

## **TECHNOLOGICAL STUDIES**

### **AIMS**

The aims of the syllabus are:

1. to develop technological competence through three integrated learning areas, namely (a) technological knowledge, (b) technological process and (c) technology context.
2. to enable candidates to participate fully in the technological society and economy in which they will live and work.
3. to enable and empower candidates with the know-how they will need to make proper choices about technology, and to be technological users and developers in future society.

### **OBJECTIVES**

The objectives of the examination are to test the candidates' abilities as follows:

1. to acquire knowledge of the principles and processes of technology;
2. to investigate, understand and use technological products, systems, and environments that have been developed in their society;
3. to understand and communicate technological ideas using various media;
4. to identify and explore needs which may be met through technological activities;
5. to think creatively and laterally and be willing to evaluate divergent ideas to develop design proposals;
6. to design their own technological solutions;
7. to develop and apply information skills through gathering and analyzing information, retrieve and process information from a wide range of sources;
8. to choose and use materials, tools, and equipment safely for realizing the solutions;
9. to manage the resources within the constraints of time, materials and environment to produce technological outcomes;
10. to work to agreed specifications and quality standards;
11. to evaluate their own choice of technological solutions and consider improvement of ideas;
12. to realize the inter-relationship between technology and society and the history of the development of technology;
13. to recognize the contemporary use and development of technology in community, business, and industry.

### **THE EXAMINATION**

The examination will consist of two papers.

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**Paper 1 Written Paper (2 ¼ hours) (70%)**

This paper will examine candidates' ability to understand the application of technology in solving various technology-based problems in the following areas:

- (a) technological knowledge;
- (b) technological process;
- (c) technology context.

This paper will contain six questions. Candidates will be required to answer four questions, each carrying 25 marks.

**Paper 2 Design and Make (30 –35 hours workshop time) (30%)**

This paper will examine candidates' ability to solve technology-based problems over a given period of time.

The project will involve candidates in investigating a given problem; identifying salient features; providing a solution to the problem by considering possible alternatives; selecting an appropriate solution; and planning, developing and realizing the chosen solution including the making of models or mock-ups. A multi-material approach is encouraged.

Candidates will be required to submit the project along with a portfolio. The portfolio should show the development of the chosen project; i.e. research, investigation and analysis of alternative design solutions, making processes, working drawings, testing and evaluation.

A list of projects will be given to candidates in the summer prior to the year of examination. Each candidate should attempt one project only.

**THE SYLLABUS**

***Section (A) Technological Knowledge***

<i>Topics</i>	<i>Explanatory Notes</i>
<b>1. Materials and Processing Technology</b>	
1.1 Materials Technology	Understand the nature, properties and enhancement of materials and be able to use suitable materials under appropriate conditions.
1.1.1 Nature of Materials	Distinguish between naturally-occurring and man-made materials.

*Topics*

*Explanatory Notes*

	<p>Classify materials into types : metals, woods, plastics, concrete and composites. Understand the terminology relating to the materials.</p>
1.1.2 Common Materials	<p>List the common materials of different types and identify their uses :</p> <p>Metals :</p> <ul style="list-style-type: none"><li>- Explain in simple terms the differences between ferrous and non-ferrous metals.</li></ul> <p>Woods :</p> <ul style="list-style-type: none"><li>- Outline the main differences between hardwoods and softwoods.</li></ul> <p>Plastics :</p> <ul style="list-style-type: none"><li>- Explain in simple terms the difference in behaviour of thermoplastic, thermoset and elastomer materials.</li></ul> <p>Concrete:</p> <ul style="list-style-type: none"><li>- List the constituents of concrete and outline the reasons for the predominant position of concrete as a building materials.</li></ul> <p>Composites:</p> <ul style="list-style-type: none"><li>- Distinguish between layer composites (e.g. Formica), fibre composites (e.g. GRP) and particle composites (e.g. Concrete).</li><li>- Appreciate the use of a range of composites in daily use.</li></ul>
1.1.3 Properties of Materials	<p>State the meaning of the physical, chemical, mechanical and machining properties of the materials and the applications of commonly used materials.</p> <p>Distinguish the meaning of the following mechanical properties: tensile strength, compressive strength, hardness, ductility, toughness and stiffness.</p> <p>State the meaning of corrosion resistance and common protective methods used to prevent corrosion.</p>

*Topics*

*Explanatory Notes*

	Describe and perform simple tests for hardness, tensile strength, stiffness and toughness.
	Distinguish between elastic and plastic deformation.
	Understand the effects of environmental conditions on the degradation of materials and select appropriate materials to suit different environmental conditions.
1.1.4 Enhancement of Materials	Identify the needs of enhancement of materials. Metal : <ul style="list-style-type: none"><li>– Describe the methods and effect of work-hardening.</li><li>– Describe the methods and purposes of heat-treatment for materials commonly found in school workshops.</li><li>– Understand that an alloy is a metallic mixture and/or compound of two or more elements.</li><li>– Give examples of alloying to improve properties of strength, hardness and resistance to corrosion.</li></ul>
1.2 Materials Processing Technology	Use appropriate processing methods on a range of materials in a safe and correct manner for production of quality products and systems.
1.2.1 Material-forming	Bending, pressing, rolling, moulding, casting, lamination of materials.
1.2.2 Material-removal	Cutting with common hand tools. Machining, including lathe turning, drilling, sawing, milling and grinding.
1.2.3 Material-joining	Permanent <ul style="list-style-type: none"><li>– welding (electrical, gas), soldering (soft, hard) riveting, seaming, and adhering (different types of adhesives)</li></ul> Semi-permanent <ul style="list-style-type: none"><li>– fastenings and knock-down fixtures</li></ul>

<i>Topics</i>	<i>Explanatory Notes</i>
1.2.4 Surface-finishing	<p>Surface preparation</p> <p>Coating - electroplating, dipping, painting, plastic-coating, using wax and protective films, veneering, and enamelling</p> <p>Polishing and buffing</p>
1.2.5 Selection of Materials Processing Methods	<p>Select appropriate hand tools, machines, and equipment for use with a variety of materials and a range of technological components in a safe and correct manner.</p> <p>Select appropriate methods of joining materials or assembling components.</p> <p>Select appropriate surface-finishing methods for aesthetic purposes, to prevent corrosion and to prolong working life.</p>
1.2.6 Introduction to Modern Production Technology	Understand the applications of modern production technology
1.2.7 Introduction to Manufacturing Methods	Understand the use of templates, jigs and fixtures for batch production.

***Note :*** *Candidates are not required to have practical experience of ALL of the above materials-processing methods. However, practical experience will be acquired through the realization of projects based on the provision of facilities available in the school workshop.*

## **2. Mechanisms and Structures**

2.1 Mechanisms	Understand and apply the concepts and knowledge of mechanisms in designing, making and control of systems.
2.1.1 Concept of machines	<p>Understand the general concept of :</p> <ul style="list-style-type: none"> <li>– load, effort, mechanical advantage (M.A.), velocity ratio (V.R.), work done, and efficiency</li> </ul>
2.1.2 Types of Motion	Classify a given motion into one of the following types :

<i>Topics</i>	<i>Explanatory Notes</i>
	<ul style="list-style-type: none"> <li>– rotary, oscillatory, reciprocatory, and linear</li> </ul>
2.1.3 Application of Mechanical Components	<p>Understand and use common mechanical components to convert and control motion :</p> <ul style="list-style-type: none"> <li>– drive systems and rotating shafts, belts and pulleys, chains and sprockets, gears, screw mechanisms, lever and linkage, cam and follower, crank/slider mechanism, rack and pinion, ratchets and pawl, brakes, clutches, and bearings.</li> </ul> <p>(Simple calculation will be required for levers, gears and pulleys)</p>
2.2 Structures	<p>Understand the nature of forces and design appropriate structures in a system.</p>
2.2.1 Nature of Forces and Types of Loads	<p>Understand the nature of forces and different types of loads acting on structures :</p> <ul style="list-style-type: none"> <li>– compression, tension, bending, torsion, shearing</li> </ul>
2.2.2 Direction of Forces and State of Equilibrium	<p>Understand the concept of vectors, resultant forces and moments.</p> <p>Understand the elements of a structure in a state of equilibrium as a result of the action of coplanar concurrent forces.</p>
2.2.3 Materials and Cross-section of Structures	<p>Understand the effect of materials and their cross-section on the result of structures.</p>
2.2.4 Structural Forms	<p>Understand the properties of a structure in terms of limiting deformation, stability and strength.</p> <p>Classify and identify various types of structures :</p> <ul style="list-style-type: none"> <li>– arch, frame, beam and box</li> </ul>

<i>Topics</i>	<i>Explanatory Notes</i>
2.2.5 Joints in a Structure	Identify different types of joints and their applications : – permanent, semi-permanent and movable
2.2.6 Simple Structural Design	Understand the structural design of a mechanism under load and describe how forces being transferred in a mechanism create stress.  Explain the meaning of safety factor in structural design and the issue on costing.  Select the appropriate fabrication methods and reinforcement of structures.
2.2.7 Testing of Structures	Perform and design simple tests to identify loading, strength and stability of a structure.  Use equipment such as dial gauge indicator to measure the deflection of simple structures.
<b>3. Systems, Control and Automation Technology</b>	
3.1 Various Forms of System	Understand that systems can take various forms: mechanical, electronic, pneumatic, and computing as well as their principles of operation.
3.2 Types of Control Systems	Analyze control systems to identify input, process and output elements and feedback. Understand the concept of two types of systems: – open loop system – closed loop system  Distinguish between manual and automatic control systems.

*Topics*

*Explanatory Notes*

		The application of control system in domestic and industrial contexts. (e.g. washing machine, intruder alarm, air-conditioner and automatic ticketing machine)
3.3	Simple Systems Design	<p>Analysis of simple system-designs by using block diagrams.</p> <p>Design simple systems to meet specified problems.</p>
3.4	Electronic Systems & Control	<p>Understand the advantages and limitations of using electronic systems.</p> <p>Understand the use of LEDs as indicators, capacitors in timing circuit, relays as interface devices and ICs as processors.</p> <p>Understand the building-blocks / modules of electronic systems :</p> <p>Input sub-systems :</p> <ul style="list-style-type: none"><li>– switch, light sensor, temperature sensor and pulse generator</li></ul> <p>Processing sub-systems :</p> <ul style="list-style-type: none"><li>– logic gates (AND, OR, NOT, NAND, NOR)</li></ul> <p>Output sub-systems :</p> <ul style="list-style-type: none"><li>– LED indicator, relay, bulb, motor, solenoid, buzzer and loudspeaker unit</li></ul>
3.5	Pneumatic Systems & Control	<p>Understand the advantages and limitations of using pneumatic systems.</p> <p>Understand the functions of common components in a pneumatic system.</p> <p>Construct simple pneumatic systems involving pneumatic valves and cylinders (limited to two, three and five port valves, single and double acting cylinders), and exercise control of motion in terms of magnitude, speed, time delay and sequence by using pneumatic systems.</p>



<i>Topics</i>	<i>Explanatory Notes</i>
	Understand and use simple pneumatic circuit diagrams and recognize the related symbols used to solve pneumatic control problems.
	Describe and illustrate examples of the use of pneumatics in industry and in everyday life.
3.6 Introduction to Computer Control System	<p>Explain the advantages and limitations of a computer-control system.</p> <p>Use flow-charts to assist in the design of a simple control program.</p>
3.7 Introduction to Computer-aided Manufacturing (CAM)	<p>Explain the advantages and limitations of CNC machines.</p> <p>Understand the use of CNC machines in industry.</p> <p>Understand the principles of a CNC lathe using common ISO codes to control the simple turning operations for material removal.</p> <p>Use of application software to control the CNC lathe to produce simple workpieces with the correct choice of cutting tools, cutting speed, feeding rate and coolants.</p>
3.8 Introduction to Robotics	<p>Understand the use of robots in industry and the basic concepts of robotics.</p> <p>Describe different types of robots grouped by their movements and functions (e.g. robots for materials-handling and welding functions in mass-production systems).</p> <p>Explain the advantages and limitations of robots.</p>

<i>Topics</i>	<i>Explanatory Notes</i>
3.9 Safety Measures and Precautions	Describe the safety measures and precautions associated with construction of the electronic, pneumatic, computer and robotic control systems and with the equipment used in the construction.
 <b>4. Products and Applications</b>	
4.1 Analysis of Products or Systems	<p>Understand the basic concepts of product-design for manufactured products or systems.</p> <p>Investigate and analyze the functions and application of simple manufactured products or systems in domestic, leisure, business and industrial contexts. (e.g. hair dryers, vacuum cleaners, electric irons)</p> <p>Investigate and analyze the materials and processes used to produce such products or systems.</p> <p>Appreciate the basic scientific principles and technologies involved in such products or systems.</p> <p>Appreciate and appraise the quality of such products or systems including the choice of resources, aesthetics, ergonomics, assembling procedures, structures, control devices and fitness for purposes.</p> <p>Be aware of the impact of the products or systems in various areas, economic, environmental and human.</p>
4.2 Evaluation and Modification of Products or Systems	Evaluate manufactured products or systems and produce creative ideas for improvement in the light of an analysis of the products or systems and a knowledge of new developments or considerations.

*Topics*

*Explanatory Notes*

Conduct case studies for simple product-design or systems and produce modified solutions in such cases by means of design sketches or mock-ups.

**5. Information and Telecommunications Technology**

5.1 Information-processing

Introduce the use of computer software packages to process data including texts, numerals, and graphics and to present information using multi-media methods.

Use of multi-media for presentations and problem-solving.

5.2 Architecture of Information Systems

Explain the functions of the essential physical architecture of information systems including major components such as the CPU, RAM, ROM, I/O ports, visual display unit, input units, and other peripheral devices.

Understand various types of computer systems and their application from stand-alone computers and workstations to mainframe computer systems.

Understand the basic concepts of operations systems and the roles of applications software.

5.3 Basic Networking Technology

Understand the needs of data communication.

Understand types of networking technology including LAN, WAN and superhighway.

Understand common network components such as modems, hubs and routers.

Understand applications of the networking technology in modern society such as the Internet.

<i>Topics</i>	<i>Explanatory Notes</i>
5.4 Tele-communication Technology	<p>Understand common means of communications such as wire cable, optic-fibre cable, wireless signals and satellites.</p> <p>Understand the basic principles and uses of the public telephone networks, electronic mail, mobile phones and video conferencing for telecommunications purposes.</p>

***Section (B) Technological Process***

<i>Topics</i>	<i>Explanatory Notes</i>
1.1 Designing	<p>Identify needs, carry out systematic investigations and propose ideas to solve technological problems.</p> <p>Draw from experience and previous knowledge when designing.</p> <p>Develop proposed solutions in stages and critically analyze various factors including technological, economic, social and ergonomic factors before drawing up their final solutions.</p> <p>Generate, explore and develop a range of ideas for alternative solutions employing various appropriate design methods as appropriate.</p> <p>Consider ergonomic factors and carry out anthropometric measurements when designing products.</p>
1.2 Making	<p>Plan and organize resources and processes for making the products or models of proposed solutions.</p> <p>Conduct research and exercise decision making skills in selecting the appropriate processes, instruments and materials to be used for the making processes.</p>

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*Explanatory Notes*

1.3 Communication

Test and evaluate the quality of production of the system, products or environments against various essential factors.

Aware of safety measures and precautions required for making the products.

Communicate and present information and design ideas in an integrated and coherent manner.

Recognize and use relevant symbolic notation to represent technical devices or design ideas using internationally-accepted symbols.

Apply graphic-design skills to produce pictorial drawings.

Apply technical graphic skills to produce technical drawings of the products.

Use basic information-technology tools such as computer-aided design software to present design ideas.

***Section (C) Technology Context***

*Topics*

*Explanatory Notes*

1.1 Technology Development

Recognize the trend of development of technology in the past, present and future.

Be aware of the changes in design considerations in light of technology development.

1.2 Technology and Society

Recognize the relationships between technology and society.

Realize the contemporary use of technology in business and industry.

*Topics*

*Explanatory Notes*

Critically evaluate the impact of modern technology on society and in our daily life in terms of personal, social, economic aspects.

Be aware of health and safety issues related to technological development.

Recognize the need for environmental protection and pay attention to the environmental issues when designing and making.