DESIGN AND TECHNOLOGY

AIMS

The aims of the syllabus are to foster and develop pupils' creative, intellectual, and technical abilities through the use of materials and the application of technological knowledge; the technological design process being seen as central to such development.

OBJECTIVES

The objectives of the examination are to evaluate candidates'

(i) understanding of the basic properties of materials through analysis and exploration,
(ii) understanding of the basic elements of design,
(iii) ability in the utilization of scientific knowledge through the technological design process,
(iv) awareness of technology through analytical, critical and historical studies,
(v) ability in problem-solving design activities,
(vi) craftsmanship through the realization of project work,
(vii) ability in the employment of communication techniques as an integral part of the technological design process,
(viii) senses of social being and community spirit through technological design studies.

THE EXAMINATION

The examination will consist of three papers. Each paper carries equal marks.

Paper 1 Design (2 hours)

This paper is concerning with graphic solutions to set design problems. The paper will consist of four questions. Question ONE will be compulsory and candidates should answer two questions from the remaining three.

Question ONE will examine candidates' abilities to solve a set problem based on the application of appropriate construction methods and techniques. Given a set brief the candidate will be expected to:

(i) analyse the brief to formulate design specifications or criteria upon which the ultimate solution will be based.
(ii) from (i) propose solutions in the form of sketches and notes to show the development of ideas.
(iii) give reasons for choice of the final design and elaborate in greater detail in the form of sketches, notes and orthographic drawings.

The other four questions will examine candidates' understanding of design theory and practice, social awareness and the historical background of modern design.

Paper 2 **Technological Studies (2 hours)**

This paper will examine candidates' abilities to understand the application of technological studies, materials, tools and equipment, techniques and processes in relation to problem solving.

There are two papers for 'Technological Studies', each paper will consist of 6 questions. Candidates are restricted to answering 4 questions in either Paper 2A or 2B. The scope of this paper will be as follows:

Paper 2A : Technological Studies in Wood
Paper 2B : Technological Studies in Metal

Paper 3 **Project Work (30 – 35 hours practical time)**

This paper will examine the candidates' abilities in solving a specific design problem over a given period of time.

The project will involve the candidate in investigating a given design problem; identifying salient features; providing a solution to the problem by considering possible alternatives; selecting a solution, and planning and carrying out, in practical terms, the development of the chosen solution.

Candidates will be required to submit the project together with a design folder. The folder should show the development of the chosen project; i.e. research, investigation and analysis of various alternative design solutions, planning procedures, working drawings and final evaluation of the project.

A list of design projects will be given to candidates during the year prior to the examination. Candidates should attempt one project only.

THE SYLLABUS

Topics	*Contents*
1. **DESIGN**	
1.1 **Design Theory & Practice** The Study should cover design methodology which comprises a statement of the problems, methods of research, graphic communication techniques and appreciation of design work in terms of available techniques, materials, functions, visual aspects and costs: problems will be set to test the candidates' understanding of the following:	
(a) General concepts	Explain the use in simple calculations the terms for lever, such as load, effort, mechanical advantage, velocity ratio and efficiency. Motion: Describe what is meant by linear, rotary, oscillating, and reciprocating motion, e.g. as used in workshop machines.
(b) Structures	Simple structural problems in terms of the location of the main forces acting upon a structure. Calculations will not be required. Identification and location of simple tension and compression forces. Simple considerations of equilibrium.

Topics	*Contents*
(c) Energy sources	Application of knowledge of energy sources such as gas, wind, battery, electricity, solar energy, hydraulic energy and winding system.
(d) Mechanisms	Application of knowledge of levers, linkages, gears, racks, pulleys, cams, ratchets, and bearings to the solution of design problems.
(e) Ergonomics and anthropometrics	Application of knowledge about human dimensions and physical attributes to design problems. Candidates should be aware of standard sources of information.
(f) The design of tools and dies	Understanding the design of simple press tools: (i) blanking, piercing and cropping (ii) bending (iii) drawing
(g) The design of simple jigs and fixtures	The importance of (i) locating (ii) clamping the workpiece (iii) positioning tools
(h) Design Fundamentals	Studies of basic design elements. Studies of organisational principles.

Topics		*Contents*
1.2 **Historical & Social Background** This encourages the general study of the historical and social factors which have influenced modern design.		
1.21 *Design in Wood*		
	(a) Historical background	The historical evolution of furniture-making in relationship to Western culture. Western furniture – From the 19th to the 20th century.
	(b) Social background	The modern utilization of wood in relation to how it affects man's everyday life i.e. environmental applications – considering such aspects as choice of materials, fitness for purposes and cost.
1.22 *Design in Metal*		
	(a) Historical background	A brief history of how man developed ferrous and non-ferrous metals and how, in turn, he evolved ways of treating, refining and utilizing these materials.
	(b) Social background	The modern utilization of metals in relation to how the materials affect man's everyday life i.e. environmental applications – considering such aspects as choice of materials, fitness for purposes and cost.

Topics	*Contents*
2. TECHNOLOGICAL STUDIES	
Section A Technological Studies in Wood	
2.1 Hand tools	Common hand tools and their specific features in relation to their function in cutting, scraping, forming, boring, shaping and finishing materials. Production of furniture employing hand methods of working with traditional tools. Maintenance of hand tools including grinding and sharpening of chisels, gouges, plane irons, saws, scrapers and bits.
2.2 Machine tools Production of furniture employing machine techniques both for one piece off and mass production	Recognition of techniques and processes in relation to the operation of the following: Woodworking machinery: router, circular saw, thicknessing and planing machine, spindle machine, mortiser, flat belt sanding machine, spraying gun. (Practical experience is not expected.) Portable Power tools : router and orbital sander. (Practical experience is not expected.)

Topics	*Contents*
School workshop woodworking machines:	
(a) Drilling machine	Essential features of the drilling machine (bench and portable type), its action, and operation.
Holding accessories	Drill chuck Mortiser attachment and its use.
Speed, holding and setting-up work for drilling	
Drills and bits	Applications and common types of drills and bits
Common operations performed on the drilling machine	Drilling, countersinking, counterboring.
(b) Woodworking lathe	Essential features of the woodworking lathe, its action and operation.
Lathe tools	Types (cutting tools and scraping tools) and their applications.
Lathe operations	Preparation of materials. Turning between centres. Faceplate turning, and long boring.
(c) Jig saw (Bench & portable type)	Uses, operations and proper care.

	Topics	*Contents*
	(d) Band saw	Uses, operations and proper care.
2.3	Understanding of materials	
	(a) Science and technology of wood:	
	Botanical description of trees	Growth and structure – bark, bast, cambium layer, pith, sapwood, heartwood, annual rings, medullary rays.
	Classification and identification – softwood/hardwood	Grain/figure/colour. World timber distribution. Uses of timber.
	Conversion of timber	Methods of conversion: Plain (tangential) sawing, Quarter (radial) sawing, Shrinkage of timber and its effects.
	Seasoning of timber	Methods of seasoning: Natural – air drying, Artificial – kiln drying, Advantages and disadvantages of both methods.
	Moisture content and control	Moisture content of timber. Calculation of moisture content.

Topics	*Contents*
Defects of timber	Growth defects. Grain defects. Defects caused by insects. Decay of timber. Seasoning defects.
Preservation of timber	Types of wood preservative. Application of preservatives.
Manufactured Products	The construction, usage, advantages and disadvantages of the following manufactured products: veneer, plywood, blockboard, laminboard, chipboard, hardboard (fibre board) plastic surface board: – melamine, – polyvinyle chloride (PVC), laminated plastic sheet, insulation board

	Topics	*Contents*
	(b) Testing and recording:	
	Strength of different types of adhesives	Testing of the durability and strength of different types of adhesives on various applications.
	Strength of different types of joints	Testing of the strength of different types of joints by applying forces upon them.
	Influence of moisture content	Testing of the movement of timber by changing moisture content. Testing the strength of timber affected by the influences of moisture content.
2.4	Techniques and Processes	
	Construction	Box and drawer construction. Frame and stool construction. Slab construction.
	Assembling and hardware fittings	Uses of different types of nails, screws, bolts and nuts, hinges, catches, handles, fasteners and knock-down fittings.
	Methods of veneering Laminating and bending	Use of material, jigs, adhesive and equipment for laminating and bending. Use of different types of former.

	Topics	*Contents*
		Methods and processes of bending and laminating solid timber, veneers and plywood.
	Surface coverings	Application of upholstery and plastic laminate.
	Lipping and edging	With veneer, plastic strips and solid wood.
	Simple carving, sculpture and bowl carving	Use of tools/timbers suitable for carving. Methods of carving.
	Applications of woodwork aids and devices	Use of jig and fixture.
	Adhesives	Applications, properties, advantages and disadvantages of animal glue, casein glue, resin glue, white glue (PVA), contact glue, and epoxy.
	Finishing	Uses of abrasive papers.
		Applications of stains, shellac, waxes, oils, lacquers, varnishes, enamels, vinyl, and polyurethane.
Section B	**Technological Studies in Metal**	
2.1	Hand tools	A general study of common hand tools and their specific features in relation to their function in cutting, forming, shaping, finishing and their maintenance.

	Topics	*Contents*
2.2	Measuring, testing, and marking-out tools	Their uses, care, reading and storage, including micrometers and vernier calipers.
2.3	Machine tools	
	(a) Drilling machine	Essential features of drilling machines including bench and pillar types, their actions, operations and lubrication.
		Tool-holding accessories including drill chucks and sleeves.
		Holding and setting-up work for drilling.
	Drills	Types, materials, cutting angles, method of sharpening (practical experience not expected), effect of incorrect grinding.
	Common operations	Drilling, countersinking, counterboring, spotfacing, reaming, etc.
	(b) Centre lathe	Essential features of the centre lathe, its action, operations and lubrication.
	Methods of setting work on the lathe	Using three and four jaw chucks, between centres, on face plates, on mandrels, on steadies etc.
	Lathe tools	Types and their applications, the cutting action of lathe tools, tool angles, tool setting methods, effect of tool height on cutting.

	Topics	*Contents*
	Lathe operations	Facing, straight/parallel turning, turning between centres, taper turning (using compound slide, setting-over tailstock, using taper turning attachment), drilling, parting-off, boring, reaming, knurling, threading (using taps and dies only).
		Calculations on screw-thread cutting.
	Cutting speed, feed and depth of cut	With respect to materials, tool, and cutting fluids. Simple calculations on cutting speed and spindle speed.
(c)	Grinder	Bench and pedestal types, their essential features and operations.
	Grinding operations	Theory of off-hand grinding. (Practical experience not expected.)
(d)	Polisher (Buffer)	Bench and pedestal types, their essential features and operations.
	Polishing operations	Theory of off-hand polishing. (Practical experience not expected.)
2.4	Understanding of Materials	
(a)	Classification and identification of metals:	
	Ferrous	Irons and steels – their nature, carbon content and uses (including high speed and stainless steel). Effects of carbon content.

Topics	*Contents*
Non-Ferrous	Recognition, nature, composition and uses. Effects of alloying.
Market forms	The common available forms: wire, strip, flat, bar, sheet, and extruded sections.
Properties of metals	Under normal conditions – strength, ductility, brittleness, malleability, toughness, hardness, thermal and electrical conductivities, machinability, and resistance to corrosion.
(b) Heat treatment of metals	Theory and practice of heat treatment processes: hardening, tempering, annealing, normalizing and case-hardening.
	The iron-carbon equilibrium diagram. The effect of cooling rate.
	The annealing and normalizing of aluminium, copper, and copper-base alloys.
(c) Material testing	
Properties of materials	Comparison of physical properties such as hardness and toughness of different types of metals in the school workshop.

Topics	*Contents*
Strength of joints	Comparison of strength between the following joints: (i) mechanical, (ii) metallurgical, and (iii) adhesive.
Chemical reactions of metals	Chemical reactions of metals on exposure to air, water, acid and alkaline.
2.5 Techniques and Processes	
(a) Cutting of metals	
The action and application of the common cutting methods	The characteristics and action of: (i) single-point cutter – turning, shaping etc. (ii) multiple-point cutters – jig saw, milling, and drilling etc. (iii) abrasive – sanding, grinding, and polishing. (iv) shear cutters – snips, shears etc.
Cutting angles	Rake and clearance angles and their effects on cutting. The rake and clearance angles for cutting various materials.
Cutting speeds and feeds	Simple calculation on cutting speeds and feeds.
Cutting fluids	Primary functions of cutting fluid. Types of cutting fluid.

Topics	*Contents*
(b) Fastening and jointing of metal	Factors that influence the choice of securing methods.
Mechanical methods	
(i) Fastening	A temporary method. e.g Bolt and nuts, screws and studs, and other fasteners.
(ii) Riveting	The semi-permanent method. e.g Rivets and riveting tools.
(iii) Seaming	Jointing of sheet metal.
Metallurgical Methods	
(i) Electric arc welding	The basic principle of arc welding as a process of melting and casting.
(ii) Hard and soft soldering	The principle of soldering as a process of fusion and alloying. Common solders and filters – their uses and compositions. Fluxes – their functions, constituents, and applications.
The preparation of joints	Edge preparations for butt, lap and tee joints.
Adhesive	Types of adhesion: Interlocking bond between surfaces, molecular attraction.

Topics		*Contents*
		The common adhesives for metals.
	Selection of joining methods	Selection criteria related to service, fabrication, and economic requirements.
(c)	The manipulation of metals	The principles of the following workshop and industrial processes:
	Casting	Cuttle fish bone, sand moulding, pressure die casting, and investment casting-uses, characteristics, tools and processes.
	Cold working	Cold rolling, coining, deep drawing, drawing, embossing, pressing, spinning, and cold heading.
		The effect of cold working – work hardening.
		Beaten metalwork : Metals for beating. Tools and equipment. Processes and techniques.
	Hot working	Hot rolling, extrusion and forging (including drop forging).
(d)	Surface treatment and finishing of metals	Reasons for surface treatment.
	Mechanical finishing	Hand polishing and buffing.
	Chemical finish	Colouring of steel, copper, and copper base alloy.

Topics	*Contents*
Metallic-coating	Hot-dipping and electroplating.
Organic coating	The common primers and paints. Brushing and spraying.
Conversion coating	Anodizing of aluminium and aluminium base alloys.
The selection of surface treatment	Understanding the characteristic of the various treatments. Appraisal of alternate selections.

3. **SAFETY**

Precautions to be observed in the school workshop	Reference: 'Safety in School Workshops' published by the Education Department, Hong Kong.