191 – GENERAL METAL WORK

Examination Structure

There will be two papers:

191-1 – PAPER I : This will consists of two sections, viz:

SECTION A: OBJECTIVE: This will be forty (40) multiple choice questions. Candidates will be required to answer all in 40 minutes. This section carries forty (40) marks.

SECTION B: ESSAY: this will be a written paper of six questions. Candidates are to answer five questions in 2 hours. This Section carries sixty (60) marks.

191-2 PAPER II: PRACTICAL: This will comprise of two (2) Practical tests (A & B). Test A – Fitting Work and Test B – Machining. There will be compulsory Questions, one each from Fitting and Machining. The practical work is to be done for a total of 100 marks in six (6) hours; the paper is to be released to the candidates one (1) week before the examination date.

191 – GENERAL METAL WORK

S/NO	TOPICS/ OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
1.	**Workshop Safety Rules and Practice** 1. Explain and state sources of hazards in workshop, how to prevent them, application of factory safety regulations and demonstrate first aid applications in case of accidents. 2. Outline and name safety equipment and wears, safety rules and regulations in the machine shop and state their application in working situations.	1. Sources of hazards in the workshop and how to prevent them e.g. a. handling and using hand tools, portable power tools and machines. b. Stepping on or stricking obstructions left on floors or benches. c. Lifting, moving and storing materials or jobs. d. Using inflammable or corrosive liquids and gases. e. Inhaling vapours or fumes. 2. Application of factory safety regulations. 3. First aid application. 4. Safety equipment and wear essentials in the machine shop. 5. Power in the workshop. 6. the vee belt drive. 7. Lubrication of bearings. 8. Care and order in the workshop. 9. The care of tools and machines. 10. Appropriate procedure in an event of accident in the workshop. 11. Safety rules and regulations relating to: a. clothing and health hazards. b. workshop hygiene. c. Movement and other behaviour of	1. Carry out exercises on handling and using of tools. 2. Carry out demonstration as to when and how a first aid is applied in case of accident or any hazard. 3. First aid applications may include: artificial respiration, cold compress, dressing. 4. Safety means and equipment should include overall goggles, gloves, hard shoes, head shield fire extinguisher etc. 5. Examples of procedure may include: a. application of first aid to the victim. b. removal or notification of the accident. c. Reporting accident to appropriate authority. d. keeping a record of accidents for management use.

S/NO	TOPICS/ OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
		workers in the workshop. d. Materials handling. e. Tool handling, storage and usage. f. Machine operation. g. Fire protection.	
2.	**Ferrous and Non-Ferrous Metals** Explain the meaning of physical properties of metals and outline manufacturer processes as related to ferrous and non-ferrous metals.	1. Physical properties of metals: ductility; malleability; strength; toughness; elasticity; plasticity; brittleness. 2. Physical pr9perties and application of non-ferrous metals e.g. copper, tin, zinc, alumi8nium and aluminium alloys, brass (metals muntz, phosphorus, bronze and lead). 3. Ferrous metals, e.g. cast iron, wrought iron, steel, alloy steels, tool steels, high speed steel etc. 4. Identifying steels. 5. Manufacturing processes: a. Cupola process of manufacture of cast iron. b. The blast furnace process of manufacture of pig iron. c. The direct reduction process manufacture of steel.	1. Identify different types of metals and their properties. 2. Specific examples of tools and equipment from the various sheet and cast iron should be mentioned. Such examples should include: plain carbon steel, dead mild steel, mild steel, medium carbon steel, high carbon steel. 3. Cast iron – grey cast irons, malleable cast iron, alloy cast irons (spheroidal and acicular). Alloy steel high tensile steels, tungsten, carbide, stainless steels, stellite etc. 4. A visit to a steel manufacturing plant is recommended.
3.	**Bench Work and Tools** 1. Explain	1. Physical properties and application of non-ferrous metals e.g.	1. List and use of instruments applicable in metal workshop.

S/NO	TOPICS/ OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
	difference between 'line' and 'end' measurement and the use of measuring instrument in bench work. 2. Maintain and describe various types of instrument used in metal work, their various functions, their grades, applications and state the safety precautions to be observed. 3. Compare the limits of accuracy perform marking out exercise on plain surfaces. 4. Sketch the bench vice, explain its clamping power and demonstrate the technique holding work in the vice. 5. Select and install hawksaw correctly.	copper, tin, zinc, aluminium and aluminium alloy brass (metal muntz, phosphorus, bronze and lead). 2. The difference between 'line' and 'end' measurement. 3. The functions and application of instrument used in metal work. 4. The use of datum points, datum lines and datum faces in marking out. 5. Essential features and use of tools and instruments. a. micrometer b. vernier caliper c. combination set etc. 6. Maintenance of tools/instrument - limits of accuracy. 7. Marking out exercises on plain surfaces. 8. Types of files, grades and applications. 9. Classification of files and their composition. 10. Filling of metals to given specifications using either: 11. Cut a piece of metal to a given specification to be filed using different types of files. 12. Sketching of a bench vice. 13. Demonstrate the technique of holding work in the vice for	2. Carry out maintenance work on the instruments. 3. Explain the working principles of: a. Micrometer; b. Vernier caliper c. Vernier height gauge d. Combination set. 4. Sketch various tools and instruments used. 5. Types of files should include: flat, square, half round, triangular, warding, mill and rasp. 6. Demonstrate how all the tools mentioned are used in the workshop.

S/NO	TOPICS/ OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
		various exercise with a piece of metal. 14. Description of the functions. 15. Functions of the parts. 16. Hammers and mallets. 17. Chisels. 18. Punches 19. Scrapers. 20. Power hacksaw 21. Safety precautions 22. Types of hacksaw 23. Explain and sketch various tools used in the workshop. 24. Types of hacksaw blades their pitches and application. 25. Selection and installation of blades. 26. Cutting process using: a. adjustable hacksaw b. junior hacksaw c. piercing saw etc.	
4.	**Drills and Drilling** 1. Identify, set up, operate and describe with sketches, the various types of drilling machine, their main features, where they are best suited and safety precautions to be observed when using them. 2. Perform drilling operation, state the cause and remedy of	1. Types of drilling machine and their operations. 2. Sharpening of drills bits. 3. Sketches and explanation of various drills e.g. Twist drill (taper shank, parallel and jobbers drill and their relative merits). 4. Effects of faults in twist drill bits e.g. a. point angle too acute. b. Point angle too obtuse. c. Cutting edges at unequal angles. d. Insufficient lip	1. Setting up drilling machine should include: a. Change of spindle speed. b. adjustment of drilling table to the required height and angle, holding of works on drilling table using appropriate clamping device. c. Install the drill bit in chuck 2. Cut a piece of metal to a given specifications and perform drilling operations on holes given. 3. Drill and ream holes on

S/NO	TOPICS/ OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
	drilling faults. 3. Explain the purpose of reaming and reamers to given specification by hand and machine method. 4. Calculate spindle, the revolution or cutting speed for specific size of drill.	clearance. e. Excessive lip clearance. 5. Calculation of spindle formulae: $N = \frac{1000S}{\pi d}$ $S = \frac{\Pi d}{1000}$ Where S = cutting speed (m/min) N = revolution/minute d = diameter of drill (mm) $\pi = 3,142$ 6. Causes and remedy of drilling faults e.g. a. Drill breaking. b. Drill coloured blue c. Walls of drill hole left rough. d. Chipped cutting lips. 7. Safety precautions. 8. Drilling operations e.g. 9. Types of hand and machine reamers. 10. Reaming and mode of operations. 11. Reaming to specifications.	metals and other engineering materials. 4. Calculate some problems in spindle revolution or cutting speed on particular size of drill. 5. Carry out different drilling operations base on specified materials and measurements.
5.	**Fastenings** 1. State and explain the meaning of tapping size or tapping drill, its functions, precaution to be taken when tapping on bench and estimate its	1. Forms of threads and application. 2. Functions of taps. 3. Sketching various forms and the meaning of the following: a. The 150 metric thread. b. The unified thread. c. Whitworth and British fine thread. d. British Association	1. Demonstrate the application of various forms of screw thread, rivet and cut screws by hand. 2. Draw and perform an exercise on how to apply rivets and solve a problem involving allowance.

S/NO	TOPICS/ OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
	value. 2. Sketch the thread forms, state their application, their operational sequence and cut internal thread external thread by hand method. 3. Describe and differentiate types of rivets, sketch rivet set, state their uses, calculate the diameter and rivets metals together.	(BA) thread. e. Square thread. f. Acme thread g. Butress thread. 4. Functions and sketches of: a. taps (taper tap, second tap, plug) b. tap wrench c. die and die stock 5. Operation sequence 6. Cutting and precaution to be observed. 7. Sketching and riveting exercises. 8. Calculation of tapping value in any situation using formulae T = D-P where T = Tapping diameter D = thread top diameter, P = Pitch. 9. Types of rivets e.g. snap and pan heads, mushroom and counter-sunk head, flat head, pop rivet etc. 10. Calculation of diameter and allowance of rivet.	
6.	**Tolerance and Fit** 1. Explain the importance of tolerance and fit in engineering production and describe briefly the I.S.O. 2. Differentiate between tolerance and fits, calculate the amount of tolerance and types of fit in given situations.	1. The difference between limits, fits, nominal size and tolerance. 2. Importance of fits and tolerance engineering production. 3. Calculation of fits and tolerance	Do some calculation on tolerance and fit based on given specifications.

S/NO	TOPICS/ OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
7.	**Production** 1. Determine layout procedures from working drawing of simple engineering components or tools. 2. Mark out only given bench work and produce any type of centre lathe to given specification. 3. Carry out simple precision fitting project.	1. Layout procedures of a working drawing e.g. a. Open ended spanner b. Engineer's try square c. Tools makers clamp d. Plate bracket or gusset (involving wounds, angles, holes). e. Centre square. 2. Methods of marking out for given bench work with the use of centre dot, punch, scribing block or measurement transfer. 3. Production of some mentioned items. 4. Simple precision fitting projects e.g. Hexagonal mild, steel bar making push fir through a mild steel plate.	1. Produce simple engineering components on the bench based specifications. 2. Carry out some precision fitting project in the workshop.
8.	**Lathe and Lathe Work** 1. Identify, explain and describe the working principles, essential features, functions of a centre lathe and its accessories, differentiate between centre lathe and capstan lathe in terms of their functions. 2. State and name	1. Features of a centre lathe e.g. lathe bed, head stock, tail stock, saddle or carriage etc. 2. Function 3. Working principles. 4. Types of cutting fluids. 5. Tools involved and their functions. 6. The difference betweens centre lathe and capstan lathe. 7. Types of cutting fluid and safety. 8. Sketching of common tools e.g. buttbrazed tool, typed tool, bit and holder – functions and	1. Explain the essential features of a lathe machine. 2. Carry out basic operations e.g. Facing, Turning (Plain), Stepped Turning, Knurling etc. 3. Tool description should include tool materials e.g. Plain carbon steel, high speed steel, stellite, cemented carbide diamond.

S/NO	TOPICS/ OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
	types of cutting fluids used for lathe turning operations, their composition, their purposes and outline safety precautions involved. 3. Sketch, explain and describe common tools, functions of tools, angle rake, clearance and state the values for different metals to be machined.	values. 9. Functions of centre lathe accessories e.g. Catch or driving plate, face plate, lathe dog, or carrier, lathe centre, fixed and traveling steadies.	
9.	**Heat Treatment** 1. Explain the structural behaviour of plain carbon when heated to 1000°C and carry out heat treatment on plain carbon steel engineering component or tools. 2. Outline and explain the meaning of hardening in metal work and safety precautions relating to hear treatment processes. 3. Anneal copper,	1. The structural behaviour of plain carbon steel e.g. hardening, tempering, annealing, normalizing, case-hardening. 2. Hardening of metals 3. Heat treatment of metals and precautions. 4. The behaviour of steel when heated. 5. Hardening and tempering of carbon steels. 6. Case hardening of mild steel. 7. Tests for iron and steel. 8. Annealing of metal e.g. a. Copper, b. Brass etc.	1. Carry out heat treatment of some metals in the workshop e.g. Hardening and tempering of carbon steel tools. 2. Produce simple engineering components based on given specifications.

S/NO	TOPICS/ OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
	brass and aluminium for various purposes.		
10.	**Forging Processes** 1. Explain with sketches, the main features and working principles of the blacksmith forge. 2. Describe with sketches, the forging operations, common forging tools and their functions. 3. Select appropriate forging tools and produce given engineering component.	1. Main features and working principles of blacksmith forge and tools. 2. Equipment for hand forging. 3. How to light a forge. 4. Functions of the common forging tools e.g. Anvil, Swage Blockj, Log Vice, Forging Hammers, Hot and Cold Set, Set Hammer, Punches and Drifts, Hardle, Fullers, Top and Bottom Swages Flattes, Tongs, Open mouth, Closed Mount, Hollow etc. 5. Forging operations e.g. upsetting, drawing down, setting down, twisting, forging welding (scarf and splice weld), bending, forming closed ring, forming an eye. 6. Forging tools and production of engineering components.	Produce simple engineering components based on given specification.
11.	**Gas and Arc Welding** 1. Describe, set up, operate and explain the principles and application of gas and metal arc welding	1. Equipment, principles and application of gas and arc welding. 2. Setting and operation of gas or arc welding equipment. 3. Preparation of joints for welding. 4. safety precautions to be	1. Fabricate simple metal components involving both gas and arc welding. 2. Cut a piece of mild steel bar to a given specification for a turning between centres operation.

S/NO	TOPICS/ OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
	equipment. 2. Prepare joints for welding, weld the components by arc or gas welding method, state and apply the safety precautions involved. 3. Select and sharpen cutting tools, set them up to centre height, differentiate between tools shape, state their function and explain with sketches the effect of wrong setting of cutting tools. 4. Set up, define and calculate the cutting speed and feed with respect to lathe, rate of metal removal, time required for turning operation and carry out turning operations between centres. 5. Compute required taper dimension from giving data using taper rectic angle	observed. 5. welding of components by arc and gas welding methods. 6. The difference between various tools shapes and their uses e.g. a. Knife tools, round nose roughter, b. Fine finishing side finishisng, knife tool, form tool, parting off tools, boring tools etc. 7. preparations of tools for turning on lathe machine. 8. Turning operation on a lathe machine a. 3 jaw chuck b. work piece c. cutting tool 9. Setting up of cutting tools for turning and facing operations. 10. Cutting speed and feed with respect to lathe operations. 11. Calculation of cutting speed and feed-line required for a turning operation. 12. Effect of wrong setting with sketches e.g. vibration and chatter, tool rubbing against or digging into the job etc. 13. Chukwork on lathe e.g. a. facing, radiusing, chamfering b. under cutting, parting off c. knurling d. step turning	3. Equipment operation should include: choice of correct nozzle of electrode, adjustment for correct gas pressure/flame or voltage etc. 4. Components should be produced to specified tolerance and finish. 5. Calculate or solve a problem involving cutting speed and feed.

S/NO	TOPICS/ OBJECTIVES	CONTENTS	ACTIVITIES/REMARKS
	formulae and produce simple components by using compound slide. 6. Set up rough and turned stock in 3-jaw chuk, carry out chuk work and state precautions to be observed when turning between centres.	14. Safety precautions to be observed. 15. Turning operations between centres on lathe machine. 16. Taper ratio calculation with formulae. Taper ratio = $\frac{d_2 - d_1}{L}$ OR $\frac{\text{Tan } Q}{2} = \frac{dz - di}{2}$ Where Q = taper angle di = small end diameter d_2 = large end diameter L = length of taper	