of basic geometrical lines and forms, etc., to communicate designs and conceptual sketches.	11.3a Apply elements of design to guide and facilitate manufacturing.
11.1b Label an illustration to identify its parts.	11.2b Label an illustration with annotations that highlight the design.	11.3b Explain an idea further with detailed annotations referring to manufacturing, functionality, and usability.
11.1c Identify 2D views of given 3D views and vice versa.	11.2c Draw working sketches to communicate required design information, graphically. *Refer to Table I, Section I.2 - Working sketches.*	11.3c Draw working drawings with sufficient detail to guide and facilitate manufacturing. *Refer to Table I, Section I.2 - Working Drawings.*
11.1d Draw freehand conceptual sketches of basic 3D forms. *Note: Basic 3D forms refer to right solid or shell geometric forms – prisms, cylinders, pyramids and cones.*	11.2d Draw a 3D form composed of compound forms through freehand sketching.	11.3d Design complex 3D forms using freehand sketching techniques.

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
11.1e Associate surface developments /nets with their corresponding basic 3D form.	11.2e Draw surface developments / nets of basic 3D forms.	11.3e Design surface developments as working drawings to guide the manufacturing of the design solution.
11.1f Identify aesthetic features of given designs. *Note: Aesthetic features refer to colour schemes, logos, applied graphics, fonts and applied elements of design.*	11.2f Apply aesthetic features related to the product with guidance.	11.3f Discuss features of a product identity in relation to the product or brand being developed with minimal guidance.
11.1g Identify different techniques to convey information graphically.	11.2g Apply infographics techniques to communicate information effectively with guidance.	11.3g Design infographics independently to communicate information effectively.

Subject Focus:	Technology Aspect – Graphics, Communication and Digitisation
Learning Outcome 12: (Paper I and Paper II)	**At the end of the programme, I can understand and apply digital resources to enhance design and manufacturing.** ● *Image manipulation* ● *2D Vector drawings* ● *3D modelling* ● *Digital manufacturing (CAD-CAM)* ● *Digitisation* ** A content range referring to the following Assessment Criteria is found in Table I: Design Graphics.*

Assessment Criteria (Level 1)	Assessment Criteria (Level 2)	Assessment Criteria (Level 3)
12.1a Use raster/bitmap editing software to manipulate 2D graphics.	12.2a Manipulate digitally raster/bitmap images independently.	12.3a Create digital raster/bitmap images that satisfy the needs of my product presentation.
12.1b Use 2D vector editing software to manipulate 2D vector graphics.	12.2b Manipulate new and modified vector graphics and 2D Computer Aided Design (CAD) designs to satisfy the required needs using relevant software.	12.3b Create digital vector graphics and 2D CAD designs that satisfy the needs of my design.
12.1c Use 3D (three-dimensional) modelling software to manipulate digital 3D forms.	12.2c Produce a digital 3D form as part of a required design using CAD software.	
12.1d Identify traditional and digital manufacturing technology and production scales. *Refer to Table F.1.*	12.2d Apply appropriately digital manufacturing resources to enhance design and manufacturing with assistance.	12.3d Discuss the suitability of digital manufacturing technologies for a specific task.

Scheme of Assessment

School Candidates

The assessment consists of Paper I and Paper II. Paper I consists of unmoderated school-based assessment (SBA) that is to be set and assessed by the school. Paper II consists of a controlled assessment that will take place at the end of the three-year programme.

School-based assessment (SBA): is any type of assessment of a candidate made by the school relevant to the respective SEC syllabus contributing to the final level awarded in the subject.

Controlled assessment: is comprised of a two-hour written exam set at the end of the programme and differentiated between two tiers:

a. Levels 1 and 2;
b. Levels 2 and 3.

Candidates are to satisfy the examiner in Paper I and Paper II to obtain a level higher than 1.

Paper I - School Based Assessment (30% of the total mark)

The school-based assessment shall be marked out of 100 each year (9, 10 and 11). The assessment for each year will contribute to 10% of the overall mark and will be reported to MATSEC by the school in Year 11. Therefore, each year will equally contribute to the final mark of the school-based assessment. The school-based assessment shall reflect the MATSEC syllabus covered in Year 9, Year 10 and Year 11.

School-based assessment can be pegged at either of two categories:

- SBA at categories 1-2 must identify assessment criteria from these two levels. It is suggested that ACs are weighted at a ratio of 40% at Level 1 and 60% at Level 2.
- SBA at categories 1-2-3 must identify assessment criteria from each of Levels 1, 2, and 3. It is suggested that ACs are weighted at a ratio of 30% at each of Levels 1 and 2, and 40% at Level 3.

The mark for SBA at level categories 1-2 presented for a qualification at level categories 2-3 will be calculated to 60% of the original mark. The mark stands in all other cases.

Paper II - Controlled Assessment (70% of the total mark)

Written Examination (100 marks; 2 hours)

Learning outcomes with assessment criteria related to the psychomotor domain may be assessed by asking questions in pen-and-paper format.

Controlled Assessment will:

- cover most learning outcomes including all learning outcomes which are not indicated to be covered through SBA;
- be marked out of 100 and all questions are compulsory - answers are to be written on the examination paper provided.

- Controlled Paper 1-2 will consist of:
  - Section A: 15 – 20 short non-contextual questions carrying 30 – 40 marks.
    - Non-contextual questions are direct questions which are in most cases standalone and which do not need reference to a wider design situation.
  - Section B: 8 – 15 structured contextual questions carrying 60 – 70 marks.
  - 40% of the marks allotted will be based on Assessment Criteria from MQF 1.
  - 60% of the marks allotted will be based on Assessment Criteria from MQF 2.
- Controlled Paper 2-3 will consist of:
  - Section A: 15 – 20 short non-contextual questions carrying 30 – 40 marks.
    - Non-contextual questions are direct questions which are in most cases standalone and which do not need reference to a wider design situation.
  - Section B: 8 – 15 structured contextual questions carrying 60 – 70 marks.
  - 40% of the marks allotted will be based on Assessment Criteria from MQF 2.
  - 60% of the marks allotted will be based on Assessment Criteria from MQF 3.
- will include any required relevant formulae / information on the front page.

Private Candidates

Private candidates will not be expected to carry out any school-based assessment as school candidates. Instead, private candidates need to sit for another Controlled paper as an alternative to the school-based assessment. Private candidates will be assessed through the means of **TWO** Controlled Papers, one of which is common with school candidates.

Paper I – Controlled Assessment - Private Candidates Only (30% of the total mark)

Written Examination (100 marks; 2 hours)

Paper I for private candidates shall be a controlled assessment assessing levels 1, 2 and 3 as described in the respective syllabus and set and marked by MATSEC. It shall mainly focus on the learning outcomes marked in the respective syllabi as suggested for school-based assessment.

Learning outcomes with assessment criteria related to the psychomotor domain may be assessed by asking questions in pen-and-paper format.

Controlled Assessment will:

- cover **all** learning outcomes;
- be marked out of 100 and all questions in each section are compulsory - answers are to be drawn / written on the examination paper provided.
- have two sections:
  - Section A: carries 45 – 55 marks and includes questions based on a given Situation indicated at the bottom of the list found in Appendix 3;
  - Section B: carries 45 – 55 marks and includes questions about an already developed unseen design solution not necessarily related to the situation in Section A.
  - 30% of the marks allotted will be based on Assessment Criteria from MQF 1.
  - 30% of the marks allotted will be based on Assessment Criteria from MQF 2.
  - 40% of the marks allotted will be based on Assessment Criteria from MQF 3.
- include any required relevant formulae / information on the front page.

Paper II - Controlled Assessment (70% of the total mark)

Paper II is common with school candidates.

Appendices

Appendix 1: Content Range Tables

Table A: Broad Iterative Design Process		
The instances of *Exploration, Designing, Making and Evaluating*, form the broad iterative design process which guides to develop relevant design solutions. These stages are non-sequential.		
A.1 Broad Design Stages		
Explore	**Design Situation**	Used to describe details about the problem, restrictions and identified stakeholders. Other related terms: **Theme** (a general topic/area where a situation is presented), **Context** (the general background to a given situation), **Problem** (the specific part of a situation that is given attention).
	Design Brief	Used as a broad statement that includes the general aim and scope of a project, its target users, in a marketable manner.
	Marketability	The products' ability to respond to a wider market and/or offering further benefits.
	Analysis	A detailed study about a product, problem, or solution (Product analysis, Existing solutions/ products).
	Specifications	Used as a detailed description of a design requirement, later compiled as separate summarised statements (Examples: Restrictions, budget, timeframe, facts, target users).
	Market	Both the related products already available and the different people interested in these.
	Needs and Opportunities	**Needs** refers to the requirements identified in situation as well as 'wants' which are subjective to different values **Opportunities** refers to possible further benefits of a concept.
	Further needs	Further needs and opportunities found after research.
	Design Ideas	Concepts communicated in response to a problem in a concrete way (concepts, sketches, 2D/3D sketches, reference to materials and scale, annotations, iterations; Ideas must reflect the needs identified in a task).
Design	**Design Solution**	A relevant solution based on a chosen design idea. A Final design solution refers to a chosen solution which is implemented.
	Prototyping	Refers to modelling of a design idea using mock-ups, sketching, tinkering, annotation, dimensioning, models, scenarios, simulations, concept model simulations or a prototype, which is a model that shows a partially final solution.
	Plans	Written or diagrammatic sequences of work limited to system plans, development lists, organisational plan, aesthetic design schemes, process plans, assembly plans.
	Concept Design	Broad design ideas that summarise or explore the concept limited to Mood-board, brand identity, system overviews.
	Idea feedback	Stakeholder and contributors feedback limited to peer feedback**,** client feedback, initial usability testing, target user feedback.

Make	**Design project**	Any task or combination of tasks in Design and Technology that follow/s a design process can called a design project. A mini project usually is a task with only parts of the design process, or which involves less effort than a complete project.
	Lists	Information listed to facilitate project management limited to Iteration list, Component/Material Information Sheet, detailed Cutting and Component Lists, required equipment list, and task list.
	Plans	Detailed information on the manufacturing of a solution. (E.g. sequence of manufacturing, working sketches, working drawings, part drawings, etc.)
	Making	Refers to the implementation of a project physically including, but not limited to functional models, artefacts, manufacturing procedures, finishing procedures, graphic finishing, and assembly.
	Marketing	Promotion related to a product or solution, usually including packaging, project marketing and communication.
Evaluate	**Testing**	Refers to ways to check parts of a solution or a complete product against what it was meant to do, like usability tests (how users feel when using the product), functionality tests (specific functions or parts are tested), etc.
	Evaluation	In a product evaluation: Thinking critically and writing notes about what was done, how it could be done better, how it could be developed further. In a self-evaluation: Thinking critically and writing notes about what was learned, self-confidence and experience gained. Evaluation can be written during and/or after a task is completed.
	Iterations	Leaps between progress stages, improvements, modifications done and future improvements.
	Values	Factors that guide the decisions taken in a design solution including: **Personal values**: Preferences, Likes and personal creative expression. **Financial values**: Cost, affordability. **Ethical and cultural values**: Authenticity, moral considerations, and cultural relevance. **Environmental values**: product/material environmental sustainability. **Added values** refer to consideration of further factors that affect the wider picture of a product, a brand, society, and the world on a global level.
A.2 Other Considerations		
Project/Task components	**Documentation**	All project information (data, images, progress, user manuals, leaflets, usability guides).
	Student Portfolio	Collection of design projects, tasks, and work that show the student's collated efforts.
	Design Folio	Organised document including structured project documentation showing all the stages of the project and the design solution.
	Design Proposal	Concise, visual, digital, or physical summary of project proposal. Related terms: pitch, chart, presentation, audio-visual.
	Design Solution	One possible complete answer to a design problem, including sufficient design information (written, graphical and/or prototype format) to be understood and considered for implementation.
	Prototype	One working iteration of a design solution at an advanced stage, one-off, functional model. A Prototype artefact is a physical solution.

Project Roles	**Device or Product**	A fully working product, which satisfies the project's identified needs which is a close example of a product that can be manufactured. Variations from a finished product include scale, materials, production scale and processes.
	Artefact	An item that encompasses a physical outcome which includes components and or parts that make up a solution including prototypes, devices, and products
	Presentation	Digital, Online, Charts, vivo, product, public.
	Stakeholders	May include users, clients, customers, manufacturers, management, owners, personas, interested groups.
	Project team contributors	Contributors including the designer, design team, area experts, peers, research respondents, tutors.
	Client	The entity requesting the development of the product/service or financing the project.
	Target users	The final customer or user of a product or service.

Table A - Broad Iterative Design Process

Table B: Data Collection and Interpretation		
Data Collection	**Research tools**	**Questionnaires**: Printed, online, vox-pop, polls, survey; **Interviews**: in-person, online, audio/video recording, transcript; Other terms: Peer feedback, product analysis, discussions, brainstorming, common knowledge, respondents, sample, interviewer, interviewee.
	Data sources	**Sources:** data sheets, internet, publications, literature, user manuals, patents, area experts. Other terms: online, users, peers, surveys, project proposal feedback, own test results, stakeholder input, available test results, etc.
	Testing	**Test:** a procedure that can determine if the relevant claim/prediction is valid **Claim:** a claim refers to a statement outlining how something is expected to perform, within a design task. **Validity:** of a test: refers to whether a test was fairly designed and administered of a claim: refers to whether a claim/prediction was correct **Product Usability tests:** tests carried out on a product with typical users
Communicating Data	**Recording and Organisation**	Spreadsheet, tables, database, audio-visual recordings, online and digital tools.
	Data handling	**Data Communication tools:** spreadsheets, web diagrams, mind maps, charts, audio-visual material, infographics. **Knowledge:** research material, relevant information, available and found data.
	Referencing data ethically	**Referencing to Data sources** (as per list above) reference is limited to Author, (Date) and Source. (Example: Borg. A (2021), Designing Mechanisms/website source). In case of websites refer only to date accessed and main website URL in short. (Example: Wikipedia.com, Accessed March 2021) **Referencing to Intellectual property**: acknowledging origin only (E.g. [Brand Name]) **Referencing to personal data (GDPR)**: with consent

Table B - Data Collection and Interpretation

Table C: Material Qualities	
C.1 Material Origin	
Origin	**Material Origin:** Limited to the generic term of origin as per **Table D** and a broad understanding of the generic process converting raw material to processed material: **Origin**: Mineral, Organic, Petroleum.
	Raw Material Processing: Limited to a generic understanding of the following broad stages: origin → raw material state → pre-process forms → standard forms of supply e.g. Steel: Mineral → Ore → Ingot → Hollow section
C.2 Material Properties Materials may be described and compared using the following range of properties: Note: *Such properties shall apply as general descriptors of materials and assessment is limited to knowing these terms and the way materials compare in these aspects, without the need to elicit the quantification of such properties unless given.*	
Aesthetic Properties	Colour (chromatic, hue), texture, opacity, translucency, grain, effect (print).
Physical Properties	Electrical conductivity, melting points, thermal conductivity, density & mass (relative weight), absorbency, flammability.
Mechanical Properties	Hardness, elasticity, plasticity, malleability/ductility, toughness/brittleness, environmental degradation (durability).
C.3. Material Form & Type	
Form of Supply of Materials	**Standard forms:** limited to: bar, sheet, board, pipe, tube, wire, filament, fibres, plank, rod, mouldings, extrusions, particle, powder, liquid, gel, gas, solid section, hollow section, yarn, fabric, laminate, veneer, composites. *Note: Variations like 'round' bar or 'triangular' hollow sections are expected.* **Pre-processed forms**: ingot, billet, lumber, pellet, liquid chemical.

Table C - Material Qualities

Table D: Material Range				
Type	**Origin**	**Class**	**Material name**	**Processing**
Metals	Mineral	Ferrous	Cast Iron, Carbon steels, Mild steel	Mineral → Ore → Ingot / billet / Casting/ Standard Forms (S.F.) Recycled metals → Ingot / casting/ S.F.
		Non - Ferrous	Aluminium, Copper, Gold, Lead, Zinc	
		Alloys	Stainless-steel, High-Speed Steel (HSS), Brass	
Woods	Organic	Hardwoods	Oak, Walnut, Mahogany, Teak, Tulip	Lumber → S.F.
		Softwoods	Pine, Fir, Deal	
Polymers	Petroleum	Manufactured	Plywood, Chipboard, MDF, Veneered boards, Laminated boards	Engineered → S.F.
		Thermoplastics	ABS, PET, HIPS, PVC, PMMA (Acrylic), PLA, Nylon	Chemical polymerisation→ S.F. Thermoplastics recycled → S.F.
		Thermosetting	Melamine resin, Polyester resin (as in GRP), Natural / Synthetic rubber	
Textiles	Organic	Cellulose-based-fibres	Cotton, linen	Fibres → Yarn → S.F. Recycled textiles → Fibres/ particle
		Protein-based-fibres	Wool, Silk	
		Modified Cellulose	Rayon	
	Mineral	Mineral-based-fibres	Carbon fibre, Fibreglass	
	Petroleum	Polymer-based-fibres	Nylon, Acrylic, Polyester	
Graphic	Organic	Paper	Cartridge paper, Tracing	Pulp → S.F Recycled → pulp
		Boards	Corrugated board, Cardboard, white board	
	Mixed	Laminate boards	Foam-board, Packaging laminate	Combined
Smart Materials			Shape memory alloy (SMA), Thermo-chromic ink	Engineered/ varies
Composites			GRP (Glass reinforced polymer), CFRP (Carbon Fibre Reinforced Polymer)	Engineered/ varies

Table D - Material Range

Table E: Components		
Domain	**Classification**	**Component**
Mechanical	**Cams and Followers**	Disc cams, followers (flat, roller)
	Belts and Pulleys	V-belt, flat belt, cable
	Levers	Parts of a lever: lever arm (e.g. input arm and output arm), pivot, effort and load
	Linkages	Bell crank, reverse motion, parallel motion, scissor type
	Gears and sprockets	Friction gear, crown gear, spur gear, rack and pinion gear, bevel gear, worm gear, sprocket, chain
Generic	**Structural components**	Threads and springs, struts and ties
	Fasteners	Rivets, screws, nuts and bolts, nails, hinges, knock down joints, dowels and adhesives; buttons, toggles, hook and eye, zips, press fasteners (e.g. press studs), Velcro, laces and eyelets and clips/buckles.
	Decorative components	Decals, badges, varied (e.g.: embroidery, sequins, etc.)
Electrical	**Connectors**	Wires, screw terminal connectors/blocks, plug, socket (E.g. jack, U.K. 3 pin plug).
	Resistors	Fixed, variable, potentiometers, pre-set
	Sensors	LDR, thermistor
	Capacitors	Polarized, non-polarized
	Actuators	D.C. motors; relays: NO/NC type, latching; solenoid; buzzer; siren; loudspeaker
	Switches	SPST, SPDT, DPDT, momentary (NO/NC type), tilt, latching, push, toggle, rocker, reed, rotary, micro
	Power Sources	Primary / Secondary Batteries (E.g. AA, AAA, PP3 types at typical voltages), power supplies, button cell, solar cell.
	Integrated circuits	Reference limited to generic 6, 8, 14 and 18 pin dual-in-line IC packages, notch Examples of ICs: PIC microcontroller
	Semiconductors	Diodes (biasing component), LEDs (size, colours, efficiency, package), transistors (NPN, PNP)
	Miscellaneous	Lamp, bulb, motor, RGB LED, modular LED array

Table E - Components

Table F: Tools, Machines and Equipment	
F.1 Mechanical Tools, Machines and Equipment	
Hand tools	**Hammers & mallets** **Pliers:** combination pliers, longnose pliers, nail pincers. **Saws:** back/Tenon saws, hand/panel saw, coping saw, hack saw. **Fastening:** screwdrivers, spanners, sockets, taps and dies, pop riveter. **Wasting:** files / rasps, hand planer, abrasive paper. **Cutting:** scissors, sheers, craft knife, chisels, hole-cutters, seam ripper.
Measuring & marking out tools	**Measuring:** tape measure, ruler, safety ruler, meter ruler, Vernier calliper. **Marking:** Pencil, scriber, centre punch, dividers/callipers, tri square, tailor's chalk, sliding bevel, engineer's square, centre finder.
Holding and working	**Holding devices:** G–clamp, woodworking vice, engineer's vice, jigs, machine-vice. **Work areas:** engineering bench, woodwork bench.
Power tools and machinery	**Power tools:** cordless drill, cordless screwdriver, hot air blower, dry or steam iron, orbital sander, hot glue gun, hand-held power drill. **Power machines:** pillar/bench drills, scroll saw, strip wire heater, belt/disk sanding machines, vacuum former, sewing machine.
Traditional Manufacturing	Manufacturing which involves the use of traditional tools, machines and equipment without the use of computer numeric control (e.g. all the above)
Digital Manufacturing	**Digital Manufacturing** refers to manufacturing that involves the use of **CNC** (Computer Numeric Control) equipment. **Additive manufacturing CNC Tools and Machines**: 3D Printer (E.g. FDM 3D printer machine, FDM 3D printing pens, SLA 3D printer machine) **Subtractive manufacturing CNC Machines:** (E.g. Laser cutter & Engraver; CNC milling, PCB and engraving machine) **Graphic CNC machines:** Digital plotters or Engravers (E.g. Laser cutter & Engraver, 2D cutter and plotters, Vinyl cutter, Digital printers)
F.2 Electronics Tools, Machines and Equipment	
Hand tools	Side cutter, wire stripper, track cutter, de-soldering pump
Measuring Instruments	Multi-meter (voltage, current, resistance, continuity)
Power supply	Battery pack, Power supply unit
Holding Tools	Helping hands holder, soldering iron stand
Assembly and Prototyping	Soldering iron, breadboard

F.3 Main Operational Parts of Tools, Machines and Equipment	
Input (human interface) parts	foot-press (sewing machine), lever, power switch, control panel
Process supporting parts	chuck, working surface, machine bed, needle assembly
	vacuum chamber, shaft, motor, belt/ roller, dust bag, feeders/bobbin case
Output parts	extruder head, heating element, disk, blade, twist drills, tool bits, abrasive belt/disk, operational light
Safety features and parts of equipment	emergency switch, guard/shield, insulation, covers, heat shield (e.g. cable thermal sleeves), dust extraction system, fume extraction system
F.4 General Health and Safety	
PPE	dust mask, safety goggles/specs, apron, ear plugs, safety gloves (e.g. heat resistant gloves, latex disposable gloves), safety shoes (e.g. closed toed shoes for generic safety and capped safety shoes for specific applications)
Workshop	floor markings, safety signage, fire extinguisher, first aid box, ventilation, lighting, work area space, waste disposal, hand washing sink, dust collector

Table F - Tools, Machines and Equipment

Table G: Manufacturing Processes	
G.1 Manufacturing Strategies	
Process flow	**Process Flow** refers to optimisation of a manufacturing process. Aspects of process flow to consider are: (Limited to understanding the terms and describing the concept not eliciting of the terms shown in italics). *Efficiency*: Includes consideration of time, quality, relative cost, use of resources *Planning*: includes Identifying key processes and putting them into a logical sequence. *Safety procedures*: include the consideration of H&S requirements specific/relevant to the process considering PPE and workshop equipment.
Scales of production	**One-off production:** production of custom work in very small quantities. (e.g. custom furniture) **Batch production:** manufacturing products in small groups where each group is different from the others (e.g. baking a batch of a type of pastry) **JIT (just-in-time) production:** an approach to manufacturing where the batch is produced just when an order has been done, which reduces time, resources used and limit the amount of inventory as well as enables more customisation. **Mass production:** manufacturing identical products in large quantities (e.g. mobile phones) **Continuous production**: a type of production where material is continuously in motion
5 'S' Approach	The **5 'S' approach** is followed by manufacturing workshops to promote a good and safe work environment. **Sort:** keep only the necessary items **Set in order:** arrange items such as materials and tools in an efficient manner **Shine:** clean the work area/workshop/class so it is clean and tidy **Standardise:** set standards/criteria for a consistently organised workshop/class **Sustain:** maintain and review standards and criteria
Sustainability 3Rs	These **3Rs** are the essential concept for sustainable manufacturing. Further terms are explored later as additional points for discussion in Appendix 2. **Reduce:** A process where less material is used or needed. (E.g. choosing to use things with care to reduce the amount of waste generated, finding new ways to use less material) **Reuse:** A process where a product is given new use after it is not needed for its intended purpose. (E.g. tyres can become furniture, used car parts sold) **Recycle:** A process where a particular material is isolated, and processed again into new 'recycled' material, or as an additive to raw material (E.g. PET plastic bottles are shredded, to make new PET products).

G.2 Manufacturing Processes	
Category	**Processes**
Wasting	Drilling, sawing, filing, sanding, machining - threading, tapping, engraving.
Deforming	Thermoforming: vacuum forming, line bending, steam (textiles); laminating, metal jigs, hand modelling, stamping.
Cutting	Shearing: using scissors, shears, craft knives.
Joining and assembly	Heat joining: soldering Mechanical joining: butt joint, lap joint, mitre joint, dowel joint, dovetail joint Fabric joining: plain seam, French seam Chemical joining: using adhesives
Finishing	Galvanising, painting, varnishing, polishing / buffing, plastic coating, hems, oiling, stencilling, decal application and block printing.
Rapid prototyping	CAD-CAM (Computer Aided Design for Computer Aided Manufacturing) including: CNC additive manufacturing - 3D Printing CNC subtractive manufacturing (E.g. Laser engraving & cutting and PCB engraving) CNC Plotting (E.g. Vinyl cutting, plotting and digital printing)
Treatments	Heat Treatment (E.g. Annealing, hardening) Chemical Treatment (E.g. Fabrics Water proofing, flame proofing)
Shaping Fibres	Spinning, weaving (plain twill), knitting, bonding; Pleating (e.g. fabrics), creasing and scoring (e.g. card, paper)

Table G - Manufacturing Processes

<table>
<tr><th colspan="3">Table H: Systems</th></tr>
<tr><th colspan="3">H.1 Mechanical Systems</th></tr>
<tr><th>Subsystem</th><th>Type</th><th>Variables & Formulae</th></tr>
<tr><td>Generic</td><td>Motion: rotary, linear, reciprocating, oscillating</td><td>Communication: use of arrows
Type: Simple / Complex mechanism
Velocity: RPM, stationery, constant speed</td></tr>
<tr><td>Cams and followers</td><td>Cams: Disc
Followers: Flat and roller</td><td>Terms: Rise, fall, cycle, dwell (pause)</td></tr>
<tr><td>Levers</td><td>Class 1,2,3 levers</td><td rowspan="3">Labelling: Fulcrum, load, effort, driver, driven, input, output, Anti/clockwise, fixed pivot, moving pivot, slider

Mechanical advantage: Calculations:

In terms of Force (F): $\frac{Output\ Force}{Input\ Force}$

In terms of Length (D): $\frac{Input\ Arm\ Length}{Output\ Arm\ Length}$

Velocity ratio (e.g. gear ratio): Calculation:

General: $\frac{Effort\ (Length)}{Load\ (Length)}$

Calculation for gears/sprockets in terms of Teeth/Diameter(d): $\frac{Driver\ (Teeth/d)}{Driven\ (Teeth/d)}$

Moments: Force x Distance (Fd)

Equilibrium: Fd = Fd

Law of Moments:

Total Clockwise moments = Total Anticlockwise moment</td></tr>
<tr><td>Linkage</td><td>Linkages: bell crank, reverse motion, parallel motion,</td></tr>
<tr><td>Pulleys and Belts</td><td>Belts: v-belt, flat, cable</td></tr>
<tr><td>Gears, Chains and sprockets</td><td>Status: driver, driven, idler
Types:
Gears: Friction gear, crown gear, spur gear, rack and pinion gear, bevel gear, worm gear
Sprockets: Simple
Chains: Simple

Gear Assembly: Simple gear train, compound gear train (including different types of gears)</td></tr>
<tr><td>Structural</td><td>Mass structure
Frame structure
Shell structure
Natural structure</td><td>Mass: e.g. solid block, counterweight
Frame: e.g. beams, struts, ties
Shell: e.g. vacuum formed shell
Natural: e.g. seashell, organic forms
Mechanical properties: tensile forces, compression forces</td></tr>
</table>

H.2 Electronic Systems		
Subsystem	**Type (Application areas)**	**Terms, Variables & Formulae (Required as working proof)**
Connections, and conductivity	**Switch states** **Electrical connections**	Closed (connection) switch - ON Open (connection) switch- OFF Normally open (NO), Normally closed (NC) Electrical conductivity, continuity, short-circuit, dry joint.
Voltage **Current** **Capacitance** **Resistance**	**Voltage and current in series** **Voltage and current in parallel** **A.C./D.C. Power** **Resistors in series/ parallel** **Potential divider** **Resistor colour code**	**Units:** Resistance: R/Ω; Voltage: V/V; Current: I/A; Capacitance: C/F; Frequency: F/Hz. **Laws:** Ohm's Law *Standards: British Standard (B.S.)* **Resistor colour coding**: B.S. **Voltage control**: potential divider **Formulae:** Ohm's law: **V=IR** Power: **P=IV** Total Voltage: $\mathbf{V_T}$ R in series: $\mathbf{R_t=R_1+R_2+R_3}$ R in parallel: $\frac{1}{Rt} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$ Potential divider: $V_{out} = V_{in}\left(\frac{R2}{R1+R2}\right)$
Timing & Sensing	**Timing circuits** **Sensing circuits**	Timing state: high (ON), low (OFF) Pulse, multiple pulses Frequency *Type*: light and temperature sensing circuits *Through PIC:* system design. *Refer to H.3*
Logic concepts	E.g. Logic, logical conditions **Logic gates:** AND OR NOT (Through PIC)	Truth table: limited to two inputs Through PIC: System design. *Refer to H.3*
PIC microcontroller	**PIC microcontroller Systems**	System design. *Refer to H.3* Suggested Hardware: E.g. PICAXE® Suggested Software: E.g. PICAXE Editor®
H.3 Generic System Design		
System	Simple system Closed loop system Open loop system	**System Part function**: Input, Process, Output, feedback **Type:** Open and Closed loop system **Representation:** *Use of arrows, connectors, block diagrams, flowcharts* *Power/Effort block (shown as block with arrow)* *Branching: using labelled connectors*

Table H - Systems

Table I: Design Graphics	
I.1 Elements of Design	
Line	Centre, hidden detail, folding line, construction, bold, contour, outlines, border.
Shape	Geometric, organic, dynamic, cross-section, pattern, scale, 2D shapes.
Form	Solid, shell, geometric, organic.
Colour	Colour Categories (Primary, Intermediate, Complementary), Colour Harmonies (warm colours, cool colours, monochromatic), Colour variables (Hue, Saturation, lightness, vibrancy)
Space	Interior, exterior, focal point, proportion, patterns.
Texture	**In illustrations**: shade, shadow, matt, gloss, shiny, transparent. **In real products**: grainy, rough, smooth, sleek, translucent
I.2 Graphic representations	
General	**2D:** 2-dimensional **3D:** 3-dimensional **Pictorial:** drawings that show a 3D view of an item **Orthographic:** drawings that represent a 3D object shown in a parallel view from pre-defined viewing angles. E.g. Front elevation, End elevation and Plan view
Annotations	Design annotations are an added layer of information to design ideas and include dimensions, materials, components, physical properties, finishes as well as other relevant remarks or evaluations.
Construction	Using lines, arcs and shapes for part design and marking on material.
Parts	Part drawing (2D) and part list (part name, material, quantity, and relevant processes involved)
Conceptual Sketches	**General**: 2D and 3D Freehand sketching, Block diagrams (system design), concept design, mood boards (collage of sketches and research ideas) **Mechanical systems**: conceptual system sketch. **Electronic Systems**: conceptual layout diagram (sketch or simple circuit simulation). Note: freehand sketches may be drawn using grids and other drawing aids.
Working Sketches	2D drawings, individual Orthographic views, Assembly drawings, 3D drawings (pictorial drawings), sectional views, compound surface developments. (Achieved through freehand sketching, use of drawing aids or digital sketching) **Component level design**- draft circuits layouts (photo/simulation of prototyping 'breadboard')/ mechanical layouts (mock-up/ model), flow charts.
Working Drawings	Connected Orthographic views (Use 3rd angle or 1st angle, but in controlled assessment only 3rd angle will be presented), scale drawings, 2D part drawing, regular geometric surface developments. (Achieved through draughting and/or use of drawing aids or CAD) detailed circuit layout design (strip board/PCB design)
Infographics	**Infographic charts:** bar charts, pie charts, Gantt charts, flow charts. **Organisational diagrams**: mind maps, web diagrams, system diagrams. **Infographic signs:** safety signs: corporate graphics: logos, emblems.

I.3 CAD-CAM and Digitisation (All terms are examinable however examples are elective to available resources)	
Image Editing and CAD-CAM Packages	**Image and Vector editing:** Manipulation of images and vector graphics (for images: open, scale, save, picture attributes, filters; for vector: open, save, manipulation of dimensions, lines, surfaces, 2D adding, intersecting and subtracting shapes) using relevant software. **CAD: Computer Aided Design -** Manipulation of 2D digital designs like 2D part drawings and draughting (e.g. view, scale, extrude, basic edge, face and vertex manipulation, line type) using relevant software. Manipulation of digital 3D designs (familiarity with general commands in such user interfaces to view, edit and save relevant files.) Using software and production of 3D form. **CAM: Computer Aided Manufacturing:** equipment E.g. rapid prototyping equipment, CNC equipment (refer to CNC Equipment in Table F).
Digitisation	**Media types:** Images, illustrations, documents, audio, and video **Input devices:** Scanners, digital cameras, and smart devices.

Table I - Design Graphics

Appendix 2: Suggested information about Emergent Technology, Strategies and Values

Table 1: Emergent Technology Areas and Concepts	
Area	**Concepts**
Emergent Resources Concerns	Emergent **Energy** issues: Awareness of: Emergent battery technology, hybrid devices, alternative energy applications. Emergent **Materials** issues: Further discussion regarding any materials from Table D and beyond, new smart materials (e.g. magnetically controlled fluids, nanotechnology). Emergent **Production** issues: Avoiding unsustainable product issues like disposable, single-use plastics, non- standard parts (e.g. mobile chargers), non-recyclable components.
Emergent Communication Technology	Awareness of new and emergent communication technology as possible innovative ways to suggest the development of further solutions. (E.g. **AI** (Artificial Intelligence), **IOT** (Internet of Things), **AR** (Augmented reality), **VR** (Virtual Reality), **Bluetooth®** wireless connectivity)
Emergent Industry Concepts	**Maker movement**: community maker spaces may lead to more people innovating or repairing products. **Industrial processes:** reforming: e.g. injection moulding, blow moulding, extrusion; machining: e.g. lathe turning, milling; permanent joining: e.g. brazing, welding. **Industry 4.0:** a commercial model where production is becoming more customised. **Digital manufacturing:** CAD-CAM is replacing how people manufacture things, now also at home where customers have access to such equipment. **Crowdfunding:** a product may be sold before its produced using crowdfunding to back manufacturing. **Design/Innovation driven products:** refer to exceptional designers or innovators that have changed completely a product, for example: Apple iPhone®, Dyson Cyclone® vacuum, etc. **Technological Disruption:** for instance, Netflix® changed TV/home video entertainment.
Automation	**Robotics:** the application of technology to automate or animate a device. **Home automation:** emergent application of IOT and electronics for domestic use; e.g. Alexa® Smart Controller for home lights and devices. **CAD-CAM:** digital manufacturing leading to a shift in manufacturing scales towards a maker movement and customisation (Industry 4.0); e.g. use of 3D printers, new 3D printing devices combining CNC with lights, embedded electronics (e.g. Shapelamp®), etc.
Emergent Educational Concepts	**Design thinking:** A way of solving problems involving a creative design process that considers users, technology, and values. **Computational thinking** (adopting a logical sequence of steps). **S.T.E.M.** (Science, Technology, Engineering, Mathematics) is a multi-disciplinary line of study and work that D&T education explores and may lead to. When studying D&T, the 4 STEM areas are explored in a practical way along with a design thinking approach.

Table 2: Emergent Strategies and Values *(Intended as a guide for further critical discussion only)*	
Emergent Sustainable Material Strategies	'**6Rs**': Rethink, Refuse, Reduce, Reuse, Recycle, and Repair Key terms: product life cycle, carbon footprint, material separation, waste reduction, recyclability, global warming.
Emergent Design Strategies	Design thinking, creative problem solving, User centred design.
Emergent Design and Technology Values	**Personal:** E.g. Cost, fit-for-purpose, accessibility, usability, time, Health and Safety. **Manufacturing:** E.g. Cost, timescale, purpose, material used, manufacturing capabilities. **Society:** E.g. Employment and unemployment, unethical employment, exploitation, circular economy, new working scenarios (apprenticeships, internship, remote working), fair trade, new economic modes (crowdfunding, peer to peer). **Environmental**: E.g. Natural resource exploitation, sustainability, global warming, carbon footprint (resources and transportation), waste. **Educational**: Learning, self-development, employability, STEM. **Other Values:** E.g. moral, ethical, financial, brand values.

Appendix 3: Situations (to be used in Private Candidate's paper – Section A)

1. Outdoor festive activities like (Christmas villages, village feasts and funfairs, etc) bring with them commercial activities like kiosks selling a variety of products. Electrical/mechanical display devices that are fun to interact with attract more customers, especially kids and families.

2. Retail and community spaces such as shops, restaurants, play areas, libraries, swimming pools, etc. need to maintain a proper level of hygiene and disinfection for visitors to feel safe and reassured during their visit. To achieve this, these spaces follow procedures which reduce the spread of harmful germs and disease. However, children may encounter difficulties to understand and follow such procedures.

3. Many people living in local urban towns and cities have limited space in their homes. This might discourage the uptake of hobbies, which are important for an individual's wellbeing. A new trend sees consumers highly interested in Do-It-Yourself (DIY) hobbies. Storage and organisation products, which include electronic functions and are easy to store and use, might be attractive products for such consumers.

4. Throughout the years, Local Councils organised several environmental awareness campaigns to continue raising awareness and target sustainability concepts in public spaces and events, in new ways, through interaction and play. Playful interactive devices including mechanical and electronic aspects attracts more people.

5. **Enjoying outdoor activities is part of our lifestyle. Many people enjoy outdoor cooking, camping, physical activities, boating, etc. Outdoor activities may require the completion of a series of tasks. Such tasks can be simple for some and problematic for others, especially for people who have physical difficulties. Overcoming these difficulties enable such tasks to be more accessible for more people who can independently enjoy their lifestyle. Devices can be developed to offer solutions to several users.**

6. Businesses such as pet/fish shops, boarding kennels, etc., have an added struggle to ensure that their living hosts are well cared for, while maximising their commercial activity. Suitable devices can be used to manage and care for a commercial quantity of animals in a small-scale business.

7. Flora and fauna enhance the people's experience when visiting local open spaces such as natural parks, public gardens, and other recreational areas. A local campaign is encouraging young designers to propose ideas that will help to attract and sustain wild fauna to these open spaces. A sustainable standalone working prototype that could be suitable for such public open spaces and does not need constant human intervention and maintenance could be developed for a chosen specific local environment.

8. Throughout the ages, human beings have developed particular interactions with animals. Some of these interactions include humans adopting animals to assist with particular jobs and activities (e.g. petting farms, agriculture, transportation, sport, etc.) or domestic companionship (pets). Improving the animals' conditions leads to a better human-animal interaction. Physical products can useful to improve or enhance the experience for all those involved.

9. Every house presents various challenges to keep it clean, welcoming, safe, and secure for all. Domestic accidents, faults, climatic conditions as well as security issues, can drastically affect the lifestyle of some members of a household. An innovative working prototype of a system that can make a home safer and/or more secure for its family members can be created following thorough exploration of possible hazards, threats and needs of the particular members in a house.

10. Some elderly people (aged 65+) find it difficult to carry out physical activities for different reasons. Few might lack motivation, others might have some type of physical limitations, or simply cannot find the right activity. Relating physical wellbeing with memories of childhood (when they were 3-12 years) might encourage such elderly people to start exercising. An innovative device can be created to encourage people to engage in adequate physical activity through nostalgia.

Situation for Private Candidates Controlled Assessment Paper I Section A is: **Situation 5.**