

Contents

PART I: MATERIALS	1
1. FUNDAMENTAL NATURE OF MATERIALS	3
Engineering materials. Atomic structure. Periodic table of elements. Atomic bonds. Crystal structure. Crystallization. Allotropy. Questions.	
2. PROPERTIES OF ENGINEERING MATERIALS	21
Chemical properties. Physical properties. Mechanical properties. Strain. Stress. Elasticity. Hooke's law. Bulk modulus of elasticity. Modulus of rupture. Plasticity. Tension test. Stress-strain relations in tension. Proportional limit and elastic limit. Resilience. Yield point and yield strength. Ultimate strength. Ductility. Reduction of area. Tough- ness. Fractures in brittle and ductile materials. Compression. Malleability. Hardness. Brinell test. Diamond pyramid hardness. Rock- well test. Scleroscope test. Microhardness test. Monotron test. Relation of strength to hardness. Strain hardening. Recrystallization. Fatigue. Endurance limit and endurance strength. Factors affecting endurance properties. Effect of temperature on properties. Creep. Stress rupture. Dynamic loading. Impact tests. Rapid loading. Transition temperature. Factor of safety. Selection of materials. Questions.	
3. ALLOY SYSTEMS	87
Alloy formation. States of matter. Compounds. Solid solutions. Factors influencing solubility in the solid state. Structural constituents. Solidifica- tion. Phase equilibrium diagrams. Cooling curves. Phase rule. Lever-arm principle. Components soluble in liquid state and insoluble in solid state. Components completely soluble in the liquid state and partially soluble in the solid state. Other types of equilibrium diagrams. Peritectic r i Eutectoid transformations. Ternary p diagrams. Trans formation di Properties f s, st	
4. METALLURGY, PROPERTIES, AND USES OF FERROUS METALS AND ALLOYS—I. THE MANUFACTURE OF IRON AND STEEL	127
Classes of metallurgy. Occurrence of metals in nature. Factors determin- ing the price of metals. Ores. Chemical nature of ores. Primary metals. Ore dressing. Purification. Reduction of ores. Refining of metals. Chemi- cal strength. Fluxes. Furnaces. Refractory materials. Fuels. Iron ores. Smelting. Classification of pig iron. Wrought iron. Puddling process. Aston process. Composition and properties of wrought iron. Uses of wrought iron. Steel. Fundamental considerations in the manufacture of steel. Deoxidation and rimming. Cementation and crucible processes. Bessemer process. Direct-oxygen process. Open-hearth process. Duplex process. Electric refining process. Ingots. Defects in ingots. Questions.	
5. METALLURGY, PROPERTIES, AND USES OF FERROUS METALS AND ALLOYS—II. CONTROL OF PROPERTIES	173
Impurities in steel and their effects. Properties and uses of steel. Equilibrium diagram of iron and iron carbide. Allotropic forms of iron.	

Solid solutions of carbon in iron. Eutectic and eutectoid of iron and iron carbide. Transformation in the range 0 to 1.7 per cent carbon. Heat treatment of steels. Isothermal transformation. Hardenability. Tempering of steel. Annealing and normalizing of steel. Casehardening of steel. Carburizing. Nitriding. Cyaniding of steels. Flame hardening. Induction hardening. Cast iron. Malleable cast iron. Gray cast iron. Ductile cast iron. Questions.	
6. METALLURGY, PROPERTIES, AND USES OF FERROUS METALS AND ALLOYS—III. THE ALLOY STEELS AND CAST IRONS	205
Function of alloy elements in steel. Designations for steel. Nickel. Chromium. Manganese. Tungsten. Molybdenum. Vanadium. Silicon. Chrome-nickel. Selection and properties of alloy steels. Alloy cast iron. Questions.	
7. METALLURGY, PROPERTIES, AND USES OF NONFERROUS METALS AND ALLOYS	223
Introduction. Copper. Treatment of copper ores. Zinc. Tin. Aluminum. Lead. Titanium. Copper-zinc alloys. Copper-tin alloys. Copper-nickel alloys. Copper-silicon alloys. Copper-beryllium alloys. Aluminum alloys. Precipitation hardening. Magnesium alloys. Die-casting alloys. Bearing metals. Other nonferrous alloys. Solders and brazing alloys. Fusible alloys. Questions.	
8. MOLDING OF PLASTICS	251
Types of plastics. Organic high polymers. Processing plastics. Compression molding. Injection molding. Transfer molding. Cold molding. Inserts. Casting. Extrusion. Plastic laminates. Plastic-bonded plywood. Rubber. Synthetic elastomers. Neoprene. Buna S. Buna N. Butyl rubber. Silicone rubber. Processing the elastomers. Questions.	
PART II: PROCESSES	267
9. PRODUCTION OF CASTINGS	269
Classification. Patterns. Molding sands. Sand molding. Founding. Defects. Shell-mold casting. Die casting. Dies for die casting. Die-casting machines. Die-casting alloys. Permanent-mold casting. Centrifugal casting. Plaster mold casting. Precision investment casting. Powder metallurgy. Properties of castings. Questions.	
10. HOT WORKING OF METALS	307
Introduction. Rolling. Rolling mills. Forging. Drop forging. Press forging. Extrusion forging. Smith forging. Machine forging. Extrusion. Hot drawing. Hot forming of tubular products. Butt-weld process. Lap-weld process. Seamless processes. Effect of hot working on structure and properties. Questions.	
11. COLD FORMING OF METALS	347
Development. Classification. Cold rolling. Sizing. Swaging and cold forging. Coining. Stamping. Impact extrusion. Hobbing. Shearing. Cold-drawing. Cold-drawing tubes. Cold-drawing of wire. Spinning. Embossing. Stretch-forming. Bending. Roll forming and seaming. Effect of cold working on properties of metals. Questions.	

12. JOINING OF METALS	381
Introduction. Soldering. Brazing. Forge and pressure welding. Cold pressure welding. Resistance welding. Flash welding. Pressure welding—open-butt and thermit. Fusion welding. Gas welding. Arc welding. Gas-shielded arc welding. Thermit welding. Structure of fusion welds. Weldability. Metal spray (metallizing). Flame plating. Cutting of metals. Questions.	
13. MACHINE SHOP PRODUCTION METHODS	411
Shop equipment. Interchangeable manufacture. Selective assembly. Metal fits. Classification of fits. Examples. Jigs and fixtures. Mass production. Machine tools. Cutting tools. Cutting-tool materials. Machinability. Questions.	
14. LATHES, BORING MILLS, AND SCREW MACHINES	435
Classification of lathes. Development of lathes. Engine or power lathes. Chucking. Feeding. Multicut lathes. Turret lathe. Boring mills. Screws. Thread-forming methods. Thread-cutting machines. Screw machines. Single-spindle automatic screw machines. Multiple-spindle automatic screw machines. Questions.	
15. MILLING AND DRILLING OPERATIONS	473
History of milling and drilling. Classification of milling machines. Milling operations. Indexing head. Indexing, simple and differential. Drilling and reaming. Questions.	
16. SHAPERS, SLOTTERS, PLANERS, BROACHING MACHINES, AND SAWS	505
Introduction. Shapers. Slotters. Planers. Broaching. Sawing. Questions.	
17. GEARS, GEAR CUTTING AND GEAR-CUTTING PROCESSES	523
Introduction. Gear-tooth action. Classification of gears. Gear production processes. Forming processes. Processes using templates. Generating process. Hobbing. Bevel-gear generators. Gear-finishing processes. Questions.	
18. ABRADING, GRINDING, AND FINISHING PROCESSES	551
Introduction. Natural abrasives. Artificial abrasives. Manufacture of grinding wheels. Selection of grinding wheels. Grinding machines. Lapping. Honing. Superfinishing. Buffing. Questions.	
INDEX	567