

II-3 工学部 機械工学科 農業機械



## EAST AFRICAN EXAMINATIONS COUNCIL

### 1020 - AGRICULTURAL ENGINEERING TECHNICIANS CERTIFICATE

#### 1. INTRODUCTION

- 1.1 This scheme for the Agricultural Engineering Technicians' Certificate has been adopted by the E.A.E.C. on the recommendation of its Advisory Committees. It provides for courses and related examinations designed to meet the needs of skilled Agricultural Engineering Technicians in tropical countries, particularly those working in agricultural mechanical service depots, or mechanised farms, soil erosion control measures, land development schemes, or on any other large scale-field operations.

#### 2. PURPOSE OF THE TECHNICIANS CERTIFICATE

- 2.1 The Certificate is a continuation of the Agricultural Engineering Mechanics certificate but has been designed to allow also for lateral entry.
- 2.2 It provides for an advanced study of agricultural machinery tractors and implements, workshop processes and related science. The aim is to provide students with the knowledge and ability which will enable them to solve problems and prepare them for supervisory duties and positions of responsibility. It is intended for students who have already passed the examinations for Agricultural Engineering Mechanics, or perhaps by lateral entry for those who have successfully completed a secondary school course or a secondary technical school course, and have obtained an East African Certificate of Education issued by the E.A.E.C. at ordinary level in English. Mathematics and an approved science subject with credit passes.

#### COURSE OF STUDY

2. The scheme has been devised on the assumption that normally students will attend courses of instruction on a full time, or sandwich basis. It is in three stages.

Part I (about 780 hours) covers the introduction to the working principles and function of tractors and machinery.

Part II (about 1170 hours) deals with overhaul, the diagnosis and correction of faults. Each part is complemented by supporting studies of applied science and Workshop Practice.

It is envisaged that practical work, both in the workshop and laboratory, will form an important part of all courses based on the scheme.

Part III provides for advanced courses of study and qualification at a higher level in the three specialized areas over a period of two terms (or 520 hours instruction) of fulltime study.

3. The subjects of the course are shown below.

PART I      Agricultural Machinery - Function, Operation and  
Maintenance  
Frames and Power Transmission Elements  
Tractors and Power Units  
Workshop Processes and Practice  
Related Subjects  
General Studies

PART II     Agricultural Machinery - Fault Diagnosis and Repair  
Tractors and Power Units  
Workshop Processes and Practice  
Related Subjects  
General Studies

PART III    (Specialized Courses of Study)

A    FIELD ENGINEERING

Mechanisation of Crop and Animal Production  
Installation of Equipment in Farm Buildings

B    FIELD TEST AND DEVELOPMENT

Applied Hydraulics  
Design Evaluation in the selection of Equipment

C STRUCTURE AND ORGANIZATION OF THE AGRICULTURAL  
ENGINEERING INDUSTRY

Organization of Industry Principles of supervision,  
Industrial relations, communication & Administration.

4. General Studies are regarded as an integral part of the course and the aim should be to allocate about 60 hours per year to them in Parts I and II. The Council will not examine in General Studies and colleges are free to devise their own syllabuses and approach to the subject. The Council has published a pamphlet in which an approach to General Studies is suggested.
5. This scheme has been planned in association with Agricultural Mechanic's Certificate.

ENTRY TO COURSE

6. Students for the course must satisfy one of the following conditions or have reached the appropriate standard by an alternative route.

(a) PART I

- (i) East African Certificate of Education issued by the E.A.E.C. at Ordinary level in English Mathematics and an approved science subject with credit passes.
- (ii) Part I certificate of the Agricultural Mechanics Course with credit-pass.
- (iii) Appropriate academic ability in a mature student.

(b) PART II

The students must have completed a minimum of 52 weeks in Industrial attachment before starting the part II.

- (i) A pass in part I of the Agricultural Technicians' Course.
- (ii) A pass in part II of the agricultural mechanics course with credit.

(c) PART III

A pass in the Agricultural Technicians' Course Part II examination.

EXAMINATION REGULATIONS - GENERAL

7. The Council's examinations are conducted in accordance with its General Regulations and Examinations Timetable. Candidates must submit their entries through an examination centre by the date specified in the Timetable.
8. If during the currency of the scheme, the Council deems it appropriate to modify the pattern of the examination and awards, the necessary changes to the regulations will be notified to colleges in advance of their being applied.

ELIGIBILITY FOR ENTRY TO EXAMINATIONS

9. Candidates enter for the Council's examinations as internal candidates.

(a) INTERNAL CANDIDATES

Internal candidates are those who at the time of entry to the examinations are undertaking (or have already completed) the course (including, for part I and Part II, General Studies) at an approved institution.

EXAMINATIONS

10. The examinations for the Agricultural Engineering Technician's Certificates are as listed below. In the examinations for Parts I, II, & III candidates must take all papers on their first entry.

PART I

1020/01	Workshop Processes and Material	3 hours
1020/02	Agricultural Machine's	3 hours
1020/03	Power and transmission (Related studies)	3 hours
1020/04	Drawing, Mathematics and Science	3 hours

Candidates must keep written records of their laboratory and practical work and a selection of these note books may be inspected by the E.A.E.C. each year.

#### PART II

1020/11	Workshop Processes and Materials	3 hours
1020/12	Agricultural implements and Machines	3 hours
1020/13	Tractor Power Unit (Related subjects)	3 hours
1020/14	Drawing, Mathematics and Science	3 hours

Candidates may be referred if failed in either paper 1020/11 or paper 1020/14 provided, he has satisfied the Council's regulations. Candidates must keep written records of their laboratory and practical work and a selection of these note books may be inspected by the Council each year.

#### PART III

1. Field Engineering  
Mechanisation of Crop and Animal Production 3 hours  
Installation of Equipment in Farm Buildings
2. Field Test and Development 3 hours  
Design Evaluation in the Selection of equipment  
Applied Hydraulics
3. Structure and Organization of the Agricultural Enquiries Industry 3 hours
4. Project work assessment

#### PROJECTS

11. In part III a candidate will be required to undertake a minimum of 50 hours' project work under the supervision of a college tutor assigned by the college authorities.

12. The project may relate to more than one of the subjects included in the scheme, and the topic chosen by the colleges must first be approved by the council.
13. The projects will be assessed by the colleges, but the Council reserves the right to call for candidates written accounts of their project work when completed and if the council deems it necessary.

#### EXAMINATION RESULTS AND CERTIFICATES

14. Each candidate will receive a record of performance giving the class of result obtained in the examination as a whole - there are four classes, 'PASSED WITH DISTINCTION', 'PASSED WITH CREDIT', 'PASSED' and 'FAILED' - and an indication of performance in each paper.
15. Certificates are awarded to candidates who pass the examinations. The certificates indicate the level of examination, i.e. Part I, Part II or Part III as appropriate, and the class of result.

#### FULL TECHNOLOGICAL CERTIFICATE

16. The full Technological Certificate in Agricultural Engineering will be awarded to a candidate who holds all the following qualifications.
  - (a) An Agricultural Engineering Technician's Certificate Part I or Agricultural Mechanics Certificate Part II.
  - (b) An Agricultural Engineering Technician's Certificate Part II.
  - (c) Agricultural Engineering Technician's Certificate Part III and
  - (d) has had relevant Industrial Experience of 2 years after passing Part III.
17. Candidates wishing to apply for the award must write to the Council (Certificate Unit) for the appropriate form.



GENERAL REGULATIONS

18. In the case of any inconsistency between the subject regulations set out in this syllabus pamphlet and the General Regulations, General Regulations shall prevail.

AGRICULTURAL ENGINEERING  
TECHNICIAN'S CERTIFICATE

SYLLABUSES

NOTE: In all work in connection with power units, tractors, machinery and equipment, attention must be paid to the following:

- (i) cleaning procedure
- (ii) dismantling procedure
- (iii) systematic examination and measurement of wear
- (iv) replacement of worn parts
- (v) assembly procedure
- (vi) tests on overhauled machinery and equipment
- (vii) interpretation of published test reports
- (viii) safe practice and prevention of accidents.

PART I

1. EQUIPMENT FOR WORKING SOIL

1. Ploughs. Purpose of ploughing; working principles of mould-board ploughs. Trailed; semi-mounted and mounted ploughs (including reversible.) Types of hitch; hitch geometry and its effect on ploughing. Types of coulter and their effects. Effects of body design, working adjustments and speed on the work produced; relationship of furrow depth to width and its significance. Modifications to suit terrain and available power. Methods of setting out; systematic ploughing Principles of plough setting; diagnosis and correction of ploughing faults.
2. Disc cultivators. Action of concave discs on the soil. Disc ploughs and disc harrow; survey of types.

3. Rotary cultivators. Function and working principles of rotary cultivators with vertical or horizontal rotors (including spading machines and helical ploughs). Correct hitching. Effects of blade type, arrangement and working adjustments on the work produced, with particular reference to the relationship between p.t.o. speed and forward speed.
4. Tine cultivators. Function and working principles of tined implements including row crop equipment. Chisel ploughs, cultivators and harrows (powered and non-powered). Types of tine and their uses; types of point and their uses. Correct hitching. Tine setting, operational speeds.
5. Rollers and levellers. Action of flat, Cambridge, conical and ridge rollers on the soil. Effects of size, weight and forward speed on tilth produced. Hitching and unhitching tandem gangs. Action of scrubbers and floats.

EQUIPMENT FOR SOWING AND PLANTING CROPS AND EQUIPMENT FOR  
DISTRIBUTING FERTILISERS AND MANURES

6. Methods of application and application practices. Metering mechanisms; relationship between speed of mechanism, gate or orifice opening, (where applicable), and forward speed of travel. Seed and fertiliser characteristics affecting flow. Need for calibration, methods of calibrating.
7. Grain drills. Types of coulter and seed tube. Control of sowing depth. Use of markers.
8. Gang drills. Type of toolbar, adjustment of row width; significance of tractor wheel size and track width setting.
9. Planters. Working principles of common types of maize, cotton planters.

10. Full width fertilizer distributors and broadcasters: power and ground-driven types. Suitability of common types for different terrains. Correct hitching and hitch settings, factors affecting uniformity of distribution. Principles of setting and using.

#### EQUIPMENT FOR CROP PROTECTION

11. Ground crop sprayers. Function; liquid flow circuits; types of pump and pressure regulators, types of nozzle and their rating; factors affecting droplet size, importance of correct coverage and application range. Preparation for use; avoidance of drift, checking of spray patterns and nozzle outputs. Output checking and calculation of correct quantity of chemical for tank capacity. Verification of tractor tachometer reading. Special safety precautions when using chemicals.

#### EQUIPMENT FOR HARVESTING

12. Reciprocating knife and disc mowers, flail mowers and harvesters. Correct hitching; relationship between cutting mechanism and forward speed.
13. Forage harvesters including those with metered feed. Correct hitching and preparation for use. Preparation of swath. Sharpening and replacement of flails.
14. Balers. The tying cycle in automatic twine-tying, ram type, pick-up balers. Safety devices. Adjustment of ram clearance, sharpening of ram knife and shear plate. Control of bale density, shape and output.
15. Combine harvester. Principles of cutting, threshing and separating. Detection and correction of grain losses and damage.

#### BARN MACHINERY

16. Hammer mill, roller mill and mixer. Factors affecting quantity and quality of output.

## AGRICULTURAL MACHINERY - FRAMES AND POWER TRANSMISSION ELEMENTS

- II A study of inspection and overhaul procedures should be included for each of the following:
1. Frames. Simple plough, implement and machine frames; bracing in tension and compression. Use of angular, tubular and box section members. Checking for distortion. Faults and their correction.
  2. Shafts. Tubular and solid shafts; need for static and dynamic balance, avoidance of whip.
  3. Belts and pulley drives. Types and constructional features of flat and vee pulleys (including fixed and variable). Effects of pulley wear. Checking and correction of alignment, wear and distortion. Flat belts; construction, jointing, methods of engagement. Vee belts; construction, classification, use of matching sets for multiple drives. Alignment, tensioning and control of slip. Safety factors. Selection of belting for particular applications from suppliers catalogues. Effects of tensioning on wear and power transmission.
  4. Chain drives. Common types of chain and their applications; fitting and adjustment of chain drives; inspection of chain and sprocket for serviceability; care and maintenance of chain drive components.
  5. Gears. Types of gear tooth; simple and compound gear trains, including constant mesh and epicyclic gearing. Gear shift linkages, such as selector shafts and forks. Inspection and replacement of worn or damaged gears, tolerances, assembly and correction of faults.
  6. Bearings. Common types of bush, shell and guide bearings (including sealed and impregnated types). Common types of ball and roller bearings and their uses. Materials used. Types of bearing housing.

Removal, cleaning, inspection, assembly and installation of bearings Lubrication, alignment, pre-loading.

7. Sealing elements. Gaskets, Sealing rings. Fluid seals. Removed and fitting of seals. Materials used. Applications. Dirt excluders.
8. Couplings. Splines and serrations: Keys and keyways. Hubs and driving flanges. Types of coupling, including flexible and universal and their applications. Collars and fixing devices. Universal joints and drive shafts, their applications and limitations.
9. Inspection and fitting of keys; cutting key ways. Selection, fitting, removal and inspection of flexible couplings and universal joints.
10. Clutches and overload protection. Dog, plate, centrifugal, audible, overrun and slip clutches. Shear pins and bolts. Inspection; assembly, adjustment and torque testing.
11. Cams and ratchets. Simple cams, variable cams and ratchet feeds. Inspection, adjustment and replacement.
12. Springs. Types of spring, flat, coil and torsion and their application. Inspection, adjusting and fitting procedures including safe practices. Spring life; fatigue and common causes of failure.

### 3 TECHNOLOGY

#### Tractors and Power Units

##### POWER UNITS

1. Internal combustion engine principles. An introduction to the conversion of heat energy to mechanical work through the combustion and behaviour of gases in an engine; conversion losses; efficiency; simple treatment of the relationship between pressure, volume and temperature.

2. The principle of the four stroke cycle; compression ratio; compression pressure. The principle of the two stroke cycle. Comparison of the operating cycles of spark ignition and compression ignition engines. Fuel types and characteristics; nature of combustion in typical engines.
3. Engine construction and materials. Review of typical single cylinder and multi cylinder engine layouts and disposition and purpose of the following main parts; cylinder blocks, wet and dry liners, pistons, piston rings, connecting rods, connecting rod bearings, crankshaft, main bearings, flywheel, cylinder heads, valve assemblies, timing drives and camshaft, manifolds.
4. Simple treatment of the influence of engine application on the design of components and reasons for the materials used.
5. Engine operation. The four stroke cycle in practice. The importance of correct valve and ignition timing. Firing orders. The two stroke cycle in practice.
6. Cooling system. Air and liquid cooling systems and their component parts. Liquid circulation pumps, general construction and overhaul. Diagnosis and correction of faults in cooling systems.
7. Lubrication. Functions of engine oil; deterioration of lubricants. Engine oils and common lubrication systems. Pumps; general construction and overhaul. Filters; types of filtration system. Diagnosis and correction of common faults in lubrication systems.
8. Spark ignition engines. The coil ignition system; principles of operation; purpose and function of components; automatic advance and retard arrangements; timing; testing procedure, inspection, fault diagnosis and correction. Overhaul of system.

9. Magneto ignition systems for single and multi-cylinder engines; principles of operation; common types (including flywheel type); functions of parts; impulse couplings; timing procedure; maintenance and simple testing procedure; fault diagnosis and correction.
10. Fuel systems for tractors, stationary engines and engines on portable appliances. Common types of carburetor in use and their principles of operation (including diaphragm types). Principles of carburation. Essential adjustments. Air/fuel ratios. Cold starting arrangements. Faults in carburation. Vaporisers. Fault diagnosis in the fuel system.
11. Construction and principles of operation of common types of governor, linkage and control. Main adjustments and settings which affect power output. Testing, reconditioning and setting.
12. Engine air supply. Function, construction and servicing of air cleaners. Effects of dirt, restriction in air supply and other faults.
13. Electrical equipment. Lead-acid batteries; construction of common types; outline of chemical changes during charging and discharging; capacity ratio, methods of testing; methods of charging; charging rate. Care and maintenance.
14. The charging circuit; general construction and working principles of tractor dynamos, output regulation systems and cutouts. Lighting and other auxiliary systems. Working principles of a.c. generators and rectifiers, maintenance and safety procedures for tractor alternator systems.
15. General construction and working principles of inertia and pro-engaged starter motors, linkages, solenoids and control circuits. Routine maintenance; test procedure; fault diagnosis; replacement of starter pinion and clutch assembly.



## TRACTORS

16. General layout of main types of wheeled agricultural tractors; disposition of power unit, transmission, traction and steering components. Provision for use of mounted equipment.
17. Transmission systems. A survey of transmission systems in common types of wheeled tractor, (including four wheel drive arrangements). Layout of gearboxes and final drive/differential gears; drives to power take-off, belt pulley, and hydraulic system pumps.
18. Clutch. General construction and working principles of single and dual-plate dry disc clutches, including clutch release mechanisms. Dismantling, inspection and replacement of components, reassembly, setting and adjustment of operating linkages. Diagnosis and correction of clutch faults.
19. Gearboxes. General construction and working principles of common types of gearbox, including epicyclic and gear changing mechanisms. Dismantling, inspection and reassembly of components.
20. Differential and final drive. General construction and working principles. Purpose of the differential and differential lock. Dismantling, inspection, reassembly of components including setting pre-load and end float of crown wheel and pinion, differential and final reduction gearing assemblies. Inspection and repair of differential locks.
21. Wheels. Common types of pneumatic tyre wheel and mounting. Provision for varying wheel track widths. Construction of pneumatic tyres, ply ratings; tyre size. Types of tread pattern and their uses. Tyre servicing and repair.
22. Brakes. Wheeled tractor braking systems. Internal expanding and disc brakes. Construction, operation, repair and adjustment of transmission and wheel braking systems. Testing of braking performance. Correction of faults.

23. Power-assisted and manual steering systems. Reason for camber and castor angle; toe-in adjustment; lubrication and adjustment of components. Types of steering box, steering mechanism and linkage. Dismantling, inspection and replacement of defective components; reassembly and adjustment.
24. Power take-off and belt pulley drive. Details of construction and arrangements for driving and control of common power take-off and belt pulley units. British Standard recommendations.
25. Hitches. Three-point linkages, categories 1, 2, and 3. Layout. Adjustments. Types of top link. Safety devices. Purpose of alternative linkage positions. Pick up hitches, swinging draw-bars, weight transfer hitches. Instant hitching devices.

#### 4. TECHNOLOGY

##### WORKSHOP PROCESSES

1. Materials. An elementary study of the production of iron and steel forgings and castings. Characteristics and physical properties of ferrous and non-ferrous and non-ferrous metals used in the construction of agricultural machinery. Forms of supply; the uses of black and bright low carbon steels, bar, sheet, plate and hollow sections in agricultural engineering. Selection of low carbon, free-cutting and plain carbon steels for specific purposes. Workshop identification of ferrous and non-ferrous metals. Corrosion control and protective coating of steel by galvanising, vitreous enamelling, cadmium plating, phosphating and plastic coating.
2. Marking out. Selection, use and care of instruments and equipment. Basic marking out exercises.
3. Screw threads. The features and identification of metric B.A., Unified (fine and coarse), Whitworth, B.S.F. threads and their applications. Use of taps and dies.

4. Use of hand tools. Selection and use of spanners and wrenches, hacksaws and files, chises and punches.
5. Metal joining components. Types of set screw, self-tapping screw, bolts and nuts and their applications. Tensile strength of bolts. Types of plain and spring washer. Locking devices and their applications. Expansion bolts and other common fixing devices. Types of rivet and their application; reveting techniques. Soldering of ferrous materials (including aluminium); selecting of fluxes for specific purposes.
6. Oxy-acetylene welding. Storage of welding gases. Welding equipment; pressure regulators, torches, cutters, pre-heating nozzles. Types of welding rod and flux, selection for specific purposes. Preparation prior to welding. Butt, lap, fillet and vertical welds in low carbon steel using the leftward technique. Butt welds using the rightward technique. Bronze welding of low carbon steel, galvanised and cast iron. Building up worn components. Use of muffle furnace.
7. Metal-arc welding equipment; relative merits of a.c. and d.c. welding systems, simple welding circuits. Types of electrode and coating, storage of electrodes. Welding techniques for downhand, horizontal, vertical and overhead welds in low carbon steel.
8. Hot working. Upsetting, twisting, swaging, bending, fullering, drawing down and shaping.
9. Hand operated power tools. Selection, safe use and care of drills, grinders, nibblers, shears, jigsaws and hammers.
10. Machining: Drilling, lathe work and shaping; selection of appropriate drill or tool shape and type, tool setting; selection of appropriate cutting speed. Chuckwork, turning between centres, face-plate work; use of steadies. The production of flat surfaces, slots and vees. Safety precautions in the use of machine tools.

5. RELATED SUBJECTS

Related Agriculture - Crop Production

A technician will be expected to have a working knowledge of the application and setting of the machines which he is asked to repair and overhaul.

It is intended, therefore, that the treatment of this section should account the technician with the farmer's problems in the use of special techniques and the application of equipment to agricultural practice. It is not intended that the agricultural engineering technician should receive instruction in pure agriculture.

1. Introduction. The development of farming systems in the Kenya with special reference to factors influencing them, and the classification of these systems, e.g. arable, grass, mixed, hill and upland farming systems.
2. Soil. Soil types and their formation. Effect of soil type upon farming system functions and objectives of soil cultivations. Soil conditions and their effect on plant growth: air content, water content, temperature, organic matter content, pH. Influence of drainage, liming, irrigation, fertilizers, (organic and inorganic) on plant growth and soil structure.
3. Crop growth. Sowing of common agricultural crops, referring to seed rates, depth of sowing, spacing and row widths. Plant structure and physiology (monocotyledons and dicotyledons) including photosynthesis, osmosis, transpiration, respiration and translocation. The control of common types of weed, pest and disease.
4. Crop varieties and cropping systems. Economic and husbandry principles underlying rotations. Common varieties of agricultural crop. Introduction to plant breeding methods.

5. Harvesting and storage. Harvesting requirements of forage, cereal and root crops. Stages of growth for cutting or harvesting including use of instruments for determining grain moisture content. Principles of crop conservation applied to forage, grain and root crops. Special problems encountered; contamination, cleaning, handling, conveying and prevention of damage.

### MATHEMATICS

Note; at all stages an awareness of SI, Imperial, and other units must be taught, together with an understanding of the use of conversion tables.

6. Fractions, decimals, proportions, percentages and averages. Imperial and metric units of length, area, volume, weight, density and specific gravity. Meaning and use of indices and logarithms. Use of slide rule for multiplication and division and for finding square and cube roots. Use of mathematical tables to find squares, square roots and reciprocals. Construction of graphs from tabulated information. Interpolation and extrapolation. Construction of graphs of the form  $y = ax + b$ ,  $y = ax^2$  and  $y = ax^3$ .

Meaning of graphs. Estimation of areas of irregular figure by counting squares and of areas under graphs by mid-ordinate rule. Transposition of simple formulae and solution of equations of the types  $a = \frac{bc}{d} + e$ . The construction of linear equations to find one unknown.

Solution of simultaneous linear equations with two unknowns.

Use of graphs to solve equations of the form  $y = ax + b$  and  $y = ax^2$ .

Angles and their notation up to  $360^\circ$ . Simple geometric properties of triangles, rectangles, circles, prisms, and spheres. Pythagoras theorem. Introduction to trigonometry, i.e. meaning and use of sine, cosine, tangent for angles up to  $90^\circ$  for solving practical problems.

## MECHANICS

7. Measurement and representation of a force. Parallelogram and triangle of forces. Solution of problems by graphical means. Force and pressure. Pressure measurement. Gauge and absolute measurements. Pressure head and measurement of partial vacuum. Meaning of work and potential and kinetic energy. Principle of conservation of energy. Work done by a constant force including rolling resistance. Coefficient of friction. Meaning of power and indicated, brake, p.t.o., drawbar and rated power. Mechanical and electrical equivalents of heat. Principle of moments. Levers; velocity ratio and mechanical advantage. Torque. Efficiency of simple machines and compound systems. Non reversibility. Principles and application of spur, bevel, hypoid and worm drives; epicyclic systems. Capstans and Weston differential pulley.

## HYDRAULICS

8. Relative incompressibility of liquids. Types of pump. Flow in pipes, hydraulic gradient, open circuits and closed circuits, importance of correct siting of bleed points, fluid friction and elementary treatment of viscosity. Pressure head. Relative compressibility of gases. Descriptive treatment of isothermal and adiabatic compression and expansion.

## HEAT

9. Simple concept of the nature of heat. Change of state. Measurement of temperature. Comparison and conversion of Celsius and Fahrenheit Scales. Quantity of heat, its units and measurements.
10. Conduction, thermal conductivity, 'k' and 'u' values in relation to farm buildings. Convection and radiation.
11. Expansion of contraction of solids, liquids and gases, coefficients of expansion.

12. Elementary treatment of the volume/pressure/temperature relationships for gases. Boyle's Law and Charles' Law. Water vapour in the atmosphere. Meaning and measurement of relative humidity. Dew point and condensation. Sensible heat. Specific heat. Latent heat of fusion and evaporation and its practical consequences.

### ELECTRICITY

13. Flow of electricity; need for an 'earth' return system. Electrical units; volts, amps, watts, ohms, Board of Trade units and their relationship. Heating effect of a current. Principle of the solenoid. Series and parallel circuits. Calculations involving resistance, current flow and voltage drop. Electro-magnetic induction, principle of transformer. Coil ignition. Alternating current; principles of simple a.c. generator. Principles of rectifier bridge. Magneto ignition for single and multi-cylinder engines. Construction and working principles of dynamo and cut-out, and output control unit. General construction and working principles of starters. Transistor Ignition Systems.

### SKETCHING AND DRAWING

NOTE: the practices specified in B.S. 308A should be used wherever appropriate.

14. Construction of angles and plane basic shapes e.g. 30°, 45°, 60° and 90° angles; triangles, rectangles, regular hexagons. Division of angles. Construction of scales. Construction of circles and parts of circles. Properties and construction of regular prisms and regular and offset cones and pyramids. Development of shapes, using parallel line and radial line methods.
15. Explanation of the value of drawing as a means of communication.

16. Selection, use and care of pencils, drawing instruments, and equipment. Standard paper sizes. Principles of orthographic projection in first and third angle. Freehand exercises in orthographic projection, using squared paper, to produce views and sections of agricultural machinery components. Elementary exercises in projection using drawing instruments.
17. Conventions for showing outlines, sections, projection lines and dimensions. Representation of screw threads, spring, keys, cotters, rivets, washers, nuts, bolts and studs.
18. Interpretation of engineering drawings. Preparation of detail drawings of agricultural machinery components and guards. Pictorial representation of agricultural machinery parts and equipment.

## PART II

### 1. TECHNOLOGY

#### AGRICULTURAL MACHINERY - FAULT DIAGNOSIS AND REPAIR

The aim of the sections dealing with Agricultural Machinery and Tractors and Power Units is to develop the subject matter beyond Part I level, which deals with the general layout, function of main components and the field use of common types of machine. Part II will deal with mechanisms and their component parts at an advanced level. It will concentrate on the inspection of machines, diagnosis of faults, the correct repair of machines and the reassembly and testing of complete machines and sub-assemblies prior to their re-use. Students must have an appreciation of the economic considerations which affects the value of machines, such as the cost of parts, the cost of labour and the purchase and re-sale value of used machines. In addition they must have an appreciation of the cost of 'one off' parts and adaptations, compared with proprietary fittings and manufacturer's spares. The machinery and equipment listed below should be dealt with under the following headings.



- (i) inspection procedure
- (ii) measurements of wear, determination of serviceability
- (iii) overhaul procedures
- (iv) final test procedures
- (v) routine maintenance requirements
- (vi) safe practices and prevention of accidents
- (vii) interpretation of manufacturers' workshop manuals.

Special features of the machinery and equipment that require additional attention are indicated under the appropriate headings. The sections dealing with 'Mechanical Handling Equipment' and 'Crop Storage' should, however receive a more general treatment, particulars of which are given in the relevant section.

#### EQUIPMENT FOR WORKING SOIL

1. Ploughs. Frame and legs, disc coulters, soil engaging parts, operating levers and linkages, trip and lift mechanism (as applicable) on trailed, semi-mounted and mounted right and reversible ploughs. Testing for rotation, locking and correct functioning of reversible ploughs. Identification and diagnosis of faults by examination of the work produced. The building up of worn components by hard facing and drawing down shares.
2. Disc cultivators (See list of headings given in the introduction).
3. Rotary cultivators (see list of headings given in the introduction).
4. Tine cultivators, (including power driven types). Action on the soil of tine, tines and blades; wide and narrow tines; effects of rake angles.
5. Rollers and levellers. Frames and bearings.

## EQUIPMENT FOR SOWING AND PLANTING CROPS AND EQUIPMENT FOR DISTRIBUTING FERTILIZERS AND MANURES

6. Grain and combine drills. Feed mechanisms. Delivery tube and coulter assemblies; methods of coulter spacing; coulter lift mechanisms. Drive mechanism and components.
7. Gang drills. Spacing drill feed mechanisms; monitoring mechanisms; appreciation of suitability of machines for specific purposes.
8. Full-width fertilizer distributors and fertilizer broadcasters. Properties of materials used; corrosion control; freeing corroded parts. Mechanical factors affecting correct distribution and efficiency. Characteristics of main types, their uses and limitations.

## EQUIPMENT FOR CROP PROTECTION

9. Ground crop sprayers. Characteristics of main types. Theory of atomisation of liquids by cone (solid and hollow), fan and vibrating type nozzles. Construction, rating and care of nozzles. Influence of machine design on droplet size; spray drift. Formulations, agitation and decontamination. Filters, valves and pressure regulators. Characteristics of common types of pump; roller vane, gear, diaphragm and piston types pumps. Importance of suitable boom mountings, stability and height control.
10. Dusters. Brief outline of methods of applying dusts and powders to control weeds and pests. Type of machine available with particular reference to dust nozzles.

## EQUIPMENT FOR HARVESTING

11. Reciprocating knife mowers. Principles of cutting. Bedding in the knife; knife maintenance; register; cutter bar lead; cutter bar lead; cutter bar balance; cutter bar lift and flotation.

12. Disc and rotation knife mowers. Principles of cutting. Drum timing and drum balance where applicable.
13. Flail mowers and forage harvesters. Sharpening and replacement of chopper knives (flywheel and cylinder), and shear plates; balancing of rotors. Characteristics of main types of forage harvester; significance of metered feed; diagnosis of causes of poor performance.
14. Characteristics and relative merits of reciprocating knife, disc and flail mowers.
15. Swath treatment equipment including crimpers and crushers.
16. Balers. Study of the complete machine and sub-assemblies. Timing.
17. Combine harvesters. Study of complete machine and sub-assemblies. Principles involved in the cutting, separation and handling of grain.
18. Factors which influence 'throughput' and 'losses'. Adjustments to sub-assemblies to suit crop condition and minimise crop damage and losses. Systematic diagnosis and rectification of causes of grain loss and damage.

#### MECHANICAL HANDLING EQUIPMENT

19. General construction and uses of fore end loaders, pallet and unit handling equipment for bales, fertilizer and grain. General construction and uses of forage boxes, dump boxes, blowers, tip and bottom unloaders and conveyors from silo to feed point. General construction of trailers with special reference to wheel gear, tipping and unloading mechanisms. Inspection and overhaul of common types.

## CROP STORAGE

- 20 Principles of moisture extraction from grain and forage crops. Construction characteristics and working principles of fans and furnaces. Temperature control of stored crops. Working principles and use of instruments to measure air pressure, moisture content and temperature of stored crops.

## 2. TECHNOLOGY

### TRACTORS AND POWER UNITS

1. Combustion. Combustion process in the internal combustion engine; descriptive treatment of detonation and its causes. Meaning and significance of octane and cetane numbers. Elementary treatment of turbulence and the effect of combustion chamber shape with reference to flame fronts and combustion pressures. Complete and incomplete combustion with reference to the chemical nature of the exhaust gases.
2. Compression ignition engines
  - (a) Direct and indirect injection systems; principal types of combustion chamber.
  - (b) Fuel injection equipment; general construction, operation, stripping, setting and testing of fuel injection pumps; construction, operation, maintenance and reconditioning of injectors; pump and injector servicing and testing equipment. Cold starting arrangements; principles, inspection and repair.
  - (c) Systematic diagnosis and correction of faults in fuel injection systems. General construction and principles of operation of common types of governor; linkage and controls. Setting and adjustment; diagnosis and correction of faults.

- (d) Routine engine maintenance. Systematic fault diagnosis. Use of simple test equipment as an aid to checking engine performance. General symptoms of engine wear and need for reconditioning. Overhaul requirements and procedure including removal of engines. Measurement of wear on engine components. Use of workshop manuals and specification sheets.
3. Hydraulic systems. General construction and working principles of typical systems (including upper-link and lower-link sensing mechanisms). Control valve systems. Methods of achieving draught-control, position-control and control of speed of response. Provisions for external services. Testing, dismantling, inspection, overhaul and adjustment of a complete modern hydraulic system. Types of oil used.
  4. Tracklaying tractors. Common types. Methods of steering. General construction of gearboxes and final drive assembly. Common types of track and trackmounting.
  5. Tractor testing. Principles of power unit testing; torque and p.t.o. output at various speeds. Use of dynamometer for tractor testing. Calculations of power, fuel consumption and efficiency from dynamometer readings. Morse test on spark ignition and compression ignition engines. Interpretation of official test reports on tractors. Systematic fault diagnosis and use of workshop manuals, specification sheets, fault finding charts and test equipment. Testing and assessment of performance after repair. Use of report forms. Repair documentation.
  6. Tractor implement combination. A review of the features and properties of common types of tractor/implement combination; effects on drawbar, hitch and linkages positions. Multiple hitches. Safety devices. Correct coupling of power-driven implements to power take-off of tractor (reference to BS1495, 1841, 3413, 3417 and subsequent publications).

7. Wheel adhesion; loss of power through wheel slip; methods of improving traction and their relative merits, including use of four wheel drive.

### 3. TECHNOLOGY

#### WORKSHOP PROCESSES

1. Materials. A brief outline of the general characteristics (including approximate composition), physical properties, standard forms of supply and uses in agricultural engineering of the following materials:  
Mild steels and alloy steels containing nickel, chromium, vanadium, silicon, manganese, molybdenum and tungsten.
2. Cast irons, including spheroidal graphite and malleable irons.
3. Non-ferrous metals and alloys; copper, zinc, tin, aluminium, magnesium, lead, brass, bronze, gunmetal, die casting alloys and bearing materials.
4. Plastics; thermosetting and thermoplastic. Natural and synthetic rubber.
5. Metallurgy. A simple account of the changes in structure caused by heat treatment of plain carbon steel and also of the internal structures produced by solidification, hot working and cold working of metals. Introduction to the iron-carbon equilibrium diagram and time-temperature transformation curves. Testing of metals; methods used for tensile, torsion, hardness, impact and fatigue testing. Units and terms used and their significance. Micro and macro examination of metals; preparation of samples, recognition of common crystal types, carbon combinations and common flaws. Outline of common methods of non-destructive testing.

6. Heat treatment. Hardening, tempering, annealing and normalising plain carbon steels. Case hardening. Nitriding, flame and induction hardening. Temperature measurement.
7. Measurement and inspection: use of dial, slip, limit, small hole and telescopic gauges. Introduction to the use of a limit system with reference to the primary and secondary selection of fits in in B.S. 1916. Theory and use of vernier, micrometer and bevel protractors. Measurement of large bores. Degree of accuracy. Checking and setting measuring equipment. Test for acceptance or rejection of new or worn parts. Measuring exercises including those involving concentricity and run-out.
8. Machining. Chip formation, cutting tool nomenclature, sharpening of cutting tools, tool life, tool deterioration and its causes. Lathe work; taper turning, eccentric turning and screw thread cutting. Machining fabricated components with a lathe, shaper and miller. Use of dividing head, simple indexing. Selection of grinding wheel and discs for specific purposes. Grinding, honing and lapping.
9. Welding by oxy-acetylene and metallic arc processes. Welding of carbon, alloy and stainless steels, cast iron and malleable castings, non-ferrous metals and two dissimilar metals. Use of jigs for fabrication of components. Preheating and stress relieving. Temper brittleness and weld decay. Causes of weld failure, standard methods for testing welds. Flame cutting including use of the profile cutter for producing complex shapes. Brief outline of the argon arc and carbon dioxide welding processes and of methods used for welding plastics.
10. Corrosion control De-watering fluids, protective coatings and rust inhibitors; properties, selection and methods of application. Paints and protective coatings; types, properties and methods of application. The selection of corrosion control and painting processes for specific applications.

#### 4. RELATED SUBJECTS

##### RELATED AGRICULTURE - ANIMAL PRODUCTION

A technician will be expected to have a working knowledge of the application and setting of the machines which he is asked to repair and overhaul. It is intended, therefore, that the treatment of this section should acquaint the technician with the farmer's problems in the use of specified techniques and the application of equipment to agricultural practice. It is not intended that the agricultural engineering technician should receive instruction in pure agriculture.

1. Utilization of food. Elementary treatment of digestive systems of cattle, pigs, sheep and poultry; mechanical and chemical digestion of foods; enzymes and bacteria. Digestibility and palatability of home grown foods. Requirements of different classes of stock, with reference to protein, carbohydrate, fibre, minerals, vitamins and water. Rationing of animals. Mixing, cubing, storage and handling of food.
2. Animal health. Structure and functions of organs making up the respiratory system. Requirements of animals kept under intensive production conditions, i.e. warmth, light, humidity and ventilation. Environmental control.
  - (a) Milk production. Systems of housing dairy cows. Equipments used for producing clean milk. Cooling and storage requirements. Mechanization of milking, feeding and manure handling. Labour requirements, capital investment, production costs and profitability.
  - (b) Meat production. Systems of housing employed in the production of: beef, mutton, pork, lamb, veal and poultry. Environmental control and its application to each specialized enterprise. Mechanization of feeding and manure disposal.



- (c) An elementary treatment of labour requirements, capital investment, production costs and profitability of the above. Illustrated by visits to specific enterprises.

#### MATHEMATICS

Note: at all stages an awareness of SI, Imperial and other units must be taught, together with an understanding of the use of conversion tables.

4. Use of logarithms for evaluating fractional and negative indices. Use of sine cosine rules for solving practical problems; including the interpretation of ambiguous answers. Problems involving angles up to  $180^\circ$ . Construction of quadratic equations to find one unknown. Solution by factorization and by use of the standard formula (Proof not required). Use of graphs for solving quadratic equations.

#### MECHANICS

5. Laws of linear motion. Use of the standard formulae relating force, velocity, acceleration (uniform) and distance covered. Rotational and peripheral speeds. Centrifugal force; angular velocity. Use of radian notation. Parallelogram and triangle of velocities. Solution of problems by graphical means. Resolution of components of forces and velocities by trigonometrical methods. Work done by a force acting on a body on an inclined plane, including considerations of friction. Forces in the tractor/implement combinations, weight transfer (including effects on steering); longitudinal stability; tractive forces; true line of draft; implement resistance; steering forces; side draft; lateral stability.

## HYDRAULICS

6. Critical velocity. Fluid drives; principles and applications hydrostatics and hydrokinetics. Bernoulli's Theorem.

## ELECTRICITY

7. Voltage drop in cables. Factors affecting selection of cables, i.e. current carrying capacity, resistance and insulation. Use of reference charts. Fusing and overload protection. Earth leak protection. Flow and float switches. Introduction to three-phase alternating current systems. Descriptive treatment of the National distribution system. Colour codings and their importance. Working principles, characteristics and suitability of common types of electric motor, including starting gear, for agricultural horticultural applications. Consequences and avoidance of overloading, fouling and accidental mechanical damage.

## SKETCHING AND DRAWING

8. Intersection and interpenetration to cylinders and cones. Development of regular and offset cylinders, cones and pyramids, using parallel and radial line methods. Development of hoppers fitted with radial and tangential feed pipes. Construction of simple locl.
9. Interpretation of drawings of assemblies, e.g. from workshop manuals and spare part lists. Preparation of component and assembly sketches from engineering drawings of assemblies. Preparation of engineering drawings, in orthographic projection to show sections and dimensions, using sketches made in the workshop, of agricultural machinery components and simple assemblies.
10. Conventional representation of electrical, pneumatic and hydraulic components. Interpretation and preparation of line circuit diagrams for electrical, pneumatic and hydraulic (including fuel)

systems. Interpretation of layout drawings, e.g. grain processing daily and bulk feeding installations. Preparations of installation drawings from sketches made on the farm.

#### INTRODUCTION TO DESIGN

11. Project work, the design of a simple article or component used on a farm or in a farm workshop e.g. a barrow for an oxy-acetylene welding set; a fabrication to replace a casting; a bracket to wall-mount a pump or motor; a hopper, including control slide to suit a given layout; a hub or bearing extractor. Use of models and mock-ups. Selection of particular materials, component-parts and processes for the construction of agricultural machinery. Use of bar, angle iron and tube; the relative merits of welding and riveting; wrapped and welding joints; fabrications to replace castings.

## PART III FIELD ENGINEERING

### MECHANISATION OF CROP AND ANIMAL PRODUCTION

#### 1. GENERAL CONSIDERATIONS

1. Aim and objectives; mechanization as a function of productive efficiency.

#### ECONOMIC CONSIDERATIONS

2. Resources available to the farmer, land, capital and labour. Management of these resources, degrees of substitution of capital for labour. An understanding of capital investment and influencing factors. Potential benefit analysis.

#### ACQUISITION OF DATA

3. Sources of information, technical press, evaluation of articles, official and industrial advisory services, information and reports from research and experimental stations and farms, technical conferences. Terminology. Interpretations and comparison of machine specifications and performance, extraction of significant factors.

#### EVALUATION OF SYSTEMS AND MACHINES

4. Object to be achieved, the place of the machine in the farming systems. Evaluation of work produced and working rate; ease of operating and maintenance costs. Assessment of economic liability and other advantages arising from purchase. System operating costs.

#### SELECTION OF MACHINES AND SYSTEMS

5. Performance and suitability for specific purposes. Evaluation of special factors; machine throughput and quality of work, flexibility, ease of operation and ergonomic considerations, availability of service, costs and power requirements. Legal aspects of transportation along the highway. Labour requirements;

possible labour reduction or improvement in labour profile, elimination of peak labour demand. The uses of standards in calculating labour requirements. Advantages of timeliness. Integration into an existing system. Use of contractors services.

6. Acquisition policy; purchase, hire lease. Consideration of initial price of machines, reliability, obsolescence and resale value. Use of economic data as a performance yardstick.

#### MATERIALS HANDLING

7. Principles of handling and conveying in unit, bulk and free-flowing loads. Special problems relating to agricultural mechanization, handling of bulky materials and semi solids. An introduction to work study and practicability of mechanized handling in relation to size and volume of loads and the distance involved. Characteristics of materials being handled.

#### ORGANISATION OF LABOUR AND MACHINES IN THE SYSTEM

8. Operation and management of systems; elimination of bottlenecks; influence of machine size, type and transport distance on output. Analysis of the performance of systems; applications of work study to overall performance. Comparison of average. Output with standard figures. Selection of field pattern techniques.

#### TRAINING AND INSTRUCTION OF STAFF

9. An appreciation of the need, and the arrangements available for the education and training of staff.

#### FARM MAINTENANCE REQUIREMENTS

10. Planned maintenance and servicing. Availability and cost of service work by machinery dealers. Classification of spare parts, i.e. fast moving, wearing and critical spares. Review of workshop tools and equipment. Farm workshops and their

limitations. Source of materials supply. Fuel and oil storage. Equipment and vehicle records and their use in calculating machine costs. Estimation of repair costs. Decisions involving repair of replacement of parts.

## 2. INSTALLATION OF EQUIPMENT IN FARM BUILDINGS

The syllabus aims to give an understanding of the problems involved the installation of equipment in farm buildings. It does not deal with building design which is the subject of a separate syllabus.

### LOADING

1. Soil load-bearing capacities. The different forms of load and their implications on building structure, foundations and soils, e.g. solid, semi-solid and fluid loads, point and distributed loads, dead loads, imposed loads, shock loads and vibration loads.
2. Assessment of loading and use of factors of safety.

### STRUCTURES

3. An appreciation of the load-bearing properties of floors, walls and beams, foundations and supports for specific purposes. Modifications to buildings; general and local strengthening; temporary support to walls, floors and roofs while new openings are cut. Strengthening of new openings. Limitations to the modification of buildings caused by size, strength, type of construction, shape, location and state of repair.
4. Waterproofing; exclusion of overhead, surface and below-ground moisture. Special problems of providing waterproof below-ground pits. Damp-proofing; capillary action; condensation problems.

#### DRAWING

5. Collection of data on site and the preparation of drawings to show layout and installation of equipment in buildings and farmsteads.

#### PLANT-LAYOUT

6. The layout and positioning of equipment to facilitate installation, possible expansion, alteration, alternative forms of power supply and drive, inspection, maintenance, operation in service and suitable working environment. Safety requirements including reference to appropriate statutory regulations.

#### INSTALLATION AND FIXING OF EQUIPMENT

7. Lifting, moving, locating and aligning equipment. Methods of fixing machinery and equipment permanently and semi-permanently to floors, walls and roofs. Methods absorbing vibration. Testing of installations.

#### ELECTRICAL SUPPLIES

8. Forms of electrical supply available on site; permanent, temporary and standby. Selection and application of motors and generators and control systems. The implications of regulations governing the installation of electrical equipment and wiring. General principles of good installation practice; codes of practice. Survey of types of control and recording equipment and their applications.

#### ENVIRONMENTAL CONTROL INSTALLATIONS

9. Survey of equipment used for systems of environmental control including temperature, light, humidity, ventilation and gaseous composition.

## PIPEWORK AND STORAGE TANKS FOR WATER AND FUELS

10. Types of pipe and coupling, control valve, tap, flow meter and their application. Methods of joining, manipulating and installing pipework. Location of tanks and selection of pipework for particular systems, specific materials and required rate of flow. Provisions for liquid and gaseous fuel storage, implications of regulations, bye-laws and codes of practice.

## 4. FIELD ENGINEERING

The depth of treatment should be related to the types of responsibility which are undertaken by the Agricultural Engineering Technicians in the field engineering work usually carried out by agricultural engineers.

### SURVEYING

#### 1. Chain Surveying

- (a) Aims of chain surveying. Use and care of chain surveying equipment. Planning out and carrying through of a chain survey, including the use of the field notebook.
- (b) Drawing office procedures. Care and use of instruments and scales. Conventional symbols. The determination of areas by calculation and by planimeter. Alteration of the size of plans by pantograph, proportional compasses and photographic means.
- (c) Ordnance Survey plans and maps. National grid reference systems. Use, interpretation, types and sources of supply of tracings.

#### 2. LEVELLING

- (a) Principles of levelling. Simple levels and staffs (e.g. Cowley), and complex levels and staffs (e.g. dumpy level



techniques including the use of level books. Introduction to problems encountered in levelling due to the earth's curvature and the refraction of light.

- (b) Use of levelling to determine gradients and contours.  
Elementary tacheometry.

3. Angular - measurement. Use of compass, box, sextant, levels and theodolite to determine bearings and angles. Closed and open traverses. Traverse books.

#### LAND CLEARANCE

4. Survey of types of machine and their applications for land clearing and levelling. Applications of explosives.

#### LAND DRAINAGE AND RECLAMATION

5. Principles of drainage. Types of soil; their characteristics and drainage requirements. Methods of surface and sub-surface drainage. Survey of types of drainage machinery, e.g. trench cutters and pipe layers, mold drainers.

#### SOIL MECHANICS

6. Soil plasticity and shear strength of soils and methods employed to determine their values. Angles of repose of soils.

#### MATERIALS

7. Properties and applications, with reference to field engineering of timber, metals, concrete, bricks and masonry. Methods of reinforcing concrete, including prestressing. Codes of practice used in concrete work, including reinforcing.
8. Use of tables for selection of appropriate sections in timber, concrete and steel, using bending moments and moments of inertia.

## STRUCTURES

9. Appreciation of the requirements of dams, culverts, abutments, simple bridges and retaining walls. Foundations for structures and roads. Simple calculations of stress, bending moments, shear forces and safety factors.

## IRRIGATION

10. The need for irrigation. Meaning of a saturated soil, field capacity, soil moisture tension, permanent wilting point, soil moisture deficit, available water, acre-inch and cu sec (and appropriate SI units), notches and weirs.
11. Sources of water e.g. wells and streams. Factors, including legislation, affecting the abstraction of water. Measurement of water flow in streams. Types of reservoir and the selection of suitable sites. The use of surveying as an aid to determining the quantities of water contained behind dams of various heights in particular situations.
12. Irrigation systems including those employing sprinklers, rain guns and spraylines. Irrigation equipment including types of pumps, pipes, hydrants and sprinklers. Power sources for irrigation pumps and the determination of the water power of a system. Methods and frequency of moving irrigation equipment. Planning and management of the irrigation system.

## FIELD TEST AND DEVELOPMENT

### 5. DESIGN EVALUATION IN SELECTION OF EQUIPMENT

#### DESIGN EVALUATION

Consideration of tractors, equipment and machinery under the following headings.

1. Suitability for specific crop and soil conditions. Performance; including interpretation of official test reports.
2. Adequacy of clearances and adjustments, e.g. for soil, steering lock, range of adjustment.
3. Advantages of simplicity in design, ease of attachment of equipment to tractor.
4. Controllability; ease of operation, adequacy of instruction manual, driver comfort and safety.
5. Accessibility; ease of service for operator and maintenance engineers.
6. Adaptability for a range of operations. Facilities for mounting extra equipment and range of optional fittings. Adaption from standard for local market requirements, e.g. alterations for width and ground clearance. Suitability for use in special conditions, e.g. dusty atmosphere, special soil conditions.
7. Special problems with imported or exported equipment; national legal requirements (including safety); problems arising from differing standards for threads, bearings and other components.

8. Strength, durability and reliability. Suitability of materials and methods of construction for specific purposes.
9. Assessment of potential sales in relation to likely trends in consumer demand.

#### EVALUATION OF MACHINES INCORPORATING NEW CONCEPTS AND THEIR COMPARISON WITH EXISTING MACHINES

It is recommended that the same types of machinery and equipment will be considered as have been dealt with already in Part II.

10. Use of sound mechanical principles.
11. Adequacy of range of adjustment for all conditions.
12. Probable strength, durability and reliability.
13. Appearance and styling.
14. Assessment of potential in relation to trends in local and national agricultural practices. Cost and sales potential.
15. Availability of data from pre-production testing.

#### EVALUATION OF SYSTEMS, EQUIPMENT AND PLANT

16. Sources of information, terminology, interpretation of specifications and performance reports; comparing machines with similar functions; evaluation of demonstrations and reports from users; evaluation of performance for specific environments and incorporation into a system; operating and maintenance costs.

## 6. APPLIED HYDRAULICS

This syllabus aims to give an understanding of the principles of hydraulics as applied to agricultural tractors and machines, and the diagnosis of faults and the method of correction. Mathematical treatment will be limited to those instances for which it has practical relevance.

### HYDRAULIC FLUIDS

1. Appreciation of the requirements of hydraulic fluid properties, i.e. viscosity; viscosity index, demulsibility, oxidation stability, lubricity and corrosion control. Selection of fluids for specific purposes.

### ENERGY IN FLUIDS

2. Energy stored in fluids, velocity head, pressure head. Revision of Bernoulli's theorem. Reynolds number. Qualitative treatment of forces exerted by fluids in motion.

### FLOW IN PIPES

3. Revision of characteristics of fluid flow in pipes, parallel and series. Transmission of force and power by fluids through pipes, both restricted (by nozzles) and unrestricted. Critical velocity. Measurement of flow and pressure; venturimeters, Pitot tube, flow through orifices. Coefficient of discharge, coefficient of contraction.

### HYDROKINETIC CIRCUITS

4. General construction and working principles of fluid couplings and torque converters, single stage and multi-stage; their applications and relative merits. Fault diagnosis and correction.

#### HYDROSTATIC CIRCUITS

5. Typical hydraulic circuits: functions of main components such as reservoirs, filters and strainers, pipes and hoses, control mechanisms, pumps, motors and cylinders (rams). Interpretation of standard symbols used in circuit diagrams.

#### OIL RESERVOIRS

6. Basic design requirements including dimensioning and siting. Types of oil cooler and their application.

#### STRAINERS AND FILTERS

7. Reasons for incorporation in circuits. Types of filter; full-flow and by-pass. Degree of filtration. Forms of contamination and their effect. Types of breather and filler cap.

#### HOSES, PIPES, TUBES AND FITTINGS

8. General construction of high-pressure and low-pressure hoses. Selection of correct types and size for a specific application. Adaptors, quick release couplings and fittings. Standard sizes; methods of achieving interchangeability. Construction and methods of repair of hose assemblies.
9. Forms of supply and types of material used for pipes and tubes. Types of fittings including threaded, soldered, brazed, compression and flared. Thread types, recommended standard sizes, use of thread charts and recognition of thread types. Threaded adaptors.
10. Lay-out requirements of liquid lines. Selection of pipes, hoses and fittings. Pipe cutting, bending and support. Flanges, gaskets, jointing tapes and packings; selection for specific purposes. Design and installation of liquid flow systems. Fault diagnosis and correction.

## CONTROL SYSTEMS

11. Methods of control; constant delivery systems and variable delivery systems. Pressure control valves; relief valves, unloading valves, back pressure valves, reducing valve, spool valves (open centre and closed centre) and sequence valves. Volumetric control valves, throttle valves, non-return valves and stop valves. Direction control valves. Air relief valves.

## PUMPS

12. General construction and principles of operation of the following types: gear, vane, centrifugal and piston. Constant and variable displacement pumps. Pump efficiency. Interpretation of pump test reports and specification. Selection for specific purposes. Fault diagnosis and correction.

## MOTORS

13. Comparison of the construction of pumps and motors. Relationship of displacement torque and power. Efficiency of systems. Detailed construction of main types of motor; gear, vane axial and piston. Interpretation of motors specifications and test reports; selection of motors for specific purposes. Fault diagnosis and correction.

## PISTON AND CYLINDERS (RAMS)

14. Types of piston and cylinder, seals and packing; single acting rams. Selection and installation of rams for specific purposes. Maintenance. Diagnosis and correction of faults.

## SEALS AND PACKINGS

15. Hydraulic seals and joints, materials used and their application. Sealing of working clearances, oscillating and sliding. Installation and maintenance. Diagnosis and correction of faults.

## ACCUMULATORS

16. Reasons for incorporating in a system. Types of accumulator, wight-loaded, spring-loaded, and pneumatic. Installation procedures. Diagnosis and correction of faults.

## 7. FIELD TEST AND DEVELOPMENT

### SOURCES OF INFORMATION, DATA EVALUATION, REPORT WRITING

1. Reference to abstracts and other sources of information, research associations, national and international institutions and their publications. Interpretation of official test reports. Compilation of test report forms. Report writing. Appreciation of statistical methods, collection and presentation of test data. Analysis of results using standard performance figures and graphs, comparison with similar machines. Presentation of conclusions.

### TEST ORGANISATION AND PROCEDURES

2. Determination of main objectives, relative importance of other facets of machine performance, limitations of normal test programmes. Devising test procedures, work planning and schedules. Team work; division and delegation of responsibility. Typical field test procedures and their validity. Degrees of accuracy; distinction between particular performance figures and possible variations due to fluctuating conditions; allowances for soil and crop conditions in relation to performance figures. Use of test rigs and the value of scale models and their limitations. Methods of providing accelerated tests. Simulation of test conditions. Use of control machines and components. Appreciation of the theory of dimensions. Assessment of machine performance under operating conditions, with reference to power requirements and the quantity and quality of product. Operation and field techniques; their effects on overall performance. Development of techniques for use with new machines. Evaluation of ease of operation and maintenance, flexibility and durability.



#### COLLECTION OF TEST DATA AND METHODS OF MEASUREMENT

3. Working principles and application of instruments and methods of measuring physical and other data. Use of tracers. Checking accuracy of measuring equipment. Standard test equipment, e.g. engine indicator, exhaust gas analyser, viscometer, calorimeter.
4. Working principles and application of appropriate types of recording equipment including tape recorders, still and cine cameras.

#### MATERIALS AND INSPECTION

5. Assessment of suitability of ferrous and non-ferrous metals and non-metallic materials. Testing for strength, hardness and fatigue resistance. Introduction to non-destructive testing. Tests for faulty materials.

#### DIAGNOSIS OF FAULTS

6. Inspection of faulty components; design modifications. Use of standard components. Use of special methods to produce 'one-off' components for test purposes. Appraisal of design.

STRUCTURES AND ORGANIZATION OF THE AGRICULTURAL  
ENGINEERING INDUSTRY

INDUSTRIAL ORGANIZATION

1. Organization of industry

- (a) Structure of manufacturing industry; the location of industries; influencing factors, recent trends; the integration of industries; monopolistic tendencies, types of industrial combine.
- (b) The structure, finance and the size of business firms; the factors affecting types of production.

2. The agricultural engineering industry

- (a) Production; product planning and development; economics of product planning; methods; purchasing; storekeeping quality control.
- (b) Organization of distribution; the scope and methods of distribution; the export and import trades, marketing agencies, credit facilities, leasing and hiring.
- (c) Organization of selling; the sales function, sales control, advertising.
- (d) Kenya agriculture, its general scope and regional pattern.
- (e) Home production and sales; importance of the agricultural engineering industry in Kenya's economy; structure and location of Kenya's agricultural machinery firms; recent developments in the Kenya's agricultural engineering industry. Selling agricultural engineering products, sales organization and promotion, publicity, the contract of sale and aftersales service; manufacturer, dealer and customer relationship.

- (f) Foreign trade; pattern of world trade in agricultural machinery; Kenya's trade in agricultural machinery exports and imports, factors affecting prospects for the exporting and importing of agricultural machinery and components, extent of competition, changing nature of demand.

#### THE AGRICULTURAL ENGINEERING SERVICE INDUSTRY

- 3. An introduction to the principles of general management
  - (a) Functions and objectives of management; structure of management delegation of responsibility; workshop organization.
  - (b) Personnel relations; communications, motivation, remuneration of labour; job satisfaction and working environment; selection of labour.
  - (c) Apprenticeships, further education and training, in-service training.
  - (d) Industrial relations; Workers' and Employers' organizations; joint consultations; negotiating machinery.
- 4. An introduction to accounting
  - (a) Principles of accounting with reference to: bank account; cash book; petty cash; wages records; national insurance; graduated pension; distinction between capital and revenue; inventories and valuation of equipment; profit and loss account; balance sheet; company accounts. Company taxation; income tax; P.A.Y.E. Insurance. Rates and ratable values.
  - (b) Understanding balance sheets and company reports; investment appraisal. Office organization and mechanization of office work.

5. Business Policy

- (a) Structure of simple limited and unlimited liability companies, partnerships, corporation and group complexes.
- (b) Appreciation of employer's liabilities; Offices, Shops and Factories Acts, laws of contract, statutory duties, common law duties, personnel law, premises and transport, insurance. C.O.T.U. Ministry of Labour, N.I.V.T.C., Industrial Tribunal.

II - 4 工学部 機械工学科 自動車



**THE EAST AFRICAN EXAMINATIONS COUNCIL**

**REGULATIONS AND SYLLABUSES**

**1022**

**MOTOR VEHICLE TECHNICIANS**

**COURSE**

**ALL CORRESPONDENCE TO:**

The Secretary  
East African Examinations Council  
P.O. Box 7066, Kampala  
UGANDA  
Cables: "EXAMCO" Kampala

## 1022 - MOTOR VEHICLE TECHNICIANS' CERTIFICATE

### 1. INTRODUCTION

This scheme for courses of part time study and related examinations is intended to provide broad technical qualifications for students with suitable educational background, employed in the automobile industry, to develop an ability to diagnose faults, recommend means of rectifying these faults and to test and analyse the performance of the vehicle after the repair or modification has been completed. It is hoped, therefore, that this course will help to provide technicians suitable for the more senior responsible posts in maintenance and repair workshops. In addition to the technical subjects, General Studies are included in order to develop the students' ability to absorb, interpret and transmit information, whether in spoken or written form, and to contribute to their general education and personal development. The scheme has been designed to be complementary to the training and experience students will obtain in their employment.

Further explanatory notes related to the Course are contained in appendix 'A'.

### 2. COURSE OF STUDY

The scheme has been devised on the assumption that normally students will attend a technical college on a part-time day or block release basis. It is in three stages. Part I (about 780 hours of technical studies and 52 hours of General Studies) gives a broad introduction to the theoretical and practical aspects of motor vehicle maintenance and is appropriate to the needs of apprentices and junior technicians who require a general, understanding of the basis of their work. Part II (about 780 hours of technical studies and 52 hours of General studies) is designed to enable the student, on completion of his technical studies and concurrently with suitable experience to study basic organization and administration of the three main developments within the garage, i.e. Parts, Sates and Service. This will serve as an introduction, preliminary to his taking full administrative responsibilities later in his career. The Part III is a Full Technological Certificate requirement.

### 3. THE TOPICS OF THE COURSE ARE SHOWN BELOW

PART I     Motor Vehicle Technology  
             Practical work  
             Sketching and Drawing  
             Mathematics  
             Science  
             Laboratory Work (see Appendix B)



General Studies

PART II Motor Vehicle Technology

Practical Work

Sketching and Drawing

Mathematics

Science

Laboratory Work

General Studies

PART III Parts marketing and sales

Principles of Supervision

Motor Trade Practice

Commercial Practice and Office Procedure

The Law Relating to the Motor Trade.

4. Course Work consisting of Class Work, Laboratory and Practical Work, and General Studies is regarded as an integral part of the course. With General Studies (see para 1) the aim should be to allocate about 90 hours per year to them in Part I and II. The E.A.E.C. will not examine in General Studies and institutions are free to devise their own syllabuses and approach to the subject.

The E.A.E.C. has published a pamphlet in which an approach to General Studies is suggested.

5. This scheme has been planned in association with subjects 1003 Part II Motor Vehicle Mechanics Work.

6. ENTRY TO COURSE

Students for the courses must satisfy one of the following conditions or have reached the appropriate standard by an alternative route:

(a) Part I

- (i) East African Certificate of Education issued by the E.A.E.C. at Ordinary Level in English, Mathematics and an approved Science Subject with credit passes.
- (ii) Part I certificate in Motor Vehicle Mechanics course 375 with Credit.

(iii) Appropriate academic ability in a mature student.

The student must have completed 52 weeks on Industrial attachment before starting the Part II.

(b) Part II

(i) A pass in Part I examination for Motor Vehicle Technicians.

(ii) A pass in Motor Vehicle Mechanics 1003 Part II with Credit.

(c) Part III

A pass in the Motor Vehicle Technicians Part II examinations.

## 7. COUNTRIES OUTSIDE EAST AFRICA

This scheme is available to countries outside East Africa at those institutions which have received the approval of the E.A.E.C. Application for approval of a course should be made on appropriate form issued by the E.A.E.C.

## 8. EXAMINATIONS REGULATIONS

The E.A.E.C. will offer an examination at the end of Part I of the Course, except in cases where an Institution is recognised by the Council as being capable of conducting this examination internally.

Institutions wishing to conduct their own Examination for Part I of the course should apply for permission to the E.A.E.C.

### Part I

1022/01	Technology I	(Theory & Pract) = 3 hrs
1022/02	Technology II	(Theory & Pract) = 3 hrs
1022/03	Eng Drawing Maths	= 3 hrs
1022/04	Mech Eng Scie	(Theory & Pract) = 3 hrs.

Students will not be permitted to proceed to Part II unless they have reached a satisfactory standard in the Part I examination and have met the requirements for course work as prescribed by the Part I examining body.

9. Part II examinations will be offered by the E.A.E.C. in July of each year, and will be conducted according to the regulations published by the E.A.E.C.

Each examination will consist of three papers:

1022/10	Technology I (Theory & Pract.)	= 3 hrs
1022/11	Technology II (Theory & Pract.)	= 3 hrs
1022/12	Eng Drawing Maths	= 3 hrs
1022/13	Mech Eng Sc. (Theory & Pract.)	= 3 hrs

10. Part III Examinations will be held in July of each year and will consist of two papers as follows:

1022/20	Principles of Management	= 3 hrs
1022/21	Motor Trade Practice	= 3 hrs
1022/22	Commercial Practice	= 3 hrs
1022/23	Project Works	

\* Parts I & II Candidates can be refereed only on papers 1022/03 and 1022/04 or 1022/12 and 1022/13.

All examinations will be set wholly in SI Units.

#### 11. ENTRY FOR EXAMINATIONS

The E.A.E.C. will not accept any entry form from an individual applicant. Candidates must submit their entries through an examination centre on the prescribed form obtainable from that Centre.

Colleges must submit to the E.A.E.C. on the prescribed forms lists of the full names together with colleges records of all students entered by the college for each examination.

No candidate will be admitted to the examination or be eligible for a certificate unless he/she, has satisfactorily completed an approved course at a technical college or other institutions for further education. External candidates will only be accepted if they have completed the prescribed E.A.E.C. form and satisfactorily complied with the conditions required in relation to the form & have further satisfied the authorized assessors that they are capable of attempting the examination. Late entries subject to an additional fee may be accepted at the direction of the E.A.E.C.

#### 12. RECORDS OF STUDENTS WORK

Records of marks awarded for Course Work must be kept by colleges for submission to the E.A.E.C. on the appropriate form in respect of each candidate entered for examinations. Laboratory and practical work note books must be kept and must be available for inspection by the E.A.E.C. or its examiners when called for.

### 13. ATTENDANCE AND COURSE WORK REQUIREMENTS

Each candidate will be required to make at least 75% of the possible attendances in each subject, including General Studies, and will be required to complete the schedule of Class-Work, Laboratory and practical work as prescribed by the syllabus, including project work at Part III (Appendix C).

Colleges will be required to submit evidence of such marks awarded, after the examination has been taken. These marks will be assessed by the E.A.E.C. as Course Work. (See para 12).

### 14. ENGLISH

The examination set by the E.A.E.C. will be set and answered in English, though the examiners will not be allowed to assess the standard of English used by the candidates.

### 15. RESULTS AND CERTIFICATES

Results in the examinations as a whole will be issued in four classes and for the individual papers including course work, in eight grades. The relationship between classes and grades is:-

Pass with distinction	- Grades 1 & 2
Pass with credit	- Grades 3 & 4
Pass	- Grades 5 & 6
Fail	- Grades 7 & 8

Each candidate will receive a record of performance for Part I, II and III giving the result in terms of class and grade.

Part I, Part II and Part III Certificates are awarded to candidates who pass all parts of the Part I, Part II and Part III E.A.E.C. examinations in the same examination series, and satisfy the Course Work requirements.

The certificate will show the class of and also the names of the subjects passed. Students sitting for the internal M.V.T. Part I will be advised by the Institution concerned of their results for the examination.

If during the currency of the scheme the E.A.E.C. deems it appropriate to modify the pattern of the examinations and awards, the necessary changes to the regulations will be notified to colleges in advance of their being applied.

## SYLLABUSES

### 1022 - MOTOR VEHICLE TECHNICIAN'S CERTIFICATE

#### Part I

#### Motor Vehicle Technology

#### First Year

General workshop regulations, instruction in basic safety precautions.

The layout of private cars and commercial vehicles of conventional types: function and arrangements of main components.

Alternative arrangements commonly used in private cars and commercial vehicles such as engine position, front-wheel drive and road wheel arrangements.

The petrol engine; the operation of the engine on the two- and four-stroke-cycles.

The main components of a simple four-cylinder engine.

Elementary reasons for the use of more than one cylinder in engines.

Elementary treatment of alternative arrangements of cylinders and crank throws for two-, three- and four-cylinder engines working on both four-stroke and two-stroke cycles.

Common valve arrangements and valve operating mechanisms for single-cylinder and four-cylinder engine.

The function of the main items of electrical equipment on a motor car of conventional type.

The action of a coil ignition system and the function of each part.

The fuel (petrol) supply system. Action of simple carburettors.

The thermo-syphon system. Use of the impeller or water pump.

The clutch: characteristics of the internal combustion engine which demand its use in moving the vehicle from rest.

Construction and action of a typical modern single-plate clutch.

The gearbox; engine and load characteristics which demand its use. Three- and four-speed sliding pinion gearboxes. The constant-mesh gearbox with sliding dogs.

Propeller shafts, universal joints and sliding joints (excluding constant velocity joints).

The rear axle: different types of final drive gears and reasons for same, The transmission of drive through differential gears; reasons for differential gears and their action. Methods of supporting axle shafts and arrangement of wheel bearing. Differences between semi-floating, three-quarter-floating and fully-floating shafts. Provision for oil retention. Suspension of rear axle by semi-elliptic springs.

The front axle and steering system: conditions necessary for rolling motion of all four wheels.

Simple beam-type axle with Ackermann linkage and suspension by semi-elliptic springs.

Steering gears. Types of steering gear in common use in modern vehicles.

Types of brakes and braking systems in common use (excluding power-assisted types).

The simple chassis frame and its function. Build-up of frame and attachment of components.

Automobile lamps; types used; aligning and focusing lamps anti-dazzle devices. Types of cables, connectors, connections and fuses used in automobile wiring circuits with particular reference to current-carrying capacity and common usage. Lead-acid vehicle batteries, a brief description of plates, separators and containers, including the stopper. Composition and preparation of acid electrolyte. Use of hydrometer in measuring specific gravity of electrolyte and in assessing state of charge. Symptoms of common battery faults. Testing, care and maintenance of lead-acid batteries. Effects of high and low temperatures on charging and discharging.

Common fitting tools and bench vices; their care and use.

Vice clamps.

Elementary principles of marking out; use and care of marking out tools.

Introduction to the properties and uses of common irons and steels; effects of properties on uses; identification of common irons and steels by workshop methods.

The care and use of twist drills. The importance of correct sharpening. Cutting action and tool angles for bench tools; methods of sharpening bench tools.

Solders, fluxes and their uses; composition of common solders; common methods of soldering.

Types of screw threads (B.S.W., B.S.F., B.A., U.N.C., U.N.F., B.S.P. and Metric) and their uses.

The use of screw thread tables.

Methods of measurement in the workshop.

Micrometer readings: action, care and use of internal and external micrometers.

Second Year

Engine construction. Cylinder blocks, cylinder heads and gaskets. The importance of correct lightening sequence for all joints. Cylinder liners, wet and dry types, methods of location and sealing, types of fit.

Pistons; materials used; types of piston ring and their location, piston clearances.

Gudgeon pins, their location and materials used.

Lubrication of piston assemblies.

Connecting rods; materials used; small and big end bearings.

Crankshafts: materials used, cylinder numbering, firing order, bearing arrangements; types of bearing and bearing shell; lubrication arrangements; oil seals.

Overhead valve gear; camshafts and camshaft drives; rocker arm arrangements.

Lubrication arrangements and seals. Valve timing.

Compression-ignition engine. Operation of the four-stroke cycle. Types of combustion chamber, methods of inducing swirl. Direct and indirect injection.

Comparison with constructional features of spark-ignition engines.

Fuel supply systems and carburation. Common types of mechanical and electrical diaphragm pump and their action. Principles and action of common types of carburettor. Methods of controlling mixture strength, air bleed, compound jet, variable choke. Cold starting, slow running, acceleration and economy devices.

Fuel injection equipment. Introduction to the injection pump, construction of the pump and associated parts. Control of engine speed and power.

Introduction to phasing and calibrating of in-line pumps.

Injectors; types of nozzle to suit direct and indirect injection.

Fuel lift pumps and filters. Importance of filtration.

Lubrication and lubricants. Use of splash, mist and pressure in engine lubrication systems. Types of oil pump, pressure relief valves, oil filters.

Oil pressure gauges and warning light systems. Dry sump lubrication systems. Properties of lubricants in relation to their behaviour under normal and severe conditions of load and temperature. S.A.E. classification of lubricants. Causes and effects of excessive oil consumption.

Cooling systems. Circulation pumps and air fans. Types of radiator pressure caps and thermostats. - Radiator Construction

Air cooling.

Electrical. Revision as required of lead-batteries. Nickel-iron alkaline batteries: description and construction; cell voltage, testing, care and maintenance. Installation and storage of batteries of all types in automobiles.

Coil ignition systems. Operation of coils and condensers, (simple theory only).

Advance and retard mechanisms. Uses and selection of spark-plugs. Timing distributor to engine. Starter motors. Types of inertia drive. Methods of switching: associated circuitry, including cable size and connections. Transmission. Clutch centre plate construction and friction materials. Mechanical arrangements for disengagement. Adjustments required for initial setting up and to take up subsequent wear.

Gearboxes. Survey of common types of gearbox; arrangements and methods of engagement; synchromesh devices; direct and remote control mechanisms.

Types of bearing used in gearboxes.

Lubrication and oil retention.

Final drive systems. Survey of modern bevel and hypoid final drive arrangements; conventional arrangements of front-mounted engine driving rear wheels; front-wheel drive from front-mounted engine; rear-wheel drive from rear-mounted engine. Lubrication and oil retention.

Steering systems. Survey of modern types of beam and independent wheel suspension.

Principles underlying caster, camber, wheel alignment and king pin inclination.

Methods of checking steering angles and wheel alignment on vehicles. Steering gearboxes; principal types, their action and adjustment.

Suspension. Independent wheel suspension systems. Effects on wheel geometry of dead load, driving and braking loads and steering deflections under varying road conditions; resulting effect on such items as tyre wear, heavy steering and 'toe out' when cornering.



Dampers; installation, adjustment and maintenance.

Brakes; Drum brakes: action of leading and trailing shoes in drum brakes. Friction lining, materials: brake fade. Action of hydraulic systems with details of component parts. Brake fluids; their selection; precautions in use; bleeding procedure. Adjustment of brakes and their operating controls.

Disc brakes.

Road wheels and tyres. Common types of pressed steel disc and wire spoked wheels. Hub attachments. Survey of common tubed and tubeless tyres. Tyre sizes and designations. Tyre fitting and care. Static and dynamic balancing of road wheels. The characteristics of materials used in tyre construction. Radial and cross-ply construction.

Effect of tyre construction and pressure on steering and road holding.

Testing. Vehicle inspection for road worthiness in accordance with existing regulations: compilation of reports.

Fail safe tyre.

#### Scheme of Practical Work

NOTE: Throughout the course the need for the requirements of safe working should be stressed and the correct procedure demonstrated.

#### First Year

Inspection of the layout and the main components of a car of conventional type.

Inspection of the layout and the main components of a commercial vehicle of conventional type.

Inspection of alternative drive arrangements on cars and commercial vehicles.

Dismantling a four-cylinder, four-stroke engine and a two-stroke (3 port) single cylinder engine, noting the sequence of operations and the name and function of each part. Assembly of the same engines. Inspection of other engine and their component parts with special reference to alternative arrangements of cylinders and crank-throws.

Inspection of valve arrangements and operating mechanisms.

Setting specimen tappet clearances. Measuring valve lift for various angles of crankshaft rotation using a dial gauge.

Inspection of main items of electrical equipment, including wiring details and connections of a typical coil ignition system. Dismantling and reassembling a distributor. Cleaning and adjusting spark plugs and distributor contact gaps to specification.

Inspection of a typical fuel supply system for a four-cylinder engined motor car, including piping detail.

Dismantling and reassembling the cooling system of a four-cylinder engined motor car noting the functions of the radiator, thermostat, circulating pump and connections.

Dismantling and reassembling a single-plate clutch, noting sequence of operations and the name and functions of each part. Particular reference should be made to provisions for adjustment. Dismantling a three- or four-speed gearbox noting the sequence of operations and the name and function of each part.

Particular reference should be made to the methods of engaging gears and any provisions for adjustments. Reassembly of the same gearbox.

Dismantling universal joints noting the sequence of operations and the functions of each part.

Checking an open type propeller shaft for straightness and correct alignment of universal joints.

Dismantling a rear axle noting the sequence of operations and the name and function of each part.

Assembly of the same rear axle.

Inspection of alternative types of final drive gears with particular reference to bearing arrangements and provision for adjustment.

Determination of movement (velocity) ratios by measurement.

Removal and refitting of oil seals.

Inspection of a front axle and steering system to show the effect of error in track alignment of front wheels by means of a scrubbing board; correcting the error.

Dismantling and reassembling of a steering box, noting the sequence of operations and the name and function of each part with special reference to provisions for adjustment.

Inspection of a braking system. Dismantling the components, noting the name and function of each part.

Reassembling the brakes with particular reference to provision for adjustments.

Inspection of a typical frame for a private car or light commercial vehicle with particular reference to the attachment of engine mountings, suspension units and brakes.

Examination of various types of bulb and vehicle lamps. Provision for alignment and head lamps.

Making and insulating of connections for starter motor cables. Methods of using light cable connectors.

Dismantling, examining and rebuilding a demonstration lead-acid cell noting the function of each part and the material of which it is made.

Mixing commercial sulphuric acid with water to given specific gravity with special reference to the safety precautions necessary in mixing operations.

The use of values of specific gravity and voltage to assess stage of charge and general condition of cells.

Examination of cells with known faults.

Introduction to the common fitting tools, including screwdrivers and spanners; instruction in their care and use.

Workshop tests to identify common irons and steels and to show their physical properties, as related to their use in the motor vehicle.

The use of the sensitive drilling machine; methods of holding work; safety precautions. Simple exercises in drilling with twist drills; the 'drawing' of holes when drilling.

Use of the off-hand grinding machine for sharpening bench tools; safety precautions.

Simple soldering; soldering nipples on copper pipes; making, insulating and finishing a simple soldered joint in stranded light cable (without connectors).

Soldered joints and patches in sheet metal.

The use of taps, stocks and dies. Methods used to remove broken or damaged studs.

Methods used to reclaim worn or damaged threaded holes.

Use of calipers for taking and transferring dimensions. Use of micrometer for measuring external and internal sizes.

## Second Year

Complete dismantling and reassembly of an engine to include the following: Examination of all parts listed under technology. Valve grinding and valve seat refacing. Checking alignment of connecting rods, and rectification.

Measurement and gauging of cylinder bores, crankshafts, camshafts and bearing. Correct selection of pistons, fitting off-rings. Setting up and boring cylinder to specified oversize.

Stripping compression-ignition engine for inspection.

Reassembly. Bleeding the fuel injection system. Timing of fuel pumps. Checking. If injectors are functioning correctly whilst the engine is running. Checking cylinder compression.

Examining typical engine lubricating systems. Pressure testing with oil. Dismantling, examining, reassembling and testing oil pumps of various types for satisfactory operation. Examination of full-flow and by-pass types of oil filters.

Checking of oil pressure relief and by-pass valves. Checking of oil pressure gauges.

Reconditioning of water pumps. Pressure test of cooling system for leaks. Simple flow tests through a radiator, as a means of determining internal condition. Testing radiator pressure caps for satisfactory operation. Checking thermostats.

Dismantling, inspecting and reassembling of common types of mechanical and electrical diaphragm pumps. Testing for satisfactory operation. Dismantling, inspecting and reassembling a variable choke and a constant choke carburettor, noting any special features and adjustments.

Testing secondary cells at different states of charge. Examination and test of a complete coil ignition system on the vehicle using modern analysing equipment.

Reconditioning distributors. Timing to engine and reconnecting leads. Overhaul of inertia engagement starters followed by correct testing procedures.

Testing good and faulty spark plugs in pressure chamber in conjunction with the oscilloscope.

Dismantling fuel injection pumps (in-line), checking components, reassembly, phasing and calibrating. Dismantling various injectors, reconditioning and testing.

Examination of various types of fuel filters.

Examining a single-plate clutch assembly and its details. Testing of springs.

Assembly and adjustment on a clutch jig.

Dismantling a gearbox and synchromesh device. Checking all items for wear and correct operation; reassembly and adjustments to interlocking and remote control mechanisms.

Dismantling and reassembly of a final drive unit. Methods of meshing teeth correctly, provision for adjustment; preloading methods.

Dismantling a wheel hub assembly, noting special features relating to methods of grease retention; assembly and adjustment to correct tolerances. Examination of steering boxes in service to determine lubrication arrangements and points of wear and adjustment. Examination of an independent wheel suspension system to determine the points of wear and its effect on vehicle wheel alignment.

Checking of wheel alignment, caster, camber, and king pin inclination on an independent front wheel suspension system. Measuring turning angles as a means of ensuring correct setting of steering linkages.

Spring removal and replacement on a suspension system noting any special precautions to be taken and provisions for adjustment. Testing and adjustment of dampers.

Dismantling and reassembly of brakes; resetting and adjustment; bleeding of hydraulic systems. Examination of disc brake assembly.

Inspection of various tyres as a means of determining any abnormalities. Static and dynamic wheel balancing.

Practical examination of a vehicle for roadworthiness in accordance with the existing regulations and making a suitable report.

#### Sketching and Drawing

NOTE: The aim should be to develop the ability of the student to interpret drawings together with the facility to sketch and visualise objects at various stages of assembly.

#### First Year

Interpretation of simple engineering drawings; principles of projection and their use in simple sketches of solids; use of line diagrams.

The purpose and use of dimensions in sketches and drawings.

Sketching and drawing of simple components in orthographic projection (first and third angle) with dimensions.

Introduction to limits and tolerances and their inclusion in the dimensioning of sketches and drawings.

Reading of exploded and sectional views of components and assemblies.

Geometrical constructions related to marking out problems and to linkages and mechanisms covered in motor vehicle technology.

Application of the principles of sketching and drawing to the production of engine, gearbox, rear axle, braking, steering and suspension layouts and to dimensioned sketches of the components of these systems, including some sectional views and simple sub-assemblies.

Line diagrams, illustrating fuel supply systems, electrical circuits, power paths in transmission systems, steering and suspension linkages.

Conventional representation (B.S. 308 - Drawing Office Practice) of forms and components in common use in automobiles: e.g. screw threads, springs, gear wheels, ball bearings.

## Second Year

Sketches and drawings of components and of simple assemblies to show operating principles and materials for components; methods of attachment, lubrication and assembly.

Use of cross-sectional views. Application to the units dealt with in motor vehicle technology with particular reference to engine cylinders, pistons, connecting rods and valve gears; carburettor details and fuel pumps; water pumps and thermostats; lubrication components and details.

Sketches and drawings of electrical components; contact breaker, distributor unit with provision for automatic advance and retard; sparking plugs of various types; starting motors and engagement gears.

Sketches and drawings of various types of clutch and operating mechanisms: gearboxes, including details of synchro-mesh and interlocking mechanisms: steering boxes.

Line diagrams illustrating engine lubrication systems: valve arrangements and camshaft drives; fuel supply systems for compression-ignition engines; air and water cooling systems; circuit diagrams for ignition and starting motor systems; clutch and brake operating systems both mechanical and hydraulic.

Geometrical diagrams to show the ideal conditions for steered wheels to give true steering. The layout of the Ackermann linkage.

Introduction to the plotting of loci of piston movement in relation to crank-angle displacement; valve timing diagrams and the construction of an ellipse.

Introduction to the triangle and parallelogram of forces and simple vector diagrams. Application to operating mechanisms.

## Mathematics

NOTE: Part of this syllabus will be revision and extension of previous work in the secondary school and the time spent on revision will depend on the standard of attainment previously reached. Mathematics is needed as a tool.

Its treatment and all work done should be closely associated with the technology, science and laboratory work. There should be considerable practice in calculations interpreting and supporting the associated work in technology and science.

#### First Year

Simple workshop applications of fractions, decimals, proportions and percentages; use of rough checks.

British and metric systems of length, area, capacity and weight with particular reference to units in common use; their conversion. The American gallon and short ton.

Perimeters and areas of right-angles, rectangles and circles with practical applications. Volumes and weights of rectangular solids and cylinders.

Introduction to tolerances and to clearance and interference fits. Limits of sizes with associated calculations.

The principles of the micrometer and of vernier scales.

Simple equations leading to simple formulac and their manipulation, workshop applications.

Angles and their notation (excluding radian notation) up to  $360^\circ$ .

Properties of the right-angled triangle. Use of tables to find squares and square roots for whole numbers greater than unit. Application to simple problems on the right-angled triangle.

Introduction to graphs with applications to experimental readings and tabulated information such as valve lift against crankshaft angle, speed against time from tabulated figures for vehicle performance tests.

#### Second Year

Setting up of calculations; the extraction and cancellation of common factors.

Introduction to logarithms to base 10 and their use in calculations involving multiplication, division, squares and square roots. Description and use of slide rules for similar calculations.

Graphs; slope of a graph; the forms of graphs obtained by plotting from equations,  $y = ax + b$ ;  $y = ax^2$ ;  $y = ax^3$ . Engine and vehicle performance curves.

Algebra; the solution of simultaneous equations in two variables by simple substitution and by plotting graphs.

Products and factorization of the simple expressions:

$$(a + b)(a + b) = a^2 + 2ab + b^2$$

$$(a + b)(a - b) = a^2 - 2ab + b^2$$

$$(a + b)(a - b) = a^2 - b^2$$

and graphical representation where appropriate.

Areas of irregular figures, plotted on squared paper by counting squares and by the use of the mid-ordinate rule.

Trigonometrical ratios (sine, cosine, tangent) and radian measure for acute angles, with particular reference to angles of  $0^\circ$ ,  $30^\circ$ ,  $45^\circ$ ,  $60^\circ$  and  $90^\circ$ ; use of four-figure tables.

Science

NOTE: Part of this subject matter will be a revision and extension of previous work done in the secondary school and the time spent on revision will depend upon the standard of attainment previously reached. Emphasis should be placed on the experimental work and on the applications of fundamental science in motor vehicle technology. The treatment generally should be qualitative except in the case of started items where simple calculations are required.

First Year

Heat And The Properties Of Matter

\*Simple concept of the nature of heat; measurement of temperature, use of mercury-in-glass thermometers; comparison and conversion of Fahrenheit and Celsius scale readings.

Convection, conduction and radiation of heat.

Expansion and contraction of solids, liquids and gases when heated and cooled.

Change of state: melting and solidification; evaporation and condensation. Melting point of common metals (iron, steel, aluminium, solder).

Freezing points and boiling points of water, petrol, anti-freeze solutions and electrolytes.

Elementary qualitative treatment of change of pressure, volume and temperature of gases.



Density and specific gravity of solids and liquids.

Simple concepts of the discharge of water and air through pipes and orifices due to pressure difference.

### Mechanics

The effect of force in stretching, bending, twisting, and shearing. Units of force.

\*Moment of a force about a point or an axis; leverage with examples of its workshop and vehicle applications. Concept of a torque.

\*Introduction to linear and rotational speeds with practical applications to engine and piston speeds, wheel and vehicle speeds.

\*Introduction to the concept of acceleration.

\*Work done by a constant force; work done by a constant torque.

\*Power: the horse-power; the watt as a unit of electrical power. Conversion from horse-power to watts.

\*The simple machine as exemplified by a gearbox or by a lifting jack. Movement ratio (velocity ratio), force ratio and torque ratio. Efficiency as the ratio of work output to work input.

Elementary treatment of friction and its effects; useful and wasteful friction for different materials.

Effects of lubrication.

Friction and its application for clamping devices and in the transmissions of forces and torques.

\*Rear axle transmission systems, steering systems, operating mechanisms of clutch, gearbox and brakes as simple machines. Introduction to overall speed ratios.

Force; graphical representation of a force.

Graphical determination of the resultant of two forces acting at a point; resolution of a force into two components at right-angles to each other. Forces on bearings in work gear, helical gear and bevel gear drives.

\*Simple cases of direct tensile and compressive stress and strain; effects of length and area of cross-section.

### Electricity

Flow of electricity: necessity for a complete closed circuit; general idea of electrical conductors and insulators with common examples found in motor vehicles.

The 'earth return' system.

The possibility of connecting electrical conducting devices in series and parallel connections. The idea of electric current as the rate of flow of electricity, demonstration that an electric current has heating, magnetic and chemical effects, with simple examples taken from the motor vehicles.

The ampere as a unit of current.

The idea of electrical potential difference as the electrical pressure causing the flow of electricity.

The volt as the unit of potential difference. Voltage = electrical potential difference.

The relationships between the current produced and the voltage required to produced demonstrated with several different simple circuit elements, e.g., fixed resistor, coil of an electromagnet and then with these in series with one another.

Discovery of the fact that the ratio of voltage applied to current produced is generally a constant for a given circuit element. Conclusion that this ratio is of the nature of electrical resistance.

The ohm as the unit of resistance.

The relationship between the total voltage applied across a number of series-connected circuit element and the voltages across the individual elements, and between the total resistance and the individual resistances.

The relationship between the total current taken by several circuit elements connected in parallel and the individual currents taken by each of the separate circuit elements.

Determination of the direction of currents and 'sense' of voltages with approximate values in a multi-resistance circuit using trial-and-error methods.

The heating effects of an electric current and the power consumed.

Fall of potential along conductors; voltage drop in leads with special reference to starter circuits.

\*Voltage and wattage ratings of typical lamp bulbs; determination of currents from ratings.

General principles of systematic testing of circuits.

Methods of connecting and switching lamps; dimming and other control devices. Factual description (without any attempt to explain electro-magnetic induction) of how a spark is caused at the sparking plug point.

The primary cell as a device for converting chemical energy into electrical energy by creating an internal voltage. The secondary cell as a reversible primary cell.

Lead-acid batteries; description of charge and discharge processes. Elementary treatment (without the use of chemical formulae) of the effects of charge and discharge on the plates. Undesirable sulphation.

Composition of electrolyte; variation of specific gravity with the state of charge; measurement of specific gravity by hydrometer.

Variation with specific gravity of resistance, of freezing point, and of liability to sulphation.

Battery capacity; the ampere-hour as the unit of capacity; capacity rating of batteries.

Variation of voltage during charge and discharge; effect of charge and discharge at different rates with reference to starter-motor use.

## Second Year

### Materials

Introductory treatment of the effects of loads on structural members. The meanings of load, strain, stress, elasticity, plasticity, brittleness, hardness and toughness. An outline of the mechanical properties and uses of cast iron, carbon steels, alloy steels, copper, bronze, brass, light alloys, zinc and bearing metals as applied to vehicle components.

### Lubrication

Viscosity of a lubricant. Its variation with temperature, viscosity index. Multigrade oils. Simple treatment of the theory of bearing lubrication.

### Heat

Quantity of heat; the Btu, chu and calorie. Specific heat. Comparisons of the specific heats of common materials (including air and water, with particular reference to cooling media). Meaning of absolute pressure and temperature of a gas relationship only. The specific heat of a gas under constant pressure and constant volume conditions.

### Simple Chemistry

Elements, compounds, mixtures and alloys. The distinction between atoms and molecules and between physical and chemical changes. The composition of the air, simple treatment of oxidation. Elementary treatment of the chemical reactions involved in the combustion of carbon, hydrogen and sulphur. Fuel of spark and compression-ignition engines, their properties and composition, calorific value. Volatility, flash point and specific gravity.

\*Quantitative treatment of combustion of hydro-carbon fuels to determine air/fuel ratio and its exhaust products.

Effects of variation of mixture strength on engine performance; its side effects on engine components such as valves, cylinder walls, and spark plugs.

## Electricity

Simple treatment of the structure of matter to illustrate an electric current as 'a flow of electrons'. Distinction between conductors and insulators. Necessity for a complete conductive circuit with insulation. Type of insulators.

The simple effects of an electric current. The ampere. Construction and use of ammeters for measuring current a.c. and d.c.

Electro-motive force. The main sources of e.m.f. used in motor vehicles. Brief mention electrolytic cells, generators, thermo couples, and light-sensitive cells.

Potential difference. Construction and use of voltmeters.

Resistance. Dependence of resistance upon material, dimensions and temperature of conductor.

Resistivity.

\*Ohms' Law. The relation between current, electromotive force and resistance.

Current distribution in series and parallel circuits.

\*Power. The watt as the product of current and voltage. Relationship between electrical and mechanical power.

## Combustion

The combustion process in spark and compression-ignition engines. Causes and effects of detonation, pre-ignition, diesel knock and anti-knock rating of the fuel. The need for octane or cetane rating to suit a specific combustion chamber and compression ratio. The use of additives to control detonation and deposits.

## Mechanics

\*Friction. Simple treatment of the differences in friction between dry and lubricated surfaces. Coefficient of friction. Friction torque in bearings, clutches and brakes. Heat generated and power lost in friction. Useful and wasteful friction.

\*Machines. Movement ratio (velocity ratio) and force ratio; the efficiency of mechanical lifting devices used in motor vehicle repair shops and motor vehicle mechanisms.

Simple and compound gearing as used in transmission systems.

\*The vector representation of forces. The effects of two or more forces acting at a point: the parallelogram of forces; composition and resolution of forces; the triangle of forces.

The action of leaf springs, coil springs, and torsion bars.

\*The moment of a force: the principle of moments and its application to simple-supported and cantilever beams and to straight and cranked levers.

Couples: torque.

\*Acceleration. Distance, time, velocity and acceleration relationships for uniform acceleration. Relation between mass, force and acceleration.

### Heat Engines

Cycles of operation: constant volume and constant pressure cycles, their relationship to the spark-and compression-ignition engines.

Testing of spark and compression-ignition engines for torque and b.h.p.

\*Characteristic b.h.p. and torque curves. Relationship between torque and b.h.p.

The effect of ambient temperature and barometric pressure on engine output.

Factors governing volumetric efficiency and power output.

NOTE: This programme of experiments and demonstrations is intended to establish the classwork in Science and should be closely related to the classwork and the associated Technology and Practical subjects.

### First Year

#### Heat And The Properties Of Matters

Experiments to show relative temperature readings on Fahrenheit and Celsius scales.

Simple experiments to show the relative conductivities of different metals.

Experiments to show that water is a bad conductor of heat and transmits heat by convection currents.

Experiments to show heat radiation from bright surfaces and absorption by dull surfaces.

Experiments to show that solids, liquids and gases expand when heated and contract when cooled.

Comparison of expansions of different metals such as steel, copper, aluminium.

Experiments to determine the melting points of ice, of wax, of solders and low melting-point alloys with observation of thermal and appearances changes.

Experiments to determine the boiling points and the freezing points of water and anti-freeze solutions.

Experiments to show the effect of temperature on (a) the volume, (b) the pressure of a quantity of air.

Experiments on the relative densities of water, oil, aluminium and steel.

Simple experiments to show that the discharge of water through pipes and orifices varies with the pressure and pressure head.

#### Mechanics And Materials

Experiments using dial gauges to show the types of strain produced by different loadings and the difference between elastic and permanent deformation.

Simple experiments on straight and bell-crank pivoted levers to show the effects of (a) perpendicular forces, (b) inclined forces.

Measurement of torque applied by spanners; calibration and use of torque wrench.

Using the voltmeter-ammeter method for measuring the resistance of components.

Experiments with a wheel to show relationship between linear and angular speeds; applications to the engine mechanism.

Experiments to show work being done by a force and by a torque.

Experiments on typical 'laboratory' machines and on automobile units (gear-boxes, rear axle drives, steering gears, operating mechanisms) to measure movement ratios (velocity ratios), force ratios and torque ratios.

Experiments to demonstrate the addition and resolution of forces and the relationship between three forces in equilibrium acting at a point.

Friction experiments on a horizontal plate including (a) metal to metal, (b) brake lining to metal, (c) effect of an oil film in each of these cases, (d) effect of different lubricants.

Experiments to demonstrate the part played by friction in transmitting forces and torques in clutches and fan-belt drives.

Tests on wire specimen relating load and extension to stress and strain-comparison of strengths of cast iron, steel and aluminium under similar conditions of loading.

## Electricity

Experiments on building up simple circuits with several lamps connected, first in series and then in parallel, to a suitable battery and noting the effect on light intensity. Identification of corresponding ends of concealed wires.

Use of a metal frame or bar as an 'earth return'.

Use of a voltmeter applied across several parts of these circuits to show individual and combined voltages and to demonstrate that  $V_{AD} = V_{AB} + V_{BC} + V_{CD}$ .

Simple experiments to demonstrate heating, chemical and magnetic effects of an electric current measuring the current by an ammeter.

Measurement of currents and voltages in the several parts of a simple series circuit to show that there is only one current value. Measurement of total and branch currents in a circuit consisting of a battery feeding at least three lamps in parallel with branch circuit switches to show that  $I_t = I_a + I_b + I_c$ .

Use of voltmeters to measure the fall of potential round a compound circuit.

Simple experiments to measure the power consumed in a circuit and its component parts.

Simple experiments to relate heating effect to current.

Using an ohmmeter to measure the resistance of conductors of different materials, dimensions and temperatures. Resistance of lamps.

Using the voltmeter-ammeter method for measuring the resistance of components.

Measuring the 'rating' resistance of lamps to compare low-temperature resistance with normal high-temperature resistance.

Tracing of hidden wiring in a box fitted with three or more switches, bulb holders and terminals, which are connected inside the box.

Experiments on typical vehicle lighting circuits, including fuses and control devices.

Experiments on a simple coil-ignition set to note how the spark is affected by speed and gap width.

Measuring open-circuit and load voltages and currents using dry primary cells, charged and discharged secondary cells.

Experiments on specific gravities of electrolytes using a hydrometer.

The effect of change in specific gravity on resistance and freezing point of electrolyte, in a discharged battery.

Determination of cell capacity by discharge test.

Comparison of voltages and specific gravities during charge and discharge.

## Second Year

Simple tests on related materials to show the effects of tension, shear, and compressive loads.

Boyle's and Charles' Law experiments. Experimental determination swept volume, clearances volume and compression ratio.

Oil viscosity tests of various lubricants, using an orifice type of viscometer. Comparison of the oil delivery from new and worn pumps over a range of speeds at a fixed pressure.

Specific heat experiments.

Testing of thermostats for operating temperatures.

The determination of the calorific value and flash point of a typical hydrocarbon fuel.

Testing condensers for capacitance and insulation. Testing the circuits of a coilignition system with adjustable test gaps. Use of a rotating gap to show the effect of the centrifugal auto-advance mechanisms; low battery voltage, poor and hadly adjusted contact breaker points; a disconnected condenser; a leaking high-tention lead; speed of operation.

The use of an oscilloscope for complete checking of the ignition system.

Measurement of the locked torque and current of a starter motor, the voltage drop across the switch leads and brushes, and in the battery itself.

Observation of the variation of current during an actual engine starting process.

Use of a model clutch to demonstrate the effect of mean-radius and spring pressure on the torque transmitted by the clutch.

Screw jack and simple machine experiments. Test on a vehicle to ascertain the overall ratio between the engine and the road wheels in various gears.



Simple force board experiments.

Simple beam reaction experiments. Experiments to show the relationship between the force exerted on the brake pedal and the force developed at the brake shoes. Demonstration to show the effect of braking on the front wheels, on the rear wheels and on all fourwheels.

Demonstration to show the effects of unbalanced wheels.

Use of dynamometer to determine torque, g.h.o. and b.m.e.p.

Specific fuel consumption tests to determine the thermal efficiency of both spark-ignition and compression-ignition engines.

## Part II

### Motor Vehicle Technology

#### Third Year

Combustion chamber shapes (including shapes of piston crowns) in both spark-ignition and compression-ignition engines. Piston rings; special types. Compression and oil control ring faults.

Crankshafts; attachment of fly wheels, timing gears and pulleys.

The action and mounting of crankshaft dampers.

Details of valves, valve guides and valve seats.

Use of valve timing diagrams.

Operation of C.I. engines on the two-stroke cycle.

Forced air supply.

Balancing of crankshafts; balance weights.

Carburation; special features of modern carburettors, including the principles of operation of automatic chokes and double venturi interconnected throttle valves.

Tuning and synchronisation of multi-carburettor layouts.

Supercharging compression-ignition and spark-ignition engines. Types of super-chargers.

Fuel injection equipment. Types of governors used. Correct adjustment of pump stops.

Distributor-type pump, its construction, action and operating characteristics,

Cold-start devices for compression-ignition engines: heater plugs, decompressors, ether spray, induction manifold heater; types of heavy duty starter motors.

Cooling systems; pressurized and sealed systems. Engine temperature gauges; arrangements for water supplies to vehicle interior heaters.

Coil ignition system; theory of spark generation by electromagnetic induction.

Distributors: influence of dwell angle on coil performance.

Multi-contact-breaker arrangements.

Transmission clutches: diaphragm spring operation.

Multi-plate clutches. Hydraulic arrangements for disengagement.

Centrifugally-operated clutches.

Fluid flywheel (for coupling): its construction and action.

Three-element torque convertors.

The three-element epicyclic gear train; elementary consideration of automatic gearboxes and overdrive units; freewheels and their uses. Constant velocity universal joints. Final drive systems incorporating worm drive units. Four-wheel drive arrangements and multi-drive axles for heavy commercial vehicles.

Lubricants: specification of oils and greases for special purposes for engines and transmissions. Use of additives in the blending of oils and greases.

Steering systems; testing equipment used. Rectification of steering faults, including front end vibrations. Steering dampers. Power-assisted steering for cars and commercial vehicles. Principles of steering assistance installations; desirable characteristics.

Suspension; effects of faulty dampers on vehicle behaviour.

Commercial vehicle chassis frames and suspension arrangements, incorporating leaf and coil springs.

Distribution of loads and torque reactions.

Brakes: testing, static and dynamic testing equipment. Braking efficiency, its measurement in relation to acceleration and stopping distance. The use of booster devices and pressure limiting valves in hydraulic systems.

\*Transferred to 4th year Pract. syllabus.

Generators: constructional details of d.c. and a.c. generator systems used in vehicles and of permanent-magnet type motors and generators. Types of cut-outs and regulators.

Vehicle structure; description of the general principles of composite and integral methods of construction. Typical attachments for engine, exhaust systems, suspension and other mechanical units to body structure.

Welding: storage, handling and safety in the use of welding equipment; choice of equipment and principles of operation for both gas and arc welding. Spot welding.

#### Fourth Year

Engines Factors affecting the layout of manifolds, induction and exhaust systems: air cleaners and silencers.

Principles of petrol injection systems: advantages and disadvantages.

Survey of modern types of petrol injection systems.

Operating principles of the gas turbine engine for automotive propulsion.

Operation of the rotor type (Wankel) internal combustion engine.

Transmission. Operating principles of the hydraulic and mechanical systems in automatic gearboxes.

Methods of testing automatic gearboxes.

Brakes. Automatic adjusting devices xx Dual braking circuit including Tandem Master cylinder

Servo-assisted brakes, including continuous flow hydraulic type.

Power-operated brakes (air-pressure type).

Auxiliary brakes; eddy current, hydraulic and exhaust types.

Steering effect of tyre characteristics on slip angles, cornering force and self-aligning torque.

Over and under-steer characteristics of vehicles. Geometry of twin-steering linkages for the front axles of commercial vehicles.

Suspension. Effect of suspension on steering and stability. Vehicle roll centres.\*

Use of anti-roll bars.

Rubber, air and liquid suspension systems. - Gas filled damper.

Final drives. Limited slip differential arrangements, differential locks.

Two-speed and double-reduction axles for commercial vehicles.

Electrical: analysis of complete wiring systems for automobile fault location and repair.

Fault diagnosis. Instruction in the use of special equipment developed for testing automobile electrical circuits and units.

Techniques of fault diagnosis.

Semi-conductors. Application to transistorized ignition circuits and generator control systems.

\*(Add.) Negative roll radius.

#### Scheme of Practical Work

#### Thrid Year

Examining of engine parts and other mechanical component with special reference to those that have failed or proved faulty in service.

Techniques of fitting valve guides, seat inserts and cylinder liners.

Opening up and examining a crankshaft damper.

Examining modern carburettors with emphasis on special features.

Practical tuning of multi-carburettor arrangements on a running engine.

Examination of superchargers.

Practical testing of mechanical and vacuum type governors on in-line pumps.

Examination of a distributor-type pump, including testing on a suitable pump test bench.

Examination of cold starting devices.

Examination of pressurized and sealed cooling systems to include vehicle interior heater arrangements.

Practical testing on an ignition system rig to assess the effect of incorrect gap setting on dwell angles and coil performance. Testing of automatic and retard mechanisms.

Examination of various clutches, fluid couplings and torque convertors noting

special features in each case. Adjustment of operating controls where applicable.

Dismantling, examining, rebuilding and adjusting an overdrive unit.

Examination of constant velocity universal joints.

Dismantling commercial vehicle final drive worm hypoid units, noting arrangements for adjustments.

Assembly to correct clearances and preloads.

Dismantling, examining rebuilding and adjusting a power-assisted steering unit, including the hydraulic pump system.

Removal and refitting of suspension components with special reference to safety precautions.

Examination of hydraulic brake booster devices and pressure limiting valves, including the inertia sensitive type.

Testing and tuning a running engine (spark ignition) using pressure and vacuum gauges, stroboscopic timing lamp and other forms of modern analysers and tuning equipment.

Examination and testing of vehicle generators. Examination, testing and adjustment of output control units.

Examination of vehicle body parts with emphasis on the requirements for strength and rigidity at the points of attachment of major components.

Practical repair of body, wing and door damage.

The use of hand and hydraulic equipment in body repairs.

Practical workshop tests for brazed and welded joints in sheet mild steel.

Further emphasis on safety precautions and care of welding equipment.

Car radio installation.

Use of screening and screened leads.

Aerial fitting: importance of correct installation and weatherproofing.

Diagnosis of interference and its suppression.

Body repair: repairs to bodywork, wings and doors, due to minor accidents or rust. Straightening stretched and buckled panels. Removing signs of damage.

Relative merits of 'filling in' by metal and plastic fillers.

Checking chassis for distortion. Chassis frame repairs.

Places of potential weakness. Checking alignment of car and commercial vehicle frames.

Paint shop: modern painting processes for road vehicles.

Comparison of method and process.

#### Fourth Year

Examining manifolds and exhaust systems with special regard to layout and arrangement for efficient functioning.

Engine tests with varied manifold and exhaust layouts.

Internal examination of automatic gearboxes with the practical testing of at least one type.

Examining automatic brake adjusters, servo-assisted brake units and a power-operated brake system with special reference to servicing and any special equipment required. Inspection of an exhaust braking unit, including the method of cutting off fuel supply.

Checking geometry of twin steering front axles.

Examination of rubber, air and liquid suspension units with special reference to servicing and any special equipment required.

Investigation of load-deflection characteristics.

Inspection and demonstration of the action of a limited slip differential.

Examination of a two-speed axle and a double-reduction axle with special attention to provisions for adjustments of controls.

Complete checking of an automobile electrical system with particular reference to the correct use of instruments and techniques of fault diagnosis.

Examination and testing of a transistorized ignition system and a transistorized generator control system.

Inspection of engines and other mechanical components for wear and incorrect adjustments.

Practical tracing of car radio interference and its suppression.

Practical checking of chassis alignment (cars and commercial vehicles).

Practical repairs of body, wing and door damage.

Diagnosis of faults by Rolling road inspection and or road test, Checking speedometers and tachometers.

## Sketching and Drawing

### Third Year

Introduction to isometric projection as a basis for sketching component parts in good proportion and for the preparation of pictorial views from drawings in orthographic projection.

Geometrical construction related to perpendiculars, angles, chords, tangents and arcs in the drawing of profiles and templates. Gear tooth profiles; construction of the involute curve (using tracing paper). Standard gear wheel nomenclature, the pitch circle, diametral and module pitch, addendum, dedendum and pressure angle.

Construction of typical cam profiles for flat and curved followers.

Sketches and drawings related to the work in motor vehicle technology with particular reference to layout drawings and sectional views showing main design features, component construction and assembly, related to compression-ignition engines, fuel injection pumps, injectors and nozzles; dynamos and alternators, including cut-outs and vibrating contact regulators; independent front wheel suspension systems; steering systems incorporating a power-assisted circuit; final drive systems used in heavy commercial vehicles.

### Fourth Year

Sketches and drawings of typical body layouts, engine and spring mountings, to show constructional details and methods of attachment and assembly.

Line diagrams of oxy-acetylene welding equipment, including torches.

Conventional representation of body details; interpretation of weld symbols (B.S. 499, Part 2, 1965).

Sketching and drawing applied to layout, assembly and component details to cover the scope of the motor vehicle technology syllabus.

Sketches and drawings of special tools, clamping devices, brackets and testing equipment to show methods of construction and use; provision of essential dimensions; principles of geometrical layout and alignment measurements of equipment for checking steering and suspension systems.

Extension of the application of vector diagrams to velocity diagrams for the slider-crank-chain mechanisms used in motor vehicles and reciprocating engines and to problems in the balancing of single-cylinder and multi-cylinder in-line engines.

## Mathematics

### Third Year

Formation of equations and formulae for simple problems; setting out of equations, formulae and calculations involved in solutions.

Extension of the use of logarithms to negative and fractional indices, applications Extension of the use of logarithms to negative and fractional indices, applications for formulae:

$$P_1V_1^n - P_2V_2^n, = P_1V_1 = P_2V_2 \text{ and } T_1V_1^{n-1} = T_2V_2^{n-1}.$$

Solution of quadratic equations of the form  $ax^2 + bx + c = 0$ , including graphical methods.

Interpretation of plotted information, including the determination of the equation to a straight line and the meaning of the area enclosed by a curve. Graphs of the velocity/time and distance/time for motion with uniform acceleration.

Surface areas, volumes and weights of common solids for prismoidal, cylindrical, conical and spherical shapes.

Sine, cosine and tangent of angles from  $0^\circ$  to  $360^\circ$ . Graphs of these functions.

Use of sine and cosine rules (without proof) for the solution of triangles, with applications to problems on triangles of forces and the slide-crank-chain mechanism.

### Fourth Year

The use of binomial expansions for engineering approximations. Elementary statistics applied to stock control and quality control; arithmetical mean, mean square and standard deviation. Typical frequency histograms and distribution curves.

Graphs; determination of laws reducible to linear form, including logarithmic transformations for laws of the form  $PV^n = K$ . Slope of a line; tangent to a curve, meaning of a differential coefficient.

Differentiation of a simple expression such as  $y @ ax^n$ ,  $y = ax^2 + bx + c$ ;  $y = \sin(ax + b)$ ;  $v = \cos(ax + b)$ . Integration as a process of summation and as the reverse of differentiation.

General application of differentiation and integration to typical problems encountered in motor vehicle technology, such as: work done during expansion



and compression to the law  $PV^n = \text{constant}$ ; relation of distance, time, velocity and acceleration in uniformly accelerated motion, simple harmonic motion and in the motion of a piston in a reciprocating engine.

Graphical determination of velocity/time and acceleration/time graphs for cam-operated mechanisms and for the piston in a slide-crank-chain mechanism.

Mensuration, including Guldinus' theorems applied to the calculation of surface areas, and volumes of simple solids of revolution.

Science

Third Year

Heat, linear expansion of solids, coefficient of thermal expansion, practical applications; shrink fits, and the necessity to make allowance for the variation of clearance and interference fits with changes in temperature. Volumetric expansion and contraction of liquids. Need for the venting and cooling of hydraulic systems. Effects of heat in changing the temperature and/or state of solids, liquids and gases, including sensible and latent heat. Vapour pressure of liquids.

Heat engines. Approximate methods of estimating indicated horse-power.

Mechanical equivalent of heat, conversion of heat energy to mechanical energy and vice versa, losses involved and efficiency of conversions. Specific fuel consumption and thermal efficiency. Engine heat losses and heat balance. Principles and use of a typical high-speed engine indicator. Consideration of pressure-volume and pressure-crank angle diagrams. Effect on the form of the diagram of throttle opening, ignition setting, compression ratio, valve setting, fuel-injection pump setting and supercharging. Use of the planimeter. Determination of indicated mean effective pressure and indicated horsepower from indicator diagram.

Mechanics. Newton's Laws of Motion. Acceleration due to change in direction. Centrifugal force: application to vehicle cornering, governors and clutches. Forces involved in vehicle acceleration and braking; problems involving weight transfer. Quantitative treatment of the relationship between stopping distance and brake efficiency. Graphical treatment of work done by a variable force, the mean value of a variable force. Tractive effort required to overcome gradient wind and road resistance at constant speed. The work done by a variable torque. Power expressed as a product of force and velocity, or torque and angular velocity. Power available, power required. Potential and kinetic energy. Conservation of energy. Vibrations and oscillations. Examples from motor vehicle applications such as spring oscillations, chassis vibration and valve operation.

Frequency, periodic time and amplitude.

Fluids. Fluid and atmospheric pressure; pressure gauges. The barometer.

Archimedes' principle, the hydrometer. Pressure and velocity head of a fluid, its potential and kinetic energy. The flow of a liquid through an orifice. Hydraulics and lubrication. The movement ratio (velocity ratio), force ratio and mechanical efficiency of hydraulic jacks and presses. Hydraulic fluids and brake systems; actions of fluids on natural and synthetic rubber seals. Use of rolling elements to reduce friction in bearings; lubrication of ball and roller bearings. Pre-lubricated and self-lubricated bearings.

Electrical. Semi-conductors. Simple explanation of the functions of the common types, diode, transistor and Zener. Alternators. Armature and field winding arrangements in typical vehicle generators. Rectification of a.c. and d.c. by static rectifier. D.C. generators; armature and field arrangements. Armature and brush gear of typical dynamos. Regulation of output of generators by field current control using electromagnetic and solid state regulators.

#### Fourth Year

Heat engines. Consideration of internal combustion engine cycles of operation, theoretical and practical, based on the combustion processes. Isothermal and adiabatic processes; air standard efficiency of the constant volume cycle (without proof); relative efficiency. Practical ranges of air/fuel ratios for spark-ignition and compression-ignition engines.

Filtration, handling and storage of fuels.

Gearbox reduction torque. Determination of gearbox ratios from the engine speed ratio.

Problems involving triangle and polygon of forces with special reference to brake shoes and their reaction on the drum. The relationship between the pedal effort and the physical dimensions of a braking system in order to produce a desired rate of retardation for both mechanical and hydraulic operation.

Steering gear torques direct and reversed efficiencies of operation.

Mechanics. Instantaneous, relative and average linear velocities. Angular velocity in revolutions per minute and radians per second. Velocity vectors. Centrifugal force and its effect on vehicle stability when on banked and unbanked roads and tracks, with and without sideways friction.

Static and dynamic balancing of rotating and reciprocating parts in single and multi-cylinder engines.

Principle of harmonic balancers and their action.

Materials testing. The behaviour of materials when subjected to loads in tension, compression, and shear. The effects of bending and torsion.

Relation between load, strain and stress. Moduli of elasticity and of rigidity. The testing of materials to destruction in order to determine their elastic limit, modulus of elasticity and ultimate strength. Tests for hardness. The influence of heat treatment on the strength, hardness and ductility of carbon steels, light-alloys and copper-alloys. The characteristics of the common types of alloy steels. Fatigue in metals, factors affecting fatigue failure; recognition of failures due to fatigue.

Strength of materials. Bending moment and shear force distribution in simply-supported and cantilever beams. The resistance to bending of beams of rectangular, circular (solid and hollow), channel and I-sections.

Influence of cross-section and length of resistance to twist (treated qualitatively). Use of torsional resilience in springs and in shafts subjected to torque fluctuations.

#### Laboratory Work

#### Third Year

Experiments or demonstrations to show the differential expansion of related components, such as piston rings and bore, gudgeon pin in piston or connecting rod, bearing and shaft. The fitting of components by thermal methods.

Experiments to show the flow of fluids through various types of orifices and nozzles. The venturi meter.

The morse test as a means of estimating indicated horse-power and mechanical efficiency.

Simple heat balance experiments.

Simple boiler tests to show the relationship between the pressure on a liquid and its boiling temperature.

Practical tests on voltage drop in cables and components.

Checking insulation resistance.

Centrifugal force machine experiments. Demonstration to show the application of centrifugal force in a spring-loaded governor.

Use of dummy rig to measure the turning moment on the crankshaft for a given load on the piston.

Simple flywheel experiments to show the energy equation.

Experiments using hydraulic jacks.

Measurement of acceleration forces; Fletcher's trolley or similar experiments.

Experiments on pendulums and low-rate helical and cantilever springs.

Measurement of crank connecting rod and piston displacement to show variations in movement.

Engine testing by high-speed indicator.

Testing of generators to show output against speed and load variation.

#### Fourth Year

Direct measurement of air consumption of spark-ignition and compression-ignition engines to determine volumetric efficiency.

The volumetric efficiency as determined from the analysis of the b.m.e.p. consumption loop or torque consumption loop.

Simple exhaust gas analysis using the Orsat apparatus and the electrical combustion-analyser.

Measurement of brake pedal force and its relation to brake efficiency.

Testing of steering boxes for direct mechanical efficiency by applying a known torque at the steering wheel and measuring the reaction at the drop arm.

Comparison with the reversed efficiency when the known torque is applied to the drop arm.

Static and dynamic balancing of rotating and reciprocating masses.

Testing of materials for tension, compression and shear.

Commercial hardness tests. Simple heat treatment of carbon steels.

Simple bending of rectangular and circular sections (solid and hollow).

Testing in torsion of rectangular and circular shafts (solid and hollow section).

## MOTOR VEHICLE TECHNICIANS

### PART III

#### 1. PRINCIPLES OF MANAGEMENT

##### A. Principles of Supervision

###### INTRODUCTION

- 1.1.1. The nature and purpose of supervision, significance and scope of management responsibility.
- 1.1.2. Planning and controlling work.
- 1.1.3. Personnel aspects, including safety, health and welfare.

##### B. INDUSTRIAL RELATIONS

- 2.1.1. The human factors, leadership and morale; motivation, discipline, grievances, and interviews.
- 2.2.1. Existing mechanisms for consultation, negotiation and conciliation.
- 2.3.1. Labour utilisation, instruction and training.

##### C. COMMUNICATION

- 3.1.1. Channels of communication: upwards, downwards, lateral.
- 3.2.1. Types of communication: verbal and written.
- 3.2.2. Reports, memoranda and letters.

##### D. ADMINISTRATION

- 4.1.1. Organization charts; organization and method.
- 4.2.1. Authority and responsibility; delegation; co-ordination and control of activities.
- 4.3.1. The role of the computer.
- 4.4.1. The elements of forecasting and budgeting.
- 4.5.1. Manpower budgeting; promotion and succession, training and development.

## II. MOTOR TRADE PRACTICE

### A. WORKSHOP ORGANISATION & ADMINISTRATION

- 1.1.1. Layout and maintenance of premises.
- 1.2.1. Specialist equipment in the repair shop.
- 1.3.1. Service tools.
- 1.4.1. Line servicing.
- 1.5.1. Lubrication bays.
- 1.6.1. Electrical diagnosis and other test equipment.
- 1.7.1. Washing and car valeting equipment.
- 1.8.1. Breakdown and recovery equipment.
- 2.1.1. Costing, charging and invoicing.
- 2.2.1. Work study and operation planning as applied to standard repair schedules and standard time.
- 2.3.1. Job control systems.
- 3.1.1. Wage structures.
- 3.1.2. Bonus and other incentive schemes.
- 4.1.1. Manufacturers' service bulletins and manuals.
- 4.2.1. Service records and follow-up schemes.
- 4.3.1. Warranty procedures and handling of claims.

### B. SERVICE RECEPTION

- 5.1.1. The qualifications, responsibilities and authority of the Reception Engineer and Receptionist.
- 6.1.1. Layout of the reception area.
- 6.2.1. Reception procedures.
- 6.2.2. Diagnosis, customers' instructions and work instructions.
- 6.2.3. Estimating and pricing.
- 7.1.1. Customer relations and handling complaints.
- 7.2.1. Obligations to the employer and the vehicle manufacturer.

- 7.3.1. The receptionist as a service salesman.
- 8.1.1. Collision damage procedure.
- 8.2.1. The scope of cover under each type of insurance policy.
- 8.2.2. Excesses and no-claims bonuses.
- 8.3.1. Accident report forms.
- 8.4.1. Preparation of estimates.
- 8.5.1. Relations with insurance engineers and assessors.
- 8.6.1. Satisfaction notes.

#### C. PARTS MARKETING

- 9.1.1. The contribution of the Parts Department to the profitability of the business as a whole.
- 9.2.1. Siting of the layout and equipment of the main sections of the Parts Department.
- 10.1.1. Basic stores documentation and records.
- 10.2.1. Goods received notes, damage and shortage reports, return-to-stores notes, copy orders, requisitions, bin cards, stock record cards, visible or non-visible systems, card systems, boundbooks.
- 10.3.1. Sales promotion of parts and accessories.
- 10.4.1. Sales targets, turnover/stock ratios and profitability.
- 11.1.1. The petrol forecourt; layout and equipment, conventional and selfservice installations.
- 11.2.1. Qualifications and responsibilities of forecourt staff.
- 11.3.1. Overhead costs, operation costs and profitability.

#### D. VEHICLE SALES

- 12.1.1. The contribution of the Sales Department to the profitability of the business as a whole.
- 12.2.1. Siting of the layout and equipment of the display area for new and used vehicles.
- 12.3.1. Administration and organization of the vehicle sales office.

- 12.4.1. Purchase, control and sale of new and used vehicles.
- 12.5.1. The basic considerations of salesmanship.
- 12.6.1. The personal qualities of the salesman.
- 12.7.1. The sequence of a sale.
- 12.8.1. The importance of product knowledge.
- 12.9.1. Buying motives.
- 13.1.1. Sales promotion.
- 13.2.1. Sales campaigns.
- 13.2.2. Prospecting and follow-up schemes.
- 13.3.1. Advertising methods and media.
- 13.4.1. Overhead costs, operating costs and profitability.

### III. COMMERCIAL PRACTICE AND OFFICE PROCEDURE

#### A. THE OFFICE

##### GENERAL PROCEDURE

- 1.1.1. Its place as an integral part of a business organization.
- 1.1.2. Brief outlines of the functions and relationships of the main divisions of the office; purchasing, sales, cashier, accounts, personnel and administration.

##### ESSENTIAL OFFICE SKILLS

- 1.2.1. Control of correspondence and filing.
- 1.2.2. Main types of filing, indexing and maintaining records.
- 1.2.3. Telephone services and the proper use of the telephone.
- 2.1.1. Calculations involving price, percentage applied to buying and selling, turnover, cost, wages, salaries, interest, discount and commission.
- 2.1.2. Desk calculating machines and ready reckoners.



B. COMMERCIAL TRANSACTIONS AND FINANCIAL ASPECTS

- 3.1.1. Wholesale and retail price.
- 3.1.2. Function of wholesaler and retailer.
- 3.2.1. Trade discounts.
- 3.2.2. Cash and credit sales.
- 3.2.3. Documents involved-quotation, order, invoice, credit note, debit note, statement.
- 3.2.4. Credit facilities and instalment trading.
- 3.2.5. Books required for entry of credit purchase, sales, cash recording and petty cash.
- 4.1.1. Function of money; coin, notes, legal tender, order, bearer, crossed and uncrossed cheques.
- 4.1.2. Banker's drafts and credit transfers.
- 4.1.3. Bills of exchange, promissory notes.
- 4.1.4. Postal and money orders.
- 4.2.1. The types of banks and the services rendered by them.
- 4.2.2. Current accounts, deposit accounts, loans, overdrafts, bankers' orders, travellers' cheques, credit cards.
- 5.1.1. P.A.Y.E., National Insurance, staff records.
- 6.1.1. The principal advantages and scope of insurance, e.g. fire, motor, burglary, employer liability and guarantee.

C. The Law Relating to the Motor Trade

- 1.1.1. Regulations affecting the sale of good under Common Law Contract, agency. Sale of Goods Act, Warranty and current regulations affecting the Motor Trade, Road Haulage and Passenger Transport Industry.
- 1.2.1. Factories Act; Offices, Shops and Railway Premises Act.
- 2.1.1. Condition of Employment.
- 2.1.2. Redundancy Payments Act.
- 2.2.1. The Law of Lien.

- 2.2.2. Disposal of uncollected goods.
- 3.1.1. Road Traffic Acts.
- 3.1.2. Construction and use regulations.
- 3.1.3. Lighting regulations.
- 3.1.4. M.O.T. Tests.
- 3.1.5. Operation and testing of commercial vehicle.
- 3.1.6. Trade plate regulations.
- 4.1.1. Regulations relating to the purchase, road transportation, storage and sale of petrol, oil, paints and other dangerous substances.

## APPENDIX A

### Explanatory Notes.

1. The aim of the technician's course is to study in detail the basic principles covering the design and construction of the vehicle to enable the student, with suitable concurrent industrial experience, to develop an ability to diagnose faults, recommend means of rectifying these faults and to test and analyse the performance of the vehicle after the repair of modification has been completed.
2. The motor vehicle technology is the main element of the course and the emphasis should be on general principles, which can be equally well applied to existing or 'conventional' components and assemblies and to new types not yet in service or even at the manufacturing and design stage, rather than on the small details of existing types or minor developments in design which can rapidly become out dated.
3. The Practical Work should illustrate the technology syllabus and be closely related to the student's industrial experience. Sketching and drawing should provide the background for understanding basic principles of mechanisms and their application to the design and manufacture of vehicle components, the layout and assembly of control linkages and the use of vector diagrams in analysing the motions and forces arising.
4. The aim of the related Mathematics syllabus is to develop the basic principles upon which depend the calculations a technician may be expected to use or understand.
5. The Science syllabus is closely related to the programme of Laboratory Work.
6. Throughout the course, every opportunity should be taken to apply the related studies to motor vehicle problems but the teaching of all subjects should not be taken beyond the depth necessary to support the motor vehicle technology.

## APPENDIX B

### Guide To Preparation of College Work

1. Each student must record, in time order, tasks performed in the workshop and the experiments should be entered in a 'List of Contents', preferably at the front of the book. This list should be kept from the start in chronological order and the entries should be indexed to distinguish workshop tasks from a laboratory experiments and one year's work from another.
2. It is recommended that the practical record of any task or experiment should include:

- (a) the date of performing the job
  - (b) the title of the job (which should be sufficiently extended to eliminate the need for a separate statement of the purpose or object of the job).
  - (c) a simple diagram of the experimental arrangement on which could be marked the identification numbers of all 'significant equipment' (so eliminating the need for a separate list of apparatus).
  - (d) a brief statement of the method used.
  - (e) a presentation in simple numerical, tabular and/or graphical form of observed and derived results.
  - (f) a brief explanation of the results (students should be stopped from writing mere verbal descriptions of results already fully presented in numerical, tabular, or graphical form).
3. Students should be required to write formal reports on at least one workshop task and laboratory experiment annually selected by them out of a nominated list from the year's total.

## APPENDIX C

### Projects

1. In Part III, each candidate is required to complete a written project during his course. The project should be on any relevant aspect of the motor vehicle repair industry covered in the Part III syllabus and should entail a total of approximately 50 hours of work by each student. IN ADDITION to the 780 hours envisaged for the course. The project will be assessed by the E.A.E.C. and such assessment will be used in the determination of examination results by the E.A.E.C. A list of projects should be submitted to the E.A.E.C. by the centre during the second term of the course. The E.A.E.C. reserves the right to call for candidates written accounts of their projects, when completed, and to appoint visiting assessors to assist in establishing uniform standards. A list of specimen approved project titles is available to colleges on request.
2. Local Examinations Officers are required to submit on the prescribed form details of candidates' assessments at the end of the course.
3. Each external candidate must comply with the conditions detailed in para II of the regulations for the course, and in addition must state the title of his proposed project for approval by a centre. This project will be assessed by that centre and submitted through the Local Examinations Officer on the prescribed form.