

### 3. *Workshop Knowledge.*

Hand tools used in engineering workshops, in the forge, pattern-shop, and foundry, their construction, production, and use. Measurement, scales, calipers, micrometers, surface-gauges. Taps, dies, &c. Elementary account of workshop practice in fitting, turning, machining, patternmaking, founding, riveting and boilermaking, forging, coppersmithing, &c.

### 4. *Materials.*

Properties of various timbers used in patternmaking (hardness, ease of working, durability, warping, cost, &c.); of cast iron, wrought iron, mild steel, tool steel, aluminium alloys, brass, and bronze. Hardening and tempering of steel.

## SYLLABUS OF FINAL EXAMINATION.

### 1. *Design.*

Including drawing, mechanism, dynamics of machinery, and strength of materials as applies to the design of machinery.

### 2. *Trade Practice and Theory.*

(A) *Fitters, Turners, and Machinists* :—

(a) *Measurement*.—Standards of length, subdivision, gauging-systems, limits, measuring-machines and methods. Screw-gauging, &c. Production of straight edges and surface plates.

(b) *The Simple Machine Tools*.—Centre lathes, facing and boring lathes, boring-machines, drilling-machines, planers, shapers, slotters, plain millers, plain grinders, power saws, and presses. The small tools and fittings (*e.g.*, chucks, vices, drills) used with these machines. The mechanism and detailed construction of these machines, including clutches.

(c) *Tool-room*.—Universal miller. Universal grinder, &c. Jigs, design and making. Sub-presses and press tools. Checking accuracies of machine tools. Refitting and adjusting machine tools. Lapping. The making of small tools and gauges. Templates.

(d) *Quantity Machines*.—Capstans. Automatic machines. Copying-machines. Continuous-process machines. Gear-cutters (including generating-machines). Broaching. The mechanism of such machines, their small tools and equipments.

(e) *Details of Workshop Practice*.—Lubricants, "coolants," pumps. Speeds and feeds and their calculation. Screw-cutting. Tapers and taper-turning. Methods of holding work; milling, grinding, lapping; brazing, soldering, "acetone" cutting and welding. Adjustments for wear; working-limits. Considerations governing running, push, and forced fits.

(f) *Treatment of Materials*.—Heat treatment. Case-hardening of products; colouring.

(g) *Erection and Assembly*.—Methods of obtaining correct alignments; testing and adjustment of machines; use of testing-instruments; painting and finishing and repairs to worn machinery.

(h) *Design for Easy Manufacture*.—Shop systems.

(i) *Factory Lay-out*.—Lighting, heating, power production.

(B) *Patternmakers and Moulders* :—

(a) *Patterns and Moulding*.—Timber, seasoning, defects. Contraction allowances, drafts, machining allowances. Types of patterns, prints, core-boxes, loose pieces, drawbacks, patterns requiring more than one parting; patternmaking accessories. Green sand, dry sand, and loam moulding; materials and accessories used in foundries. Core-making. Moulding-boxes. Methods of moulding. Arrangement of gates, ventilation, pouring. Metal patterns. Use of plaster-of-paris.

Pig irons, mixtures, use of scrap. Nature of castings produced. Chilled, malleable, semi-steel, steel, aluminium alloy, brass, bronze, and white-metal castings, die castings.

(b) *Pattern work and methods of quantity casting*.—Moulding machines, their equipment and methods of securing accurate work. Pattern-making machines and tools used in them. Defects in castings, their causes and methods of avoiding them. Modern methods of ventilating and core-making for intricate work. Centrifugal casting. Effects of temperature control and hot moulds. Die castings. Mixtures for various purposes; analyses; quality of the resulting material. Cupolas and equipments. methods of melting metal. Power production, lighting, heating, and ventilation to meet pattern shop and foundry requirements.

(C) *Boilermakers* :—

(a) Methods and tools required for bending plates, for straightening plates, for taking the buckle out of a plate. Punching and drilling plates.