

090 – VEHICLE BODY BUILDING

EXAMINATION STRUCTURE

The consists of the following related courses:

191 – General Metal Work

193 – Building/Engineering Drawing

The trade will be examined under the following components or subjects groupings:

1. Gas Welding, Cutting & Arc Welding (CFM 12 & 13) (See Fabrication & Welding)
2. Vehicle Painting and Trimming (CVB 13 & 14)
3. Lining Sign and Design
4. Vehicle Body Building wood and Metal (CVB 11 & 12)

EXAMINATION SCHEME

91 (2) – Vehicle Body Building

This subject grouping consists of two papers:

91-1 – 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 seven questions. Candidates are to answer five questions in 2½ hours. This Section carries sixty (60) marks.

91-2 PAPER II: PRACTICAL: This test is for four (4) hours and it carries 100 marks. This paper will be released to the candidates ONE WEEK before the examination date.

091 – VEHICLE PAINTING & TRIMMING (CVB 13 & 14)

S/N	TOPICS/OBJECTIVE	CONTENT	ACTIVITIES/REMARK
1.	<p><u>Trimming Materials</u></p> <ol style="list-style-type: none"> Identify and describe the properties uses and forms of supply of common trimming materials. List and explain the health hazards and factors in the selection of trimming materials. 	<ol style="list-style-type: none"> The Common trimming materials e.g. leather, leather cloth, wool cloth, cotton cloth, antidrum materials, sheet plastics and foams, (various types), rubberized hair carpet and linoleum, water strips, seals and dust proofing materials, wadding, canvas felts, springs (various types) etc. Health hazards: the safety precautions; to person materials and equipment. The functions of trimming materials, seat headlining, panel trimming and floor covering: <ol style="list-style-type: none"> Comfort Beauty Ease of Maintenance Class of Vehicle Durability etc. 	<p>Identification of trimming materials and their properties. Explanation on Health hazards.</p>
2.	<p><u>Trimming Adhesives and Fixing Devices</u></p> <p>Name and identify classes of adhesives, if supply of each class and factors to be considered in the selection.</p>	<ol style="list-style-type: none"> The classes of trimming adhesives: rubber, based adhesives (neoprene), nitrile rubber, epoxy resin adhesives, phenolic resins, formadehyde bitumen matics, the trade names and methods of their application as specified by manufacturer. Materials to sbe bonded, safety in use, point of application etc. Fastening/fixing materials threads, twine, tacks, gimps, black wax, bee wax, seaming cords, piping canes etc. 	<ol style="list-style-type: none"> Application methods and the precautions in use. Demonstrate the use of adhesives. Explanation on the uses of the fastening/fixing devices.
3.	<p><u>Trimming Tools and Equipment</u></p> <p>Identify, state and describe safety rules, the general features, uses, working principles of typical sewing machines and its routine and maintenance, and trimming tools and equipment.</p>	<ol style="list-style-type: none"> Tools for trimming are: Trimmer’s knife, saddle’s knife, linoleum knife, tools trimmer’s shears portable reciprocating knife, cutters, rotary cutters, magnetic headed hammer, sapling and lorging machines, chisels, bar strainers, garnish-awl, stuffing stick, adjuster (regulators sleeker, rubber composition mallet etc. Safety rules and regulations used in trimming workshop, tools and equipment, to person and materials. The parts of sewing machines table head etc. Sewing operators: <ol style="list-style-type: none"> Straight flight seam Curved seam Flutes Quilting Bound edges Binding apertures. Cleaning and lubricating of the machines. 	<ol style="list-style-type: none"> State the functions of tools. State rule and regulations Carry out operations using upholstery machine. Sewing machine setting up operations should involve selection and fixing the needles and thread, tension and stitch adjustment. Clean and oil the necessary parts.
4.	<p><u>Body Trimming Components and Feature</u></p>	<ol style="list-style-type: none"> The materials used for body trim: Body trim materials for headlining panel 	<ol style="list-style-type: none"> The interior features; Identification and

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	Name identify, state car model materials, interior features/locations and function of body trimming materials with sketches common systems of handling and floor cover in different types of squabbed and cushion seat.	trimming and floor covering. 3. The functions: heat and sound insulation, comfort, beauty, safety, cover for frame work and component etc. 4. Sketch the cross sectional view of headlining and floor covering. 5. The general principles of the design and construction.	observation. 2. Discuss the type of seats; solid base, drilled and cavity base, etc. Suspended base, or spring case, construction technique 3. Visit to the vehicle assembly plant.
5.	Preparation of Body Trimming Materials Prepare, select and mark out the scale seat layout, design and working drawings, estimate of quantities and cost materials, use the patterns to cut the shape of suitable trimming materials.	1. The scale seat of a typical passenger bus: Kombi bus, long bus (omnibus) etc. 2. Materials for headlining, panel trimming and floor covering for saloon car or passenger bus. 3. Working drawing of: Back seat, squab and padded seat, cushion seat-spring case type. A typical coach seat or bus passengers seat. 4. Estimate of quantities and cost of materials adhesive, tacks, and threads needed for a job, fabric and stuff. 5. the patterns of headlining, squabbling, seat, back for cushions. Loose covers, tonneau covers, and hood envelopes, side and floor panels, floor covers in given situations and use the pattern to cut the shape.	1. Layout should conform with the specification in the relevant international standards. 2. Design a working drawing of a coach seat etc. 3. Estimate and costing: Note that computation of area of covering should take account of cutting waste. 4. Prepare patterns.
6.	Trimming List explain, describe and outline the operation in sequence of trimming and general planning procedure for floor covering plan and method of dealing with joints on flat floors.	1. Competent trimming operations such as attaching foam plastic or foam rubber to solid base. a. taping foam to the base; b. fixing additional padding; c. preparing spring case for padding and stuffing; d. stuffing of spring case; e. fastening piping to base; f. covering bases with flat cover; g. fastening piping to bases; h. covering a padded base \with boxed covered; i. fixing envelope covers and fixing a fluted panel to a fabric anchorage. 2. Sequence of operation a. Construct the frame; b. Stuff; c. Cover typical coach; d. Cover bus passengers seat. 3. Set out the operation sequence in trimming a. Preparation routine b. Working drawing c. Personnel 4. Joints corner joints and housed joints: a. Moulded strips; b. Unprotected butt joints;	1. Explanation of sequence 2. Draw the floor plan 3. Description of jointing processes 4. Demonstrate fitting processes 5. Demonstrate on the vehicle blinds.

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		<ul style="list-style-type: none"> c. House joints at 'T' junctions etc. 5. Laying competently floor materials. 6. Set fittings on floor covering – perform on how to lay covering. 7. Materials for blinds 8. Installation, blind, sunvisor, parcel nets, roof rack or facia cabinet 	
7.	<p><u>Finishing and refinishing materials</u></p> <ol style="list-style-type: none"> 1. State four general reasons of painting and list properties, the composition. 2. Identify form of supply paints in Nigeria market. 3. Explain various types of defect in paint, the importance and define the term 'paint system'. 4. Identify factors that may influence choice of a paint system and explain the functions of the operation. 5. Explain the difference between straight paint and metallic paint in terms of their basic composition in specific paint systems suitable for large metallic surfaces. 6. Explain functions of masking before spray painting and identify common materials in the Nigerian market suitable for masking. 	<ol style="list-style-type: none"> 1. Reasons for painting: <ul style="list-style-type: none"> a. protection; b. Decoration; c. Hygiene d. Identification 2. Basic ingredients in the composition of paints e.g. pigment, binder, thinner or solvent, extenders, additives, decelerators, inhibitors and anti-evidants. 3. Properties of paints consistency, capacity, spreading capacity adhesion, elasticity, density, drying time flow durability etc. 4. Classes of auto-body paint e.g. cellulose synthetic paint, synthetic enamels, acrylic enamels etc. 5. Classification of paint and their properties. 6. Types of Paint defects. 7. Trade brand of different classes of auto-body paints. 8. Types of paint and their defects e.g. cellulose, synthetic enamels etc. 9. The properties of automobile paints: <ul style="list-style-type: none"> a. Shelf life b. Viscosity c. Spraying temperature d. Dry time 10. Paint system – priming, under coating and finishing. 11. Factors influencing the choice of a paint system e.g. availability and cost of paint and painting equipment, drying time, parent materials etc. 12. Functions and properties of the following operations: <ul style="list-style-type: none"> a. degreasing b. filling c. stopping d. burnishing e. priming f. sealing g. feather edging h. flatting i. tacking off 13. Difference between straight paint and metallic paint e.g. <ul style="list-style-type: none"> a. basic composition b. method of application 	<ol style="list-style-type: none"> 1. Name and classify the paints and coatings used by the painter and decorator and demonstrate knowledge of their main physical, technical and aesthetic properties in relation to their use. 2. Show some samples of paint ingredients 3. Paint system sequence of coats and their function in building up the system 4. Stress the characteristics of ready prepared paint, high glass flat-oil paint synthetic enamels cellulose paint, primers, sealer, varnishes. 5. Display the different type of auto-body paints 6. Examine various types of defects e.g. flatterring, feeding or levering, setting, skinning. Treatment and prevention. 7. Examples of defect should include flatterring feeding, livering, settling, skinning. 8. Select and specify a paint system for specified tasks. 9. Discuss characteristics of coating or response to environment. 10. Discuss the preparation and finish in relation requirement 11. Discuss and demonstrate various methods of operation. 12. Demonstrate the use of suitable procedure, methods tools and equipment for specific tasks. 13. Explain the method of classifying pigments

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		<p>c. peculiar problems.</p> <p>14. Paint system suitable for large metallic surfaces e.g. public services vehicles insulated and refrigerated bodies, ambulances furniture vans caravan, coaches etc.</p> <p>15. Function of masking tape.</p>	<p>according to their derivation.</p> <p>14. State the difference between straight paint and metallic paints by painting.</p> <p>15. Observe practical examples obtain knowledge of peculiar problems.</p> <p>16. Discuss paint systems suitable for large metallic surfaces e.g. public services vehicles insulated and refrigerated bodies, ambulances furniture vans caravan, coaches etc.</p> <p>17. Discuss and identify common material in Nigerian market.</p>
8.	<p><u>Vehicle Painting Equipment and Tools</u></p> <p>1. Sketch and describe the features of an air compressor and state factors in the choice in painting shop.</p> <p>2. Describe and explain an air compressor features, working principles and advantages of the spray guns.</p> <p>3. Perform proficiently, care and maintenance of the spray guns.</p> <p>4. Explain the principles of airless spray, advantages, the uses of the equipment and list spray equipment faults and method of rectifying them. Identify spraying equipment faults and their rectification.</p> <p>5. Describe the construction of the painter's brush, sketch and explain the application, the causes of deterioration.</p> <p>6. Undertake routine care and maintenance of painting tools.</p>	<p>1. Main features of air compressor and its working principles:</p> <ol style="list-style-type: none"> air lines compressor transformer air regulator volume of air types of pneumatic operations <p>2. Factors affecting the choice of air compressor e.g. durability of air compressor; volume of job involved; type of material and speed required; pressure and volume in relation to spray painting equipment.</p> <p>3. maintenance and operation of air compressor.</p> <p>4. Types of spray guns e.g. suction – feed gun, gravity-feed gun, pressure-feed gun, internal-mixed gun.</p> <p>5. External-mixed gun; bleeder type and non-bleeder type gun – advantages of the spray guns; suitable conditions for their use.</p> <p>6. Spray gun feeding and trigger operations clean the spray guns and parts after use.</p> <p>7. The principle of airless spray.</p> <p>8. Spray equipment faults and methods of rectifying the faults e.g. flatter spray, faulty spray patterns, spray fog, paint leakages from gun, faulty packaging, air leakage from gun, oil in air line, compressor over heating.</p> <p>9. Common spraying equipment faults.</p> <p>10. Construction of the painter's brush and causes of its deterioration e.g. the</p>	<p>1. Sketch an air compressor; describe its working principles.</p> <p>2. Emphasize on durable equipment.</p> <p>3. Demonstrate the method of operating air compressor.</p> <p>4. Check engine oil level always.</p> <p>5. Sketch the different types of spray guns and label the various types and parts.</p> <p>6. Emphasize the situations suitable for their uses.</p> <p>7. Demonstrate method of cleaning guns used in different types of painting materials e.g. cellulose paint, oil paint, synthetic enamel, acrylic paints etc.</p> <p>8. Dismantle, clean, lubricate, grease and reassemble.</p> <p>9. Demonstrate the principle of operating the airless spray unit.</p> <p>10. Demonstrate the use of an airless spray unit.</p> <p>11. Explain instruction supplied with spray painting equipment plan simple maintenance exercise on how to</p>

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		<p>materials for making painter's brushes – animal hair, vegetable fibre.</p> <p>11. Some painters tool and equipment and their applications e.g. Vanish brush, touch up brushes, scrappers, stainers, rollers, pallet knife, polishing machine, dual action and oscillating sander, mixing gauge.</p> <p>12. Care and maintenance of painting tools e.g. brushes and rollers.</p>	<p>maintain the equipment.</p> <p>12. Emphasize on the care of brushes, tools and equipment.</p>
9.	<p><u>Safety Regulation and Practice</u></p> <p>1. List and explain the responsibilities of employer and employee on safety, health hazards and state their causes and the preventive measures.</p> <p>2. Describe and identify a typical materials storage system and state the function of basic equipment safety rules and regulation for use in vehicle painting workshop.</p> <p>3. Undertake first aid application and routine application of safety measures of works.</p>	<p>1. Responsibility of employer to safety in paint shop e.g. print copy of the health regulation; the cellulose solution regulation; workmen compensation and other safety acts.</p> <p>2. Health hazards in painting and industrial finishing workshop e.g. fire burns, industrial dermatitis's toxic fumes, dust etc.</p> <p>3. Typical painting materials store e.g. shelves and cupboards.</p> <p>4. Function of basic safety equipment for painting shop e.g. fire extinguisher, face mask and respirators, overall, fume and dust extractors, safety shoes or boot, industrial gloves, safety helmet goggles etc.</p> <p>5. Safety precaution in a vehicle painting workshop: wearing and regulation rules.</p> <p>6. Importance of first aid application during minor cut, electric shock, contact with irritants, burns, fume poisoning etc.</p> <p>7. Importance of routine application of safety measure at work.</p>	<p>1. State the responsibility of the employer and employee with regards to safety in vehicle paint shop.</p> <p>2. Demonstrate the operational principles of</p> <ol style="list-style-type: none"> Women's compensation and other Act; Knowledge of the painter and the law should be acquired. <p>3. Observe all regulation relating to health hazards in painting and industrial finishing workshop.</p> <p>4. Demonstrate the size and layout of store required.</p> <p>5. Insist on good ventilation.</p> <p>6. Discuss the importance of safety precaution.</p> <p>7. Demonstrate the use of the function of each of the safety equipment.</p> <p>8. Display signs in the spray painting shop.</p> <p>9. State method of treating some minor accident in the spray painting workshop.</p> <p>10. Mention safety method which should be applied in every work undertaken in the spray painting job.</p> <p>11. Insist on having first aid box.</p>
10.	<p><u>Spray Booths and Ovens</u></p> <p>1. Identify the basic consideration in the location and planning of layout and facilities, sketch the standard structural and facilities requirements, showing the</p>	<p>1. Factors affecting location of a vehicle painting shop.</p> <p>2. Layout of a spray booth.</p> <p>3. Typical low bake and bake conveyor ovens.</p> <p>4. Necessary booth conditions for effective spraying.</p> <p>5. Merits of moving Vehicle in paint shop</p>	<p>1. Sketch out a standard spray booth. Indicate lighting positions and special features required at the booth.</p> <p>2. State safety installation requirements and storage facilities.</p>

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	<p>layout features of a low bake and bake conveyor ovens.</p> <p>2. State booth condition for effective spraying and describe methods of their attainment, explain their relative merits of moving vehicles in the paints shop.</p> <p>3. Explain the basic elements in the organisation of a vehicle painting shop.</p>	<p>i.e. manual, mobile hydraulic jacks; rail and bogie system.</p> <p>6. Elements in the organisation of vehicle paint shop i.e. elements of supervision; organisational knowledge and ability.</p>	<p>3. Identify and compare a typical low bake and bake conveyor ovens.</p> <p>4. Sketch diagrams of low bake and bake conveyor ovens</p> <p>5. A visit to vehicle painting workshop having all the requirement of standard workshop.</p> <p>6. Examine and understand the difference methods of moving vehicles ins the paint shop.</p> <p>7. Demonstrate the operation of different equipment.</p> <p>8. Discuss the maintenance of each type method.</p> <p>9. State the importance of strict time keeping.</p> <p>10. State the main requirements for establishing and maintaining good working relationship between apprentices/worker.</p> <p>11. Emphasise on supervision.</p>
11.	<p><u>Colour Organisation and Colour Mixing</u></p> <p>1. Illustrate primary, secondary and tertiary colours and explain the principle of pigment and interpret colour identification plate (systems) formula.</p> <p>2. Explain the effect of weather on the colours and mix paints to specification using mixing gauge or gravimetric method.</p> <p>3. Determine the viscosity and paint system.</p>	<p>1. Relationship between primary, secondary and tertiary colours</p> <p>2. The principle of pigment mixture colour circle and munshell scale.</p> <p>3. Colour identification plate or common car models.</p> <p>4. Effect of weather on automobile colours in relation to refinishing work.</p> <p>5. Specific materials required and colour to be matched.</p> <p>6. Viscosity of thinned paints sby flow cup method e.g. cellulose, synthetic and acrylic classes sof paints.</p> <p>7. Paints system for wood body finish.</p>	<p>1. Undertake the following:</p> <ol style="list-style-type: none"> Construct the colour and paint out primary colours. Colour circle and paint out secondary colours. Colour circle and paint out tertiary colours. <p>2. Demonstrate the relationship between primary, secondary and tertiary colours.</p> <p>3. Demonstrate the mixing of pigment-tricolours with other colours and note the difference.</p> <p>4. Demonstrate the painting of a colour circle with pigmentry colours.</p> <p>5. Discuss the role of atmospheric condition/ moisture in the deterioration of paint colour.</p> <p>6. Mention different types of</p>

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			<p>paint that can withstand atmospheric condition for some time without losing the colour.</p> <ol style="list-style-type: none"> 7. Stress the importance of using a good quality of a paint which contain good pigment not susceptible to weather effect. 8. Discuss the effects of weather on refinishing automobile colours in relation to refinishing work. 9. Samples effect of weather on automobile colours in relation to refinishing work. 10. Show three types of colour mixing e.g. primary, secondary and tertiary colours. 11. Demonstrate the use of mixing the gauge and the use of gravimetric method in colour organisation and colour mixing. 12. Demonstrate the method for testing thinnes or viscosity by the use of flow cup method and avoid reaction between materials of differing physical and or chemical characteristics. 13. Identify different types of wood: porosity, texture. 14. State appropriate material for priming, under-coating and finishing.
12.	<p>Job Planning and Cost</p> <ol style="list-style-type: none"> 1. Explain the need for planning and refinishing jobs and state the importance of costing before commencing a job 2. Identify and explain the elements, general procedure and estimate surface area in the costing of finishing and refinishing job. 3. Cost the quantity of paint to be used in any given finishing or refinishing 	<ol style="list-style-type: none"> 1. Adequate planning of finishing and refinishing jobs and identification of basic elements e.g. size, nature and condition of parent material. 2. Standard of finish. 3. Paint system to be used. 4. method of application and equipment. 5. Importance of costing before commencing a job. 6. Elements ins the costing of finishing and refinishing jobs, e.g. parent material preparatory, material cost, labour constant, labour hourly rate, cost of overheads profit. 7. General procedure in the costing of 	<ol style="list-style-type: none"> 1. Demonstrate various standards of preparation and working procedures in job planning and costing. 2. Discuss the importance of reasonable costing before commencing a job. 3. Discuss relationship between the size of the job and time allocation. 4. Explain the method used in calculating cost for tear and wear of equipment. 5. Demonstrate the method

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	jobs.	refinishing job. 8. Area to be painted and quantity of paint to be used. 9. Costing: a. painting job involving job application. b. Spraying of newly prefabricated metal or wood bodies c. Refinishing over an existing finish. d. Local repair.	of inspecting the job. 6. Demonstrate the method of measuring surface area. 7. Emphasize on the use of measuring instrument for calculation. 8. Explain the method of calculating quality of materials that will cover the surface and also cost for labour overhead profit.
13.	<u>Vehicle Painting Principles and Processes</u> 1. Explain simply the rusting action and forms of metal corrosion and list measures for prevention of rusting. 2. Describe application methods and equipment used in relation to the nature of work; 'high baked' low baked and stoving processes. 3. Explain special problems associated with spray painting and outline the general procedure for carrying out complete spray painting. 4. State and explain the relative merits of hot and cold spraying methods and adequate preparation of the surfaces. 5. Prepare newly fabricated and rusting (old) ferrous metal surfaces aluminium alloy-surfaces, glass fibre reinforced plastics and resinous oily wood; masking operation in organize and execute operations involved in spray painting jobs. 6. Identify the essential general final detail operation after spraying and explain their importance. 7. Identify defects in spraying painting, causes and preventive measures; execute final detail operations after spraying.	1. Rusting action and other metal corrosion. 2. Measure for preventing of rusting and metal corrosion. 3. Methods and equipment used in relation to the nature of work, paint system and finish required in painting processes e.g. brush application, spray painting, dipping process, flow coating process, curtain coating process, roller application, electro-deposition process, wet application. 4. Principles of 'High Baked' and stoving process. 5. problem associated with spray painting of various geometrical surface and demonstrate gun motion for best effect. 6. the general procedure for carrying out complete spray painting over an existing finished jobs involving multi-colours; protection of their surfaces etc. 7. Merits of hot and cold spraying. 8. Importance of adequate preparation of surfaces spraying. 9. Methods of preparing metal and wood surfaces for finishing and refinishing processes i.e. a. Use of paint remover. b. Abrasive cleaning. c. Acid prickling treatment with phosphating liquid. d. Flame cleaning. e. Washing with cellulose thinners f. Use of aluminium paint for resinous wood. g. Shot blasting. 10. Preparation of newly fabricated and rusting surfaces for spray painting e.g. a. Old ferrous metal. b. Aluminium alloy c. Glass fibre reinforced plastics. d. Resinous oily wood. 11. Masking operation e.g. on automobile body. 12. Organisation and Execution of spray	1. Explain the cost of rust mill scale. 2. Discuss electrolytic action. 3. Show a corroded metal to the students. 4. Demonstrate the system of preventing metals from corrosion either by applying appropriate primers of other coating materials. 5. Demonstrate methods of spreading and distribution of paint with the brushy. 6. Practice the technique in the use of the spray gun. 7. Identify and teach the student 'the methods of achieving high baked' 'low baked' and stoving process. 8. A visit to automobile assembly plants e.g. Volkswagen, Peugeot, layland is recommended. 9. Discuss special problems associated with spray painting of various geometrical surfaces and how to prevent them. 10. Effects of arching, tilting and holding the spray gun too close or too distant should be shown. 11. Demonstrate spraying over an existing finished jobs involving single and multi-colours. 12. Demonstrate the preparation of metal and wood surface for painting. 13. Emphasize on through preparation and the use of

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	<p>8. Inspect finishing and refinishing job for finish standards and defects and take preventive or remedying methods against defects in vehicle</p>	<p>painting with i.e. cellulose paint synthetic (half hour enamel) acrylic enamel and other classes of metallic paints:</p> <ol style="list-style-type: none"> a. complete spray from bare metal] b. Refinishing over an existing finish. c. Local repair. <p>13. Essential detail operation after spraying e.g. removal of masks, burnishing, polishing, removal of over spray, cleaning and refitting parts removed vacuum cleaning of the interior, lining work.</p> <p>14. Defects in spray painting, causes and preventive measures e.g. blistering, blooming, blushing, bridging, cob-webbing dry spray, brittleness excessive over spray lifting, orange peel, pin-holding, runs, sags, curtain shelving, discolouration grinding etc.</p> <p>15. Detail operation after spraying e.g. removal of masking, burnishing, polishing, removal of over spray cleaning and refitting of parts removed, vacuum cleaning of the interior, lining work.</p> <p>16. Quality of finishing and refinishing jobs.</p> <p>17. Preventing or remedying methods against defects in vehicle painting.</p>	<p>appropriate primer where necessary.</p> <ol style="list-style-type: none"> 14. Demonstrate the methods of preparing different surfaces e.g. old ferrous metal, newly fabricate aluminium alloy, glass fibre reinforced plastics and resinous oily wood. 15. Note the method of application and removal of masking tape after spray painting. 16. Discuss the operations involved in spray painting jobs and methods of application and use synthetic (half hour enamel) acrylic enamel and other classes of metallic paints. 17. Emphasize on appropriate techniques in the application of the different materials. 18. Demonstrate a knowledge of paint defects and explain the causes and its preventive measures. 19. Show samples of various defects to the students. 20. Describe the methods to be adopted and the techniques involved in carrying out the operation. 21. Check finishing and refinishing jobs for defects. 22. Discuss the defects and explain the causes and how they can be rectified. 23. Discuss methods of preparing surfaces e.g. ferrous metal, wood, finishing and refinishing work. 24. Care and protection of already painted vehicle against weathering.

091 – VEHICLE BODY BUILDING (WOOD AND METAL)

S/N	TOPICS/OBJECTIVE	CONTENT	ACTIVITIES/REMARK
1.	<p><u>Shop Safety</u></p> <p>1. Explain the responsibilities of the employers and employees on safety potential sources of accidents, first aid equipment application in case of accident, safety equipment and wears, and the Factory.</p> <p>2. Acts: safety rules and regulations metal body building ship</p>	<p>1. Responsibilities of employers and employees in safety precautions.</p> <p>a. Provision of safety guides.</p> <p>b. Use of safety protective materials.</p> <p>c. Observe all precautions etc.</p> <p>2. a) Sources of accidents in metal workshop</p> <p>i. Faulty electrical circuits and equipment</p> <p>ii. Toxic and inflammable substances.</p> <p>iii. Untidy shop etc.</p> <p>b) Prevention – keep to all safety rules in workshop</p> <p>3. First aid equipment in metal workshop</p> <p>4. First aid application in case of minor and severe cuts e.g. cotton wool, iodine etc.</p> <p>5. Safety equipment and wears in metal body building workshop</p> <p>a. Gloves</p> <p>b. Hardshoes</p> <p>c. Dust/Exhaust Extractors</p> <p>d. Extinguishers</p> <p>6. Factory Act. Pick relevant clues.</p> <p>7. Various safety rules and regulations in motor body shop – wearing protectives.</p> <p>8. The application of safety rules and regulations.</p>	<p>1. Demonstrate the uses of necessary safety materials.</p> <p>2. Demonstrate how faults are detected and how to avoid them in the workshop.</p> <p>3. Show by way of example how materials in first aid box are applied to any accident within in the workshop.</p> <p>4. First aid application may include artificial respiration cold compress dressing etc.</p> <p>5. State factory act on shop safety.</p> <p>6. State various safety and regulations on metal body.</p> <p>7. Display safety charts.</p>
2.	<p><u>Materials</u></p> <p>Define, describe and distinguish compositions, process of manufacture mild steel sheet, ferrous and non-ferrous, alloys and explain the properties of materials influence their choice and application in body construction in auto-body metals.</p>	<p>1. Different between ferrous and non-ferrous metals.</p> <p>2. Basic composition, physical properties and application of ferrous metal used in auto mobile industries.</p> <p>3. Mild steel: low carbon contents.</p> <p>4. Definition of ‘alloy’; types of ferrous and non-ferrous alloys e.g stainless steel, aluminium alloy, zinc-base etc.</p> <p>5. The supply of ferrous and non-ferrous metals sheets, bars rods.</p> <p>6. The properties of materials and their influence in body construction e.g. Ductility, Malleability, Fusibility, Conductivity, Elasticity, Toughness, Resistance to Corrosion, Sound and shock absorption strength, weight ratio, thermal insulation etc.</p> <p>7. Test for tensile and compressive strength hardness and malleability.</p>	<p>1. Demonstrate and explain the different between ferrous and non-ferrous metals.</p> <p>2. ferrous metals should include wrought iron, mild steel, medium and high carbon steel, high tensile steels, casts iron and dee drawing steel.</p> <p>3. Give some examples of ferrous and non-ferrous metal.</p> <p>4. Define/test metal properties.</p> <p>5. State the compositions of the common mild steel use in motor vehicle body building.</p> <p>6. Show different shapes of metals.</p>
3.	<p><u>Aluminium and Standard Metal Section</u></p> <p>1. State and describe with sketches the metal sections, common forms</p>	<p>1. The use of metal section in body building e.g. Tee-section, angle side metal section, tophat, zed, angle, side rave, J and Tee section.</p> <p>2. Common forms of brackets:</p>	<p>1. Sketch the section in vehicle body building.</p> <p>2. Sketch the extruded aluminium section and show advantages.</p>

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	of brackets and gussets. 2. The merit of extruded aluminium and other standard sections.	a. Functions b. Applications 3. Merits of extruded aluminium and standard sections in body building weight, straight etc.	
4.	3. The functions and applications in body building. 4. Name, outline, state and explain the use and relative merits of glass, manufacture, reasons for the use of curved wind screens and back light and sealers commonly used in fixing windscreens and explain the properties and materials of their application.	1. Merits of glass in vehicle body building: a. Beautification b. Prevents wind c. Provides wide vision etc. 2. Process of manufacture of various types of glass 3. The use of curved wind-screen and back light e.g. a. Reduction in wind noise b. Wide angle of vision c. Beauty etc. 4. Seals commonly used in fixing windscreens and back lights a. Methods of application b. Their properties. 5. Methods of glazing body building for: a. Water Sealing b. Draught c. Dust exclusion.	1. Fix a new wind screen to vehicle whose windscreen is broken and try to seal it. 2. Sketch methods of glazing.
5.	<u>Plastic in Body Building</u> State identify and describe the difference between thermosetting and thermoplastic, the uses of the particular types of plastics and basic composition automobile industry.	1. Difference between thermosetting and thermoplastics plastics. 2. Their merits in automobile industry, common mode of plastics types of plastics. 3. a) Body work component made of plastics e.g. a. Wind Screen; b. Light Covers; b) Reasons to protect light and wind etc. 4. Reasons for more demand of plastics in automobile industry – cheaper etc. 5. a) Composition of glass fibre b) Its application in automobile industry.	1. Identify thermosetting and thermoplastics plastics in the workshop. 2. Identify plastic in motor vehicle body building and advantages.
6.	<u>Body Hardware and Furniture</u> Name and sketch various types of common body hardware and explain the principles and methods of fixing and fitting it.	1. Types of common body hardware for all vehicle private, passenger and commercial bodies e.g. check arms, regulators, ventilators, fans. a. support lucks; b. Boot hinges, strikers; c. Doors handles, rear, view mirrors, ducting bowls etc. 2. Principles and method of fixing fitting body hardware and body furniture – use of water proofing compounds and sealants.	Practical demonstration
7.	<u>Tools and equipment</u> Identify essential power tools,	1. Essential power tools used on body construction e.g. disc, sanders, belt	1. Construct a vehicle body or undertake repair in a

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	uses and under take care and maintenance of tools and equipment.	<p>sander, electric shears, electric nibblers, s guillotines, folder. Power, drills, bending rollers, presses and brakes trepanning tools.</p> <p>2. Selection of correct tools and equipment for the job at hand.</p> <p>3. Regular care and maintenance of tools and equipment.</p>	<p>vehicle body using all necessary tools.</p> <p>2. Use of machine involve setting up and operation clean and oil tools after practical section.</p> <p>3. Emphasize on the safety use of tools.</p>
8.	<p><u>Body Work Components and features</u></p> <p>1. Explain and describe the difference between the relative advantage of integral and composite body construction sketch the layouts and chassis structure of typical models.</p> <p>2. Name the materials used in the bodies construction, identify body work components, methods of assembly with sketches, methods of increasing strength and rigidity of the various body panels and frames.</p> <p>3. Cite and illustrate design and layout standards of various types of passenger and commercial bodies.</p>	<p>1. Difference, advantages of integral and composite constructions e.g. mono-construction e.g.</p> <p>a. mono-construction</p> <p>b. separate constructions</p> <p>2. Layout and chassis structure of vehicle models e.g. Ambulance, Bus, Van, Saloon Cars, Estate Cars e.g. 504 Peugeot Station Wagon.</p> <p>a. Bus, Omnibus</p> <p>b. Haulage Vans</p> <p>3. Methods of moulding platform, vans, coaches and saloon bodies to the chassis sub-assemblies and the functions:</p> <p>c. Bending</p> <p>d. Forming etc.</p> <p>4. Functions and locations of sub assemblies of body building e.g.</p> <p>e. front and rear suspension</p> <p>f. steering gear</p> <p>g. engine and clutch</p> <p>h. transmission system</p> <p>i. brakes</p> <p>5. a) main electric circuit components, functions, locations and assembly.</p> <p>b) functions, control box</p> <p>c) locations, distributor unit and coil.</p> <p>6. The materials used in the construction of the bodies such as:</p> <p>j. Saloon bodies-m/steel sheets;</p> <p>k. Omnibus m/steel sheet</p> <p>l. Refrigerated bodies – aluminium/tin sheet.</p> <p>m. Haulage Van – m/s sheet</p> <p>n. Tankers – m/steel sheet</p> <p>o. Tipper – m/steel sheets.</p> <p>7. Body component or subassemblies in commercial and public vehicle.</p> <p>8. Method of increasing strength and rigidity of various body panels and frames e.g.</p> <p>a. wiring</p> <p>b. rolling</p> <p>c. swaging</p> <p>d. curvature</p> <p>e. flanging</p> <p>9. Details of vehicle body component and assemble form design. The design and</p>	<p>1. Draw a vehicle showing clearly the structure and chassis.</p> <p>2. Sketches layout and chassis of vehicle models.</p> <p>3. Produce a vehicle body in the workshop applying all methods of moulding.</p> <p>4. Locate and explain the functions of front and rear suspension, steering, gear etc.</p> <p>5. Show and explain various types of electrical circuit components in assembled vehicle.</p> <p>6. Explain why the materials are used in motor vehicle body building works.</p> <p>7. Methods of assembly and advantages.</p> <p>8. Methods of assembly to be identified should include:</p> <p>p. use of bolt, screws, riverts</p> <p>q. sheet metal joint</p> <p>r. guests brackets and boxes as re-enforcement.</p> <p>9. Read from design drawing.</p> <p>10. Design in details as layout standard for construction of various passenger and commercial bodies.</p> <p>11. Practice regularly the manufacturers and trade hand book regulations for design and construction.</p>

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		<p>layout standard for the construction of passenger and commercial bodies:</p> <ol style="list-style-type: none"> setting layout standards luggage compartment gangway headroom overhead position of control. <p>10. Current government and motor manufacturer and traders hand book regulation for design and construction of various vehicles bodies.</p>	
9.	<p><u>Body Work Construction Process</u></p> <ol style="list-style-type: none"> Identify, compare and sketch common production method of typical automobile body workshop and list and label the essential services. Explain the functions of jigs and fixtures for drilling, the functions and application of templates, the planning and operation scheduling and steps in each stage of construction. 	<ol style="list-style-type: none"> Common production methods of body work construction process for large scale, low scale and one off. <ol style="list-style-type: none"> layout of typical automobile body production workshop. functional relationship of various sections and department. Essential service in the workshop – building and repair of motor body. <ol style="list-style-type: none"> jigs and fixtures used for welding, drilling and assembly of body parts. their merits, functions and application of jigs of fixtures for drilling welding and assembly of body parts. Functions and application of template and formers in body production. Planning procedures in metal body construction. Inspection of jigs, former and fixture for different forms of assemblies. Planning procedures in construction for metal body and the principles involved in a construction programme. Steps to sbe taken at each stage of construction based on specifications and standard. <ol style="list-style-type: none"> design cut materials to sizes folding of parts etc. Use of working drawing. 	<ol style="list-style-type: none"> Design an automobile body workshop layout with provision for different sizes e.g. vehicles body production. Sketch the layout. Design of jig and explain the function. Demonstrate step by step stages of construction of one of metal body construction. Operation base on working drawing.
10.	<p><u>Standard Specification</u></p> <ol style="list-style-type: none"> Prepare, design details drawing and estimate of materials for the cost of labour and materials, operations process plan for the construction of the projects. Design and produce jigs, fixtures and formers, develop templates and select materials for 	<ol style="list-style-type: none"> The design and details drawing of: <ol style="list-style-type: none"> Metal fixed side lorry body Metal dropsied lorry body Metal van body. Estimate of materials required for each mentioned above and the labour cost. Also operation process of all mentioned in (1) above. The design and production of jigs, fixtures and formers for projects mentioned above. Development and production of necessary 	<ol style="list-style-type: none"> Design and produce a comprehensive projects involving all standard specification. Both design and detail drawings must be in accordance with accepted practice in body building industries in Nigeria. For made-up vans and omnibuses,s trainees should demonstrate

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	components and sub-assemblies to standard specification.	<p>templates.</p> <ol style="list-style-type: none"> 6. Section of materials and components for all body work assemblies of given specification. 7. Identification and rectifications of faults in the production process. 8. Assemble body work to specification, check the faults in the course of construction. 	<p>competence in the construction door, windows windscreen and backlight opening as well as installations of opening fitments and door leaves.</p> <ol style="list-style-type: none"> 4. Attention may be paid to the following faults among others. 5. Faults in body mounting. 6. Measurement and setout in accuracies 7. Body misalignments. 8. Faults in joints (Welded, bolted etc.), 9. Glazing faults.
11.	<p><u>Surface Protection</u></p> <ol style="list-style-type: none"> 1. State and explain reasons for protecting newly metal surface, the causes and methods of prevention of corrosion, name types of anti-corrosion treatment for ferrous and non-ferrous metals. 2. describe various techniques of surface preparation for anti corrosion, application of cloth or dry cloth and air line to remove rust particles. 3. List precautions to be observed to ensure good adhesion and surface finish and prepare fabricated surface and apply anti-corrosion treatment. 	<ol style="list-style-type: none"> 1. Reasons for protecting newly fabricated metal surfaces – rusting, corrosion etc. 2. Causes and methods of preventing corrosion water, moisture etc. - oiling, painting etc. 3. Various techniques of surface preparation for anti-corrosion application. <ol style="list-style-type: none"> a. wire brushing b. surface grinding c. use emery cloth d. wash with cellulose thinners etc. 4. Precautions to be observed to ensure good adhesion and surface finish of anti-corrosion. 5. Preparation of fabricated surface and application of anti-corrosion treatment. 	<p>Prepare a fabricated projects in the workshop and apply all anti-corrosion treatment and prevention.</p>
12.	<p><u>Shop Safety</u></p> <ol style="list-style-type: none"> 1. Explain the responsibilities of the employer and employee regarding safety, sources of accidents, first aid equipment and its application in event of accident in the workshop. 2. Identify safety equipment and wears clauses of the factory Act on shop safety rules and regulations, application of safety rules and regulations at auto 	<ol style="list-style-type: none"> 1. Responsibilities of employer and employee. 2. Sources of accidents: careless misplacement of materials and tools, electrical faults, linkage of cables etc. <ol style="list-style-type: none"> a. fault electrical circuits and equipment. b. Toxic and inflammable substances. c. Untidy workshop d. Machinery and equipment in use etc. 3. First aid box – explain the importance of first aid box and application in case of accident, severe cuts, electric shock etc. 4. First aid application – artificial respiration 	<ol style="list-style-type: none"> 1. Workshop management chart exercise and practice on the safety precautions. 2. Positions the first aid box and demonstrate on the types of medicines inside the box. 3. Inspect the compliance with safety rules.

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	body wood workshop.	<p>use of cold compress, dressing, tourniquat etc. contact with irritants, burns etc.</p> <ol style="list-style-type: none"> Safety equipment and wears are: Overall goggles, gloves, hardshoes, fire extinguishers, dust extractors etc. The chart of safety rules and regulations. The factory act in safety. Apply the safety, keep the area clean. 	
13.	<p><u>Use of Tool and Equipment</u></p> <ol style="list-style-type: none"> List and describe with sketches the features of a wood work bench and its applications and describe methods of care and maintenance of bench and classes of hand tools, uses and sharpen cutting edge. Identify and state functions of hand tools. 	<ol style="list-style-type: none"> Bench application, bench vice, cutting board, g. Cramp, sash cramp, bench holdfast. Demonstrate on the operations in the workshop. The maintenance of the tools. Some geometrical tools: marking knife, pencil, metric scales (folding rule, retractable). Functions of basic tools squared (try square, sliding level, combination square; gauges marking/cutting gauge). The tools are: there as above Cutting tools: parting and shaving; planes (metal and wood) chisels firmer, paring, mortise) etc. <ol style="list-style-type: none"> Abrading and scrapping; saws (rip saw, hack saw, cross cut, scraper, rasps, files etc. boring, brace and bit, gimlet, bradawl etc. Sharpening at 25°/35° angles, lubrication and storage in isolation. percussion and impelling tools. Hammers, (cross pein, claw) carpenters mallet, nail punch, pincers screw drivers etc. Choose and use correct tools for appropriate jobs. Storage. 	<ol style="list-style-type: none"> Display hand tools Identify hand tools, classes, functions and maintenance.
14.	<p><u>Power Tools</u></p> <p>Identify power tools, features and working principles, operation set up and operate and find out the faults, care and maintenance of the power tools.</p>	<ol style="list-style-type: none"> The essential power tools are: portable power drills, portable sanders, the band saw, surface plainer, cross cut saw etc. Operations – cutting, planing, drilling, sandling etc. Set up the machines: fence, guard, cutters etc. Faults replacement of fuse, drive belt, pulley adjustment etc. Practical. 	<p>Demonstrate the operations, explain, common faults in power tools and how it can be rectified.</p>
15.	<p><u>Materials</u></p> <p>Describe, identify and sketch parts of trunk, and state their characteristics and functions common Nigerian timber, appearance working quality</p>	<ol style="list-style-type: none"> Parts of trunk pitch or medulla, through wood or heartwood, sapwood, cambium layer, bark or cortex, medullary rays or rays growth ring etc. Difference in soft and hardwood: cell structure, colour, texture etc. 	<ol style="list-style-type: none"> Sketch the parts of a trunk and its functions. Show pieces of Nigerian Timbers

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	and properties and their suitability for automobile body construction.	<ol style="list-style-type: none"> 3. Common Nigerian timbers; Mahogany, Iroko, Cedar (Sider), Afara, Abura, Opepe, Obeche, Sapele, Utile. 4. Reasons in the term of physical properties: Toughness, stiffness, durability, density, elasticity, weather, resistance etc. 	
16.	<p><u>Conversion, seasoning and preservation</u></p> <ol style="list-style-type: none"> 1. Explain and describe conversion, and seasoning methods types and state the advantages of using them in body constructions. 2. Describe them, conversion and seasoning method with sketches and state the merit and demerit. 3. Explain the meaning and importance of moisture content (MC) of timber. 	<ol style="list-style-type: none"> 1. Conversion: break the 100g into marketable sizes. 2. Method of conversion: <ol style="list-style-type: none"> a. live sawing (through and through) b. back sawing (tangential flat or slash cut) c. quarters sawing (radial or rificut) d. physical characteristics (shrinkage and grain). 3. The timber seasoned – light, reduce warp, and corrosion etc. 4. Air seasoning: Kiln season (compartment kilns and progressive kilns); Shelter – air seasoning economically kilns heat save toe etc/steams. 5. Moisture content – Amount of moisture in cells $M.C = \frac{wt - dt}{dt} \%$ 6. <ol style="list-style-type: none"> a) growth defects: brittle, heart, heart rot, knots and shakes. b) Seasoning defects: check split, warp. c. other defects: dry and wet not weathering insect destruction. 7. Prevention of deterioration or destruction of wood due to fungi, insect, weather and fire. <ol style="list-style-type: none"> a. Oil preservatives, creosote or coal-tar b. Unleachable salts c. Water soluble preservatives e.g. zinc chloride. 	<ol style="list-style-type: none"> 1. Explain the conversion by sketches 2. Sketches seasoning methods take account of precaution against defects. 3. Sketches seasoning methods take account of precaution against defects. 4. State the recommended range of M.C. for construction timber. 5. Visit a saw mill or a timber industry. 6. The application of preservation, methods of application and its advantages. 7. Note that specific trade names in the market should be studied.
17.	<p><u>Manufactured Boards</u></p> <p>State the sizes and outline the characteristics and explain the manufactured board in automobile body construction.</p>	<ol style="list-style-type: none"> 1. The characteristics of manufactured board plywood, metal-faced, plywood, hard board, chip board etc. 2. Sizes (1,220 x 2440mm) etc. 	
18.	<p><u>Wood Adhesives</u></p> <p>Name and explain classes of wood adhesive glue, terms and outline the properties and method of applications.</p>	<ol style="list-style-type: none"> 1. Wood adhesives: <ol style="list-style-type: none"> a. protein adhesive b. synthetic resin adhesive c. contact or impact adhesive 2. Apply and explain the properties of the adhesive. 3. The glue terms: <ol style="list-style-type: none"> a. pot life b. self life c. assembly time 	

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		d. croamping time, regarding wood adhesives.	
19.	<u>Nails, Screw and Fittings</u> State information, the use of various types of nails, screw and fitting and the holding power.	<ol style="list-style-type: none"> Types of nails, screw, fitting threading and shank Information in order for nails or screws: quality metal, types, coating and sizes. 	<ol style="list-style-type: none"> Demonstrate the use of glue. Identification of nails, screws, and fittings.
20.	<u>Wood Joints</u> Name and sketch body work joints, their uses at various points and construct the various wood points in the body.	<ol style="list-style-type: none"> Types of body work joints: butt joints, bridle joints, mortise and tenon joints, dowelled joints, lap joints, splice joint etc. The construction work in a particular joints in platform, side-frame and roof stick etc. 	Sketch the joint and explain their uses.
21.	<u>Standard and specifications</u> <ol style="list-style-type: none"> Cite government/motor manufacturers standards and specification relating to the constructions, describe the planning procedures and identify steps in each stages of construction. Identify and justify the use of various fastening devices and explain with sketches method by which body weight is reduced. State and explain factors to be considered in determining spacing of bearers and methods of mounting under frame. Describe with sketches, method of mounting platform in van and coach construction. State reasons for failure and prepare assembly and working drawing of a specified coach or lorry body. Prepare estimate cost of the materials and labour and operations progress plan on a construction. Prepare cutting list and materials requisitions order in selecting the materials for the body building. Construct to specification of the body on the chassis and identify and rectify faults in the course of 	<ol style="list-style-type: none"> Design cutting list operational materials productivity. Supervision at various stages under frame members: <ol style="list-style-type: none"> platform side members roof members the fastening device: U-bolt, hook – bolt, track – bolt washers, brackets, screws etc. Weight reduces – design of members and choice of materials. Chassis structure, loading specification etc. Sketching Jointings materials, designs body, maintains etc. Preparation of working drawings showing necessary details. Materials requisition order. Costing. Operation charts. The preparation of materials as necessary. Construction of lorry with roof, fixing roof and side canvas (tarpaulin): <ol style="list-style-type: none"> faults in platform mounting; body misalignment; dimension inaccuracies; poor joints. Construction faults. The inspection and testing Preparation of body and spray. 	<ol style="list-style-type: none"> Sketch the joint and explain their uses. Sketch mounting platform method. List and select materials required. Carry out construction of lorry body. Inspect and test vehicle. Spray body and undertake delivery of vehicle to the customer.

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	construction. 9. Inspect and test the vehicle spray – paint and undertake delivery of vehicle to the customer.		

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ARC AND GAS WELDING

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1.	<p><u>Gas Welding Process</u></p> <ol style="list-style-type: none"> 1. Describe features and functions of specified gas welding equipment. 2. Differentiate and compare the oxyacetylene generators. 3. Analyse calcium carbide and generate acetylene using it. 4. Distinguish flames and describe their derivation processes. 5. Discuss welding joints and prepare plates for them. 	<ol style="list-style-type: none"> 1. <ol style="list-style-type: none"> a) Identification of gas welding equipment e.g. generators, regulators, regulators, blow pipes etc, nozzles, hoses, gas cylinders and their colours, economizers check valves etc. b) Features c) Functions d) Applications and care 2. Types of generators e.g. water to carbide, carbide to water generator. 3. Identifying the main parts of a generator e.g. valve purifiers, carbide trays etc. 4. Difference between high and pressure system of welding. 5. Composition of calcium carbide – calcium and carbon. 6. Generation of acetylene. 7. <ol style="list-style-type: none"> a) Types of welding rods – mild steel rods, aluminium rod, brass rod etc. b) Properties c) Compositions and uses 8. The difference between welding and cutting torches. 9. <ol style="list-style-type: none"> a) Types of ox-acetylene flames d) Equal volume of acetylene and oxygen e) More oxygen – Oxidizing (shorter and more pointed inner cone almost purple colour). f) More acetylene-carbonizing. 10. Application: <ol style="list-style-type: none"> i. Neutral – Most welding ii. Oxidizing – brazing iii. Light acetylene, add oxygen. 11. Operation: <ol style="list-style-type: none"> i. Flange joint, corner and lap joints. ii. ‘T’ joint, butt joint. 12. Sketches of conventional symbols for welding joints e.g. fillet joint, butt joint, lap joint etc. 13. Preparation of materials for welding: <ol style="list-style-type: none"> iii. Pieces of sheet metal iv. Fire bricks v. Welding equipment Operation: <ol style="list-style-type: none"> i. Form joints ii. Allow necessary gap iii. Track evenly and weld in down hand flat position. 14. <ol style="list-style-type: none"> a) Functions of backing bars and strips. b) Applications. 	<ol style="list-style-type: none"> 1. Demonstrate the connection of a welding unit given necessary apparatus. 2. Using appropriate sketches show the difference between the water to carbide and carbide to water generators. 3. Discuss the position of water in the generators to show how the water and carbide work together to justify the names of the generators. 4. Sketch and explain the working principles of a gas welding generator and discuss the functions of the main parts. 5. Through practical demonstration explain the difference in the use of the low and high pressure system of welding. Give reasons why one could be preferable to the other. 6. Using a suitable lab, demonstrate the formation of calcium carbide. 7. Demonstrate in the workshop using the common welding transformer – carbide to water system. How acetylene is formed. 8. Discuss through practical example, how to determine whether or not a rod is good or poor. 9. sketch looking like a welding and cutting torch, list the difference between the two, operate them and find out why those differences are necessary. 10. Demonstrate how the flames can be got from the adjustment of the

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			<p>torch and discuss the differences.</p> <p>11. Demonstrate running beads without filler rod. Prepare a 'Tee' joint and weld.</p> <p>12. a) Using appropriate welding symbols, indicate a kind of weld you would want for a lap joint. Show sketch.</p> <p>b) Demonstrate how symbols are used to show how joint should be welded using appropriate sketches.</p> <p>13. a) Demonstrate the preparation of the joints and carry out the welding. Compare butt joint to lap joint;</p> <p>b) Weld without applying a filler rod and weld adding rod. Compare the two and see if there will be remarkable differences.</p> <p>14. Design a suitable backing bar or strip. Use it to carry out a welding operation and explain its functions. Examine and see how the functions are performed.</p>
2.	<p><u>Non-Ferrous and Ferrous Metal</u></p> <p>1. Identify types of non-ferrous metals and describe the properties of materials used in fabrication engineering.</p> <p>2. Identify fluxes, functions and application on cast iron welding.</p> <p>3. Consider components composition and prepare them for bronze welding</p>	<p>1. a) Types of non-ferrous metals e.g. Tin, Copper, Zinc etc.</p> <p>b) Compositions of non-ferrous metals.</p> <p>2. The general characteristics of materials used in fabrication engineering and the physical properties e.g. hardness, ductility, Fusion etc., tenacity, distortion, toughness, strength etc.</p> <p>3. Application and explanation of cast iron:</p> <p>i. mild steel</p> <p>ii. copper, alloy etc</p> <p>iii. high mild steel</p> <p>iv. common copper alloys</p> <p>v. aluminium alloys</p> <p>vi. stainless steel.</p>	<p>1. Using small pieces, how the differences in colour, between copper, aluminium and brass.</p> <p>2. Demonstrate the welding and coding of some metals to ensure that they return their properties.</p> <p>3. Weld two pieces of mild steel, cool immediately in water and observed the sudden hardness of the joint and possible cracks around it.</p> <p>4. Weld pieces of non-</p>

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	operation.	<ol style="list-style-type: none"> 4. <ol style="list-style-type: none"> a) Properties and composition of fluxes for welding non-ferrous metals; b) Functions of the fluxes. 5. Welding of non-ferrous metals with appropriate fluxes. 6. <ol style="list-style-type: none"> a) Composition of cast iron. b) Types of cast iron e.g. gray, white etc. c) Properties of cast iron. 7. Preparation for cast iron welding – Grinder, diamond point chisel, wire brush etc. Flame for pre-heating operation: <ol style="list-style-type: none"> i. remove surface layer ii. V the edges iii. Tiny hole on each end of crack if necessary 8. Welding cast iron components. <ol style="list-style-type: none"> i. dull red before heating. ii. Good grade filler rod. iii. Flux to molten metal. iv Torch in a circular motion v. Pre-heat vi. Cool slowly 9. Suitable fluxes for bronze welding and their composition. 10. Preparation of bronze components for welding. <ol style="list-style-type: none"> i. through cleaning ii. form 90°V groove iii. weld to travel on an incline. 11. Specification of bronze weld. 12. Reasons for post-heating: <ol style="list-style-type: none"> i. stress relief ii. avoid cracks iii. avoid distortion and composition. 13. <ol style="list-style-type: none"> a) types of stainless steel b) properties 14. Preparation of stainless steel components for welding; processes – flange type joints, bevel to provide a V, claps and jigs to avoid distortion and warping. 15. Welding of stainless steel with rods, techniques involved and the safety precautions: <ol style="list-style-type: none"> i. for hand techniques ii. torch and tip position iii. filler rod close to cone iv. appropriate flux and fluxing v. weld from one side only vi. neutral flame vii. columbium treated filler rod viii. use copper backing strips. 	<p>ferrous metals using appropriate flux watch the effect of the flux on the molten metal and then explain the functions of the flux.</p> <ol style="list-style-type: none"> 5. Demonstrate the application of the flux using the filler rod or apply flux with brush if using liquid flux. 6. Demonstrate fusion welding of cast iron objects or pieces. 7. Demonstrate how stainless steel components can be prepared for welding. 8. Using the appropriate rod, flux and joint preparation weld stainless steel component properly observing necessary precautions. 9. Clean up the welded joint thoroughly to avoid weld decay. 10. Demonstrate practically, how to weld stainless steel using stainless steel rods.

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		<ul style="list-style-type: none"> ix. Cleaning: x. wash joint thoroughly xi. brushing off flux residue etc. 	
3.	<p><u>Building up of Worn Mechanic Parts</u> Discuss the composition and properties of worn mechanic parts and the suitable materials to carry out the operation.</p>	<ul style="list-style-type: none"> 1. Identifications: <ul style="list-style-type: none"> a. physical or as per manufacturer properties b. as per the metal used for the object build up operation: <ul style="list-style-type: none"> i. clean up thoroughly ii. use neutral flame iii. use appropriate flux iv. use appropriate rod v. bronze weld or fill up gradually. 2. Building up of given worn metallic surface with the application of all methods and stages of operation. 	
4.	<p><u>Welded Joints, Defects and Rectification</u></p> <ul style="list-style-type: none"> 1. Describe and state how defect can be avoided in gas welding. 2. Apply appropriate tests and state causes of defects in welded joints with their remedies. 	<ul style="list-style-type: none"> 1. Some defects in gas welded joints. Causes: <ul style="list-style-type: none"> a. slow speed and too much flame; b. flame too low and speed high; c. atmospheric contamination d. foreign substance in molten metal e. weld height uneven f. insufficient weld metal above welded surface. 2. Avoidance – normal welding procedure etc. 2. Test to detect defects in welded joints <ul style="list-style-type: none"> a. Non-destructive: <ul style="list-style-type: none"> i. by looking through a magnifying glass ii. penetrating of rays iii. high frequency vibrations or ves. b. Destructive – subject to lead until there is failure. c. Types – tensile, shear, weld uniformity, etching and impact. d. Processes: <ul style="list-style-type: none"> i. tensile, testing machine (pulling to break) ii. Nick break and free bend tests (hultility, porosity, gas pockets, slag inclusions. Overlaps penetration etc). iii. fillet welded joint test (soundness of fillet weld) iv. etch test (soundness of weld and show boundary between the weld and base metals. 3. Rectification of welded joint defects. 4. Common causes of welding defects in 	<ul style="list-style-type: none"> 1. Weld a double vee joint and cut for inspection of defects. 2. Demonstrate the application of the various weld testing method in the workshop practice. 3. a) demonstrate bearing in mind welding procedures and precautions, who a good weld can be carried out in a workshop. b) weld pieces of metal together, watch for any defect, explain why or discuss why. 4. Demonstrate the proper application of gas shielded arc and ancillary processes in welding workshop.

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		gas shielded arc and ancillary welding process: a. bad joint preparation b. too high a current c. too low a current etc.	
5.	<u>Safety Precautions</u> 1. List and explain hazards in arc welding and protective wears required for welding operations. 2. Apply appropriate safety precautions while welding in confined or dangerous areas.	1. a) some hazards in arc welding e.g. arc eye, electric shock etc. b) Causes – improper protection of eye, nose and carelessness with electricity. Solution – Observe necessary safety precautions. 2. Protective wears for welding operations e.g. hand/head shield. i. protect head, eye etc against burns; ii. radiations ray-arc-eye; iii. protect hand and body against burn radiation sparks etc. Care – wear as appropriate and keep safety after use. Precautions to be carried out: i. ventilation, exhaust system ii. thorough cleaning of all combustible substances; iii. venting container, fill with water if possible; iv. fire resisting guds, move away from inflammable materials if possible, fire extinguishers, stand-by watchers with fire extinguishers.	1. Explain the causes of the hazards in arc welding and advice on how they can be avoided. 2. Demonstrate the use of the protective wears required while carrying out arc welding operation. 3. Explain how arc welding can be carried out safely in confined spaces and near inflammable materials. 4. Demonstrate how a drum used for the storage of inflammable or toxic materials can be prepared for arc welding.
6.	<u>Welding Machines and Accessories</u> 1. Differentiate and explain functions of arc welding equipment and its accessories spelling out advantages and disadvantages. 2. Describe materials composition and state conventional electrode classification. 3. Select electrode for welding material and technique/positions involved.	1. Differences between AC and DC Machines. a. Source of electric power. b. Direction of flow of electric current polarity. c. Transformer type and motor generators machines. d. Rectifier e. Magnetic arc blow f. Dual control g. Operating and maintenance cost, overall electrical efficiency and noiselessness. 2. Working principles of AC and DC machines. a. source of power b. adjustment of welding current output c. arc booster switch d. the cables 3. Weld operation of D.C. a. source of power selection of polarity b. switch on control c. current selected d. dual control system welding	1. Demonstrate the function of the various parts of the machines (AC and DC). 2. Demonstrate the operation and use the AC machines by using the two in a welding operation. 3. Sketch and demonstrate how some A.C and D.C welding machines accessories function. 4. a) Demonstrate how the welding machine should be set. b) Use the machine to carry out welding of various operations in the workshop. 5. Pick a metal and select suitable electrode to weld the metal, discuss electrode selection method. 6. Demonstrate how to

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		<p>operation.</p> <p>4. Meaning and functions of welding accessories e.g. welding load – wire brush etc.</p> <p>5. Advantages and disadvantages of A.C and D.C machines:–</p> <p>a. A.C. Advantages: cost, weight, size, arc booster, magnetic arc blow, current flow operation cost, electrical efficiency, noise etc.</p> <p>b. D.C. Stationary or mobile, use dual control, deeper penetration light, gauge materials.</p> <p>c. Disadvantages Source of power, ease of movement, operating cost of ease etc.</p> <p>6. Using of AC and DC welding machines in the workshop - Machines, shield, electrode holder, glove etc. Operations:</p> <p>a. DC welder – set for polarity current straight or reversed.</p> <p>b. Control unit for amperage and voltage (for electrode).</p> <p>7. Safety to observe Electrode manufacturing – Processes:</p> <p>a. forcing hot metal through suitable die (bare electrode);</p> <p>b. extruding and dipping into coating. Coating Substances – Cellulose Sodium, Cellulose Potassium, Tatinia Sodium, Iron Oxide etc.</p> <p>8. Sketch different type of electrode composition materials.</p> <p>9. Classification of electrodes.</p> <p>a. State symbols e.g. E-600, E-7010, E-8010 etc.</p> <p>b. Interpret prefix E and other numbers</p> <p>10. Selection of electrode material.</p> <p>11. Methods of electrode materials.</p> <p>a. dry place, normal room temperature.</p> <p>b. 50% maximum room humidity handling;</p> <p>c. No bending, no dropping, pumping or stepping on.</p> <p>12. Striking and maintaining of metal arc</p> <p>a. tapping or scratching</p> <p>b. correct arc length</p> <p>c. correct electrode current travel speed, electrode angle.</p> <p>13. Arc loading techniques and operations</p>	<p>carefully dry, oven store and handle electrodes in the workshops.</p> <p>7. Demonstrate how to strike metal arc and maintain the arc.</p> <p>8. Demonstrate the process of weaving and laying of multi-runs in arc welding.</p> <p>9. Safety regulations and requirements must be observed.</p>

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		<ul style="list-style-type: none"> a. increasing width and breadth; b. circular movement of hand; c. running more than on run. 	
7.	<p><u>Welding Joints in all positions</u></p> <ol style="list-style-type: none"> 1. Carry out all position welding with sketches for various joints and explain factor governing selection of joints. 2. Interpret various welding symbols and prepare different joints for various techniques and all position welds. 3. Prepare and weld pipes and flanges with different methods and positions. 	<ol style="list-style-type: none"> 1. Sketches and application of joint in metal fabrication e.g. single vee, square butt etc. 2. Factors governing the selection of joints for projects e.g. type of metal thickness of metal, shape of plate, position of joint etc. 3. Various arc welding symbols and conventions e.g. single vee, fillet joint, butt joint, single u double u. etc. 4. <ul style="list-style-type: none"> a) Preparation of edges for welding joints. b) square butt, single vee, double vee, single u, double u. 5. Welding the prepared joints. 6. Preparation of metal surface e.g. Multi-run weld, Weaving welds etc. 7. Making of multi-run weld Operation – run first layer, remove slag and lay second layer etc. 8. Weaving of welds – weave as you weld, secure desired width fillet. 9. <ul style="list-style-type: none"> a) Welding joint positions – vertical position etc. 3. Operational techniques: <ul style="list-style-type: none"> i. running of seam or line of weld – gravity pull, fast-freeze electrode. ii. Shorter arc – overlap (position undercut and improperly shaped beads) iii. Most difficult – work against gravity puddles tendency to drop 10. Various position of welding pipes and flanges. Process: <ul style="list-style-type: none"> a. special pipe clamps b. hold up flange to pipe c. tack and weld. 11. Rotated position of welding pipes and flanges: <ul style="list-style-type: none"> d. lining up each section (length by length), e. welding each joint f. pipe remains stationary g. welding in various positions 	<ol style="list-style-type: none"> 1. Sketch and weld the various joint show weld and where applicable. 2. Sketch and interpret the various arc welding symbols and convention used in engineering working drawing. Show such drawings. 3. Demonstrate the various edge preparation in welding in the workshop. 4. Weld the joint, observing normal welding procedures and safety precautions. 5. Demonstrate the preparation of metal surface for multi-run and weaving welds. 6. Demonstrate the process of making multi-run welds. 7. Demonstrate the weaving action during welding operations. 8. <ul style="list-style-type: none"> a) Prepare joint for vertical, horizontal and overhead welding. b) place the jobs properly and demonstrate welding in the vertical, horizontal and overhead positions check and compare the welds. Observe areas of differences and find out why. 9. Demonstrate the process of welding pipes and flanges. 10. Demonstrate the process of welding pipes and flanges in rotated position. 11. Weld pipe using the stove method explain the difference between the fixed position,

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			rotated position and the stove pipe.
ARC WELDING			
8.	<p><u>Arc Welding Ferrous and Non-Ferrous Metal</u></p> <ol style="list-style-type: none"> Identify by inspection types, physical properties of metals and explain their welding behaviour. State the effect of welding on cast iron and prepare it for various types of welding. Identify types, composition and physical properties of non-ferrous metals. Carry out welding operations on various non-ferrous metals using appropriate equipment and heat. 	<ol style="list-style-type: none"> Identification and inspection of ferrous metals e.g. cast iron, steel etc Physical properties of cast iron – conductivity, grain structure, effects when heated, hardness etc. Behaviour of welded cast iron <ol style="list-style-type: none"> free welding quality poor welding quality Procedure for carrying out welding: <ol style="list-style-type: none"> lower cooling rate of weld, likelihood of hard zone, burns, grease oil, scale, faster welding speed; stress relief, crack avoidance. <ol style="list-style-type: none"> preparation of pieces of welding: <ol style="list-style-type: none"> removal of casting skin as necessary drill 1/8 hole if necessary keep casting as cool as possible correct electrode and amperage reinforce heavy castings with studs etc. Weld as necessary identification of non-ferrous metals: <ol style="list-style-type: none"> colour; composition; copper and zinc – brass Nickel, Chromium iron – inconel Nickel, Copper, iron etc - Monel Composition and physical properties of non-ferrous metals e.g. ductility, fusion, distortion, fatigue, tenacity, effect of heat, hardness, malleability. Selection of suitable electrodes and machines for welding non-ferrous metals. Method of heat treating finished welding non-ferrous metal: <ol style="list-style-type: none"> elevated temperature rapid quenching (in water) keep at room temperature artificial aging or precipitation hardening. <ol style="list-style-type: none"> Process of welding and heat treatment of non-ferrous metals: <ol style="list-style-type: none"> prepare joint clean joint Appropriate rod Flux and welding machine Weld 	<ol style="list-style-type: none"> Weld piece of grey cast iron, white and malleable cast iron. Watch and explain their behaviour in the process and after welding. Demonstrate the preparation of cast iron. Select suitable machine and electrode for welding non-ferrous metals and carry out welding operations in the workshop. Demonstrate appropriate method for the heat treatment of a finished welding of non-ferrous metal. Prepare suitable joint on non-ferrous metals weld joint using appropriate materials and precautions. Heat treatment after welding, cool and allow to remain on room temperature for some days.

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		<ul style="list-style-type: none"> vi. Heat and case harden vii. Metals viii. Copper ix. Bronze x. Brass xi. Monel xii. Inconel xiii. Aluminium 	
	<p><u>Building up worn metallic parts</u> Identify composition of various worn metallic parts and discuss their properties with build up operation.</p>	<ol style="list-style-type: none"> 1. Composition of worn metallic shafts and other parts – gear teeth, shaft etc. 2. Properties of worn smetallic parts: <ul style="list-style-type: none"> a. as per the metal b. weldability c. ductility d. hardness etc. 3. Building up of worn metallic parts to specification: <ul style="list-style-type: none"> a. thorough cleaning b. joint formation (stud) c. appropriate rod and flux d. appropriate welding machine e. proper setting of machine f. pre-heating g. gradual-build up h. post heating 	Following normal welding processes and observing safety precautions weld the worn out parts.
9.	<p><u>Arc cutting of metal</u> State principles application of various cutting method and identify arc cutting electrodes</p>	<ol style="list-style-type: none"> 1. Principles – application: <ul style="list-style-type: none"> i. melting heat of arc between carbon electrode and base metal, jet of compressed air blows molten metal away. ii. a melting process of forcing the molten metal down. iii. high pressure gas through the arc. As a supersonic jet, hotter than any flame, melt metal and blast molten metal through plasma – arc cutting. 2. a) Cutting electrode – carbon electrode, coated mildsteel electrode, carbon graphic electrode. b) compositions and use 3. Cutting of metals – procedures: <ul style="list-style-type: none"> a. proper electrode b. set machine to suit electrode c. metal preferably in a flat position d. start cutting at outside line e. good manipulation 	Demonstrate the cutting of metal by the different arc cutting methods.
10.	<p><u>Welding Defects</u> Describe major defects in arc welding joints and state how they can be tested ad avoided.</p>	<ol style="list-style-type: none"> 1. Major defects in arc welding joints e.g. porosity etc. 2. Solution: <ul style="list-style-type: none"> a. proper welding technique and procedure b. proper current setting, current 	<ol style="list-style-type: none"> 1. Demonstrate and explain how non-destructive testing can be carried out in detecting defects in arc welding joints. 2. Test welded joint using

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		<p>electrode, joint penetration etc.</p> <p>3. a. Tests to detect defects in arc welded joints non-destructive – using magnifying glass, penetration of rays, high frequency vibration of waves etc.</p> <p>b. Destructive:</p> <p>i. subject to load until there is failure types;</p> <p>ii. tensile, shear, weld uniformity, etching and impact.</p> <p>c. Process:</p> <p>i. Tensile testing machine (pulling to break)</p> <p>ii. Nick break and free bend test (ductility, porosity, gas pocket, slag inclusion, overlaps penetration etc)</p> <p>iii. fillet welded joint test (soundness of fillet weld).</p> <p>iv. impact test (absorb energy under impact without fracture)</p> <p>4. Rectification of welded joints – proper welding procedure good beveling, proper heating, good arc control, adequate rod and good welding technique, proper observation of precautions.</p>	<p>the destructive and non-destructive testing methods.</p> <p>3. Carry out a practical demonstration of such techniques and explain the processes.</p>